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MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.



MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.

VOLUME L, PART 1.

DESCRIPTION OF MOLLUSCA FROM THE POST-EOCENE  
TERTIARY FORMATION OF NORTH-WESTERN INDIA: CEP-  
HALOPODA, OPISTHOBRANCHIATA, SIPHONOSTOMATA. BY  
THE LATE E. VREDENBURG, A.R.S.M., B.SC., SUPERIN-  
TENDENT, GEOLOGICAL SURVEY OF INDIA. (WITH PLATES  
1 TO 13.)

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## PREFACE.

THE Memoir herewith published was first sent to Press in 1915. Its publication was delayed for various reasons, of which the War was the principal. The proofs were, however, corrected by the author just before his lamented death in March, 1923. Mr. Vredenburg was then not only in London away from headquarters, but also very ill. The description of seven of the types figured in the plates was found to be missing from the proofs sent back by him; it is not even known whether he desired that these seven types should find a place in this Memoir. As, however, the plates had been prepared and struck off, I have thought it best to add a description of these types, which was found in an earlier corrected galley proof. It must be clearly understood, therefore, that the description of the seven types found at the end of this volume, *Rostellaria curta*, *Rostellaria sindienseis*, *Rimella subrimosa*, *Terebellum subulatum*, *Terebellum naricum*, *Cerithium (Vertagus) kachhense* and *Cerithium (Bellardia) naricum*, lacks final revision by the author.

In the corrected paged proof returned by Mr. Vredenburg, the species described in the text were not grouped into families. This has been done in the Table of Contents by Dr. G. E. Pilgrim. In addition to the species described in this volume, descriptions of nearly 200 additional species by Mr. Vredenburg have been found amongst his papers, and figures for many of them have been prepared. It would be unfair to the memory of Mr. Vredenburg to publish this material, most of which appears to date from 1916, without a careful revision. It is hoped that someone will be found sufficiently public-spirited to undertake this tedious and somewhat thankless task, the result of which will then be issued as part 2 to the present Memoir.

E. H. PASCOE,

August, 1924.

Director, Geological Survey of India.





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MEMOIRS  
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THE GEOLOGICAL SURVEY OF INDIA.

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DESCRIPTIONS OF MOLLUSCA FROM THE POST-EOCENE  
TERTIARY FORMATION OF NORTH-WESTERN INDIA :  
CEPHALOPODA, OPISTHOBRANCHIATA, SIPHONO-  
STOMATA. BY THE LATE E. VREDENBURG, A.R.S.M.,  
B. SC., SUPERINTENDENT, GEOLOGICAL SURVEY OF  
INDIA. (WITH PLATES I TO 13.)

INTRODUCTION.

THE specimens dealt with in the following pages are from the provinces of Kachh, Káthiáwár, Sind, and Balúchistan in north-western India. They were obtained mostly by the geologists on the staff of the Geological Survey of India, principally by Fedden, W. T. Blanford, Wynne, Hira Lal, Ram Singh, and Noetling.

The descriptions are largely founded upon the study of a selected set of specimens which I took to London in 1912, where I had the advantage of comparing them with Sowerby's original figured types from Kachh, and with d'Archiac and Haime's figured types and named duplicates from Sind. I take this opportunity to express my heartfelt thanks to Dr. Smith-Woodward whose kindness enabled me to have access to these valuable materials, and also my deep gratitude to Mr. E. A. Smith and Mr. R. Bullen Newton who have most generously helped me in my work. I am especially indebted to Mr. Bullen Newton for his untiring kindness in helping me to elucidate many points in connection with this research.

Owing to the lack of accessible information regarding the molluscan faunas of the richly fossiliferous post-Eocene formations of



north-western India, it was decided that, pending the publication of complete monographs in the *Palæontologia Indica*, descriptions should be issued of the molluscan species so far identified, with illustrations principally of such species as were hitherto undescribed. Apart from its possible zoological merits, I considered that the publication of such a work would supply a long-felt need to the stratigrapher. To make it more readily accessible, this preliminary work was intended for publication in the *Memoirs* of the Geological Survey of India, in anticipation of the fully illustrated monographs to be issued later in the *Palæontologia Indica*. Consequently the illustrations were prepared for the *Memoirs*. These illustrations were printed in 1916, and the descriptions were ready for the press in the same year. Subsequent evidence was obtained, chiefly through the labours of Mr. Sethu Rama Rau, of the hitherto unsuspected richness in fossil mollusca of the post-Eocene formations of Burma, the fauna of which was very inadequately known from Dr. Noetling's monograph (*Pal. Ind.*, new ser., Vol. I, part 3). The rich collections now available from Burma, containing, as they do, many species in common with the Tertiary faunas of western India, have now yielded data of unexpected importance for the classification of the Tertiary formations of the East Indies. A complete comparison of the collections from Burma and from western India has necessitated numerous amendments in the descriptions and identifications of the forms from western India, while demonstrating at the same time the urgent need of a complete re-cast of Dr. Noetling's monograph.

At the same time I recognised that many of the descriptions of Eocene fossils also need revision, and was thus inevitably led to the long-needed systematic study of the whole of the rich Tertiary molluscan fauna of India. The work has made considerable progress and includes complete descriptions of almost all the Tertiary Siphonostomata at present available in the collections of the Geological Survey.

I hope to publish the results of these labours in the *Palæontologia Indica* as a series of fully illustrated monographs dealing successively with each natural family. Exclusive of the Upper Tertiary fauna of Karikal, the gastropods of which have been described in Cossmann's admirable monograph in the 'Journal de Conchyliologie,' more than 500 Siphonostomata have now been fully studied from the Tertiary of India. An adequate icono-

graphy would require between 2,000 to 3,000 figures, or perhaps even more, the preparation of which would take several years, while the descriptive text would fill several volumes of the *Palæontologia*. It has therefore been decided that, pending the publication of the complete illustrated monographs in the *Palæontologia Indica*, a useful purpose would be served by issuing without further delay the already printed illustrations of western Indian mollusca that had been prepared for the *Memoirs* together with the revised descriptive text.

The errors of zoological interpretation which it is so difficult to avoid in a work of this kind need not necessarily detract from its scientific value from the stratigraphical point of view. No one is more conscious than the author himself of the shortcomings of this study: yet, in accordance with its essentially stratigraphical aim, we may perhaps welcome its appearance in a series the object of which is stratigraphical rather than palæontological. The need for a work of this kind is daily being felt more keenly, and, as already remarked, its publication, in its present abridged form in the *Memoirs*, may increase its usefulness by making it more readily accessible to a larger number of stratigraphers.

The work, in its present form, may be regarded as an appendix to Wynne's geological description of Kachh and to Blanford's geological description of Sindh, published, respectively, in Volumes IX and XVII of the *Memoirs of the Geological Survey of India*. It is therefore an illustrated descriptive supplement to the stratigraphical list appended by Feilden to Blanford's memoir in 1880, (*vol. cit.*, pp. 197—210).

The forms dealt with in the present volume are exclusively post-Eocene, and were obtained from the stratigraphical divisions distinguished by Blanford as the Nari, Gáj and Mokrán. The detailed study of these faunas has revealed the existence of many forms identical with species already known either from Europe or from the East-Indian archipelago. The maximum of close relationship with Europe is observed at the horizon of the Lower Nari, the fauna of which contains an unexpectedly large proportion of European Oligocene species, the nearest analogy being with the Oligocene fauna of Liguria. A wide-spread temporary oceanic connection established by the great marine transgression of the Oligocene undoubtedly accounts for the mingling of eastern and

western forms at this horizon. The Lower Nari clearly corresponds with either the Lattorfian or the Stampian of western geologists, or may include both these stages.

Beds undoubtedly referable to the Upper Nari have not, as yet, yielded any recognisable mollusca. They frequently contain lepidocyclines of the group of *Lepidocyclina dilatata* analogous to those which are found in countless numbers in the Lower Nari. The age of the Upper Nari presumably corresponds with that of the upper Oligocene stage distinguished by western geologists as the Chattian.

The Gáj contains two closely related, though distinct, faunas respectively characterising its lower and upper horizons. These two horizons have not been separately mapped, and, though they are clearly distinguishable in the detailed accounts of certain sections, yet there are many assemblages of fossils which, owing to the absence of characteristic species or mutations, cannot be assigned with precision to the lower or to the upper stage from the data at present available.

The proportion of European species is much smaller in the Gáj fauna than in that of the Nari; yet it is amply sufficient to establish the lower Miocene age of the Gáj division. The oceanic connection with the seas of southern Europe, perhaps completely interrupted during the upper Oligocene, appears to have been re-established only imperfectly during the Lower Miocene.

The lower and upper stages of the Gáj may be taken as approximately equivalent respectively to the Aquitanian and Burdigalian of western geologists.

There is a distinct faunistic connection between the Gáj and that portion of the Tertiary system of Java which, on independent stratigraphical and faunistic grounds, has been referred by Martin to the Lower Miocene. The Lower and Upper Gáj respectively correspond with the beds distinguished by Martin as the Rembang and Njalindung Series.

It is when we come to the Mekran Series that the comparison with the post-Eocene faunas of the Indian Archipelago acquires especial importance, for, while the connection of the Mekran faunas with certain of the further eastern faunas, particularly in Java, is very striking, the relationship with the fossil faunas of Europe has

almost entirely ceased. The oceanic connection with the European seas had, apparently, become severed as completely as at the present day.

The Mekran Series includes a considerable thickness of strata with numerous fossiliferous horizons the detailed survey of which is not sufficiently advanced for the precise demarcation of separate zones. Nevertheless, in many instances, the strata can be roughly referred to a higher or lower horizon. Fossils are particularly abundant in the lowest and uppermost fossiliferous horizons so far recognised. We may provisionally subdivide the Mekran Series into two stages of which the lower may be distinguished as the Talar Stage after the richly fossiliferous locality of the Talar Gorge on the northern border of the Talar Range, some forty miles north-east of Gwádar; while the upper, less completely known stage, may be distinguished as the Gwádar Stage after the fossiliferous rocks of the peninsula on which stands the city of that name.

The Talar Stage undoubtedly corresponds with the horizon of the Odéng beds of Java which Martin regards as possibly at the mutual limit of the Miocene and Pliocene, and therefore approximately equivalent to the Pontian. The overlying Gwádar Stage must therefore correspond with the Sondé Stage of Java and with the Pliocene.

The Mekran fauna contains many species in common with the Upper Tertiary of Karikal referred by Cossmann to the Pliocene. The division that more particularly coincides with the Karikal horizon is probably the Gwádar Stage.

The Mekran Series as here defined coincides with the strata which I had formerly referred to the Hingláj Series. Amongst the regions which he traversed rapidly in the Mekrán province, Blanford may have referred to the Mekran Series certain rocks consisting of great accumulations of shales and impure sandstones, generally of a bluish or greenish colour, now known to be equivalent to the Gáj and Nari. I therefore proposed to include all the lithologically extremely homogeneous post-Eocene formation of the Mekrán province within a single system defined as the Mekran System and consisting of three series, the Nari, the Gáj and the Hingláj (*Rec., Geol. Surv. Ind.*, Vol. XXXIV, p. 90). Nevertheless we would adhere more closely to Blanford's intention by restricting the designation "Mekran" to the strata containing faunas newer than

that of the Gaj. The designation "Hingláj" may therefore be discarded.

In conclusion, I wish to express my gratitude to Dr. Anandale by whose unfailing courtesy the valuable collections of mollusca of the Indian Museum have been placed at my unrestricted disposal, and without whose generous aid it would have been impossible to carry out with the necessary precision and completeness, the comparison of the fossil forms with those now inhabiting the Indo-Pacific region, which constitutes so essential a feature in the study of post-Eocene geology in the East-Indies.

## DESCRIPTION OF SPECIES.

### NAUTILUS POMPILIUS Linnæus?

1758. *Nautilus pompilius* Linnæus.—Syst. Nat., ed. X., p. 709.

The Mekran beds of Balúchistán have yielded a fragment perhaps referable to this species, though too incomplete for secure determination.

*Occurrence.*—North of the Talar gorge, on the road from Kej to Gwádar, at the base of the sandstones constituting the Talar mountains.

### ATURIA NARICA n. sp.

Pl. VIII, figs. 1, 2.

*Description.*—Medium-size, discoidal, non-umbilicated, compressed, with rounded margin and flattened flanks, spiral rapidly increasing. There are about 13 or 11 septa to each whorl, strongly convex from the axis to the middle of the flanks, beyond which they are recurved backwards in a deep narrow sinus or lobe, the inner side of which is sinuous, and which terminates in a hook-like constriction turned inwards. The sutures cross the external margin almost normally or with a very slight anterior convexity, bordered on either side by a slight depression close to the junction with the external side of the deep lobe. The hook-shaped termination of each lobe usually extends as far as the lobe of the previous suture into which it penetrates, coming into contact with its outer border. In other specimens, the septa do not come into contact, a space remaining between the hook-shaped termination of the lobe and

the next suture. The inner convexity of the suture projects forwards far beyond the level of the external marginal portion of the suture in such a manner that an axial plane tangent to the external saddle would not only cut off the greater part of the lateral saddle of the same septum, but a considerable portion also of the lateral convexity of the previous septum. The siphuncle is large, oval, internally marginal, enclosed in deep conical sheaths formed by the backward prolongation of the septa. The lines of growth, convex on leaving the axis, become strongly retrocurrent towards the external margin where they form a deep concavity.

*Measurements.*—The largest specimen, with a considerable part of the body-whorl still preserved, has a maximum diameter of about 77 mm., and thickness of about 35 mm.. A second specimen of almost equal size is entirely chambered, indicating that the species can reach much larger dimensions.

The ratio of thickness to diameter and that indicating the rate of increase, that is the ratio of the radius of one whorl to that of the previous one, as measured in various specimens are as follows:—

—	Maximum diameter	Relative thickness.	Rate of increase.
	mm.		
1 . . . . .	77	.45	3
2 . . . . .	72	.38	3
3 . . . . .	47	.40	3
4 . . . . .	42	.32	3
5 . . . . .	37	.41	3.1

It will be noticed that these ratios remain about the same at the various stages of growth represented by the specimens available.

*Occurrence.*—Nari of Sind.

Near the base of the Nari beds, near Rádak, seven miles south-south-west of Bhagothoro, and ten miles south-south-east of Jhángára, close to the western side of the Dharaa pass near Laki. (Fedden &  $\frac{30}{74}$ .)

Bhagothoro Hill (Noetling). Fedden mentions from the Nari beds a *Nautilus* allied to *Nautilus forbesi* (*Mem. Geol. Surv. Ind.*, Vol. XVII, p. 210). The nautiloid shells mentioned in Fedden's list are not accurately identified, and it is probable that the *Aturia*

above described is the form alluded to, especially as it is the only Nautiloid shell from the Nam beds in Fedden's collections.

*Comparison with other species.*—Apart from the fossil above described, there appear to be eight species of *Aturia* at present recognised:—

1. *Aturia præcæticæ* Oppenheim, 1902, Sitz. d. math.-phys. Cl. d. k. bay. Ak. d. Wiss. z. München, Vol. XXXII, p. 436, Pl. VII, figs. 1—3. Danian.
2. *Aturia vanuxemi* Conrad (see: Whitfield, 1892, Monographs of the U. S. Geol. Survey, Vol. XVIII, p. 287, Pls. XLIX, L). Lower Eocene.
3. *Aturia charlesworthi* Foord, 1891,<sup>1</sup> Catalogue of the fossil Cephalopoda in the British Museum, II, p. 316. Lower Eocene.
4. *Aturia ziczac* Sowerby, 1812, Min. Conch., I, p. 12, Pl. I. Throughout the Eocene.
5. *Aturia rovasendiana* Parona, 1898, Pal. It., Vol. IV, p. 156, Pl. XII, fig. 1, Pl. XIII, figs. 1-3. Bartonian.
6. *Aturia paronai* Rovereto, 1900, Ill. d. Moll. foss. tongr., p. 186, Pl. IX, fig. 16 (Atti d. r. un. di Genova, Vol. XV). Oligocene.
7. *Aturia basteroti* Benoist, 1888, Actes de la Société Linnéenne de Bordeaux, Vol. XLII, p. 22, Pl. II, fig. 2.) Oligocene.
8. *Aturia aturi* Basterot, 1825, Descr. géol. du Bassin Tertiaire du Sud-Ouest de la France, I, Mém. de la Soc. d'Hist. Nat. de Paris, pp. 12, 17. Miocene.

Mayer-Eymar has described an eocene *Aturia costata* in his monograph on the fauna of Einsiedeln, a work which is not available in Calcutta.<sup>2</sup>

*Nautilus parkinsoni* Edwards and *N. spatki* Vred. (*N. delphinus* Forbes *apud* Foord et *Nautilus* sp., *Pal. Ind.*, new series, Vol. III, part 1, Pl. VIII, fig. 1) have been referred to *Aturia* by Foord and

<sup>1</sup> This species resembles *Aturia vanuxemi* in its rate of increase which is slower than in *Aturia ziczac*, the relative thickness is about the same as in *A. vanuxemi*; like *A. vanuxemi* it has more crowded septa than *A. ziczac*. Both *A. vanuxemi* and *A. charlesworthi* are, so far as is known, restricted to the Lower Eocene. It would be worth while ascertaining whether the two forms might be identical.

<sup>2</sup> *Aturia australis* McCoy, described from the Australian Tertiary (Prodr. Pal. Vict., Pl. XXIV, figs. 1-5), cannot be taken into consideration, because we are not certain whether the illustrations of the septa are taken from the same species as those showing the external characters, nor whether the latter all belong to a single species.

by Parona who has also included *Nautilus serpentinus* Blanford in the same genus, while the species first named has been referred to *Heeroglossa* by Conrad, Meek, and Quaas. These three species lack the funnel-shaped septal sheaths round the siphuncle characteristic of *Aturia* and may be referred to a section "*Atuoides*" of *Nautilus*.

The numerical ratios in the nine species of *Aturia* with which I am acquainted may be tabulated as follows:—

Species.	Relative thickness.	Rate of increase.	Number of septa in one whorl.
<i>Aturia præziæ</i> Oppenheim . . .	.61	2.7	12
" <i>vanuxemi</i> Conrad . . .	.33	2.7	16
" <i>charlesworthi</i> Forst . . .	.38	2.2	15
" <i>ziczac</i> Sowebly . . .	.50—.60	3.2—3.3	11—13
" <i>rovasendiana</i> Parona . . .	.25—.30	3.4	11—12
" <i>narica</i> Vredenburg . . .	.32—.45	3.0—3.1	13—14
" <i>paronæ</i> Rovereto . . .	.7	4	11—12
" <i>basteroti</i> Benoit . . .	.5	2.6	12
" <i>aturi</i> Basterot . . .	.40—.51	1.9—2.5	16

The differences between the Indian form and other species may be summarised as follows:—

*Aturia narica* is distinguished:—

from *A. ziczac* and *A. paronæ* by its more compressed shape;

from *A. rovasendiana* by its less compressed shape;

from *A. aturi*, *A. charlesworthi* and *A. vanuxemi* by its more rapid rate of increase;

from *A. præziæ* by its larger size, much more compressed shape, somewhat more rapid increase, and more complex sutures;

from *A. basteroti* by its somewhat more rapid increase, its more compressed shape, and, usually, its more elongate lobes.

The form that most nearly resembles the Nari fossil is *Aturia rovasendiana* Parona from the Bartonian of Gassino near Turin. Both forms agree in the rate of increase, the flattening of the flanks, and the shape of the septa. The Nari form is thicker than the extremely compressed Gassino form, and its septa are somewhat more numerous. The ratio of thickness to diameter in *A. rovasendiana* is .25 to .30, while the specimens of *Aturia narica* give a



ratio of .4 to .45, with the exception of a particularly compressed specimen in which it is about .32.

At a diameter of 10 to 50 mm., the number of septa in one whorl is 11 for *A. rovasendiana*, while it is 13 for *A. narica*. Even for a specimen of more than 20 cm. in diameter, where the septa show signs of crowding towards the body-whorl, *A. rovasendiana* still has only 12 septa in the last whorl.

It may be noticed that both in *Aturia narica* and *A. rovasendiana* the septa are often not only in contact, but even overlap, the extremity of one lobe extending well into the lobe of the previous septum. In other instances again, in both species, the sutures do not come into contact: both dispositions may be observed at different stages of growth in a single specimen of *Aturia rovasendiana*.

The differences between *Aturia narica* and *A. rovasendiana*, though definite, are slight, and it is not improbable that further material linking both forms may eventually allow *A. narica* to be classified as a variety of *A. rovasendiana*.

#### ATURIA ATURI Basterot ?

1825. *Nautilus aturi* Basterot.—Descr. géol. du Bassin Tertiaire du Sud-Ouest de la France, I. Mem. de la Soc. d'Hist. Nat. de Paris, pp. 12, 17.

A fragment with crowded septa, collected by Blagrave in 1845 from strata presumably of Lower Gáj age near Karachi, formerly preserved in the collections of the Asiatic Society of Bengal, exhibits the remarkably continuous convexity of the sutures and extreme narrowness of the lobes characteristic of *Aturia aturi*, to which species it may perhaps belong.

#### ACERA NARICA n. sp.

Pl. I, fig. 1, 2; Pl. IV, fig. 3.

Very large, cylindrical, very elongate, with very low deeply and broadly canaliculated spire consisting of a minute embryo and three whorls. Body-whorl entirely decorated with delicate, flat, ribbon-like, feebly raised spiral threads, usually simple, but sometimes bifid or tripartite, of the same width as, or narrower than the intervals which occasionally carry a subsidiary narrow thread. There are a few broad folds in the direction of the lines of growth close to the margin of the outer lip. Inner lip thin, but very well defined. Outer lip curvilinear, with the usual deep posterior notch.

*Comparison.*—No form of this size seems to be known from the Oligocene of other countries. The ornamentation recalls that of *Acera strepta* Cossmann and Pissarro from the lower Eocene of Sind, but the dimensions are much larger and the shape more elongate. The same differences distinguish this fossil from *Acera striatella* Lamarck from the Eocene of the Paris basin. The living *Acera soluta* Chemnitz, which occurs abundantly in the Indian Ocean, is similar in size and shape, but its shell is thinner, its ornamentation much more delicate.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### SCAPHANDER OLIGOTURRITUS Sacco.

1897. *Scaphander oligoturritus* Sacco—Sacco, Moll. terr. t. 17. Piem. e Lig., XXII, p. 44, Pl. III, figs. 113-115

The specimen agrees in every detail with the description and figures of the Ligurian Oligocene form.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### SCAPHANDER JAVANUS Martin.

1839. *Bulla lignaria* Linn.—J. de C. Sowerby, Trans. G. S. L., (2), V, Pl. XXVI fig. 1.

1880. *Bulla (Scaphander) javana* Mart.—Martin, Tertiärschichten auf Java, p. 85, Pl. XIII, fig. 21.

Sowerby's type agrees exactly with the figure and description of *Scaphander javanus*, its identity with the Miocene fossil of Java having already been surmised by Martin from a comparison with Sowerby's illustrations. As indicated by Martin, it differs from *Scaphander lignarius* owing to its more contracted shape and more profuse striations. Nevertheless it comes much nearer to the recent Mediterranean and Atlantic species than to any forms at present living in the Indian Ocean, and is moreover particularly closely related to certain Miocene forms regarded by Sacco as varieties of *Scaphander lignarius*, such as *Scaphander targionius* Risso.

*Occurrence.*—Gáj of Kachh: Soomrow (Grant collection).

#### ATYS PROTOCYLINDRICA n. sp.

Pl. V, figs. 1, 2.

Small, fusiform, spire concealed, apex narrow with a central cavity from which starts the outer lip which rises considerably

beyond the summit of the shell, the aperture being posteriorly angulated. The inner lip is very distinct, semi-detached at the anterior extremity where there is a slight tendency towards the formation of an umbilical fissure. The anterior and posterior thirds of the shell are decorated with rather wide-spaced, very thin, spiral incisions; the middle third is smooth.

*Comparison.*—There is no appreciable difference between this shell and *Atys cylindrica* Helbling, the common recent form of the Indian Ocean, except in point of size, the fossil form being much smaller.

*Occurrence.*—Gáj of Kachh: near Warsar ( $23^{\circ} 21'$ ,  $68^{\circ} 49'$ ) north of Jakao ( $23^{\circ} 13'$ ,  $68^{\circ} 45'$ ); Teyra River near Rampur ( $23^{\circ} 20'$ ,  $68^{\circ} 51'$ ).

TEREBRA NARICA n. sp.

Pl. I, fig. 6.

Large, moderately elongate, with conical, stepped spire measuring from two-thirds to four-fifths of the total height.

The body-whorl and later spire-whorls are alone preserved in the solitary available specimen which lacks all the earlier part of the shell. The number of spire-whorls following the protoconch is probably about fifteen. They are sub-cylindrical and their height is equal to two-fifths of their width. Posteriorly they exhibit a swelling measuring slightly less than half their height, the anterior border of which is marked by an ill-defined groove. It is this swelling that communicates a stepped appearance to the spire. It carries fairly wide-spaced blunt vertical nodes of about the same width as the intervening spaces, continued on the anterior part of the whorls by rather blurred curved ribs, at first strongly oblique in an anteriorly retrocurrent direction, terminating normally or steeply antecurrently to the anterior suture.

The body-whorl measures more than one-third of the total height. Anteriorly to the level of the suture it gradually contracts with a hemispherical or ovoid convexity which a rather short concavity separates from the zone of accretions of the terminal notch, the anterior extremity of which is missing. The axial ribs are continued, anteriorly to the level of the suture, on to the convexity of the base, gradually becoming indistinct towards the anterior concavity.

The aperture, of very moderate dimensions, is narrowly angulated posteriorly, anteriorly deflected to the left of the shell into the terminal notch. The columella forms an angle of  $110^\circ$  with the base of the penultimate whorl, the junction being scarcely rounded off. The columellar lip is extremely thin. The outer lip is normal to the suture; anteriorly to the swollen band it recedes with a shallow concavity succeeded by a slight convexity opposite the concave portion of the base, the terminal portion once more receding towards the terminal notch.

*Dimensions.*—The approximate restored measurements are as follows :—

Height . . . . .	mm.
Height . . . . .	75
Thickness . . . . .	18
Height of spire . . . . .	55
Height of body-whorl . . . . .	27

*Occurrence.*—Nari of Balúchistán. North-eastern spurs of the Takatu range, north-east of Quetta.

*Comparison and remarks.*—This fine shell is obviously a forerunner of *Terebra crenulata* [Linn.], one of the most conspicuous species of the recent fauna of the eastern seas, with which it agrees in shape, while it approaches it in size. It is distinguished from the typical form of *Terebra crenulata* by the rather closer-set circumsutural nodosities and the persistence of the ribs on the later spire-whorls and on the body-whorl, while in the closely related *Terebra fimbriata* Deshayes, and *T. interlineata* Desh., the crenulations are less prominent and the axial plications, though persisting on the later whorls of the full-grown shell, are more delicate and more crowded. If we follow Tryon, according to whose opinion the two above-named species are only varieties of *Terebra crenulata*, the differential features of the fossil become insufficient for a precise specific separation, and it will have to be regarded as a premutational variety characterised by somewhat smaller dimensions and the persistence and coarseness of the axial folds at full-grown stages.

This shell affords one of the many remarkable instances of the first appearance in the Indian Oligocene of forms characteristic of the recent fauna of the eastern seas, the group of *Terebra crenulata* being unrepresented, in a fossil condition, in the Tertiary formations of Europe.

## TEREBRA SUBTESSELLATA d'Orbigny var. OLIGOCENICA nov. var.

## Pl. I, figs. 3, 4.

1847. *Terebra tessellata* Michelotti.—Foss. mioc., p. 215, Pl. XVII, fig. 13.

1852. *Terebra subtessellata* d'Orbigny.—Prod. Pal. stat., Vol. III, p. 88.

1891. *Terebra subtessellata* d'Orb., var. *perturnita* Sacco (pars).—Moll. terr. terr. Piem. e Lig., part X, p. 25.

1900. *Terebra subtessellata* d'Orb. (var. *perturnita*.)—Rovereto, Ill. moll. foss. tongr., p. 183, Pl. IX, fig. 8.

Medium-size, somewhat elongate, with conical spire measuring five-sixths of the total height.

The earlier part of the shell is missing in all the available specimens. The number of whorls following the protoconch is probably about sixteen. Their height ranges from over three-fifths to nearly two-thirds of their width. Their outline is slightly convex. The sutures are well marked, somewhat incised. A posterior band, measuring slightly more than one-third of the height of the whorls is divided off from the remaining surface by a sharp furrow. The whorls are ornamented with close-set, narrow, rather prominent ribs, of the same width as the intervening spaces, the general direction of which is rather steeply oblique and anteriorly retrocurrent, with, at the same time, a stiff sigmoidal double curvature in consequence of which the terminations of the ribs are rather steeply antecurrent to the posterior suture, still more steeply antecurrent or else normal to the anterior suture. Extremely fine, crowded, spiral markings may be detected with a strong magnifying power, especially in the intervals between the ribs.

The body-whorl exceeds two-sevenths of the total height. Anteriorly to the level of the suture, it contracts with a hemispherical convexity which a pronounced, short concavity separates from the rather oblique twisted zone of accretions of the terminal notch, posteriorly bounded by a thin, moderately prominent ridge by which it is divided off from the adjacent concavity. The ornamentation of the last spire-whorl is continued over the corresponding part of the body-whorl, and, anteriorly to the level of the suture, the ribs are continued over the base.

The small aperture is terminated posteriorly by a rather narrow, rather elongated angulation, while anteriorly it is deflected towards the left of the shell into the deep terminal notch. The details of the columella are concealed by an adherent rocky incrustation.

Judging from the strong flattening of the basal convexity at its junction with the concavity, the angle formed by the columella and the base of the penultimate whorl must be relatively rather moderately broad. The columellar lip is thin. The outer lip is steeply antecurrent to the suture, anteriorly to which, it recedes obliquely with a sigmoidal bend of which the short convexity corresponds with the differentiated posterior band of the whorls, anteriorly followed by a broad shallow concavity, the outline once more becoming slightly convex opposite the convexity of the base, and finally retrocurrent towards the terminal notch.

*Dimensions.*—The following are the approximate restored measurements :—

	mm.
Height . . . . .	48
Thickness . . . . .	8
Height of spire . . . . .	10
Height of body-whorl . . . . .	14.5

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks.*—Some rather imperfectly preserved specimens from the Oligocene of Carcare and Mornese in Liguria were referred doubtfully by Sacco to the variety *perturrita* of *Terebra subtessellata*. Other specimens from Squaneto and Sassello, from the same formation and the same region have been referred to the same variety, also with a query, by Rovereto. It may be noticed that in all the Miocene forms figured by Sacco, the posterior band of the whorls is rather narrower than in the Sind specimens, and that this is specially noteworthy with the figured type of the variety *perturrita*, while the Oligocene specimen figured by Rovereto agrees perfectly with the Sind fossil both as regards its somewhat elongate shape and its relatively broad circumsutural band. It seems therefore that the Oligocene specimens both in India and in Europe represent a truly distinct form uniting the slender outline of the variety *olygoturrita* with a circumsutural band broader than that of the Miocene forms. The Oligocene specimens may therefore be regarded as constituting a variety *oligocenica*.

Amongst living forms, *Terebra duplicata* Linn., and *T. dussumieri* Kiener, both from the eastern seas, are related, but grow to much larger dimensions.

## TEREBRA MEKRANICA n. sp.

## Pl. V, figs. 3-5.

Medium-small, moderately slender, with somewhat elongate, slightly conoidal, slightly stepped spire measuring two-thirds of the total height.

The apex is missing in all the available specimens. The number of whorls following the protoconch is probably ten or eleven. They are very steeply conical to sub-cylindrical, thus accounting for the slightly stepped disposition of the spire. Their height, at later stages of growth, measures, in different specimens, from three-quarters to ten-elevenths of their width, being slightly less in the earlier part of the spire in consequence of its slightly conoidal outline. The sutures are rather sharply incised. They are surrounded by a band which, in different specimens occupies either one-third, or else slightly more or slightly less of the total height of the whorls, anteriorly bounded by a deeply incised furrow, anteriorly to which is a second rather narrower band, bounded by a somewhat shallower furrow. Crowded, steeply elongate, narrow oblique nodes, of the same width as the intervening furrows, antecurrent towards the posterior suture, decorate both the differentiated bands. Their average obliquity is slightly greater on the circumsutural band than on the second band upon which, however, they are straight, while on the circumsutural band they exhibit a slight curvature with anteriorly directed convexity in consequence of which they terminate normally to the suture. Anteriorly to the nodes of the second band and in direct straight continuation of their direction, there is yet a third row of nodes anteriorly contracting into straight, angular, very steeply oblique ribs which terminate retrocurrently to the anterior suture. At the junction of the third row of nodes and of the anterior ribs, there may be a slight constriction outlining the course of a very faint furrow, so that certain specimens exhibit three bands of successively decreasing width, bounded by three furrows of successively decreasing depth.

The body-whorl measures more than three-eighths of the total height. It consists of a posterior rather elongate cylindrical portion contracting, anteriorly to the level of the suture, with an ovoid convexity, separated by a very short concavity from the terminal moderately steeply oblique twisted zone of accretions to the terminal notch which is strongly convex and somewhat ridged,

moderately scaly, posteriorly bounded by a narrow, sharp keel by which it is isolated from the adjacent concavity. The ribs which become slightly more crowded on the body-whorl continue anteriorly to the level of the suture, preserving their steep anteriorly retro-current obliquity which increases on approaching the terminal concavity.

The aperture is posteriorly angulated, anteriorly deflected to the left of the shell into the very deep terminal notch. The columella forms an angle of  $115^\circ$  with the base of the penultimate whorl, anteriorly to which it is vertical only for a very short distance as far as the spiral fold constituted by the inward extension of the boundary ridge of the accretion zone, anteriorly to which it bends with a convex curve towards the left of the shell, anteriorly ending in a twisted edge towards the terminal notch. The columellar lip is very thin. The outer lip, at its posterior termination, is normal to the suture, anteriorly to which, for the greater part of its course, it recedes with a steep obliquity increasing at its anterior termination where it passes into the terminal notch.

*Dimensions.*—

	mm.
Height . . . . .	31
Thickness . . . . .	6.7
Height of spire . . . . .	21
Height of body-whorl . . . . .	12

*Occurrence.*—Mekran beds: north of the Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison with other species.*—*Terebra gemmulata* Kiener and *T. mariesi* Smith exhibit some resemblance to this shell, but are distinguished by their much wider-spaced ribs.

TEREBRA GEDROSIANA n. sp.

Pl. V, fig. 6.

Rather small, moderately elongate, with conoidal spire measuring about seven-ninths of the total height.

The earlier part of the shell is missing. The number of spire-whorls following the protoconch may be from ten to twelve. They are very slightly convex. Their height is equal to five-sixths of their thickness. The sutures are incised and are surrounded by a



slightly convex band measuring two-fifths of the height of the whorls anteriorly, bounded by a deep furrow. Both the circumsutural band and the anterior portion of the whorls are ornamented with close-set angular ribs, the spaces between which are also angular, reproducing in an inverted manner the shape and width of the ribs which are steeply oblique, though slightly less so on the circumsutural band than on the anterior portion of the whorls, antecurrent to the posterior suture, very steeply retrocurrent to the anterior suture.

The body-whorl measures somewhat less than four-ninths of the total height. Anteriorly to the level of the suture it contracts with an ovoid convexity separated by a short concavity from the terminal moderately oblique zone of accretions to the terminal notch posteriorly bounded by a projecting rim. The decoration of the last spire-whorl is continued on the corresponding portion of the body-whorl upon which the ribs become slightly more crowded and are continued on the base, anteriorly to the level of the suture up to the anterior concavity upon which they become more retrocurrent and at the same time fade away.

The aperture is posteriorly angulated, anteriorly deflected towards the left of the shell into the terminal notch. The columella forms an angle of about  $110^\circ$  with the base of the penultimate whorl, anteriorly to which it is largely concealed by an adhering rocky incrustation in the only available specimen. The columellar lip is thin. The outer lip is steeply antecurrent to the suture anteriorly to which it recedes with a very steep obliquity increasing close to its anterior termination.

*Dimensions.*—The following are the approximate restored measurements:—

	mm.
Height . . . . .	27
Thickness . . . . .	6
Height of spire . . . . .	21
Height of body-whorl . . . . .	11

*Occurrence.*—Mekran beds, north of the Talar Gorge, on the road from Kej to Gwádar, base of the sandstones constituting the Talar Mountains.

*Comparison with other species.*—In many respects this shell so closely resembles the previously described species that it might be interpreted as representing a more simply ornamented variety.

Nevertheless the absence of all three rows of nodosities, and of the second band and second furrow constitute such conspicuous differences that, in the absence of any intermediate passage forms, the shell may provisionally be treated as a separate species. It closely resembles *Terebra duplicata* Linn. and *T. dussumieri* Kien., but is distinguished by its much smaller size, the specimen being adult as is indicated by the crowding of the ribs on the body-whorl. *Terebra kieneri* Desh. also exhibits some resemblance but is much less elongate. The Balúchistán shell is closely related to *Terebra protoduplicata* Noetling (*Pul. Ind.*, new series, 1901, Vol. I, part 3, p. 338, Pl. XXII. fig. 17), a fossil form from the Miocene of Burma, from which it is distinguished by its relatively taller whorls, its broader circumsutural band, its more elongate and more gradually tapering base.

TEREBRA (MYURELLA) ASPERA Hinds.

Pl. V, figs. 7, 8.

1843. *Terebra aspera* Hinds.—Proc. Zool. Soc., p. 154.

Medium-size, moderately elongate, with stepped conical spire exceeding five-sevenths of the total height.

The apex is missing in all the available specimens. The number of spire-whorls following the protoconch is probably from ten to twelve. Their height measures, in various specimens, from two-fifths to two-thirds of their width, and they are approximately cylindrical, thus accounting for the stepped disposition of the spire. The sutures are linear, slightly incised, surrounded by a raised band measuring two-sevenths of the height of the whorls, anteriorly bounded by a rather broad, rather deep furrow, anteriorly to which there are three spiral threads anteriorly decreasing in thickness, the intervals also decreasing in the same proportion, with the addition, sometimes, of a fourth thread along the anterior sutures of the later spire whorls of full-grown specimens. The circumsutural band is ornamented with prominent, vertically elongate nodes, of the same width as the intervening spaces, very steeply antecurrent to the posterior margin. From the posterior furrow that bounds the circumsutural rim to the anterior margin the surface carries crowded thin vertical ribs, more numerous than the crenulations of the circumsutural rim, giving rise to coarse granules at their intersections with the spiral threads. The floor of the posterior furrow

is divided at regular intervals by fine lines still more numerous than the anterior ribs, strongly oblique and antecurrent towards the posterior band. Some very fine spiral markings may be detected, with a strong magnification, in the intervals between the crenulations of the circumsutural furrow.

The body-whorl measures somewhat less than two-sevenths of the total height. Almost immediately anteriorly to the level of the suture it is somewhat angulated and contracts very rapidly with a very flat, scarcely curved outline, separated by a short concavity from the slightly scaly, convex, ridged zone of accretions of the terminal notch, posteriorly bounded by a prominent rim. The ornamentation of the last spire-whorl is continued on to the corresponding portion of the body-whorl, the crenulations of the circumsutural rim tending to become more crowded. At the termination of the spire, an additional granulated thread, or a pair of such, is disclosed at the level of the suture along the angulation, anteriorly to which two or three more fainter spiral threads, also granulated, are developed on the base.

The columella forms an abrupt angle of 125° with the base of the penultimate whorl at a short distance from which it carries a spiral ledge representing the inward extension of the bounding rim of the zone of accretions, the median crest of which is also continued on the columella as a spiral swelling. As the terminal oblique twist of the columella is also continued inward, the inner extension of the columella seems to carry three spiral folds. The columellar lip is very thin. The outer lip is normal to the suture. It recedes for a short distance anteriorly to the circumsutural band and then becomes vertical, finally receding into the terminal notch at its anterior extremity.

*Dimensions.*—

	mm.
Height . . . . .	35
Thickness . . . . .	9
Height of spire . . . . .	26
Height of body-whorl . . . . .	13

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwádar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—Judging from available descriptions and illustrations, this shell agrees with the living *Terebra aspera* Hinds regarded by

Tryon as one of the numerous varieties of *Terebra variegata* Gray, a species widely spread throughout the Indian and Pacific Oceans and also extending to the west coast of Africa. *Terebra mamillata* Watson, obtained by the Challenger expedition from the Philippines which has a wider-spaced ornamentation seems also related.

TEREBRA (MYURELLA) RETICULATA J. de C. Sowerby.<sup>1</sup>

1839. *Terebra reticulata* J. de C. Sowerby.—Trans. Geol. Soc. Lond., (2), Vol. 1, Pl. XXVI, fig. 9.

1857. *Terebra lima* De-hayes.—Journ. Conch., p. 69, Pl. III, fig. 2.

1879. *Terebra indica* Martin.—Tertiärschichten auf Java, p. 33, Pl. VI, fig. 12.

Large, slender, with elongate, conical, slightly stepped spire exceeding nine-elevenths of the total height.

The apex is missing in all the available specimens. The number of spire-whorls following the protoconch is probably about nineteen. Their height is equal to nearly five-sevenths of their width. The sutures are linear and somewhat incised. The posterior portion of the whorls, to the extent of more than half their height, is somewhat swollen, thereby causing the slightly stepped appearance of the spire, and, at earliest stages of growth, is divided by a deep furrow into two unequal bands of which the posterior one is the broadest. From a very early stage of growth both bands become lined or

<sup>1</sup> The correct title of the work containing the description of this and many other species is "Systematic list of organic remains, the plants determined by Mr. John Morris, and the remainder by Mr. James de C. Sowerby, A. L. S." (*Trans., Geol. Soc. Lond.*, ser. 2, Vol. V, pp. 327—329, Pl. XX-XXVI). It constitutes an appendix to the celebrated "Memoir to illustrate a Geological Map of Cutch, by C. W. Grant" (*Trans., Geol. Soc. Lond.*, ser. 2, Vol. V, pp. 289—326.) The numerous references to this standard work give the date of publication either as 1837 (d'Orbigny, Wynne, Sacco, LaTouche, etc.) or 1840 (d'Archiac and Haime, Duncan and Sladen, Oldham, etc.), both of which are incorrect, 1837 being the date of the reading of Grant's Memoir before the Geological Society of London, while 1840 is the date of the title-page and of part 3 of Volume V (second series) of the *Transactions* of the Geological Society. Grant's memoir was published in part 2, issued in 1839, together with the Appendix and illustrative plates.

At the Annual General Meeting of the Geological Society, on the 19th February 1841, the Council reported that "the third part of Volume V has been published since the last Anniversary" (*Proc., Geol. Soc. Lond.*, Vol. III, p. 368). On the 21st February, 1840, that is, on the occasion above referred to, the Council made the following statement. "A new part of the Transactions has been already published since the last report, and another is ready to be laid upon the table in a few days." (*Proc. Geol. Soc. Lond.*, Vol. III, p. 190.) This statement, taken in connection with the statement subsequently made in 1841, clearly refers to parts II and III of Vol. V, and it is evident that part II was published in 1839, part III in 1840. The date of Grant's memoir and of its appendix is unquestionably, therefore, 1839. A short abstract was published in the *Proceedings* of the Geological Society in 1837.

started and both of them, but more especially the posterior one, soon tend to break up into variously disposed spiral threads of various widths, the dividing furrow at the same time becoming somewhat broader. On the last spire-whorls of adult specimens the splitting up of the original swollen band may have proceeded to such an extent as to make it scarcely distinct from the spirally decorated anterior part of the whorls. At earliest stages of growth, the anterior portion of the whorls, anteriorly to the raised band is slightly concave or cylindrical. With increasing growth it becomes or remains cylindrical, and either remains so at all succeeding stages, or else, in the last spire-whorls of full-grown specimens, it may become slightly convex. At early stages of growth this anterior portion of the whorls is decorated with five spiral threads, usually distributed at slightly wider intervals posteriorly than towards the anterior margin. At full-grown stages they may be of somewhat varying thickness, and some subsidiary raised spiral lines may also be added, especially, in certain specimens, along a narrow slightly swollen zone, adjacent to the anterior suture. In the later whorls of full-grown specimens, the spiral threads may be generally of about the same width as the intervening spaces, or else slightly wider, or slightly narrower. In addition to the spiral ornaments, the whorls carry crowded, thin, axial ribs which are oblique and antecurrent towards the posterior suture over the posterior swollen part of the whorls, while over the anterior portion they are more nearly vertical, slightly curved with forward directed concavity, ending either normally, or, more frequently steeply antecurrently to the anterior suture, and combining with the spiral ornaments of the anterior section of the whorls to form a network of meshes either square or more or less oblong in the direction of the revolving ornaments, with feebly raised granules at the intersections.

The body-whorl measures scarcely more than one-quarter of the total height. Anteriorly to the level of the suture it contracts rapidly with a rather flattened convexity separated by a short concavity from the very oblique strongly twisted zone of accretions of the terminal notch, posteriorly bounded by a narrow prominent keel by which it is divided off from the adjacent concavity. The ornamentation of the spire is continued on to the corresponding part of the body-whorl. Anteriorly to the level of the suture, the character of the surface changes abruptly, the base being nearly

smooth, with only faint and blurred revolving markings crossed by lines of growth which are not differentiated into distinct ribs, and which become strongly retrocurrent at their anterior termination towards the marginal keel of the terminal zone.

The aperture is relatively small, posteriorly angulated, anteriorly deflected into the deep terminal notch towards the left of the shell. The short columella is abruptly connected through an angle of about  $115^\circ$  with the base of the penultimate whorl anteriorly to which it is at first vertical with a spiral fold formed by the inward continuation of the boundary keel of the terminal zone. At its termination, the columella is obliquely twisted to the left of the shell towards the terminal notch. The columellar lip is well demarcated, slightly callous and thickened, somewhat spreading forward over the convex portion of the base. The thin outer lip is steeply antecurrent to the suture anteriorly to which it recedes obliquely with a slightly sigmoidal outline, of which the short convexity corresponding with the posterior main subdivision of the circum-sutural band, is followed by a broad concavity, the outline becoming vertical on approaching the convexity of the base, and finally retrocurrent towards the terminal notch.

*Dimensions.*—The following are the partly restored measurements of a full-grown individual:—

	mm.
Height . . . . .	87
Thickness . . . . .	15
Height of spire . . . . .	72
Height of body-whorl . . . . .	22

*Occurrence.*—Gáj of Kachh. Teyra River near Rampur ( $23^\circ 20'$ ,  $68^\circ 51'$ ); near Warsar ( $23^\circ 21'$ ,  $68^\circ 49'$ ), north of Jakaw ( $23^\circ 13'$ ,  $68^\circ 45'$ ).

*Comparison with other species.*—A careful comparison of Sowerby's type of this fossil, at the British Museum, with *Terebra lima* Deshayes from the eastern seas, failed to reveal any precise distinction. The fossil from the Miocene of Java described by Martin as *Terebra indica* also seems identical. A very indistinct fragment from the Miocene formation of Burma described by Noetling as *Strioterebrum protomyuros* (*Pal. Ind.*, 1901, new series, Vol. I, part 3, p. 335, Pl. XXII, fig. 14) specifically identical to another associated fragment erroneously referred by Noetling (*loc. cit.*, p. 337, Pl. XXII,

fig. 15) to *Terebra bicincta* Martin (*non* Hinds),<sup>1</sup> exhibits some resemblance to *Terebra reticulata* but represents a much smaller species in which, moreover, the two divisions of the circumsutural band, at early stages of growth, before tending to break up, are of equal width, while, in *Terebra reticulata*, from the earliest stages, they are unequal.

TEREDRA (MYURELLA) KACHHENSIS n. sp.

Pl. IX, fig. 2.

Large, extremely slender, baculiform, with very elongate conical stepped spire, exceeding five-sixths of the total height.

The earlier part of the shell is missing in all the available specimens. The number of spire-whorls following the protoconch is probably about nineteen. Their height is equal to nearly five-sevenths of their width. They are cylindrical or very slightly convex, thus accounting for the stepped disposition of the spire. The sutures are linear, slightly incised. Posteriorly, the whorls exhibit a differentiated zone occupying a great deal more than half the height of the whorls, divided into two bands, of which the posterior one is the broader, by a deep furrow much more pronounced than the rather inconspicuous line which forms the anterior boundary of the anterior band. The anterior part of the whorls carries four, or, exceptionally, six rather thick subequal spiral threads, of about the same thickness as the intervening spaces or else a little broader. Of the two differentiated bands of the posterior portion of the whorls, the more posterior one carries thick, even-spaced, vertical ridges of the same thickness as the intervening spaces. On the anterior band they become oblique and anteriorly retrocurrent and are continued on the anterior part of the whorls as slightly narrower, practically straight and practically vertical ribs. Together with the anterior spiral threads they form a coarse network the meshes of which are either square or else somewhat oblong with the greater elongation in the direction of the revolving ornaments, with a slight tendency to the formation of raised granules at the intersections. Very fine, even-spaced lines of growth are observed, over the anterior section of the whorls, in the intervals between the ribs.

The body-whorl measures less than two-ninths of the total height. Anteriorly to the level of the suture it contracts very

<sup>1</sup> The specific name *bicincta* being preoccupied for a recent species published by Hinds in 1843, the Javanese fossil may be distinguished as *Terebra martini*.

rapidly with a strongly flattened spheroidal convexity separated by a short concavity from the very oblique, strongly twisted zone of accretions of the terminal notch posteriorly bounded by a thin ledge by which it is divided off from the adjacent concavity. The ornamentation of the last spire-whorl is carried on to the corresponding portion of the body-whorl. At the level of the suture, the ornamentation, anteriorly, changes very abruptly. There are at first some feebly prominent blurred revolving threads crossed by faint indications of ribs, anteriorly to which, on the flattened portion of the convexity, the surface becomes practically smooth, except for the lines of growth which become strongly retrocurrent towards the boundary ledge of the terminal zone.

The small aperture is posteriorly angulated, anteriorly deflected towards the left of the shell into the deep terminal notch. The short columella is abruptly connected through an angle of about  $105^\circ$  with the base of the penultimate whorl anteriorly to which it is at first vertical, carrying a spiral fold representing the inward extension of the boundary ridge of the terminal zone, terminating in a strongly oblique edge twisted towards the terminal notch. The columellar lip is thin, though well demarcated, spreading slightly forward over the convexity of the base. The outer lip is normal to the suture anteriorly to which it becomes first oblique and anteriorly retrocurrent, then straight, and finally, at its termination, retrocurrent towards the terminal notch.

*Dimensions.*—The restored measurements are approximately as follows :—

	mm.
Height . . . . .	96
Thickness . . . . .	13
Height of spire . . . . .	81
Height of body-whorl . . . . .	22

*Occurrence.*—Gáj of Kachh.

*Comparison with other forms.*—This shell should perhaps be regarded as a variety of the closely related *Terebra reticulata*, but in the absence of any connecting links, it is provisionally regarded as distinct. It differs by its more elongate shape, the more distinctly stepped disposition of the spire-whorls, the coarser reticulation and wider-spaced more prominent ribs, their vertical disposition on the posterior circumsutural band, and the total absence, even at full-grown stages, of any tendency to a breaking up of either of the posterior bands.



## TEREBRA (MYURELLA) QUETTENSIS n. sp.

## Pl. I, fig. 5.

? 1901. *Terebra* im, spec 1.—Noctung, Pal Ind, new series, Vol. I, part 3, p. 340, Pl. XXII, fig. 10.

Medium-size, moderately elongate, with conical slightly stepped spire measuring three-fourths of the total height.

The earlier part of the shell is missing in the solitary available specimen. The number of whorls following the protoconch is probably thirteen or fourteen. Their height is equal to two-thirds of their width, their shape steeply conical to cylindrical, thus accounting for the somewhat stepped disposition of the spire. The sutures are linear, somewhat impressed and are surrounded by a band measuring one-third of the height of the whorls, anteriorly demarcated by a deep furrow, anteriorly to which is a second slightly swollen band the anterior edge of which is somewhat indistinct. The anterior part of the whorls carries six or seven spiral threads, on an average of about the same width as the intervening spaces. Prominent elongate nodes, antecurrent towards the posterior suture, equalling or slightly exceeding in width the intervening spaces, decorate both the posterior swellings, their obliquity being steeper on the posterior than on the anterior band anteriorly to which they contract gradually into narrow prominent ribs, thicker than the spiral threads which they intersect, slightly curved with forward directed concavity, terminating either normally to the anterior suture, or with a very steep obliquity which may be either antecurrent or retrocurrent. The spiral threads are not interrupted by the ribs, but rise as they cross them as if constituting a superimposed system, though there is no tendency for the formation of granules at the intersections. Some fine spiral threads also occur on both the posterior swellings, although faintly visible on account of the weathered state of the surface.

The body-whorl measures less than three-eighths of the total height. Anteriorly to the level of the suture, it contracts with a hemispherical convexity, separated by a short concavity from the moderately oblique twisted zone of accretions to the terminal notch, which is posteriorly bounded by a narrow ledge. The axial ribs are continued anteriorly over both the convexity and concavity of the base, ending retrocurrently towards the boundary ridge of the terminal zone.

The rather small aperture is posteriorly angulated, anteriorly deflected towards the left of the shell into the terminal notch. The columella is joined through an angle of  $120^\circ$  with rounded apex, to the base of the penultimate whorl, anteriorly to which it is at first vertical and swollen by the inward extension of the boundary ridge of the terminal zone, and is finally bent anteriorly towards the left of the shell. The columellar lip is somewhat callous. The outer lip is antecurrent to the suture anteriorly to which it recedes obliquely with a slightly sigmoidal flexure, the broad shallow concavity of which terminates on reaching the convexity of the base where the outline becomes vertical or slightly convex, finally receding towards the terminal notch.

*Dimensions.*—The restored measurements are approximately as follows :—

Height . . . . .	mm.
Height . . . . .	42
Thickness . . . . .	9
Height of spire . . . . .	31
Height of body-whorl . . . . .	15

*Occurrence.*—Nari of Balúchistán. North-eastern spurs of the Takatu Range, north-east of Quetta. In Burma, this species is very abundant at Singu, and perhaps occurs also at Yenangyat, from which latter locality a very indistinct fragment has been figured by Noetling (*loc. cit.*)

*Comparison with other species.*—In consequence of its weathered condition, the above-described specimen might be taken to represent an immature stage of the previously described *Terebra narica*, from which, however, it is readily distinguished by several important characters, such as the presence of a second nodular band anteriorly to the circumsutural band, and of spiral threads on the anterior portion of the whorls. The furrow bounding the circumsutural band is much broader and deeper than in *Terebra narica* in which it is indistinct. The spire-whorls, in *Terebra quettensis* are also proportionately taller than in *Terebra narica*. *Terebra protomyuros* Noetling,<sup>1</sup> from the Miocene of Burma bears some resemblance to the species above described, but its ornamentation is much more delicate, the ribs of the anterior part of the body-whorl being as

<sup>1</sup> This species includes the type, very incorrectly figured in fig. 14, Pl. XXII of Noetling's monograph (Pal. Ind., new series, Vol. I, part 3) and a second specimen incorrectly referred to *Terebra bicincta* Martin (*non* Hinds) represented in fig. 15 of the same plate.

thin as the spiral threads which they cross. On the body-whorl of the Burmese fossil, the ribs do not extend on to the base which is shorter than in the Balúchistán form.

TEREBRA (MYURELLA) TRIZONATA n. sp.

Pl. IX, fig. 1.

Fairly large, elongate, with conical stepped spire measuring five-sixths of the total height.

The earlier part of the shell is missing in the single available specimen. The number of whorls following the protoconch is probably about sixteen. Their height is equal to two-thirds of their width. The sutures are incised and surrounded by a raised fillet-shaped band causing the stepped appearance of the spire and separated by a furrow traversed by two raised spiral lines from another narrower raised band. The two raised bands together with the intervening space occupy half the height of the whorls. Anteriorly to them the steeply conical or cylindrical surface carries two conspicuous thin, sharply delineated spiral threads the space between which is broader than that between the more posterior thread and the more anterior of the swollen bands, this space in turn being broader than that between the more anterior thread and the anterior margin of the whorls along which is seen a third spiral thread half concealed by the overlapping posterior edge of the succeeding whorl. The two posterior swollen bands carry elongated prominent nodes, narrower than the intervening spaces, rather steeply antecurrent towards the posterior suture, anteriorly continued by thin, sharply raised, almost straight ribs which become vertical towards the anterior suture, forming, with the spiral threads a lattice the middle meshes of which, bounded by the two principal threads, are square, rounded granules being developed at all the intersections. Some very fine lines of growth are also visible in the intervals between the ribs, while, on the posterior circum-sutural swollen band, some very fine spiral incisions are visible, under a strong magnification, in the intervals between the nodes.

The body-whorl measures about one-quarter of the total height. It contracts rapidly anteriorly to the level of the suture. The anterior termination of the shell is missing. The ornamentation of the last spire-whorl is continued on to the corresponding part of the body whorl. Anteriorly to the level of the suture, the base appears to be nearly smooth.

The details of the aperture are not preserved.

*Dimensions*.—The restored measurements are approximately as follows :—

	mm.
Height . . . . .	61
Thickness . . . . .	10
Height of spire . . . . .	50
Height of body-whorl . . . . .	15

*Occurrence*.—Mekran beds, 7 miles north-west of Dram.

*Comparison with other species*.—This shell closely resembles *Terebra protomyuros* Noetling, from the Miocene of Burma, but it grows to a larger size, and its spiral threads and axial ribs are much wider-spaced.

#### CLAVATULA SACERDOS [Reeve].

1845. *Pleurotoma sacerdos* Reeve.—Proc. Zool. Soc., p. 110.

1845. *Pleurotoma sacerdos* Reeve.—Monograph of the genus *Pleurotoma*, species 172.

Medium-size, with extraconic dimorphous spire measuring somewhat less than five-ninths of the total height, rather slender in its earlier portion and gradually broadening anteriorly, and with broad body-whorl, anteriorly contracted into a short stem.

The short, somewhat hemispherical protoconch consists of a coiled, flattened nucleus and of one globose-conical whorl. It is followed by six spire-whorls, the height of which, in the earlier portions of the shell is nearly three-fifths of their breadth, while it scarcely exceeds half the breadth at later stages in consequence of the conoidal shape of the spire. The maximum thickness is not far from the anterior margin. The sutures are linear and are surrounded by a narrow, feebly raised rim decorated with a pair of spiral threads. Anteriorly to this circumsutural rim, the surface of the whorls, at earlier stages of growth, is divided into two equal portions of which the posterior one is concave and corresponds with the accretions of the apertural notch, while the anterior one is convex. In addition to the lines of growth forming a broad sinuosity, the concave band carries crowded, very fine, spiral, raised lines which may be delicately granulated at their intersections with the lines of growth. The anterior convexity carries both axial and spiral ornaments. The axial ornaments consist of numerous straight, oblique ribs, anteriorly antecurrent, slightly narrower than

the intervening spaces, crossed by three or four evenly spaced, delicate spiral threads. Towards the end of the spire, the posterior concavity increases at the expense of the anterior convexity, and broadens considerably anteriorly. The anterior ribs become much fewer and wider spaced, considerably shortened so that they no longer reach the anterior margin; instead of constituting axially elongated rods, they are now vertically flattened and, at the same time, elongated in the direction of the spiral ornaments; they become very prominent, and form a sharp, serrated angulation, not far from the anterior margin of the whorl.

The outline of the last spire-whorl is continued into the posterior part of the large ventricose body-whorl measuring nearly seven-tenths of the total height. Anteriorly to the spinose angulation the surface contracts with a flattened convex outline connected by a rather broad, strongly curved concavity with the short terminal stem. The circumsutural rim exhibits the same characters as on the spire-whorls. The posterior concavity, the serrations of the angulation and the space in front of them corresponding with the anterior margin of the last spire-whorl are covered with crowded contiguous fine spiral bands alternating in two orders.

Anteriorly to the level of the suture, the convexity of the base carries three conspicuous granulated threads, the intervals between which are each occupied by two or three fine raised lines. Four more similar slightly narrower and somewhat closer-set main threads occupy the following concavity, one intercalary raised line occurring in each interval with, occasionally, the addition of lines of a third order. The terminal stem carries spiral threads alternating in two orders, those of the first order being spaced at about the same intervals as the main threads of the concavity. Anteriorly from the serrated angulation, the lines of growth are disposed according to a forward directed convexity of moderate curvature. They are anteriorly antecurrent up to the posterior edge of the anterior concavity which they cross according to an almost imperceptibly retrocurrent course, finally resuming a vertical course on the terminal stem.

The large aperture is pentagonal, anteriorly contracted into a short canal. The columella is straight and vertical as far as the commencement of the canal along which it assumes an oblique disposition. The columellar lip is thin. The sinus, judging from the lines of growth, is very large, forming a wide-open angle with

rounded apex. Anteriorly to the sinus, the lines of growth indicate a broad convexity as the outline of the edge of the outer lip.

*Dimensions.*—

	mm.
Height . . . . .	32
Thickness . . . . .	14
Height of spire . . . . .	17
Height of body-whorl . . . . .	22

*Occurrence.*—Mekran beds, high horizon, N. N. E. of Mukh (25° 27', 62° 33').

*Remarks.*—Compared with Reeve's illustration, this shell lacks the puckerings which affect the circumsutural rim in the figured type. All the other characters are identical. According to Tryon this shell is to be regarded as one of the numerous forms of the protean *Clavatula muricata* Lamarck, the genotype of *Clavatula*. The presence of this South and West-African gastropod in the Mekran beds is of great interest.

CLAVATULA (PERRONA) UNISULCATA Cossmann.

1900. *Clavatula (Perrona) unisulcata* Cossmann.—Journ. Conch., Vol. XLVIII, p. 31. Pl. IV, fig. 17.

Large, with rather tall, conical spire measuring about half the total height, and with large convex body-whorl terminated by a stem of moderate length.

The apex is missing in all the available specimens. The number of spire-whorls following the protoconch is probably eight. In their general outline, the whorls are approximately conical. Their height is equal to nearly half their width, the maximum thickness nearly coinciding with their anterior margin. The well-marked suture is linear. A conspicuous revolving incision situated at the posterior third of the height of the whorls, divides their surface into two unequal portions, a smaller posterior, and a larger anterior one, both of which are very gently convex, the larger anterior division more conspicuously so than the shorter posterior one.

At the earliest stages of growth, the anterior portion is itself unequally subdivided by a very thin spiral thread visible only with a lens, and situated nearer to the main spiral incision than to the anterior margin. Of these two subdivisions, the anterior one carries numerous very feebly prominent, oblique ribs, anterior-

ly antecurrent and inclined to the suture at an angle of  $45^{\circ}$ , of the same width as the interspaces or slightly broader. These ribs disappear with increasing growth, and the fine incision either disappears or loses its individuality. Very feeble puckerings, obliquely inclined in the opposite direction to the anterior ribs, are sometimes observed on the posterior main subdivision of the whorls, especially in the neighbourhood of the main spiral incision. They totally disappear with increasing growth.

Apart from the very feeble axial ornaments of the earlier whorls, the surface of the shell, to the unaided eye, seems smooth except for the conspicuous main incision which is almost as pronounced as the suture. The posterior subdivision, between the main incision and the suture is decorated with numerous revolving slightly incised lines, scarcely visible without a lens even at full-grown stages of growth. Apart from the subsidiary incision of the earlier whorls, the anterior subdivision carries no spiral ornaments other than some scarcely appreciable lines along both its margins, that is close to the main incision, and close to the anterior margin of the whorls. The lines of growth are normal to the posterior suture, on leaving which they become strongly retrocurrent towards the revolving incision. Almost immediately in front of the main incision they are sharply deflected and the remainder of the course is anteriorly antecurrent, strongly curved with forward facing convexity, the direction being extremely oblique at first and still strongly inclined as they reach the anterior margin.

The large body-whorl slightly exceeds four-sevenths of the total height. Posteriorly it exhibits the same outline as the spire-whorls. Anteriorly to the suture line the base exhibits a rather extensive convexity of somewhat pronounced curvature, connected by means of an elongate shallow concavity with the stem which is of moderate length and slightly twisted at its extremity. On the portion of the body-whorl coinciding with the spire, the spiral decoration is practically the same as on the last spire-whorl. The spiral lines become gradually more distinct in an anterior direction on the convex portion of the base, and, on the succeeding concavity, they are followed by crowded flat spiral threads, easily seen with the unaided eye, all in contact with one another, every second or third thread being thicker than the others. Similar bands are continued on the stem, and tend to become equalised towards the anterior extremity. The lines of growth, anteriorly to the apex-

of the sinuosity form a very extensive anteriorly antecurrent curve, with forward facing convexity, the direction of which does not become completely vertical until it reaches the commencement of the stem along which the lines are continued straight and vertical.

The aperture is moderately large, oval-lanceolar, posteriorly angulated, anteriorly contracted into the canal. The columella, anteriorly to the base of the penultimate whorl, is at first vertical, after which, with a broad convex bend at the entrance of the canal, it continues up to its extremity in a direction slightly oblique towards the left of the shell. The narrow columellar lip is moderately callous posteriorly, thinner anteriorly. The outer lip is normal to the suture, or even slightly retrocurrent. The apex of the rather angular, deep, broad sinus, is slightly anterior to the main spiral incision. Anteriorly to the sinus, the outer lip is strongly prominent.

*Dimensions.*—The restored dimensions of two specimens are as follows:—

	mm.	mm.
Height . . . . .	68	34
Thickness . . . . .	25	12
Height of spire . . . . .	35	18
Height of body-whorl . . . . .	42	20

*Comparison with other species.*—This shell is very closely related to the living *Clavatula turus* [Chemnitz], from the Cape of Good Hope. Its later spire-whorls lack the slight anterior nodosities which are regarded as characteristic of the recent species. The characteristic spiral sulcus is shallower in the living shell than in the fossil and occupies a relatively more anterior position.

In the specimens above described, the spire-whorls, anteriorly to the main spiral incision, are very slightly more convex than in Cossmann's type in which the corresponding surface is practically conical.

*Occurrence.*—Mekran beds, west of Gharh Hill.

CLAVATULA (CLIONELLA) SINUATA [Born], var. ARABICA nov. var.  
Pl. XII. fig. 3.

1780. *Buccinum sinuatum* Born.—Test. Mus. Cæs., p. 268.

1822. *Pteroloma buccinoides* Lamarck.—An. sans vert., VII, p. 94.

Rather large, with broadly conical spire measuring three-fifths of the total height, and with broad, anteriorly attenuated body-whorl.



The protoconch, missing in the available specimens, is followed by seven or eight spire-whorls, the height of which slightly exceeds half their height; the maximum thickness coinciding with their anterior margin. The linear, shallow, slightly wavy sutures are surrounded by a narrow sloping rim, the crest of which is occupied by a fine spiral thread, while the slope between this thread and the suture is subdivided by spiral incisions into two or three still finer spiral threads. The crest of the narrow circumsutural rim forms the posterior edge of a narrow shallow furrow corresponding with the accretions to the apertural notch. Anteriorly to the shallow sinus groove, the remaining surface of the whorl, constituting by far the greater portion of its total height, forms a steep slope, so slightly convex as to be practically conical, decorated with rather steeply oblique, anteriorly antecurrent ribs, somewhat angular, and approximately of the same width as the intervening spaces, extending up to the anterior margin, and practically straight, except for a very short distance at their slightly swollen terminations against the sinus groove where their obliquity slightly increases retrocurrently towards the groove. From the crest of the circumsutural rim to the anterior margin, the whole surface is covered with crowded, raised, spiral lines, of about the same width as the intervening spaces, rather thinner and more crowded on the sinus groove than on the anterior ribbed slope.

The broad body-whorl exceeds only slightly half the total height. Posteriorly it exhibits the same conical shape as the spire-whorls. Anteriorly to the level of the suture it contracts rapidly with a flattened convexity passing into a short concavity followed by the terminal notch. The ribs, which may become either more crowded or else fewer on the body-whorl, and, in either case, generally less prominent, are continued upon the anterior convexity upon which their direction gradually becomes normal, and do not disappear until the anterior concavity is reached, close to the termination of the shell. The spiral striations continue all over the base.

The aperture is short and broad. The columella, anteriorly to the base of the penultimate whorl is short, vertical, and straight. The columellar lip is thin, but distinctly demarcated. The rather small and rather shallow sinus is quite close to the suture against which the outer lip terminates normally. Anteriorly to the sinus, judging from the disposition of the lines of growth, the outline of

the outer lip forms a broad convexity projecting considerably further forward than its posterior termination.

*Dimensions.*—The approximate restored measurements are as follows:—

	mm.
Height . . . . .	38
Thickness . . . . .	15
Height of spire . . . . .	23
Height of body-whorl . . . . .	21

*Occurrence.*—Mekran beds. West of Gharh Hill.

*Comparison and remarks.*—Except for its somewhat smaller size, this shell does not appreciably differ from the living South-African species. The published figures and descriptions of the living form are not sufficiently detailed for ascertaining whether the narrow inconspicuous circum-sutural rim is disposed in exactly the same manner as in the fossil. If, on comparison with actual specimens, this feature is found to be identical, the separation of the Mekran shell as a distinct variety may probably be considered superfluous.

As with the above-described species, *Clavatula sacerdos*, we have here another interesting instance of a South-African shell having lived, in upper Tertiary times, along the northern coasts of the Arabian Sea.

#### SURCULA TUBERCULATA [Gray].

1839. *Pleurotoma tuberculata* Gray.—Zool. Beech. Voy., p. 120.

1845. *Pleurotoma punctata* Revc.—Proc. Zool. Soc., p. 111.

1900. *Surcula punctata* [Revc.].—Cossmann, Journ. Conch., Vol. XLVIII, p. 34, Pl. III, figs. 3-5.

Medium to fairly large, with more or less broadly conical, somewhat stepped spire measuring about half the total height, and with large body-whorl, anteriorly terminated by a canal of medium length.

The minute protoconch, imperfectly preserved in all the available specimens, is followed by about ten spire-whorls, the height of which is equal to two-fifths of their width, the maximum thickness being situated quite close to the anterior margin. The sutures are linear and inconspicuous, often slightly and very finely wavy. They are surrounded by a moderately broad, moderately prominent rim, smooth in some specimens, slightly nodose in others. At the earliest stages of growth its crest is occupied by a spiral thread. With increasing growth, a second thread appears between

the first one and the suture, at first narrower than the original thread, but becoming equal to it at full grown stages when the intervals between the two threads and between the second one and the suture become occupied by minute spiral raised lines numbering two or three in each interval. Anteriorly to the circumsutural band, the whorls are divided into two portions of about equal height. Of these two subdivisions, the posterior one, corresponding with the sinus band, is concave, with a varying degree of curvature from one specimen to another, the surface, in certain specimens, being an almost conical slope, expanding anteriorly. The anterior subdivision is convex. At its junction with the sinus band the posterior edge of the convex portion is very prominent and forms a pronounced angulation anteriorly to which the surface may be almost cylindrical and gradually contracting towards the anterior margin, in which case the maximum thickness of the whorls is close to the angulation, or else the outline may be more evenly convex, when the greatest thickness of the whorls is situated about halfway between the angulation and the anterior margin. It is the prominence of this anterior convexity that communicates to the spire its somewhat stepped appearance. The anterior convexity carries numerous prominent short ribs or nodes, steeply oblique and anteriorly antecurrent, almost vertical in some specimens. They are thickest close to their posterior termination, and end abruptly against the sinus band. Anteriorly they often reach the anterior suture, causing the slight waviness of the suture line, or else they may show a tendency to bifurcate, or break up into a number of narrow ribs or raised lines of growth. According to the stage of growth of the shell they are crossed by from three to five spiral threads of approximately the same width as the intervening spaces, which may be all of approximately equal strength or else more or less distinctly alternating in two orders. In those specimens in which the ribs terminate anteriorly before reaching the anterior margin, there occurs, next to the suture, and usually more or less encroached upon by it, a thread thicker than those which cross the ribs, and bearing granules. Fine spiral threads decorate the sinus band. Their disposition varies a great deal in different specimens. They are usually crowded and uniform and practically contiguous; in other instances they are separated by distinct intervals. Occasionally they are flat and ribbon-like. All these spiral ornaments, both on the sinus band and on the

anterior convexity are cut up into elegant granules by the fine lines of growth which form a deep sinuosity on the sinus band, and which, on the anterior convexity, are anteriorly antecurrent, more oblique than the ribs, and reach the anterior margin antecurrently.

The large body-whorl equals from three-fifths to two-thirds of the total height. Posteriorly it repeats the features of the spire whorls. Anteriorly to the ribbed portion it exhibits a short flattened convexity rapidly contracted into the concavity of the neck continued into the terminal tapering stem which is of medium length and slightly tortuous at its extremity. Posteriorly, the portion corresponding with the spire bears the same ornaments as the last spire-whorl. The short ribs either terminate anteriorly against the prominent granular thread which is usually visible against the anterior suture of the later spire-whorls, or else they cease just before reaching it. Almost coinciding, as it does, with the suture line, this strongly granulated thread practically forms the boundary of the base upon the convexity of which it is followed by two more still more prominent granulated threads which are more conspicuous than all the spiral threads of similar character which follow them on the concavity of the neck and the anterior stem. Numerous fine intercalary spiral ornaments sometimes alternating fairly regularly in several orders, occupy all the intervals between the main spiral threads. All the main threads are conspicuously granulated by equally spaced raised lines following the direction of the lines of growth: from the posterior angulation of the body-whorl to the more anterior of the two most prominent threads of the convexity of the base, the lines form a curve with forward directed convexity and anteriorly antecurrent up to the above-mentioned thread which they reach vertically. They are slightly retrocurrent on the concavity of the neck, and once more become vertical on the terminal stem.

The aperture is lanceolar, posteriorly angulated, anteriorly contracted into the terminal canal. The columella is at first practically straight and very slightly oblique; at the junction of the main portion of the aperture with the terminal canal, it exhibits a slight bend which slightly increases its anterior obliquity towards the left side of the shell in its terminal portion. The columellar lip is narrow and thin, though it has a distinctly demarcated, slightly

raised edge. The outer lip meets the suture normally. Anteriorly to the deep narrow sinus, it is strongly prominent.

*Dimensions.*—The following are the dimensions of two specimens from the Mekran beds:—

	mm.	mm.
Height . . . . .	40	20
Thickness . . . . .	15	9
Height of spire . . . . .	22	11
Height of body-whorl . . . . .	23	13

The most conspicuously variable proportion is the relative thickness, in consequence of which the spire assumes a rather narrow-conical shape in many specimens, while it appears somewhat broadly-conical in others.

*Comparison with other species and remarks.*—This species is very closely related to *Surcula javana* [Linn.] (= *Surcula nodifera* [Lam.]) the genotype of *Surcula*, from which it is distinguished by its somewhat smaller size, its decidedly more prominent anterior tuberculated swelling, and its granular ornamentation. From Pangkah, in the Tegal district of Java, Martin has described a variety *tegalsensis* of *Surcula javana* which has a granular base (Samml. des geol. Reichs-Mus. in Leiden, new series, Vol. I, p. 28, Pl. V, figs. 70, 71), nevertheless, as regards the disposition of the tubercles of the spire-whorls, it agrees with *Surcula javana* and not with *Surcula tuberculata*.

The above-described fossil occurs abundantly in the Tertiary beds of Karikal from which it has been described and figured by Cossmann as *Surcula punctata* Reeve. From the somewhat schematic figures of Tryon's Manual it would appear as though *Surcula tuberculata* lacked the characteristic granules that ornament the base of *Surcula punctata*. From an examination of actual specimens Tryon had no hesitation in uniting both forms, a conclusion that has been borne out by an examination of the shells preserved in the British Museum, where it may be noticed that the specimens which Gray himself has labelled as *Pleurotoma tuberculata* all have a granulated base. Tryon's illustration of *Surcula tuberculata* is a very imperfect copy of a figure published by Reeve, which, though itself not very satisfactory, yet shows perfectly distinctly the granulations of the base which, moreover, are specially mentioned in the text. The figure of *Surcula tuberculata* published by Reeve represents a much more elongate shell than the type-figure of *Surcula punctata*. The degree of elongation of

the shell is precisely the most variable character of this very variable species, and similar differences are observed in all large series of specimens of this shell, both fossil and recent; Reeve's two illustrations approximately coinciding with the two extremes.

*Occurrence.*—This is one of the most abundant amongst the Mekran fossils: north of Talar Gorge, on the road from Kej to Gwádar, base of the sandstones constituting the Talar Mountains; between Kanderi and Sari Dasht in Kulanch.

*SURCULA TUBERCULATA* var. *VOYSEYI* [d'Archiac and Haime].

1850. *Pleurotoma* indet. d'Archiac.—Hist. progr. Géol., III, p. 291.

1854. *Pleurotoma voyseyi* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 305, Pl. XXIX, fig. 10.

non *Surcula voyseyi* [d'A. and H.] in Cossmann and Pissarro, Pal. Ind., new series, Vol. III, part 1, p. 7, Pl. I, figs. 25 28.

The differences between this fossil and *Surcula tuberculata* are so slight as to scarcely suffice for the definition of a variety. The circumsutural rim is more distinctly nodose than in the majority of specimens of *Surcula tuberculata*. Of the two threads which, with advancing growth decorate the circumsutural rim of *Surcula tuberculata*, the second one, that is the one nearest the suture, in most specimens, though not in all, eventually tends to assume the same importance as the first. In *Surcula voyseyi*, the first thread maintains its preponderance with increasing growth until it eventually splits into two threads, so that, in the full-grown shell, to the two circumsutural threads of the typical form of *Surcula tuberculata*, three correspond in *Surcula voyseyi*. The thickest portion of the anterior ribs coincides more exactly with their posterior termination in *Surcula voyseyi* than in the typical specimens of *Surcula tuberculata*; consequently they terminate somewhat more abruptly against the sinus band, and communicate to the spire a slightly more stepped appearance. Apart from these slight differences, all the other characters coincide exactly with those of the typical form.

*Dimensions.*—The following are the approximate dimensions of d'Archiac and Haime's type from Blagrave's collection from the Gáj beds of the neighbourhood of Karachi, and of a second specimen from Baker's collection from the same locality:—

	mm.	mm.
Height . . . . .	35	18
Thickness . . . . .	13	7
Height of spire . . . . .	18	9
Height of body-whorl . . . . .	22	12

*Remarks.*—A beautiful species of *Surcula* also from Sind, but from the lower Eocene Ranikot beds, has been referred by Cossmann and Pissarro (*loc. cit.*) to d'Archiac and Haime's species. The identification was made by reference to the type-figure. A comparison with the original type and with Baker's topotype, has shown that the Ranikot species is specifically different. It has a much more elongate base, and bears much coarser, wider-spaced, and more coarsely and irregularly granular threads on the anterior part of the spire-whorls and on the base. It lacks the distinct threads of the circumsutural rim, and it carries only half the number of axial costæ. Cossmann and Pissarro have commented upon the resemblance between the Ranikot fossil and the forms belonging to the group of *Surcula dentata* [Lamk.] from the Paris Eocene. The Ranikot species may be distinguished as *Surcula blagrovei*.

*Occurrence.*—Gáj of Sind, Karáchi, Blagrove and Baker collections.

#### PLEUROTOMA ICKEI Martin.

Pl. I, figs. 8, 9.

1906. *Pleurotoma* (s. str.) *ickei* Martin.—Samml. des geol. R.—Mus. in Leiden, new series, Vol. I, p. 293, Pl. XLIII, fig. 703.

Rather large, slender, with elongate conical spire measuring nearly three-fifths of the total height, and with rather large body-whorl, posteriorly globose, anteriorly rather abruptly contracted into a narrow, rather elongate stem, either straight or else steeply tortuous towards its extremity.

The protoconch slightly oblique to the axis of the spire proper, is conoidal, and consist of a minute nucleus followed by four convex whorls, the two first of which are smooth, while the two newer whorls are decorated with numerous somewhat oblique ribs, stretching from suture to suture, anteriorly antecurrent, and moderately curved with forward directed concavity. It is quite clear that these ribbed whorls belong, not to the spire proper, but to the protoconch, for they fully share its obliquity. There is a perfectly abrupt transition to the spire-whorls proper, the number of which is nine. Their height is equal to half their thickness or a little less, the thickness being measured across the spiral ridges. The maximum thickness corresponds with the most anterior of the

three most important spiral ridges, and is therefore situated much nearer to the anterior than to the posterior margin of the whorls. Omitting the prominences of the spiral ornaments, the outline of the whorls is regularly and very feebly convex. The sutures are very narrow, linear, sharply incised. Apart from the lines of growth, the ornamentation is entirely spiral. The anterior and posterior margins are each bounded by a very fine thread so that the sutures lie in a very narrow groove between a pair of spirals belonging to two adjacent whorls. In addition to these marginal threads, each whorl carries three principal spiral ridges. Of these three principal ridges, the more posterior one is situated in the immediate vicinity of the posterior sutural thread, while a rather broad interval separates the anterior one from the anterior marginal thread. The intermediate principal ridge corresponds with the accretions to the apertural notch. In some specimens it is situated exactly midway between the other two principal ridges; in other instances it is a little nearer to the posterior principal ridge than to the anterior one. In the earliest whorls the sinus ridge is delicately granulated, but throughout the greater portion of the shell it is smooth, and not distinguishable from the other principal keels except in a few specimens where it is characterised by the presence of a median furrow. Of the three main ridges in each whorl, each one projects a little further than the remainder according as it is more anteriorly situated. The progression is particularly gradual in the earlier part of the spire which thereby acquires a remarkably regular conical shape, the spacing of the ridges being so even and their increasing degree of prominence so consistent that it is difficult to distinguish one whorl from another. Towards the end of the spire of full-grown specimens, there is a tendency for the degree of prominence of the two most anterior ridges to become more nearly equal. A mere groove separates the posterior principal ridge from the posterior sutural thread to which it is almost adjacent. The two intervals between the main ridges and that between the anterior main ridge and anterior marginal thread, are regularly concave, and are decorated with more or less crowded, extremely fine raised spiral lines forming, by their intersections with the fine crowded lines of growth, a very elegant minutely chagreened or rasp-like trellis. The lines of growth are normal or very slightly antecurrently oblique to the posterior suture. They are retro-current from either side towards the rounded sinuosity that crosses



the sinus ridge. They are antecurrent towards the anterior margin.

The large body-whorl measures from four-sevenths to three-fifths of the total height. It exhibits posteriorly a globose spherical convexity connected by a well-defined, rather short concavity with the narrow, tapering, rather long anterior stem corresponding with the apertural canal, the termination of which is truncated almost horizontally, with only a slight degree of obliquity facing towards the right of the shell. In some specimens the stem is practically straight, the zone of accretions to the terminal truncation not interfering appreciably with the straightness of outline, although differentiated by its ornamentation. In other instances, the zone of accretions forms a very steeply twisted, very feebly prominent swelling, forming a slight bulge at about half the height on the left side of the stem the extremity of which it causes to be very slightly deflected dorsally.

The posterior portion of the body-whorl carries the same decoration as the spire-whorls. The anterior thin marginal thread of the spire, as it runs free of the suture, becomes a ridge equal to the three main spiral ridges of the spire. On the short spherical convexity of the base, it is followed first by a space of about the same width as the spaces between the principal spire-ridges, and similarly decorated with very thin raised spiral threads. The anterior part of the convexity carries a pair of rather close-set main ridges the space between which also carries fine raised spiral lines. The following short concavity only carries fine spiral threads which may be of one or of several sizes. The anterior stem carries rather wide-spaced main spiral threads, thinner than the main ridges of the convex portion of the body-whorl. The intervals between the main spiral lines of the stem are either of the same size as those of the convex part of the body-whorl, or else may be rather thicker. The main threads of the stem may be all of one size or of two alternating sizes. Their spacing decreases in an anterior direction. The terminal zone of accretions carries rather close-set spiral threads of about the same thickness as the main threads of the stem, which may be all of one size, or of two alternating sizes. All the finer spiral ornaments of the body-whorl are trellised and granulated by the lines of growth. Anteriorly to the sinus ridge, the lines of growth are at first strongly oblique and anteriorly antecurrent, forming a forward directed concavity. Their obliquity decreases in an anterior direction, till their course becomes normal on reaching

the pair of main spiral ridges of the anterior part of the convexity. On the following concavity. they are, at first, slightly retrocurrent, and then once more resume a vertical course which they maintain on the anterior stem until they become once more retrocurrent on the terminal zone of accretions.

The aperture is oval-lanceolar, posteriorly angulated, anteriorly contracted into the narrow canal which is steeply oblique anteriorly towards the left of the shell. The columella, which joins the base of the penultimate whorl somewhat abruptly, is vertical and straight up to the commencement of the canal, when, with a broad convex bend, it becomes oblique anteriorly towards the left of the shell. The columellar lip is narrow, very thin, practically absent towards the posterior termination of the aperture. The outer lip, at its posterior termination, is slightly antecurrent to the suture. The notch is moderately deep and not very narrow, and is surrounded by a small raised rim. The outer lip, judging from the direction of the lines of growth, is strongly prominent anteriorly to the notch. The inner walls carry three feebly prominent, narrow ridges corresponding approximately with the main ridge anterior to the sinus ridge, the ridge limiting the thread corresponding to the anterior marginal thread of the spire, and to the pair of spiral ridges of the anterior border of the convexity of the body-whorl.

*Dimensions.*—The specimens from Western India, although well preserved, lack the anterior termination of the shell. Several complete specimens have been obtained by M. R. Ry. Sethu Rama Rao, from the Prome Series of Burma. The following measurements were taken from specimens from two different localities:—

	Thanga. Myaukmigon.	
	mm.	mm.
Height . . . . .	46	42
Thickness . . . . .	15	14
Height of spire . . . . .	27	24
Height of body-whorl . . . . .	27	24

*Comparison with other species.*—This species resembles *Pleurotoma virgo* Lamk. from the China seas.<sup>1</sup> In the recent species

<sup>1</sup> The comparison with the recent species was made at the British Museum, and, unless there has been some confusion in my notes, the locality "China seas" must correspond with that indicated for the British Museum specimens. In Tryon's Manual, the habitat of *Pleurotoma virgo* is stated to be the West Indies.

the whorls are much more decidedly convex, so that the spiral ridge corresponding with the apertural notch projects more than any of the others; in the fossil, owing to the more nearly conical shape of the whorls, the anterior principal spiral ridge generally projects more than the one carrying the accretions to the sinus.

Compared with the living *Pleurotoma fascialis* Lamk. of the eastern seas, and the fossil *Pleurotoma pseudofascialis* Martin from the upper Miocene of Selatjau in Java (Samml. des geol. R.-Mus. in Leiden, Vol. I, p. 226, Pl. X, fig. 22; new series, Vol. I, p. 35), *Pleurotoma ickci* is distinguished by the shorter and anteriorly more abruptly contracted convexity of its body-whorl, its narrower and longer anterior stem, its more conical spire-whorls, and various details of the ornamentation.

Compared with the specimens of *Pleurotoma ickci* Martin from the Miocene beds of Tjadasngampar on the Tji Longan in Java, the beautiful shell above described agrees in every essential character, with the exception of the crenulations of the sinus ridge which disappear at an earlier stage in the Indian specimens, both from Kachh and from Burma, than in the Javanese type. Should it therefore be considered necessary to distinguish the Indian specimens, they might be taken to represent a variety *virginoides*. The intercalary spiral decoration is more crowded and profuse in the Burmese specimens than in the type, while the Kachh specimens exactly agree in this respect with the Javanese form.

*Occurrence.*—Gáj of Kachh. Teyra River near Rampur (23° 20', 68° 51'); south bank of river from Teyra (23° 17', 68° 58'). Also in beds of the same age in Burma.

#### PLEUROTOMA HAYDENI n. sp.

Pl. IX, figs. 3-5.

Large, somewhat ventricose, with broadly conical spire slightly exceeding half the total height, and with large body-whorl anteriorly terminated by a rather elongate stem.

The apex is missing. The number of spire-whorls following the protoconch is probably about nine. Their height is about equal to half their thickness, or very slightly more. The situation of the zone of greatest thickness varies at different stages of growth and in different specimens. Leaving out of account the spiral

ornaments, the earlier whorls are almost perfectly conical, and this condition persists, in some specimens, up to a fairly advanced stage of growth. The convexity increases with growth, more so in some specimens than in others, and may become somewhat pronounced in the last spire-whorl of some full-grown specimens. The raised keel that coincides with the accretions to the sinus, and which is situated somewhat nearer to the anterior than to the posterior margin, generally constitutes the most prominent portion of the whorls. Nevertheless, owing to the exactly conical outline of the general surface of the earlier whorls, the width, at the anterior margin, at the early stages of some specimens, is actually greater than across the sinus ridge, in which case the thickest part of the whorl actually coincides with the anterior margin. Again on the last spire-whorl of some full-grown specimens, the sinus-ridge may lose its pronounced prominence, and this circumstance, combined with the development of a distinctly convex outline of the surface, may carry the greatest thickness into a position slightly anterior to the sinus ridge.

The sutures are linear and inconspicuous, practically lost amidst the profuse spiral ornaments. The earliest whorls carry two conspicuous spiral ridges, one of which encircles the suture, while the other which is the more prominent of the two, and which corresponds with the accretions to the apertural sinus, is at a little distance from the anterior margin. These two main threads maintain more or less their supremacy up to the termination of the spire, though, in certain specimens, owing to the equalisation of the numerous additional spiral ornaments, they are difficult, at first sight, to identify. At the earliest stages of growth, the sinus ridge exhibits some faint traces of crenulations. It is, afterwards, smooth. On the earliest spire-whorls, in addition to the two main keels, there is a fine spiral thread along the anterior margin; there are also two fine spiral threads between the two main keels. With increasing growth these intercalary threads assume more prominence; an additional thread appears between the posterior main keel and the suture, and another, anteriorly to the sinus ridge, in the space separating it from the anterior subsidiary thread. The increase of convexity of the later spire-whorls is largely due to a shortening of the posterior surface of the whorl, in consequence of which a greater portion of the anterior marginal portion of each preceding whorl becomes uncovered, disclosing an

additional anterior thread. Consequently, at later stages of growth, there may be three spiral threads between the sinus ridge and the anterior margin: the original marginal thread, the intercalary thread which first appears somewhat later, and finally a further anterior thread disclosed in consequence of the change in shape of the whorls. In certain specimens, the number of threads anteriorly to the sinus ridge eventually rises to four, and there may be three between the sinus ridge and posterior main keel, two between the posterior main keel and the suture. At late stages of growth, many of these threads may tend to become almost equal in prominence to the two original ridges, though not according to any uniform law, and there are many variations in different specimens. In the intervals between all these threads and ridges, on the last spire-whorls of full-grown specimens, there may be additional fine spiral lines, the number of which varies a great deal from one specimen to another. The lines of growth are very inconspicuous. They are steeply antecurrent or normal to the posterior suture, obliquely antecurrent to the anterior margin, and form a deep sinus across the sinus ridge.

The large body-whorl measures nearly three-fifths of the total height. It exhibits posteriorly a globose convexity, rather rapidly contracted anteriorly into the rather short concavity which connects it with the anterior stem which is of medium thickness, apparently of medium length, and the preserved portion of which is straight. The sinus ridge becomes bifid on the body-whorl of some specimens. All the other ornaments, on the posterior portion of the body-whorl corresponding with the spire, are similar to those of the last spire-whorl. Anteriorly to the level of the suture, the ornamentation of the body-whorl includes spiral ridges the prominence and spacing of which are about the same as the average on the posterior portion of the body-whorl. Each interval is usually bisected by a thread of a second order, and the remaining spaces are more or less profusely lined. This decoration occupies the convexity of the base, the following concavity, and the anterior stem as far as preserved. The lines of growth gradually become less oblique anteriorly to the level of the suture, till they become vertical at the junction of the convexity and concavity of the base. They become very slightly retrocurrent on the concavity,

and on reaching the terminal stem, resume their vertical course which they maintain as far as the shell is preserved.

The aperture is moderately large, oval-lanceolar, posteriorly angular, anteriorly contracted into the terminal canal. From the base of the penultimate whorl to the origin of the canal, the columella is vertical and straight. Its anterior portion is missing in all the available specimens. The columellar lip is narrow and very thin. The outer lip, judging from the lines of growth, is strongly prominent anteriorly to the apertural notch.

*Dimensions.*—The following are the restored dimensions of the most complete specimen available:—

	mm.
Height . . . . .	59
Thickness . . . . .	21
Height of spire . . . . .	31
Height of body-whorl . . . . .	36

The shell also attains larger dimensions, one specimen reaching a thickness of 25 mm., corresponding with a total height of about 70 mm.

*Occurrence.*—Mekran beds, west of Gharh Hill.

*Comparison with other species.*—In its general outline, and in the profuse character of its spiral decoration, this species bears some resemblance to *Pleurotoma sondeiana* Martin from the Pliocene beds of Sondé in the Gendingan district of Java (Samml. des geol. R.-Mus. in Leiden, new series, Vol. I, p. 35, Pl. VI, fig. 89). The Javanese species has a more elongate spire, and differs in the disposition of some of its essential features: the sinus ridge is situated much further from the anterior margin from which it is separated, even at early stages of growth by a very prominent revolving keel corresponding with the greatest width of the whorls, and quite unrepresented by any corresponding feature in *Pleurotoma haydeni*. The sinus band is more distinctly crenulated at early stages of growth in *Pleurotoma sondeiana* than in *Pleurotoma haydeni*.

Compared with living species, this shell is very closely related to *Pleurotoma deshuyesi* Doumet from the China seas. The living species, as represented by shells from Hongkong in the collections of the Indian Museum, is distinguished by a more elongate spire, a more delicate, more profuse and more equal spiral ornamentation, and a more consistently and more distinctly bifid sinus ridge.

PLEUROTOMA (HEMIPLEUROTOMA) YEMANENSIS Noetling var.  
 NARICA n. var.

Pl. I, fig. 7.

1895. *Pleurotoma yemanensis* Noetling—Mem. Geol. Surv. Ind., Vol. XXVII, part 1, p. 42. Pl. X, fig. 3.  
 1901. *Drillia yemanensis* Noetling.—Pal. Ind., new series, Vol. I, part 3, p. 353. Pl. XXIII, fig. 5.

Fairly large, very elongate, with slender conical spire measuring nearly seven-elevenths of the total height, and with narrow body-whorl anteriorly contracted into a narrow stem corresponding with the terminal canal.

The apex is missing. The number of spire-whorls following the protoconch is probably about ten. Their height is about half their thickness, or very slightly more. The greatest thickness measured across the spiral ridges is at about half the height of the whorls and corresponds with the sinus ridge, but the general convexity of the outline is very feeble. The sutures are linear and inconspicuous. The spire-whorls are bordered both anteriorly and posteriorly by a narrow, delicate raised margin, so that the sutures appear to lie in a narrow groove between a close-set pair of fine spiral threads. On each spire-whorl there are three principal prominent spiral ridges, together with several spiral threads of a second and third order of magnitude. Of the three principal ridges, the posterior one is quite close to the posterior margin, while a fairly broad space separates the anterior one from the anterior margin. The intermediate principal ridge, which is more or less bifid, and which corresponds with the accretions to the sinus, is nearer to the anterior principal ridge than to the posterior one. Feebly prominent broad crenulations occur at regular intervals along the sinus ridge. They tend to become effaced towards the end of the last spire-whorl. A mere groove separates the posterior main ridge from the posterior sutural spiral thread. The concave anteriorly expanding space between the posterior main ridge and the sinus-ridge, carries five spiral threads of alternating size, finely granulated at their intersections with the fine lines of growth. The vertical surface between the sinus ridge and anterior main ridge carries a thread of a second order of magnitude situated closer to the sinus ridge than to the anterior main ridge and accompanied by one or two spiral lines of a third order. Two or three

fine spiral lines also occur on the anteriorly contracting conical surface between the anterior main ridge and the anterior margin. The fine regularly-spaced lines of growth are normal to the posterior suture. They are strongly retrocurrent from either side towards the sinus ridge, anteriorly to which they are very oblique, reaching the anterior suture antecurrently.

The body-whorl measuring half the total height of the shell is narrow. Its main portion constitutes a somewhat elongate ovoid convexity succeeded anteriorly by a shallow convexity gradually passing into the anterior tapering narrow stem the anterior termination of which is missing. The ornamentation of the posterior part of the body-whorl corresponds with that of the spire except that the sinus ridge no longer bears any crenulations, these being replaced by lines of growth. The suture, at its termination, discloses a fourth main spiral ridge, practically level with the suture line. It is followed anteriorly, first by a space almost equal to those between the spiral ridges of the spire, and then, along the anterior border of the convexity by a pair of somewhat closer-set main spiral ridges. Another main spiral ridge decorates the anterior concavity, being situated nearer to its posterior than to its anterior margin. The terminal stem bears main spiral ridges succeeding one another at intervals about equal to the average width of the spaces between the other main threads. With the exception of the interval between the pair of ridges decorating the anterior border of the convexity, which appears to be smooth, all the intervals, anteriorly to the level of the suture, are divided more or less symmetrically by a thread of a second order of magnitude, flanked, on either side, by a thread of a third order. All the spiral ornaments of the body-whorl are decussated, and, the finer ones especially, more or less granulated by the crowded, fine, raised lines of growth. On the posterior part of the body-whorl they follow the same course as on the spire-whorls. Anteriorly to the level of the suture their obliquity decreases, till they become normal at the anterior edge of the convexity of the base. They are imperceptibly retrocurrent on the following concavity and once more vertical and straight on the anterior stem.

The aperture is rather small, narrow, oval-lanceolar, posteriorly narrowly angulated, anteriorly contracted into the terminal canal. The details of the columella and columellar lip are concealed by a hard, adherent, calcareous incrustation. The outer lip is steeply



antecurrent, almost normal to the suture. The apertural notch is deep and very narrow. Anteriorly to the notch, the outer lip is convex and projects forward considerably beyond the level of its posterior termination.

*Dimensions.*—The partly restored measurements of the solitary available specimen are as follows:—

Height . . . . .	mm.
Thicknes . . . . .	54
Height of spire . . . . .	12
Height of body-whorl . . . . .	34
	27

*Comparison with other species.*—Compared with *Pleurotoma yenanensis* Noetling, from the Tertiary of Burma, this shell does not exhibit any differences sufficiently precise to be regarded as of specific value. The type described and figured by Noetling is somewhat less elongate than the specimen above described. Other Burmese specimens exhibit a much broader conical shape and would appear to represent a separate species were it not for the gradation established by those of a more slender build. The species is probably very variable. The greatest thickness of the whorls, in the Burmese specimens, is on a level with the next main spiral keel anterior to the sinus ridge instead of actually coinciding with the sinus ridge as in the Sind specimen. The form above described may provisionally be regarded as a variety *narica* distinguished by its very elongate outline.

This species exhibits the closest resemblance to *Pleurotoma odontophora* von Koenen, from the Oligocene of Lattorf in Saxony. In the Lattorf shell, the next principal keel anteriorly to the sinus ridge immediately borders the anterior margin instead of being separated from it by a space, so that the last spire whorl, where running free from the suture at its termination, comes into full view with only three main keels instead of four as in the Indian shell. The Lattorf shell, moreover, is much smaller. It exhibits the same extreme variations in shape as the Indian species.

It is worth noticing that the anterior thread accompanying the anterior suture of *Pleurotoma yenanensis* which, on the body whorl, becomes finally disclosed as a girdle equal in importance to the three main girdles of the spire-whorls, is always visible throughout all the spire-whorls, and is never completely hidden by the posterior suture of the following whorl even in specimens with exceptionally short

whorls and an exceptionally squat outline; thereby forming a useful distinction from *Pleurotoma sindiensis* which may sometimes resemble some of the more broadly conical specimens of *Pleurotoma yenanensis*.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

PLEUROTOMA (HEMIPLEUROTOMA) BONNETI COSSMANN.

1900. *Pleurotoma (Hemipleurotoma) Bonneti* Cossmann.—*Journ. Conch.*, Vol. XLVIII, p. 30, Pl. III, figs. 1, 2.

A fragment from the Gáj of Kachh, including the protoconch followed by five spire whorls, and the posterior rim of the body-whorl, exhibits the very characteristic shape and ornamentation of this species. A comparison with a number of perfectly preserved complete specimens from the Prome Series of Burma, leaves no doubt as to its correct identification. This beautiful shell is one of the most characteristic species of the Upper Tertiary of India as represented by the Karikal formation regarded as Pliocene. It is, however, represented already by specimens in every respect identical with the type at a low horizon of the Miocene in Burma and in Western India. Cossmann has drawn attention to the fact that it is closely related to certain European Miocene forms such as *Pleurotoma denticulata* Basterot, *Pl. decorata* Bellardi, *Pl. caperata* Bell., *Pl. bellatula* Bell.

*Occurrence*.—Gáj of Kachh: near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45'). Also at the same horizon in Burma. Also in the Pliocene of Karikal.

PLEUROTOMA (HEMIPLEUROTOMA) BONNETI var. BHAGOTHORENSIS n. var.

Pl. XII, fig. 5.

Small, somewhat pupoidal, with rather broad conoidal spire measuring rather less than five-eighths of the total height, and with rather large body-whorl anteriorly contracted into a relatively short stem.

The protoconch, the apex of which is missing, is moderately large and is slightly oblique to the axis of the remainder of the shell. Its earlier whorls are smooth. Its last whorl which is moderately convex carries crowded thin angular ribs, stretching from suture to suture,

practically vertical and straight except at the termination of the protoconch where the two last ribs are slightly curved with forward directed concavity. The transition between the protoconch and the spire proper is abrupt. The number of spire whorls following the protoconch is from four-and-a-half to five. Their height, at the later stages of growth is equal to about three-sevenths of their width, being slightly less in the earlier whorls in consequence of the slightly pupoidal shape of the shell. The maximum thickness is situated at about half the height of the whorls and corresponds with the sinus ridge. The sutures are narrow, linear, inconspicuous, surrounded by a prominent rim the crest of which consists of a spiral thread crenulated by the intersection of short oblique ribs anteriorly retrocurrent. A rather deep narrow concavity separates the circumsutural rim from the rather broad prominent sinus band which consists of a pair of crenulated spiral threads, the crenulations being connected by short vertical ribs. These ribbed crenulations of the sinus band correspond with those of the circumsutural rim from which, in some specimens, they are entirely separated by the intervening concavity, while in other specimens, they are connected, across the concavity, by narrow, very oblique ridges coinciding in direction with the lines of growth. In consequence of this obliquity, the crenulations of the circumsutural and sinus bands do not truly correspond vertically, the true equivalent of each sinus crenulation being one step forward on the circumsutural rim. Two very fine spiral raised lines are observed along the concavity between the circumsutural and sinus bands. The anteriorly slightly contracting slope anteriorly to the sinus band carries, at later stages of growth, two spiral threads one of which coincides with the anterior margin of the whorl and abuts against the suture. Both are granulated by the intersections of fine oblique rod-shaped ribs forming the anterior continuation of the crenulations of the sinus band. At early stages of growth only one of these anterior threads is visible, the more anterior one being concealed by the margin of the subsequent whorl.

The rather large body-whorl measures rather less than five-eighths of the total height. Anteriorly to the sinus band it contracts anteriorly with a hemispherical to ovoid shape connected by a broad rather shallow concavity with the terminal short stem. The ornamentation of the posterior part of the body-whorl corresponds with that of the last spire-whorl. Anteriorly to the pair of spiral threads continued from the anterior part of the spire-whorls, the convex

portion of the base carries two more principal threads at slightly wider intervals. Of the two intervals which they determine, the more posterior one, that is the one situated immediately anteriorly to the level of the suture, is bisected by a fine intercalary raised thread. Two more slightly thinner principal threads decorate the following concavity, and are followed by similar ornaments on the terminal stem. All these spiral ornaments, anteriorly to the sinus band, are coarsely granulated at their intersections with the raised axial lines or ribs forming the anterior continuation of the crenulations of the sinus-band. Their course, anteriorly to the sinus-band is at first anteriorly antecurrent, curved, with forward directed convexity. As the lines or ribs are followed anteriorly, their obliquity decreases until, on reaching the margin of the concavity of the base they become vertical, continuing with a slightly retrocurrent obliquity across the concavity.

The aperture is rather narrow in consequence of the great prominence of the outer lip. The details of the columella and columellar lip are rather concealed by an adherent rocky incrustation. The outer lip is normal to the suture. The apertural notch is deep, rather narrow, with parallel margins. Anteriorly to the notch the outer lip forms a broad convexity through an arc of 90° beyond which it is practically vertical or very slightly retrocurrent.

*Dimensions.*—

Height . . . . .	mm.
Thickness . . . . .	10.5
Height of spire . . . . .	5
Height of body-whorl . . . . .	6.4
	6.4

*Comparison with other species.*—This is evidently a premutation of *Pleurotoma bonneti*, and the differences are scarcely sufficient to allow of specific distinction. The principal difference is the structure of the circumsutural rim which is somewhat narrower in the variety *bhagothorensis*, with more of a ridge-like disposition than in the type in which it assumes more of the appearance of a raised band usually subdivided by a furrow, occasionally by two furrows, isolating either two or three component threads, while it never carries more than one spiral thread in the variety *bhagothorensis*. The dimensions of this variety are also slightly less than those of the type.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

PLEUROTOMA (*GEMMULA*) CONGENER E. A. Smith, var.

MEKRANICA n. var.

Pl. V, figs. 9, 10.

1879. *Pleurotoma coronifer* Martin.—Tertiaerschichten auf Java, p. 61, Pl. XI, fig. 2.
1881. *Pleurotoma coronifera* Martin.—Samml. des geol. R.-Mus. in Leiden, Vol. III, p. 58, Pl. IV, fig. 58.
1891. *Pleurotoma congener* E. A. Smith.—Ann. Mag. Nat. Hist., Ser. VI, Vol. XIV, p. 160, Pl. III, figs. 4, 5.
1895. *Pleurotoma (s. str.) coronifera* Martin.—Samml. des geol. R.-Mus. in Leiden, new series, Vol. I, p. 38.
1917. *Pleurotoma (Gemmula) congener* E. A. Smith.—Vredenburg, Rec., Ind Mus., Vol. XIII, p. 315, Pl. XII.
- non *Pleurotoma coronifera* Bellardi, Moll. terr. terz. Piem. e Lig., 2nd part, p. 34, Pl. I, fig. 20 (1877).

Medium size, with fairly broadly conical girdled spire, measuring five-ninths of the total height, and with moderately large body-whorl anteriorly contracted into a narrow stem.

The small protoconch is slightly oblique to the axis of the remainder of the shell. It is conoidal and consists of a minute nucleus followed by three moderately convex whorls, of which the two first seem smooth, while the third, at least towards its termination, is decorated with close-set thin angular ribs, stretching from suture to suture, practically vertical or very slightly antecurrent in an anterior direction, slightly curved, with forward directed concavity. The transition to the spire proper is abrupt. The number of spire whorls following the protoconch is about eight. Their thickness is equal to about four-ninths of their height, the greatest width being situated somewhat closer to the anterior than to the posterior margin, upon the ridge that corresponds with the accretions to the apertural sinus. The sutures are somewhat sharply incised. They are surrounded by a prominent rim which, from a very early stage of growth, commencing with the second whorl following the protoconch, consists of a pair of prominent spiral cords or ridges, of which the more anterior one is only slightly more prominent and thicker than the one nearest the suture. At full-grown stages, a subsidiary thin raised line may appear along the suture, and an intercalary raised line may also intervene between the two main threads. The circumsutural rim is separated from the sinus ridge by a rather deeply concave surface expanding anteriorly. In many specimens it is decorated with three thin raised spiral lines at all stages of growth up to the end of the spire and even on the full-

grown body-whorl. In other instances their number, at full-grown stages, may gradually increase up to six. These threads may all be approximately equal, or else the most anterior one, that is the one nearest the sinus ridge, may be more prominent than the remainder. The concave surface varies, according to different specimens, both in width and in depth, and may be, in certain instances, so narrow and so deep as to assume the appearance of a groove separating the circumsutural rim from the sinus ridge. The sinus ridge is broad and prominent. It consists of two more or less individualised spiral threads of varying thickness, separated by an interval of varying width and depth. Both threads carry an equal number of crenulations connected by short ribs which, in most instances, are straight and slightly oblique, being anteriorly retrocurrent; in a few instances they are slightly curved, with forward directed concavity. The short interval between the sinus ridge and the anterior margin contracts slightly in an anterior direction. It carries a sharply raised spiral thread close to the anterior edge of the sinus ridge, with or without a varying number of subsidiary fine raised lines. In a few specimens, a second spiral thread appears in immediate contact with the suture, by which, in most instances it is concealed throughout the spire, becoming clearly visible only on the body-whorl. The two principal spiral features, that is the circumsutural rim, and the sinus ridge, project, relatively to their distance from the apex, with about the same degree of prominence, and are so situated as to be consistently interspaced from whorl to whorl, thus communicating to the spire a very evenly conical shape and regularly girdled appearance. The spiral ornaments are decussated by the very fine lines of growth which are steeply antecurrent or normal to the posterior suture, retrocurrent from both sides towards the sinus ridge, and obliquely antecurrent towards the anterior margin.

The fairly large body-whorl measures a little less than five-eighth of the total height. Anteriorly to the sinus band it contract anteriorly with a hemispherical-shaped convexity, connected by means of a short well-marked concavity with the terminal tapering stem. The posterior part of the body-whorl, coinciding with the spire, carries the same decoration as the last spire-whorl: anteriorly to the sinus band there are usually two well marked principal spiral threads, one of which corresponds with the spiral thread which always observed on the spire-whorls anteriorly and close to the sinus band while the other one is on a level with the suture and is onl

occasionally visible on the spire-whorls. The interval between these two threads is usually bisected by a fine raised spiral line. Occasionally the main thread that is situated anteriorly to the sinus-band may lose its individuality on the last spire-whorl and body-whorl, being replaced by three approximately equal, finer threads. In such a case, four subequal threads intervene between the sinus band and the principal thread which is level with the suture. Anteriorly to the level of the suture, the rather short convexity of the base carries, at its anterior border, a further pair of principal threads. The interval between this pair and the thread occupying the level of the suture, and also the interval between the two members of the pair, may or may not carry subsidiary raised lines the number of which may be one or two in each interval. The following concavity carries a varying number of spiral threads, variously disposed and of various thickness, none of which are equal in thickness to the threads of the first order. A principal thread separates the concavity from the terminal stem which, as far anteriorly as it is preserved in all the available specimens, carries a succession of prominent threads the intervals between which are each bisected by a raised line of a second order. All the spiral ornaments of the body-whorl are decussated, sometimes even slightly granulated by the lines of growth which, anteriorly to the level of the suture, gradually become less oblique, until at the anterior edge of the convexity of the base, they assume a vertical direction which they maintain anteriorly as far as the specimens are preserved.

The aperture is of moderate size, broadly lanceolar-oval, posteriorly angulated, anteriorly somewhat abruptly contracted into the terminal canal. Between the base of the penultimate whorl, with which it is connected by a gradual curve, and the commencement of the canal, the columella is slightly oblique, and carries, close to its posterior termination, a broad, blunt spiral fold. The anterior portion of the shell is not preserved in any of the available specimens. The columellar lip is narrow and thin. The outer lip, judging from the lines of growth, is convex anteriorly to the notch. The walls of the shell are internally lirate.

*Dimensions.*—

		mm.
Height	. . . . .	27
Thickness	. . . . .	10
Height of spire	. . . . .	15
Height of body-whorl	. . . . .	16

The species also reaches larger dimensions, one of the specimens reaching a width of 13 millimetres, corresponding with a height of about 34 mm.

*Occurrence.*—Gáj of Kachh; Mekran beds: West of Gharh Hill and between Kanderi and Sari Dasht in Kulanch.

*Comparison with other forms.*—Compared with *Pleurotoma congener* Smith, living in the Bay of Bengal and Arabian Sea at depths of from 120 to 400 fathoms, this fossil is distinguished by its somewhat smaller dimensions. The circumsutural rim, in some of the recent specimens is somewhat crenulated, a tendency also observed in some of the fossils, though to a much feebler degree. The differences are insufficient to establish a specific distinction, and can, at most, be regarded as defining, for the Mekran specimens, a variety *mekranica*. Compared with the Mekran specimens, the Gáj specimens are, apparently, of a still smaller size which if, really characteristic of their horizon, might serve to distinguish them as a variety "*gajensis*." None of them, however, exhibit more than five spire-whorls, and they are, therefore, certainly immature. These Gáj specimens are distinguished from the living representatives of the species by their much smaller protoconch, but the same difference holds good with the Mekran specimens, for, although none of them have the protoconch preserved, their earliest whorls are so much smaller than the first whorls of the spire proper in the living form as to necessarily indicate also a relatively very small protoconch.

Judging from the figures and descriptions, no essential difference can be discovered between this fossil and a shell from the Upper Miocene of Java and Sumatra which Martin has described as *Pleurotoma coronifera* (a name pre-employed by Bellardi in 1877 for a species from the Miocene of Piedmont). The circumsutural rim in the Javanese form is less conspicuously divided into two subequal ridges than is usually the case with the living form and with the Gáj and Mekran specimens. Nevertheless it is expressly described by Martin as consisting of two particularly prominent keels though of different thickness. The relative size of these two keels varies somewhat in the Indian specimens, both recent and fossil, and the keel nearest the suture is generally somewhat thinner than the other. Whatever slight difference there may be in the circumsutural rim of the Javanese form seems insufficient to distinguish it as a species, or even as a variety from the Indian fossil. All the other characters appear to be perfectly identical, including the peculiar swelling of



the posterior portion of the columella which is specially mentioned by Martin, and which has also been noticed by Smith in the recent form.

This peculiar swelling has not been observed in any other species of *Pleurotoma* fossil or recent, while the strongly prominent double circumsutural keel of *Pleurotoma congener* readily distinguishes it from other species of the *Gemmula* group.

*Pleurotoma monile* Brocchi from the Pliocene of Piedmont and of Liguria, especially in some of its varieties, such as the form *granocostata* Sacco from Zinola near Savona, seems related to *Pleurotoma congener* from which it is distinguished by its less distinctly bifid circumsutural rim, and by the disposition of the crenulations of its sinus band which are much wider-spaced than in the eastern shell, and are elongated in the direction of the spiral ornaments instead of being constituted by axial ribs. Judging from the illustrations published by Sacco (Moll. terz. Piem. e Lig., part XXX, Pl. XI, fig. 35), it shows indications of an expansion of the outer lip analogous to that observed in the recent specimens of *Pleurotoma congener* (see Rec. Ind. Mus., Vol. XIII, p. 315).

PLEUROTOMA (GEMMULA) SINDIENSIS n. sp.

Pl. V, figs. 13, 14.

Medium-size, with tall moderately broad conical spire exceeding four-sevenths of the total height, and with large body-whorl anteriorly contracted into a stem of probably moderate length.

The large protoconch is conoidal and consists of a minute nucleus followed by four whorls of which the two first are very broadly conical, low, and smooth, the two last relatively much taller, convex and globose, and decorated with crowded, narrow, angular, straight vertical ribs stretching from suture to suture. The transition to the spire proper is abrupt. The number of spire-whorls following the protoconch, in full-grown specimens, appears to be seven-and-a-half or eight. Their height somewhat exceeds half their width. The greatest width coincides with the sinus band and is situated slightly nearer to the anterior than to the posterior margin of the whorls. The sutures are rather sharply incised and are surrounded by a rather narrow, very prominent rim, the crest of which consists of a spiral ridge or thread, separated from the suture either by a narrow ledge, or by one or two fine, raised spiral lines. A rather deep and

rather narrow concave surface ornamented with two or three thin raised spiral lines, separates the circumsutural rim from the prominent sinus band which is made up of two raised spiral threads, both of which, as well as the intervening shallow space, are waved by regularly distributed crenulations. Anteriorly to the sinus is another concave space, narrower than the posterior interval, and bounded anteriorly by a spiral thread which is situated quite close to the anterior margin of the whorl and is much less prominent than the circumsutural ridge. This space, between the anterior thread and the sinus band, is usually divided more or less symmetrically, by an intercalary raised spiral line. Proportionately to the increase of radius, the sinus band of each whorl is just as prominent as the corresponding circumsutural rim. Moreover the space between the sinus band and the circumsutural rim of one whorl is proportionately the same as between the sinus band and the circumsutural rim of the following whorl. Consequently, the spire exhibits a remarkably regular girdled appearance. The lines of growth are scarcely visible.

The rather large body-whorl measures rather more than four-sevenths of the total height. Anteriorly to the sinus band it exhibits a pronounced hemispherical convexity, connected by a short well-marked concavity with the terminal stem. The circumsutural rim and sinus band exhibit essentially the same characters as on the spire whorls. Anteriorly to the sinus-band, the following convexity, concavity and terminal stem carry spiral threads alternating in two or three orders, the exact disposition varying slightly in different specimens. The two anterior threads of the spire-whorls become approximately equal on the body-whorl, the interval between them either remaining bare, or being bisected by a raised line, while upon that between the more posterior of the two and the sinus band, there may be from one to three fine spiral lines. Anteriorly to the level of the suture, the convexity carries two more main threads with a narrow line bisecting each of the intervals which they determine. The following concavity carries three more equally spaced principal threads, less prominent than the principal threads of the convexity, the intervals between them being also sometimes bisected by a fine line. On the terminal stem the principal threads resume their full thickness, and alternate with threads of a second order. The lines of growth are extremely fine, though better developed than on the spire-whorls, and are distinctly visible, under

a magnifying power, as extremely crowded lines in the intervals between the spiral ornaments.

The aperture is lanceolar-oval. The columella is either broken or concealed in all the available specimens. The outer lip is convex anteriorly to the notch.

*Dimensions.*—The restored measurements of an apparently nearly full-grown specimen are as follows:—

	mm.
Height . . . . .	27
Thickness . . . . .	10
Height of spire . . . . .	16
Height of body-whorl . . . . .	16

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—This shell is to be regarded, in all probability, as a permutation of *Pleurotoma congener* with which it agrees in almost every essential character. The chief distinction is to be sought in the circumsutural ridge which, although equally prominent in both species, is narrower in *Pleurotoma sindiensis* where it carries only one predominating spiral thread instead of the two subequal prominent threads observed in *Pleurotoma congener*. It is decidedly smaller than *Pleurotoma congener* and its fossil variety *mekranica*.

#### DRILLIA (CRASSISPIRA) KACHHENSIS n. sp.

Pl. V, figs. 16, 17.

Small, with moderately broad conical spire slightly exceeding half the total height of the shell, and with relatively large body-whorl, greatly contracted anteriorly. The small protoconch consists of a minute nucleus followed by two-and-a-half moderately convex, smooth whorls. It is followed by six spire whorls the height of which is equal to two-thirds of their width. Their greatest thickness coincides with their anterior margin. The sutures which are narrow and inconspicuous are surrounded by a prominent narrow angular rim the crest of which forms the posterior edge of a rather narrow, and rather deeply concave zone, corresponding with the sinus band. The surface situated anteriorly to the sinus band occupies more than half the height of the whorls. It is regularly conical and carries, in each whorl, eight prominent, straight, rod-like ribs, slightly oblique and antecurrent to the anterior margin. Their greatest thickness is at their posterior termination where they abut

abruptly against the concave sinus band, thus greatly contributing to its deeply sunken appearance. They do not extend over the sinus groove and do not therefore reach the circumsutural rim. This circumsutural rim nevertheless exhibits a succession of very pronounced protuberances which originate from its moulding itself round the ribs of the preceding whorl. As the ribs often coincide exactly from whorl to whorl, the illusion is thereby produced that the ribs of each whorl reappear posteriorly on the sutural rim: the illusion being destroyed whenever the ribs do not correspond exactly, as it is then clearly seen that the sutural knobs really owe their origin to the ribs of the previous whorl. There appear to be one or two spiral incisions on the floor of the sinus groove, ill-seen on account of the rather encrusted condition of the specimens. The anterior part of the whorls is divided into equal spiral bands by three spiral furrows which intersect the axial ribs and their intervals.

The relatively large body-whorl is equal to three-fifths of the total height. Anteriorly to the sinus groove it is at first cylindrical, and then strongly convex, passing into the concavity of the rather long neck continued by the stem which is terminated by a moderately oblique truncation turned towards the right of the shell. The termination of the stem is not distinctly notched and the zone of accretions of its termination constitutes neither a dorsal bulge nor a distinct ventral umbilicus. Over the portion of the body-whorl corresponding with the spire-whorls, the spiral decoration is the same as on the spire. Over the convexity of the base the spiral furrows become wider, deeper, and wider spaced, so that the intervening raised portions assume the appearance of spiral threads instead of flat bands. The spacing becomes still wider on the concavity of the neck, once more contracting on its anterior vertical portion. Close-set spiral furrows decorate the zone of accretions of the terminal truncation which is not distinctly marked off from the rest of the surface. The axial ribs are very prominent on the body-whorl, upon which their number increases to ten. They extend, in an anterior direction, over the concavity of the neck, and, in the neighbourhood of the aperture, they even reach the edge of the terminal zone of accretions.

The tall aperture is imperfectly preserved as the outer lip is missing in all the available specimens. The elongate columella is very slightly convex, and is slightly oblique, the obliquity being directed anteriorly towards the left of the shell. The columellar

lip has a very sharply defined raised edge which is completely detached anteriorly, thus conveying a false semblance of an umbilical fissure along the terminal zone of accretions. At its posterior termination, the columellar lip exhibits a callous thickening.

*Dimensions.*—

	mm.
Height . . . . .	11.5
Thickness . . . . .	4
Height of spire . . . . .	6
Height of body whorl . . . . .	7.

*Occurrence.*—Gáj of Kachh, near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45').

*Comparison and Remarks.*—This species is related to *Drillia sinensis* Hinds, of the eastern seas (also occurring fossil at Karikal) from which it is distinguished by its more prominent ribs. It is very closely related to one of the Burmese fossils described by Noetling under the name of *Drillia protointerrupta*. Three separate species have been figured by Noetling, in 1901, in his second monograph on the tertiary fauna of Burma (Pal. Ind., new series, Vol. I, part 3), as *Drillia protointerrupta*. The first one, represented on Plate XXIII, fig. 8, which had previously been represented in 1895 (Mem., Geol. Surv., Ind., Vol. XXVII, part 1, Pl. X, fig. 2) as *Drillia interrupta* Lamarck, is a specimen from Minbu which is readily distinguished from the two other figured specimens on account of its tall convex whorls, as well as its relatively large dimensions. To this species, by right of priority, belongs the specific name *protointerrupta*. The two other specimens figured by Noetling are from Kama. The one represented in fig. 9, Pl. XXIII, is a very beautiful shell somewhat resembling *Drillia geslini* Desmaret from the miocene of Europe. It may be distinguished as *Drillia cotteri*. The third specimen, represented in fig. 10, Pl. XXIII, which may be distinguished as *Drillia kamaensis* is very closely related to *Drillia kachhensis*, but is distinguished by relatively broader and lower spire whorls, and a relatively shorter body-whorl. The number of axial ribs decreases on the body-whorl of the Burmese fossil instead of increasing as in the species from Kachh. Another closely related species is *Drillia semisulcata* Bellardi from the Helvetian of Piedmont. The Piedmontese species grows to a larger size and has less prominent ribs.

## DRILLIA (CRASSISPIRA ?) MEKRANICA n. sp.

Pl. V, fig. 12, Pl. VI, figs. 1, 2.

Medium to fairly large, with tall spire measuring from one-half to nearly three-fifths of the total height, and with anteriorly attenuated body-whorl.

The apex is missing in the available specimens. The protoconch was probably followed by eight spire-whorls the height of which slightly exceeds half their thickness. The maximum thickness coincides with the anterior margin of the whorls. The wavy sutures are incised and conspicuous. They are surrounded by a prominent rim which shares their waviness. Spiral grooves divide the circum-sutural rim into three portions; two of which are narrow, and occupy the circum-sutural slope, while the most anterior band, coinciding with the crest of the rim, constitutes a prominent spiral thread. Anteriorly to the circum-sutural rim there is a concave zone coinciding with the sinus-band, anteriorly to which the anterior part of the whorls is steeply sloping and slightly convex. The sinus band carries five very thin contiguous threads separated by spiral incisions, and somewhat granulated by the intersections with the lines of growth. The slightly convex, almost cylindrical anterior portion of the whorls, measuring slightly more than half their height, carries both axial and spiral ornaments. The axial ornaments consist of straight, convex ribs, very slightly oblique and anteriorly antecurrent, of about the same width as the intervening spaces. Their thickness is uniform from the anterior margin to the edge of the sinus band upon which they somewhat encroach, but they do not reach the posterior circum-sutural rim, the waviness of which is due to the manner in which it moulds itself round the ribs of the preceding whorl. There are eight to ten ribs to each whorl. According to the mode of growth observed in different specimens, the ribs become either less or more crowded towards the end of the spire. The spiral ornaments of the anterior portion of the whorls include three or four prominent spiral threads, which swell somewhat as they cross the ribs, and which, on the earlier part of the spire, are as broad as the intervening spaces. On the two last spire-whorls of full-grown specimens there intervenes a secondary thread in each of the intervals; in some specimens both sets of threads becoming of nearly the same thickness towards the end of the last spire-whorls and somewhat broader than the intervals.

The body-whorl measures from one-half to four-sevenths of the total height. Its base exhibits a somewhat pronounced convexity which the concavity of the neck connects with the anterior stem, the extremity of which is missing. Judging from the direction of the lines of growth, the stem was truncated obliquely towards the right of the shell. The truncation is not sinuated or notched, and the zone of its accretions does not bulge dorsally, though, ventrally, it surrounds a shallow, narrow umbilicus. The portion of the body-whorl coinciding with the spire-whorls carries the same decoration as the later part of the spire, with the addition, sometimes, of very fine threads of a third order. Similar spiral threads, alternating in two or three orders, continue over the convexity of the base and over the neck upon which they become slightly wider-spaced. They once more become closer-set on the zone of accretions of the terminal truncation, which is not differentiated from the rest of the neck. The axial ribs on immature specimens are continued almost to the anterior termination of the shell, their course being feebly sinuous. In full-grown specimens, they fade away on the concavity of the neck. Over the earlier part of the body-whorl of immature specimens they become duplicated by a median axial furrow as they cross the convexity of the base. Over the later part of the body-whorl of immature specimens, the bifurcation is no longer observed, but the ribs become narrower and more numerous. On the later part of the body-whorl of full-grown specimens, the ribs tend to disappear.

The aperture is elongate and narrow. The columella is somewhat oblique. The columellar lip is thick, with a raised semi-detached margin along the convexity of the base and neck, becoming completely detached along the umbilical fissure. At its posterior extremity it is thickened into a very prominent callous knob which greatly contracts the entrance into the posterior sinus of the outer lip. The posterior termination of the outer lip is cemented to this callosity from which it is marked off only by a shallow groove, and terminates normally to the suture. The sinus is rather small, narrow, contracted into a horse-shoe shape by the terminal apertural callosity. It is surrounded by a thin, raised rim. Anteriorly to the sinus the outer lip is imperfectly preserved, but, judging from the shape of the lines of growth, it must have been moderately convex. It is thickened externally by a prominent, rounded, rather narrow varix.

*Dimensions.*—The following are the approximate restored dimensions of two specimens:—

	mm.	mm.
Height . . . . .	21	34
Thickness . . . . .	5.5	10
Height of spire . . . . .	10.5	21
Height of body-whorl . . . . .	12	17

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison.*—*Drillia fugatu* Smith, from Ceylon, somewhat resembles this fossil in shape and size, but its conspicuous sinus fasciole bears no spiral striations.

BATHYTOMA CATAPHRACTA [Brocchi] var. GEROSIANA n. var.

Pl. V, fig. 11.

1814. *Murex (Pleurotoma) cataphractus* Brocchi.—Conch. foss. sub., p. 427, Pl. VIII, fig. 16.
1877. *Dolicholoma cataphracta* [Br.].—Bellardi, Moll. terr. terz. Piem. e Lig., Vol. II, p. 230, fig. 20, (with full synonymy).
1900. *Genotia (Bathytoma) cataphracta* [Br.].—Roverto, Ill. Moll. foss. Tongr. p. 181.
1904. *Bathytoma cataphracta* [Br.].—Sacco, Moll. terr. terz. Piem. e Lig., Vol. XXX, p. 50, Pl. XIII, figs. 21-23.

Medium size, with rather broadly conoidal spire measuring about six-elevenths of the total height and with large ventricose body-whorl, anteriorly tapering and obliquely notched at its extremity.

The apex is missing in all the available specimens. The number of spire-whorls following the protoconch is probably six or seven. Their width, at later stages of growth is equal to three-fifths of their height, being probably slightly less at earlier stages in consequence of the conoidal shape of the spire. The maximum width is situated nearer to the anterior than to the posterior margin. The sutures are somewhat deeply incised. They are surrounded by a rather broad, feebly prominent rim decorated with three, even-spaced, spiral threads one of which immediately borders the suture, the other two being somewhat more prominent. They are crossed by numerous thin, steeply oblique ribs, antecurrent to the suture, and forming granules at all the points of intersection. Anteriorly to the circum-sutural band is a sloping, concave surface, anteriorly expanding. It carries two very thin raised spiral threads, and is traversed by the much reduced extensions of the ribs of the circum-sutural rim, which,



in conformity with the lines of growth, become extremely oblique and anteriorly retrocurrent, the concave band corresponding with the accretions to the posterior margin of the apertural sinus. Anteriorly to the concave surface is another rather broad, moderately prominent, raised band which carries three or four, close-set, spiral threads, and upon which the ribs regain their strength, and are once more steeply oblique, but in the opposite direction to those of the circumsutural rim. The raised band corresponds with the accretions to the anterior portion of the apertural sinus, the apex of which corresponds in position with the posterior edge of the band. On the earlier spire-whorls, the anterior margin of the raised sinus band corresponds with the anterior margin of the whorl. With increasing growth the whorls become relatively taller in consequence of the conoidal outline of the spire, and a prominent spiral thread becomes disclosed between its anterior margin and the anterior suture. The last spire-whorl exhibits, anteriorly to the swollen sinus band, a broad surface contracting so steeply towards the anterior suture as to appear almost cylindrical, and ornamented with two prominent spiral threads decussated by oblique, and anteriorly antecurrent ribs which do not always coincide exactly with those of the sinus swelling as they are slightly more numerous, and which give rise to prominent granules at their intersections with the two spiral threads.

The large body-whorl measures nearly three-fifths of the total height. It consists principally of a very elongate ovoid portion anteriorly passing into a short, shallow concavity anteriorly to which the shell terminates with a rather deeply notched truncation steeply oblique and facing towards the right. The accretions to this terminal notch form a twisted zone distinguished from the rest of the shell by a different ornamentation, and divided off from the concave neck by a more or less defined keel. The spiral ornaments of the last spire-whorl are continued on the corresponding portion of the body-whorl. Anteriorly to the two principal threads, which form the continuation of the two anterior principal threads of the spire, the convexity of the base carries three more prominent main threads the intervals between which may be each bisected by a thread of a second order. The anterior concavity carries four closer-set and slightly thinner spiral threads of two alternating sizes, a similar thread forming the boundary keel of the terminal zone of accretions. All these spiral ornaments are granulated at their intersections with the crowded ribs the course of which coincides with that of the lines of

growth and which cover the whole body-whorl with the exception of the terminal zone of accretions. Anteriorly to the posterior concavity which corresponds with a portion of the sinus zone, the ribs form a perfectly continuous, broad curve with forward directed concavity, anteriorly antecurrent over the portion forming the continuation of the anterior part of the spire-whorls, reaching a vertical position at the first main thread anteriorly to the level of the suture, and then becoming anteriorly retrocurrent. The swollen portion of the sinus band loses its prominence on the body-whorl and its ribs instead of being fewer and more prominent than on the more anteriorly situated surface as on the spire-whorls, correspond exactly with them, so that each spiral thread of the base carries as many granules as there are ribs on the sinus band. The terminal zone of accretions is decorated with a number of raised ribbon-like spirals, somewhat narrower than the intervening spaces.

The large aperture is posteriorly angulated, anteriorly contracted into a very short terminal canal. The columella, in its general outline, is slightly inclined to the axis, the direction of obliquity being anteriorly towards the right of the shell. From its junction with the base of the penultimate whorl to the commencement of the rudimentary canal, it exhibits a broad convexity of very feeble curvature, at about half the height of which there is a moderately oblique, blunt spiral fold, readily observable in one of the figured specimens, though not clearly visible in the illustration. The columellar lip is thin.

The outer lip, at its posterior termination, is normal to the suture. It is breached by a very broad, deep, somewhat triangular sinus anteriorly to which it exhibits a broad continuous convexity of moderate curvature which does not project forward beyond the level of the posterior termination. The internal walls of the shell bear prominent liræ corresponding with the principal bands of the outer surface.

*Dimensions.*—The restored measurements are approximately as follows :—

	mm.
Height . . . . .	34
Thickness . . . . .	13
Height of spire . . . . .	18
Height of body-whorl . . . . .	21

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—Compared with the extremely variable *Bathytoma cataphracta* which occurs abundantly throughout the Oligocene, Miocene and Pliocene of Europe, this shell does not exhibit any differences of sufficient precision to distinguish it specifically. Amongst European specimens those which are as distinctly and coarsely granulated as the Mekran specimens exhibit much more prominent ribs or nodes along the sutural swelling, in consequence of which the whorls assume a distinctly angulated appearance anteriorly to the concave band. The number of these nodes, as a result of their prominence, remains inferior to that of the anterior ribs up to a much later stage of growth than in the Mekran specimens: only on approaching the aperture of such specimens do the ribs of the sinus swelling decrease in prominence and increase in number till they correspond with the anterior ribs, while, at the same time, the angulation becomes smoothed away. The Mekran specimens combine, therefore, the granular decoration of certain angulated varieties with the more even scarcely angulated outline of certain smooth forms. This character, and their somewhat moderate dimensions, may serve to distinguish them as a variety.

The same species occurs in the Miocene beds of Burma where it represents, amongst the gastropoda, one of the rare instances of a European form having reached thus far eastward in Miocene times.

Three more fossil species of *Bathytoma* have been described from the east: *Dolichotoma herklotsi* Martin, and *Dolichotoma ornatissimum* Martin, from Java, and *Borsonia granosa* Woodward from the island of Nias; one of these, *Bathytoma herklotsi*, also occurring in Burma. They lack the anterior vertical portion of the later spire-whorls, in consequence of which the full-grown shell exhibits a biconical outline recalling that of a *Cryptoconus*.

The genus still survives in the Indian Ocean where it is represented by the beautiful *Bathytoma oldhami* E. A. Smith (1899, Ann. Mag. Nat. Hist., ser. 7, Vol. IV, p. 238; 1901, Zoology of the Investigator, Pl. IX, fig. 2), occurring in deep water off the coast of Travancore, which is readily differentiated from the various fossil species herewith mentioned by its broad smooth, circumsutural rim.

## CONORBIS DORMITOR [Solander] var. SINDIENSIS n. var.

Pl. I, fig. 10.

1766. *Conus dormitor* Solander.—Brand., Foss. Hanton., p. 16, Pl. I, fig. 241821. *Conus dormitor* Sol.—Sowerby, Min. Conch., Vol. III, p. 179, Pl. CCCL.1860. *Conus dormitor* Sol.—Edwards, Monogr. Eoc. Ceph. and Univ. of England, p. 200, Pl. XXIV, fig. 11.

Medium-size, biconical, moderately slender, with rather elongate slightly conoidal spire measuring more than one-third of the total height.

The imperfectly preserved protoconch which is of very small size, is followed by eight spire-whorls the height of which is equal to one-third of their width, their maximum thickness being situated relatively close to their anterior margin. They are separated from one another by thin incised sutures. The anterior portion of the whorls is convex, while the posterior part consists largely of a concave surface separated from the posterior margin by a feebly prominent angular keel. At early stages of growth the convex and concave portions of the whorls pass gradually into one another, the convex portion occupying approximately the anterior half of the whorls. On the later whorls they are separated by a distinct angulation so situated that the concave portion of the whorls encroaches considerably upon the anterior convex portion which now becomes reduced to about two-fifths or one-third of the height of the whorls. A thin spiral thread corresponds with the crest of the circumsutural rim and posteriorly bounds the posterior concavity. The anterior portion of the whorls is decorated with spiral threads slightly narrower than the intervening spaces, their number being three on the earlier whorls, increasing to four at later stages of growth in consequence of the slightly conoidal disposition of the spire, owing to which a slightly increased surface along the anterior margin of the whorls becomes disclosed with increasing growth. Counting from the most posteriorly situated of this anterior group of spiral threads, it is the second one that corresponds with the angulation which, at later stages of growth, separates the concave and convex portions of the surface. The crowded, sharply defined, fairly evenly distributed, raised lines of growth form a sigmoidal flexure of which the forward-facing concavity is situated posteriorly, the point of inflexion corresponding with the angulation which, at later stages of growth, separates the concave and convex portions of the whorls. The concave portion of the flexure has a pronounced curvature, the apex

of which is situated at about half the height of the concave portion of the whorls. Posteriorly it terminates antecurrently to the suture. The anterior convex portion of the flexure also terminates antecurrently to the anterior suture.

The body-whorl measures slightly more than seven-tenths of the total height. Posteriorly it exhibits the same circumsutural rim, and the same concave zone anteriorly bounded by an angulation as is observed in the later spire-whorls. Anteriorly to the angulation the shape is, in general, moderately steeply conical, the surface exhibiting at first a distinct convexity which is best marked close to the angulation and which gradually stiffens into a straight outline towards the anterior termination of the shell. The angulation is scarcely further distant from the anterior than from the posterior termination of the shell which it consequently divides into an almost symmetrical biconical shape. The anterior termination is missing, but the anterior portion is nevertheless sufficiently preserved to indicate that the terminal truncation must have been narrow. Posteriorly to the angulation the ornamentation, throughout the greater part of the body-whorl, generally coincides with that of the last spire-whorl though with the addition of another spiral thread at about half the height of the concave surface. Anteriorly to the angulation the entire surface is decorated with flat, ribbon-like, raised threads or bands, narrower than the intervening spaces and at first all of one width and equally spaced, while, on approaching the aperture, intercalary threads are apt to appear in many of the intervals. The lines of growth, posteriorly to the angulation, are disposed in the same manner as on the spire-whorls. Anteriorly to the angulation they form a forward-facing strong convexity extending to the anterior termination of the shell, and so disposed that it is mostly anteriorly antecurrent, reaching a vertical trend only when it approaches very close to the anterior termination. The lines of growth form a delicate crowded web across the floor of the spaces separating the spiral bands.

The aperture, of moderate width, is rather obscured by a strongly adhering incrustation of hard rock. The outer lip is antecurrent to the suture between which and the angulation it forms a well rounded sinus. Anteriorly to the angulation it projects forward to a considerable extent with a strong convexity continuous as far as the anterior termination of the shell on nearing which its course becomes vertical and finally anteriorly retrocurrent.

*Dimensions.*—

	mm.
Height . . . . .	30
Thickness . . . . .	13.5
Height of spire . . . . .	11.2
Height of body-whorl . . . . .	21.7

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison.*—Compared with *Conorbis dormitor* Sol. from the upper Eocene of England, the Sind fossil is perhaps slightly more elongate than the average of the English shells, with a less conoidal, more nearly truly conical spire. The difference does not seem sufficiently precise for the establishment of a distinct species.

CONORBIS DORMITOR VAR. BHAGOTHORENSIS n. var.

Pl. I, fig. 11.

Rather small, fusoidal, with rather elongate, slightly conoidal spire measuring three-eighths of the total height.

The protoconch, missing in the single available specimen, is followed by six spire-whorls, the height of which, at later stages of growth, slightly exceeds one-third of their width, their maximum thickness being situated close to their anterior margin. They are separated by rather deeply incised sutures surrounded by a rather narrow, raised rim, the crest of which is formed by a raised, spiral thread. A moderately deep and rather narrow groove separates the circumsutural rim from the main portion of the whorls which is rather strongly convex and which is decorated with five spiral threads, the intervals between which are of about the same breadth as the posterior groove, but much shallower. The most posterior of these five threads forms the anterior border of the posterior groove; the next anteriorly-following thread becoming bifid at later stages of growth. The lines of growth form a sigmoidal flexure of which the posterior portion has a forward-directed, pronounced concavity, while the point of inflexion is situated slightly anteriorly to the second, or bifid thread. They are antecurrent to both sutures.

The body-whorl measures three-fourths of the total height. Posteriorly it exhibits the same convexity as the spire-whorls. Anteriorly to the level of the suture, its shape is, on the average, moderately broadly conical, the straightness of the outline being slightly modified by an elongate convexity of feeble curvature, succeeded anteriorly by a much shorter, very shallow concavity.

The terminal truncation is narrow, the zone of its accretions being flush with the adjacent surface. Posteriorly, the portion forming the continuation of the spire bears the same spiral ornaments as the last spire-whorl. The remainder of the surface bears spiral threads narrower than the intervening spaces, and approximately equidistant, except on the terminal zone of accretions where they are more crowded. The lines of growth, posteriorly are disposed as on the spire-whorls. The remainder of their course constitutes a pronounced convexity extending to the anterior termination of the shell, anteriorly antecurrent until they reach the neighbourhood of the anterior extremity where, after reaching a vertical direction, they become anteriorly retrocurrent. They form a crowded web across the floor of the spaces separating the spiral threads.

The aperture, of moderate width, is greatly obscured by an adhering incrustation of hard rock. At the anterior termination of its inner border, the terminal edge of the columella is separated by a shallow umbilical depression from the anterior winding margin of the terminal zone of accretions. The outer lip is antecurrent to the suture anteriorly to which it forms a deep semi-circular concavity followed by a broad convex sweep extending to the anterior extremity of the shell and so disposed that, for the greater part, it projects forward, reaching a retrocurrent trend only as it approaches its anterior termination.

*Dimensions.*—

Height	.	.	.	.	.	.	.	.	.	mm.
Thickness	.	.	.	.	.	.	.	.	.	23
Height of spire	.	.	.	.	.	.	.	.	.	10.3
Height of body-whorl	.	.	.	.	.	.	.	.	.	8.8
	.	.	.	.	.	.	.	.	.	17

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison.*—This shell is distinguished from the one previously described, by the different shape of its spire-whorls, which, except for the posterior circumsutural rim and adjacent groove, are uniformly convex, lacking the pronounced concavity which occupies a considerable portion of the surface of the whorls in the previously described shell. As a further consequence of this disposition, the angulation of the body-whorl is also missing. The other characters agree essentially with those of the previously described shell. Considering the wide range of variability of the English shell, the ob-

served differences do not appear sufficient to form the basis of a specific distinction.

CONUS (LEPTOCONUS) VIMINEUS Reeve.

- ?1844. *Conus aculeatus* Reeve.—Monograph of the genus *Conus*, Pl. XLIV, sp. 240.  
 1849. *Conus vimineus* Reeve.—Monograph of the genus *Conus*, suppl. Pl. VII, sp. 269.  
 1895. *Conus vimineus* Reeve.—Martin, Samml. des geol. Reichs-Museums in Leiden, new series, Vol. I, p. 16, Pl. II, figs. 23-25.  
 1895. *Conus palabuanensis* Martin.—Samml. des geol. Reichs-Museums in Leiden, new series, Vol. I, p. 16, Pl. II, fig. 26.  
 1900. *Conus (Chelyconus) subvimineus* Cossmann.—Journ. Conch., Vol. XLVIII, p. 64, Pl. IV, figs. 47, 48.  
 1901. *Conus (Leptoconus) protofurvus* Noetling.—Pal. Ind., new series, Vol. I, part 3, p. 365, Pl. XXIII, fig. 26 (non. fig. 25).

The collections from the Mekran series include a form identical with one of the most abundant fossils lately collected by M. R. Ry. Sethu Rama Rao from the Tertiary formation of Burma. A careful study of the abundant and beautifully preserved specimens from Burma clearly establishes that they all belong to a single species identical with the forms described as *Conus vimineus* and *C. palabuanensis* by Martin, and as *C. subvimineus* by Cossmann, and with one of the fossils described as *Conus protofurvus* by Noetling. Specimens occur identical with each of the above-mentioned forms, but are connected by every possible intermediate gradation, clearly establishing the specific identity of all these fossils.

I intend to consider this species in detail on some future occasion in a monograph dealing with the Burmese fauna.

The anterior termination of the shell is broken in all the available specimens from the Mekran beds. The largest specimen has a diameter of about 15 mm. corresponding with an approximate height of 42 mm.

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains; between Kanderi and Sari Dasht in Kulanch.

*Remarks.*—Cossmann has classified this shell as a *Chelyconus* on account, probably, of the seemingly conoidal outline of the spire. I have ventured to refer it to *Leptoconus* on account of its close resemblance to various species of that section.



## CONUS (LEPTOCONUS) FASCIATUS Martin ?

1884. *Conus fasciatus* Martin.—*Samml. des geol. Reichs-Museums in Leiden, Series 1, Vol. III, p. 50, Pl. IV, fig. 50.*

A specimen in the Blaggrave collection from Karachi, too badly weathered for detailed description, probably belongs to the above-named species described by Martin from the Tertiary formation of Java.

*Dimensions.*—

	mm.
Height . . . . .	20
Thickness . . . . .	11
Height of spire . . . . .	5
Height of body-whorl . . . . .	16

*Occurrence.*—Gáj of Sind, Karachi (Blaggrave collection).

## CONUS (LEPTOCONUS) AMADIS Martini.

1773. *Conus amadis* Martini.—*Conch. Cab., Vol. II, p. 290, Pl. LVIII, figs. 642, 643.*

1844. *Conus amadis* Martini.—*Reeve, Monograph of the genus Conus, Pl. XLI, sp. 222.*

Medium to large, with extraconic spire measuring less than one-quarter of the total height.

The protoconch, imperfectly preserved in all the available specimens, is followed by nine or ten spire-whorls separated by distinctly incised sutures. They consist of a sloping surface, straight-conical in outline, and moderately steep in the earlier whorls, shallower and moderately concave at later stages of growth, anteriorly followed by a very short vertical step. This anterior step scarcely varies in height throughout the spire the extraconic outline of which is entirely due to the gradual decrease of slope of the main portion of the whorls. The angulation separating the posterior slope and anterior vertical step is feebly crenulated at early stages of growth. On the later whorls, when the sloping surface becomes concave, it forms a very slightly raised rim round this concavity. The sloping surface is ornamented with well defined spiral threads, the number of which, at later stages of growth, is almost invariably four, though, in exceptional cases, it may amount to double that number. The lines of growth are strongly curved on the sloping portion upon which they are steeply antecurrent to the suture, very obliquely antecurrent to the angulation.

The body-whorl measures three-quarters or slightly more of the total height. Posteriorly it exhibits the same concave slope and the same angulation as the corresponding portion of the spire-whorls. Anteriorly to the angulation, its shape is, in general, steeply conical, modified by a slight convexity of very feeble curvature which, in an anterior direction stiffens to a practically rectilinear outline, with, in some specimens, a very feeble concavity, on the left side, near the anterior termination. The outline is generally stiffer in immature than in full-grown specimens; but there is a fairly pronounced range of variation, in this respect, even amongst specimens of one dimension. The exact shape of the outline is seldom perfectly preserved in the available fossil specimens, nearly all of which are slightly crushed or distorted. The terminal truncation is narrow, oblique, scarcely notched, its accretions forming a steeply winding, slightly swollen zone. Posteriorly to the angulation, the concave slope carries the same spiral ornaments as the corresponding portion of the spire-whorls. A portion of varying extent of the anterior part of the shell is decorated with wide-spaced thin spiral grooves more or less evenly distributed. On nearing the terminal zone of accretions they become somewhat deeper and wider, and the intervening raised spaces become each subdivided by a secondary groove, either symmetrically or unsymmetrically. Posteriorly, the bare space intervening between the spirally decorated portion and the angulation may be reduced to only one-third of the height of the body-whorl in the case of very immature specimens, but it extends considerably with increasing growth, and, in some large specimens occupies considerably more than half of the height of the body-whorl. There is, however, a considerable range of individual variation in this respect. The terminal zone of accretions carries much closer-set, well-defined, spiral grooves, sometimes more or less distinctly distributed in groups of two. The lines of growth, posteriorly to the angulation, are disposed in the same manner as on the spire-whorls. Anteriorly to the angulation, they constitute, for a short distance, a pronounced forward-facing strongly antecurrent convexity which soon passes into an extensive, almost rectilinear portion, nearly vertical or very feebly anteriorly retrocurrent, the direction becoming finally much more distinctly retrocurrent on approaching the terminal zone of accretions. The spiral grooves are delicately punctuated by the lines of growth between their intersections.

The moderately broad aperture, with almost straight borders, expands very slightly anteriorly. The inner border, towards its anterior end, exhibits two very feeble concavities one on either side of the very slight swelling formed by the winding terminal zone of accretions anteriorly to which a short very narrow feebly callous twist represents the terminal edge of the columella. The posterior parietal furrow is shallow, nearly horizontal, separated by a slightly raised, rather broad, callous band from the posterior termination of the inner wall. The outer lip is antecurrent to the suture, between which and the angulation it constitutes a rather deep curved sinus. It continues for some distance forward along the continuation of the angulation, and then takes an anterior bend with a convexity which still further increases the extent of its forward projection, beyond which it recedes with a slight convexity so steeply as to appear almost vertical.

Some specimens exhibit faint traces of the beautiful colour-scheme, with the dovetailing, forward directed, triangular patches.

*Dimensions.*—All the full-grown specimens have the anterior termination of the shell more or less broken. The following are the dimensions of the most complete available specimen, which is immature :—

	mm.
Height . . . . .	41
Thickness . . . . .	19
Height of spire . . . . .	9.1
Height of body-whorl . . . . .	33.2

For the sake of comparison, the dimensions of a slightly larger recent specimen from the Andaman Islands are herewith appended :—

	mm.
Height . . . . .	48.7
Thickness . . . . .	21
Height of spire . . . . .	11
Height of body-whorl . . . . .	39

Amongst the fossil specimens are many with diameters of 30 mm. or 32 mm. which, by comparison with recent specimens, must have reached, when complete, a total height of from 60 mm. to 70 mm.

*Occurrence.*—Very abundant at various horizons of the Mekran beds, though rather rare and of relatively small size in the lowest strata: base of Talar section; about 1 m. to  $1\frac{1}{2}$  m. from Barambab camp on the way to Bán; between Kanderi and Sari Dasht in Kulanch; west of Gharh Hill.

*Comparison with other species.*—This fossil, the characters of which are remarkably constant, agrees down to the minutest details with the living *Conus amadis* Martini, which, as represented by specimens from widely different localities in the Indian seas, also appears to be particularly constant. The close relationship of this shell to the fossil hereafter identified as *Conus scalaris* Martin, will be discussed after describing that form.

CONUS (LEPTOCONUS) SCALARIS Martin.

1879. *Conus scalaris* Martin.—Tertiaerschichten auf Java, p. 12, Pl. II, fig. 4.

Medium-large to large, with more or less extraconic, moderately elongate to very tall spire, measuring from slightly more than one-sixth to nearly one-third of the total height, the more depressed specimens being at the same time more extraconic, and with elongate, conical body-whorl.

The protoconch, measuring one millimetre both in height and in breadth, is broadly and regularly conical in general outline, consisting of a minute nucleus and of three rather low, smooth, convex whorls. It is followed by nine spire-whorls of which the earlier ones consist of a steep, slightly concave, posterior slope and an anterior vertical portion, both divisions being connected by an angulation which carries crenulations elongated in the direction of the spiral ornaments and slightly projecting horizontally. With increasing growth, at a stage varying, in different specimens from the third to the fifth whorl, the slope of the posterior portion becomes shallower, its concavity deeper, and the crenulations dwindle and disappear, being replaced by a vertically projecting rim encircling the concave zone. The relative height of the anterior vertical step decreases with increasing growth, combining with the decrease in slope of the posterior portion to bring about the extraconic disposition of the spire. The posterior concave slope is decorated, in different specimens, with from three to seven spiral furrows. In those specimens in which the furrows are most numerous, three of them, situated either about the middle or more towards the posterior margin of the surface, are broader, deeper, and wider-spaced than the remainder. The furrows may be narrower than the intermediate spaces, or of the same width, or so much broader that the raised portions acquire the character of spiral threads, when the ornamentation is best described as consisting of raised, spiral threads rather than of furrows, in which case some extremely thin, intercalary, raised lines may appear in the

intervals between the main threads. On the earlier spire-whorls, the crenulations that decorate the angulation arc continued over the anterior vertical step in the shape of low, blunt ribs, of the same width as the intervening spaces, rather steeply antecurrent towards the anterior suture. They are crossed by two narrow, spiral furrows, which, with increasing growth, even after the disappearance of the ribs, remain visible, provided that the zone which they occupy is not encroached upon by the posterior margin of the next following whorl, such as happens when the spire has a relatively depressed shape. The lines of growth, on the posterior concave slope, exhibit a falciform curvature, being steeply antecurrent, almost normal to the posterior suture, very obliquely antecurrent to the anterior rim or angulation, anteriorly to which they are antecurrent to the anterior suture.

The body-whorl measures from somewhat over three-quarters to nearly seven-eighths of the total height, its relative height being greatest in the specimens with a relatively short spire. Posteriorly the body-whorl exhibits the same concave sloping zone as the spire-whorls, similarly bordered by a raised rim constituting a sharp angulation anteriorly to which the outline contracts steeply, at first with a slight convexity of very feeble curvature which soon stiffens into a perfectly rectilinear outline, continued, in many specimens, without interruption to the anterior termination, a very feeble concavity intervening sometimes, close to the anterior end, on the left side of the shell. The terminal truncation is horizontal, very narrow, without the slightest tendency to acquire a notched disposition, the zone of its accretions being either quite flush with the remainder of the surface, or else forming a feebly raised bulge anteriorly bordering the above mentioned feeble concavity. The posterior concave zone bears the same spiral ornaments as the corresponding portion of the spire-whorls. The anterior part of the shell throughout a zone measuring about one-third of the distance between the anterior end and the posterior angulation of the body-whorl, is ornamented with moderately close-set grooves narrower than the intervening spaces, becoming more crowded, shallower, and somewhat imbricated on the narrow terminal zone of accretions. Posteriorly to the zone thus decorated, the remainder of the surface of the body-whorl, as far as the angulation, may remain bare, but it is more usually decorated with thin, equidistant, rather wide-spaced, spiral incisions which, in some instances, especially amongst specimens of small or medium

growth, may cover the whole distance to the angulation, but which, more frequently leave, posteriorly, a bare interval, which, in very large specimens, occupies seldom less than one-half of the distance between the angulation and the anterior termination. Posteriorly to the angulation the lines of growth are disposed in the same manner as on the corresponding part of the spire-whorls. Anteriorly to the angulation they form at first a short, forward directed, pronounced convexity anteriorly to which, for a considerable distance, they assume an elongate convexity of so feeble a curvature as to appear practically straight, with an average direction which is slightly oblique and anteriorly retrocurrent, the obliquity becoming more pronounced as they approach the terminal zone of accretions.

The tall aperture has practically straight and practically parallel borders, the outline of the inner border being scarcely affected anteriorly by the winding of the terminal zone of accretions, anteriorly to which the termination of the columella or columellar lip is visible only for a short distance in the shape of a steeply oblique thin callous edge winding out of the interior of the shell. The posterior parietal furrow is shallow, rather narrow, almost horizontal, separated from the posterior edge of the inner wall by a rather broad, callous band. The outer lip has, posteriorly, a rather shallow notch. Anteriorly to the angulation the greater part of its course exhibits so feeble a convexity as to appear nearly straight, its average direction being very steeply oblique, anteriorly retrocurrent.

*Variability.*—The variations in the height of the spire are so excessive that extreme forms of this shell might readily be taken to represent two distinct species. In a large series of specimens it is at once observed that there is a perfectly gradual transition from the steepest to the shortest spires. These variations cannot generally be distinguished as varieties or even races, as they all occur together with every possible intermediate gradation.

*Dimensions.*—The following measurements will give some idea of the proportions of shells of various shapes:—

	SPECIMENS WITH		
	long spire mm.	medium spire mm.	short spire mm.
Height . . . . .	52	39	40
Thickness . . . . .	22	17	19
Height of spire . . . . .	16	10	7
Height of body-whorl . . . . .	39	31	34

None of the specimens from which the above measurements were taken, are full-grown. A large specimen with the anterior part of the shell missing has a thickness of 32 mm., and a height of spire of 23 mm. Its total height must have been about 75 mm.

*Occurrence.*—Mékran beds. Between Kanderi and Sari Dasht in Kulanch; about 1 m. to  $1\frac{1}{2}$  m. from Barambab camp on the way to Ban; base of Talar section.

*Comparison with other species.*—So far as it is possible, amongst so variable a group as the Conidae, to define a species from a single specimen, *Conus scalaris* Martin from the Tji Karang streamlet, east of Tjiore, near the southern coast of Java, appears to be perfectly identical with the above described species corresponding especially with the specimens of average intermediate characters.

Compared with *Conus amadis*, the above-described shell seems so closely related that there can be no hesitation in regarding both forms as varieties of a single species. Nevertheless, the differences, although very slight, are constant, and there is no difficulty in sorting out both forms whenever the specimens are tolerably preserved. The most conspicuous difference is afforded by the structure of the spire the whorls of which have a much more conspicuously developed anterior vertical step in *Conus scalaris* than in *Conus amadis*. This difference remains noticeable even in specimens with a lower spire than the average of *Conus amadis*, for the shortness of the spire in such specimens is due as much to the flattening of the slope of the concave portion as to the shortening of the anterior vertical step, the spire thus acquiring its very characteristic stepped appearance. Even the later whorls of short-spined specimens of *Conus scalaris* still exhibit a more conspicuous vertical step than those of *Conus amadis*, and this is partly due to the more developed rim anteriorly bordering the concave portion of the whorls. In *Conus amadis*, as has been pointed out in the description of that form, the extra-conic shape of the spire is due entirely to changes in the degree of slope of the main surface of the whorls, the anterior vertical step being always very short, even at the earliest stages, so that the crenulations, always weaker than in *Conus scalaris* are never anteriorly continued by axial ribs such as are conspicuously exposed on the early part of *Conus scalaris*.

Amongst less important and less constant differences may be mentioned the somewhat more elongate body-whorl of *Conus scalaris*, the character of the spiral decoration of its spire-whorls consisting

more usually of furrows instead of the raised threads of *Conus amadis*, the usually greater extent of the spirally decorated portion on the body-whorl. Lastly, a characteristic difference is to be observed in the remarkable constancy of *Conus amadis* and the extreme variability of the form referred to *Conus scalaris*. Were it not for priority of nomenclature, it would seem more logical to regard *Conus amadis* as a particularly stable variety of the unstable *Conus scalaris* rather than to classify *Conus scalaris* as a variety of *Conus amadis*. For the present, while recognising their close relationship, it may be convenient to continue naming them separately. Both forms appear to have existed simultaneously at separate localities, but, so far as can be gathered from the information at present available, *Conus scalaris* appears generally to characterise by its greater abundance a slightly older horizon.

CONUS (LEPTOCONUS) MARGINATUS J. de C. Sowerby.

1839. *Conus marginatus* J. de C. Sowerby.—Trans. Geol. Soc. Lon. 10, Series 2, Vol. V, Pl. XXVI, fig. 36.

Medium-size, slender, with rather broad, extraconic, stepped spire measuring nearly one-quarter of the total height, and with elongate conical body-whorl.

The protoconch, which is broken in the available specimens, is followed by seven spire-whorls which consist of three portions: a scooped out circumsutural portion, separated by a pronounced angulation from a marginal portion, with straight outline expanding anteriorly with a moderate slope, and separated by another sharper angulation from a very short anterior portion contracting in an anterior direction. The sloping middle portion projects considerably beyond the anterior portion to which its edge constitutes a sharply defined narrow rim. In consequence of this disposition, the sutures appear to be somewhat sunken. The concave circum-sutural portion carries about four shallow, very thin, spiral grooves. The deeply falciform lines of growth are rather steeply antecurrent to the suture, strongly oblique and anteriorly antecurrent to the outermost angulation.

The elongate body-whorl measures slightly more than four-fifths of the total height. Posteriorly it exhibits the same concave zone encircled by the same broad sloping margin as the spire-whorls. The anterior or outer edge of this marginal slope constitutes a pronounced angulation the sharp appearance of which is accen-



tuated by the projection of the edge of the slope and the narrow overhanging rim thus produced, as noticed already in the description of the spire. Anteriorly to this angulation, the shell forms, in some specimens, a steep conical surface, the almost perfectly straight outline of which is scarcely affected by a very feeble elongate convexity of scarcely perceptible curvature occupying the more posterior portion of the conical surface, close to the angulation. In other instances the convexity is more distinct, but still very tense and very steep. Anteriorly the shell is terminated by a narrow truncation the accretions to which do not form a distinctly differentiated zone. Posteriorly, the portion of the body-whorl corresponding with the spire-whorls, carries the same feeble spiral ornaments as the spire. The anterior half of the body-whorl carries spiral grooves, at first extremely thin and very wide-spaced, becoming gradually wider and more crowded in an anterior direction. Posteriorly to the angulation the lines of growth are disposed in the same manner as on the spire-whorls. Anteriorly to the angulation they form a perfectly continuous forward directed convexity of somewhat strong curvature extending to the anterior termination of the shell. They form a delicate trellis across the floor of the spiral grooves.

The aperture is rather narrow, with practically straight, almost parallel margins. The posterior parietal furrow is concealed by rocky incrustation in the available specimens. The outer lip forms a deep concavity between the suture to which it is antecurrent and the angulation anteriorly to which the remainder of its course constitutes a continuous rather pronounced convexity.

*Dimensions.*—

	mm.
Height . . . . .	38
Thickness . . . . .	17
Height of spire . . . . .	9
Height of body-whorl . . . . .	31

*Occurrence.*—Gáj of Kachh: Bayr Stream.

*Remarks.*—Noetling, in 1895 (Mem., Geol. Surv., Ind., Vol. XXVII, p. 43, Pl. X, fig. 8), identified with this species a Burmese fossil which in 1901 (Pal. Ind., new series, Vol. I, part 3, p. 365, Pl. XXIII, fig. 25, *nm* fig. 26) was redescribed under the name of *Conus protofervus*. The Burmese fossil shows but a simple angulation between the posterior slope and anterior vertical portion of the whorls instead

of the flattened rim of *Conus marginatus*. The second specimen figured by Noetling in his second monograph is specifically distinct from the type of *Conus protofurvus* and corresponds with *Conus vimineus* Reeve.

*Comparison with other species.*—No other form appears to have been described bearing the remarkable flattened margin that surrounds the posterior concave zone of the whorl in this species. Amongst the recent fauna of the eastern seas, *Conus sieboldii* Reeve, from Japan, also occurring fossil in the Tertiary formation of Java, closely resembles the Kachh fossil in general outline.

#### CONUS (LITHOCONUS) ODENGENSIS Mart in.

1895. *Conus odengensis* Martin.—Samml. des geol. Reichs-Museums in Leiden, new series, Vol. I, p. 19, Pl. III, figs. 39-44.  
 1901. *Conus literatus* Linn.—Noetling, Pal. Ind., new series, Vol. I, part 3, p. 359, Pl. XXIII, fig. 13 (*non* fig. 12, 14).  
 1901. *Conus avaënsis* Noetling.—Pal. Ind., new series, Vol. I, part 3, p. 362, Pl. XXIII, figs. 15, 16.

The Gáj beds of Kachh contain a shell which is specifically identical with *Conus odengensis* Martin, one of the commonest shells in the Tertiary formations of Java, and extremely abundant in the Tertiary beds of Burma where, besides the typical form completely identical with the Javanese type, there also occur several varieties. Amongst the Burmese specimens figured (*loc. cit.*) by Noetling, that represented in fig. 13, Pl. XXIII, under the name of *Conus literatus* corresponds with the type-form. A slightly different form is represented by the type of Noetling's *Conus avaënsis* (*loc. cit.*, fig. 15) in which the outer lip is slightly more oblique than in the typical form of *Conus odengensis*, the anterior terminal truncation a little broader, the anterior spiral decoration more even and not spreading quite so far posteriorly as in the type. The Kachh specimens are somewhat intermediate between the type and the variety *avaënsis*.

The specimen represented by Noetling in figure 16 (*loc. cit.*) does not agree with the type of *Conus avaënsis*, but represents another variety distinguished by the peculiarly even width of its spire-whorls, which may be distinguished as *var. birmanica*.

*Occurrence.*—Gáj of Kachh: Teyra River north of Naliya (23° 15', 68° 52'), higher than the Pecten bed of Sookpur.

*Relationship.*—Prof. Martin has indicated (*loc. cit.*) the relationship that exists between this species and the recent *Conus malaccanus* Hwass and also *Conus quercinus* Hwass and *C. ebarneus* Hwass.

## CONUS (LITHOCONUS) DJARIANENSIS Martin.

1895. *Conus djarianensis* Martin.—Samml. dos geol. Reichs-Museums in Loiden, new series, Vol I, p. 20, Pl. III, figs. 45-50.

Medium-size, with short spire and more or less elongate body-whorl.

The spire, measuring from one-tenth to nearly one-sixth of the total height, is slightly extraconic quite close to its apex, the greater part being conical with a very low angle of slope. The protoconch is very small, relatively short, slightly oblique to the axis of the remainder of the shell. In addition to the minute nucleus it exhibits distinctly only two convex, smooth whorls.

The protoconch is followed by eight spire-whorls, the two first of which consist of a rather steep slope anteriorly terminated by an angulation followed by a very short, vertical step. Distinct crenulations have not been observed. Beyond the second whorl the slope becomes very shallow and, not only does the short anterior vertical step entirely disappear, but the anterior margin of each whorl sinks slightly below the level of the posterior margin of the next following whorl by which it is even slightly overlapped. In many specimens each whorl may exhibit a uniform slope with the exception of the last spire-whorl which is almost always slightly concave, except in the case of some immature specimens. In other specimens again, all the whorls are slightly concave. They are ornamented with sharply defined, narrow, spiral ridges, of the same width as the intervening spaces, the number of which, on the later whorls of full-grown specimens, may be as many as nine, exclusive of the spiral thread along the posterior margin. The spiral ornaments are crossed by crowded lines of growth, falciform, with forward directed concavity the apex of which is close to the posterior suture, steeply antecurrent to the posterior suture, very obliquely antecurrent to the anterior suture, their intersections with the raised spiral lines forming crowded, delicate, microscopic granulations. On the later whorls of full-grown specimens, some of the lines of growth, at more or less irregular, more or less crowded intervals, are apt to become more prominent than the remainder, and slightly scaly, and they communicate a peculiar creased appearance to the posterior margin of the whorl.

The body-whorl constituting the greater part of the shell, measures from eight-ninths to ten-elevenths of the total height. Posteriorly it exhibits a feebly sloping, slightly concave zone, the con-

tinuation of the spire-whorls, anteriorly bounded by an angulation which represents the re-appearance of the angulation of the two first spire-whorls concealed, at all intermediate stages, by the posterior overlap of the intervening spire-whorls. Anteriorly to the angulation, the outline is, at first, convex, and disposed in such a manner that the maximum thickness of the shell is situated anteriorly to the angulation, at a distance which varies in different individuals: both the degree of curvature and the extent of the convexity varying in such a manner that, in some specimens, especially when immature, the outline of the shell may become pear-shaped, while in others the convexity is so short that the outline appears to be essentially straight-conical. In an anterior direction the convexity stiffens into a straight outline which, except in the case of unusually pear-shaped specimens, occupies a considerable portion of the shell, converging from opposite sides at an angle of from  $33^{\circ}$  to  $40^{\circ}$  in different specimens, the average being nearly  $37^{\circ}$ . Close to the anterior end of the shell, there is, on the left side, a shallow concavity by which the outline steepens slightly on nearing its anterior termination. At its anterior end the shell is narrowly truncated and indistinctly notched, the accretions to the terminal truncation accounting for the slight concavity observed anteriorly on the left side of the shell. Posteriorly to the angulation the shell carries the same spiral ornaments as the spire-whorls. Towards the anterior end of the shell, the spirally decorated portion, in adult specimens, may occupy one-half or more of the height of the body-whorl, or only two-fifths. The variation in extent is still greater in immature specimens in some of which it covers as much as two-thirds of the surface, while in others, again, it is reduced to two-fifths. The character of the decoration is extremely variable; generally the ornamentation becomes more distinct and somewhat more crowded towards the anterior end, but its disposition exhibits endless variations. In some instances, near the posterior edge of the ornamented portion, the spiral grooves may be narrow, crowded, and superficial, and all of one size, while anteriorly every alternate groove is deeper, the shallower grooves exactly bisecting the raised spaces between the deeper ones. In other specimens there are at first some thin, wide-spaced incisions, succeeded by deeper and broader grooves, disposed at first in two alternating sizes, after which two narrow grooves intervene between successive broad grooves. In some immature specimens the grooves become flat sunken bands of

the same width as the intervening raised spaces. Again, in other specimens, both full-grown and immature, the ornamentation consists merely of wide-spaced spiral incisions. Posteriorly to the angulation, the lines of growth are disposed as on the spire-whorls, with a tendency to form crowded rugose scales on approaching the aperture. Anteriorly to the angulation, they form, first a very short forward directed convexity, after which, for the greater part of their extent, they are practically straight and practically vertical, becoming distinctly anteriorly retrocurrent only on approaching the anterior termination. They are apt to become scaly across the terminal zone of accretions.

The tall narrow aperture has almost parallel borders scarcely diverging in an anterior direction. Towards its anterior extremity, the smoothness of outline of the inner border, in many specimens, is not appreciably disturbed by the terminal zone of accretions. In other instances, a very shallow concavity, corresponding to the outer anterior concavity of the left side of the shell, is observed posteriorly to the region along which the anterior zone penetrates into the aperture. In other specimens it is along the anterior border of the zone of accretions that the outline sinks in for a short space. Anteriorly to the terminal zone, the outline continues or resumes its steeply oblique trend along the short remaining portion of the inner side of the aperture which consists of a steeply winding, narrow ~~callosity~~ representing the terminal edge of the columella and columellar lip. Along the posterior termination of the inner side of the aperture is a narrow, flat, callous band winding into the interior of the shell and anteriorly bordered by a shallow, though very distinct groove, practically horizontal in the interior of the shell, slightly oblique, on approaching the aperture, towards its posterior termination.

The outer lip is very obliquely antecurrent to the suture at its immediate junction, quite close to which it abruptly bends in the opposite direction and becomes strongly antecurrent towards the angulation beyond which it projects only to a very slight extent, the remainder of its course being mostly practically straight and practically vertical.

*Measurements.*—

	mm.	mm.	mm.	mm.	mm.
Height . . . . .	36.2	31.9	27	22	18.9
Thickness . . . . .	20	16.6	14.5	12.8	9.9
Height of spire . . . . .	5	3.2	3.1	3	2.9
Height of body whorl . . . . .	32.2	29.2	24	19.9	16.9
Angle of base . . . . .	33°	3*	38°	36°	40°

The species also attains larger dimensions, a fragmentary specimen reaching a thickness of 21.9 mm. corresponding with a height of about 45 mm.

*Occurrence.*—This shell occurs at several horizons of the Mekran beds, its average size slightly increasing in the newer zones. Base of Talar section; faulted anticlinal region south of the Talar syncline, north branch of the anticline; between Kanderi and Sari Dasht in Kulanch; west of Gharh Hill.

*Comparison with other species.*—The lines of growth on the spire-whorls are more oblique than are depicted in Martin's illustration (*loc. cit.*, fig. 47a). In every other character the shell closely coincides with the Javanese fossil. A few of the more pear-shaped specimens closely resemble *Conus jenkinsi* Martin (*Tertiaerschichten auf Java*, p. 10, Pl. I, fig. 4), and, having regard to the great variability of the Mekran shell, the question may be asked whether *Conus djarianensis* might not be specifically identical with *Conus jenkinsi*. The spiral decoration of the spire is, however, described by Martin as different, and, in this respect, the Mekran specimens agree exactly with *Conus djarianensis*.

Amongst living species, *Conus radiatus* Gmelin (= *C. martinianus* Reeve = *C. parvus* Reeve) from the Philippines and Polynesia is so closely related as to give occasion to some doubt regarding its specific distinctness. It is described, however, as possessing smooth or feebly striated spire-whorls. Moreover, the evenly distributed, wide-spaced, spiral ornamentation of its body-whorl seems decidedly more pronounced than in the fossil. The same difference in the ornamentation of the body-whorl distinguishes the fossil from the living *Conus spectrum* Linn., also from the Indo-Pacific region, which, moreover, appears to be more decidedly pear-shaped.

The shell is very closely related to *Conus odengensis* from which it is distinguished by its generally smaller dimensions, its more slender build, the less rigid outline of its generally more elongate base, the somewhat more pronounced spiral decoration of its spire-whorls.

#### CONUS (LITHOCONUS) INEDITUS Michelotti.

Pl. I, figs. 12-14.

1861. *Conus ineditus* Michelotti.—*Et. Mioc. inf. Italie septentrionale*, p. 105, Pl. XI, figs. 11, 12.
1893. *Lithoconus ineditus* Micht.—*Sacco, Moll. terr. terz. Piem. e Lig.*, XIII, p. 26, Pl. III, figs. 16-24.

- 1895 *Conus malaccanus* Hwass *sec.* Noetling.—Mem., G. S. I., Vol. XXVII, p. 42  
Pl. X, figs. 4-7.
1901. *Conus (Rhizoconus) malaccanus* Hwass *sec.* Noetling.—Pal. Ind., new series,  
Vol. I, part 3, p. 360, Pl. XXIII, figs. 17-20.

*Measurements.*—The dimensions of an immature, practically complete specimen are approximately 19.5×10.5 mm. In none of the other numerous specimens is the anterior extremity preserved. The largest specimen has a diameter of 20 mm. corresponding with an approximate height of 55 mm. The sides of the base converge at an angle varying, in different individuals, from 28° to 35°, the average being 31°.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparisons and remarks.*—There is no doubt as to the identity of this fossil with *Conus ineditus* Michelotti, one of the commonest fossils in the Oligocene of Liguria. The shapes of the specimens vary to some extent, corresponding with several of the varieties illustrated by Sacco, especially those with very short spires.

Whenever a portion of the outer lip is missing the penultimate whorl exhibits a slightly swollen, horizontal, spirally wound, narrow band next to the posterior angulation; there is an abrupt, but very slight drop of the surface (a step, not a depression or groove) at the anterior edge of this band. This is the structure described by Michelotti and represented by Sacco in the specimen figured as *Lithoconus ineditus* var. *depressa* (*loc. cit.*, fig. 16 bis). It represents the callosity developed, apparently in all species of *Conus* along the posterior margin of the inner wall of the shell, which callosity carries or demarcates the parietal groove observed in many species of *Conus*. Cossmann (*Essais de Pal. Comp.*, fasc. II, p. 152) was the first who drew attention to this curious structure in the genus *Conus*. In the present species, though the callosity is distinct, the groove is not clearly developed in any of the available specimens.

The same species occurs abundantly in the Tertiary formations of Burma, and was referred by Noetling to the living *Conus malaccanus* Hwass, to which it is very closely related. The stronger convexity of the outer lip in the fossil appears to be the only distinct difference. The largest specimen from Bhagothoro Hill exhibits distinct traces of the coloured decoration disposed in rather close-set, interrupted spiral bands very similar to those observed in many specimens of *Conus malaccanus*.

## CONUS (LITHOCONUS) BREVIS J. de C. Sowerby.

1839. *Conus brevis* J. de C. Sowerby.—Trans. Geol. Soc. Lond., (2) Vol V, Pl. XXVI, fig. 33.
1839. *Conus militaris* J. de C. Sowerby.—Trans. Geol. Soc. Lond., (2) Vol. V, Pl. XXVI, fig. 34.
1839. *Conus catenulatus* J. de C. Sowerby.—Trans. Geol. Soc. Lond., (2) Vol. V, Pl. XXVI, fig. 35.
- non Conus militaris* J. de C. Sow. ? in d'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 336, Pl. XXXIV, fig. 5 (1853).
- non Conus brevis* J. de C. Sow. ? in d'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 336, Pl. XXXIV, fig. 6 (1853).
- non Conus (Lithoconus) luteus* Linn. in Noefling, Pal. Ind., new series, Vol. I, part 3, p. 359, Pl. XXIII, figs. 12-14 (1901).
- non Conus brevis* J. de C. Sow. ? in Cosmann and Pissarro, Pal. Ind., new series, Vol. III, part 1, p. 18, Pl. I, figs. 21, 22 (1909).

Medium-size. with extremely short spire and moderately elongate base.

With the exception of the very small extraconic apical portion the greater part of the spire is flat or in many specimens concave. The very prominent globular protoconch consists of a minute virguliform nucleus followed by two smooth whorls the aggregate outline of which is spherical. The protoconch is followed by eight spire-whorls of which the two first, which are very small, are angulated and faintly crenulated. Beyond the second whorl there is no longer any tendency towards a stepped disposition, the general outline having already almost completely flattened out by the time the fourth whorl is reached. All the spire-whorls, from the third to the last, are separated by sharply incised sutures. Their surface is distinctly concave, bounded by a distinct narrow raised rim, the incised sutures running between the adjacent anterior and posterior rims of successive whorls. The whorls are decorated with shallow close-set, spiral grooves, the number of which varies in different specimens, but usually reaches six, especially at later stages of growth. In some specimens the grooves become so broad in comparison with the raised interspaces that the ornamentation can better be described as consisting of raised spiral lines rather than of sunken spiral grooves. The lines of growth are falciform, with forward facing concavity, antecurrent towards both sutures, the obliquity being greatest towards the anterior suture.

The body-whorl constitutes the greater part of the shell. Posteriorly it exhibits a concave spiral zone forming the continuation of the last spire-whorl, externally bounded by a narrow rim coinciding



with the sharp angulation which limits the base proper. Anteriorly to this angulation, the surface constitutes, at first, a convexity of slight curvature which may be disposed in such a way that the outline may at once contract, although very steeply, or else the surface may be, just at first, vertical, or may even very slightly expand. In an anterior direction the curvature soon stiffens, and settles to a rectilinear conical outline, opposite sides of which converge at an angle varying, in different specimens, from  $31^{\circ}$  to  $38^{\circ}$ . All the specimens measured approach one or other of those extreme values, the intermediate average being unrepresented, and the difference may be perhaps therefore sexual, but the number of available specimens is not sufficient to ascertain whether the observed peculiarity is fortuitous or not. Anteriorly the shell is terminated by a narrow, scarcely notched truncation, the accretions to which form a steeply winding zone quite flush and continuous with the remainder of the dorsal surface. The ornamentation of the last spire-whorl is continued on the corresponding portion of the body-whorl. The terminal zone of accretions is either decorated with variously disposed spiral grooves, distributed with more or less regularity and usually becoming more crowded towards the anterior termination, or else it is divided up into imbrications with their short face turned posteriorly, and also becoming more crowded anteriorly. Posteriorly to the posterior edge of the terminal zone the ornamentation may continue of the same character, only becoming, in a posterior direction, fainter and wider-spaced, in which case the terminal zone of accretions is not abruptly marked off from the remainder of the dorsal surface; or else the terminal zone is sharply contrasted by its more crowded ornamentation, in which case, posteriorly to its posterior margin, there are only two or three wide-spaced, very thin, spiral incisions. In every case the total area carrying spiral ornaments includes the anterior third of the body-whorl. Posteriorly, on the part of the body-whorl corresponding with the spire-whorls, the lines of growth are disposed in the same manner as on the spire. For a very short distance anteriorly to the posterior angulation they are very strongly oblique and anteriorly antecurrent, and then soon pass into a continuous, graceful convexity of moderate curvature extending over the entire base, the direction becoming strongly retrocurrent towards the terminal zone of accretions upon which the lines sometimes show a tendency to become scalv.

The tall, narrow aperture has almost rectilinear, almost parallel borders, their divergence, in an anterior direction, being scarcely noticeable. In some specimens the inner border caves in very slightly, quite close to its anterior termination, opposite the anterior edge of the terminal zone of accretions; in other specimens, this slight concavity is quite unappreciable. Beyond the anterior edge of the zone of accretions, the very short remaining terminal portion resumes or continues the steep obliquity of the rest of the inner border, constituting a narrow, slightly callous, scarcely winding edge, the only part of the aperture which, strictly speaking, can be assimilated to a columella or columellar lip. The outer lip exhibits posteriorly a rather deep sinuosity formed by the combination of the concavity intervening between the suture and angulation and the convexity situated anteriorly to the angulation. It then assumes an elongate convex course such as has been described with reference to the lines of growth.

Along the posterior margin of the inner shell wall on the internal or columellar side, is a narrow callosity bounded anteriorly by a narrow groove which is slightly oblique at its apertural termination.

The original types described and illustrated by Sowerby exhibit remnants of a colour scheme somewhat recalling that of *Conus malaccanus*.

*Dimensions.*—

	mm.	mm.
Height . . . . .	36	35
Thickness . . . . .	24	22

*Occurrence.*—Gáj of Kachh: Bayr Stream; near Warsar (23° 2', 68° 49') north of Jakao (23° 13', 68° 45'); Teyra River near Rampur (23° 20', 68° 51'); Teyra River north of Naliya (23° 15', 68° 52') higher than the Pecten bed of Sookpur.

*Remarks and comparisons.*—The three specimens illustrated by Sowerby (*loc. cit.*) respectively as the types of *Conus brevis*, *C. militaris*, and *C. catenulatus*, all belong to a single species, every gradation between the three original types being observed amongst the specimens in the collections of the Geological Survey of India.

The fossil species most closely related is *Conus decollatus* Martin, from the Tertiary formation of Java which also occurs fossil in Burma. The Javanese species is smaller, narrower, with a more elongate base, a wider, more prominent, and more distinctly stepped apical projection.

The Kachh fossil is also related to *Conus ineditus* from which it is distinguished by its shorter, usually concave spire, with no trace of a stepped disposition beyond the two first whorls, the same characters differentiating it from the living *Conus malaccanus* Hwass. *Conus pumotanensis* Martin, from the Tertiary formations of Java (Samml. des Geol. Reichs-Museums in Leiden, new series, Vol. I, p. 288, Pl. XLII, fig. 689), also occurring fossil in Burma, is somewhat related to the Kachh fossil, but is much larger, and has a relatively much more extensive convexity anteriorly to the angulation.

Amongst living species, *Conus thalassiarachus* Gray, from the Philippines, is related to the Kachh fossil, but is much larger and more elongate. *Conus generalis* Linn., from the Eastern Seas, is also related, but is also distinguished by its larger size and more elongate base, while the spire is usually more prominent, and, even when exceptionally depressed, is distinguished by the more prominent rim bordering each whorl. *Conus literatus* Linn. closely agrees with the Kachh fossil in general outline, but it lacks the steep umbolike prominence of the earliest apical part of the spire, and attains much larger dimensions.

Noetling has quoted *Conus brevis* in the synonymy of some fossil specimens from Thayetmyo in Burma, which this author referred to the living *Conus literatus* Linn. Three specimens were figured, one of which (fig. 13, *loc. cit.*) corresponds with *Conus odengensis* Martin, fossil, from Java while the two others (figs. 12, 14) correspond with *Conus ickeni* Martin, also a fossil form from Java regarded by its author as closely related to *Conus millepunctatus* Lamarck, which Tryon considers to be a variety of *C. literatus* Linn. Noetling therefore correctly compared one of the Burmese forms with *Conus literatus*, but it is not very closely related to the Kachh fossil which, as has above been mentioned, is nearer related to *Conus thalassiarachus* and *C. generalis*.

The Sind fossils doubtfully referred by d'Archiac and Haime (*loc. cit.*) to *Conus brevis* and *Conus militaris*, and also doubtfully referred by Cossmann and Pissarro to *Conus brevis*, differ specifically from the Gáj fossil. They are of lower Eocene age, and all represent a single species which reaches larger dimensions than the Gáj shell and which d'Archiac and Haime considered to be related to *Conus diversiformis* Deshayes. It may be distinguished as *Conus blagruzei*.

## CONUS (DENDROCONUS) LOROISII Kienor.

1847. *Conus loroisii* Kienor.—Iconographie des coquilles vivantes, p. 91, Pl. LXV fig. 1.
- ? 1847. *Conus berghausi* Micholotti.—Descript. Foss. mioc., p. 242, Pl. XIII, fig. 9.
1864. *Conus striatellus* Jenkins.—Quart. Journ. Geol. Soc., Vol. XX, p. 54, Pl. VII, fig. 3.
1879. *Conus striatellus* Jenkins.—Martin, Tertiärschichten auf Java, p. 9, Pl. I, figs. 2, 3, 5.
- ? 1879. *Conus loroisii* Kienor.—R. Hoernes and Auinger, Gaster. I u. II Mioc. Med. Stufe, p. 21, Pl. III, fig. 5.
1882. *Conus loroisii* Kienor.—Martin, Samml. des geol. Reichs-Museum in Leiden, series 1, Vol. I, p. 100.
1883. *Conus loroisii* Kienor.—Martin, Samml. des geol. Reichs-Museum in Leiden, series 1, Vol. I, p. 223.
- ? 1893. *Conus (Dendroconus) exloroisii* Sacco.—Moll. terr. terz. Piem. o Lig., part XIII, p. 8.
1895. *Conus loroisii* Kienor.—Martin, Samml. des geol. Reichs-Museum in Leiden, new series, Vol. I, p. 21, Pl. III, fig. 52.

Fairly large, with very low extraconic spire, and with broad body-whorl measuring two-thirds of the height.

The spire, in the case of average and of large specimens, measures from less than one-twelfth to nearly one-eleventh of the total height. It is relatively longer in the case of very immature specimens in which it may reach nearly one-seventh of the height. The protoconch, broken in all the available specimens, is followed by eight feebly sloping spire-whorls, the slope decreasing slightly with increasing growth. The first whorl following the protoconch may be obscurely ribbed. All the others are slightly convex, the posterior margin of each whorl overlapping the anterior margin of the preceding one over which it projects considerably, the sutures being deeply sulcate. There are no distinct spiral ornaments. The lines of growth are moderately curved, practically normal to the posterior suture, obliquely antecurrent to the anterior suture at 40°.

The large body-whorl, constituting the greater part of the shell, measures, in the case of large specimens, fourteen-fifteenths of the total height, in those of average dimensions, from ten-elevenths to eleven-twelfths, in very immature specimens, a little more than six-sevenths. It exhibits, posteriorly, a very shallow slope corresponding to that of the spire-whorls, its surface being generally a little flatter than the spire, sometimes even slightly concave. At the level of the suture there is generally a very feeble angulation, sometimes barely perceptible, though it is generally accentuated by a

very shallow, revolving groove. Anteriorly to the level of the suture the surface expands at first, for a distance equal to a little less than one-third of the height of the body-whorl, with a convexity of slight curvature which, after reaching a vertical trend at the zone of maximum thickness of the shell, rapidly bends into an almost rectilinear, conical outline with opposite sides converging at an angle of  $37^{\circ}$  in the case of very immature specimens, of from  $38^{\circ}$  to  $44^{\circ}$  at average stages of growth, and of  $48^{\circ}$  in the case of large specimens, the straight outline, except for a scarcely appreciable anterior concavity best seen on the left side, being continued almost unchanged to the extremity of the shell. The terminal truncation is narrow, horizontal, scarcely notched, the zone of its accretions either forming a very feeble winding bulge, or else remaining practically flush with the remainder of the surface. Along the anterior portion of the shell, a zone measuring about two-fifths of the height of the body-whorl carries spiral ornaments the nature and disposition of which vary a great deal in different specimens. They may consist of fairly close-set well-defined imbrications the edge of which faces posteriorly, distributed evenly, and covering the whole of the spirally decorated area as far as the terminal zone of accretions; or else the imbrications may be much less prominent, much wider-spaced, alternating in two sizes and occupying only the posterior half of the decorated area, the anterior half being ornamented with fairly close-set, fine, well-defined, spiral threads; or else the ornamentation may consist entirely of close-set, spiral grooves of different depth, more or less regularly alternating in two or three orders, those of the second and third order becoming easily obliterated by even a slight degree of weathering, so that the only remaining ones are those of the first order, to the number of only one to every two or three grooves, producing an appearance of very wide-spaced incisions. There are no distinct spiral ornaments on the terminal zone upon which they are obliterated by the scaly accretions. Posteriorly to the level of the suture, the lines of growth are disposed in the same manner as upon the spire-whorls. Anteriorly to the level of the suture the lines, with a forward directed convexity, maintain an anteriorly antecurrent trend for only a short distance, after which they become practically straight throughout the greater part of the body-whorl, with a very slight anteriorly retrocurrent obliquity, becoming more distinctly oblique and retrocurrent only quite close to the anterior extremity. They become scaly on the terminal zone of accretions.

The aperture is rather broad, its average width remaining approximately even throughout its height. The regularity of the inner border is scarcely disturbed anteriorly, in some specimens, by the feebly bulging terminal zone of accretions anteriorly to which the termination of the columella and columellar lip forms a short inconspicuous, narrow, callous edge winding out of the interior of the shell. The posterior parietal furrow is very distinct, rather narrow, somewhat oblique at its apertural termination. The outer lip is practically normal to the suture beyond which it projects forward only moderately with a sigmoidal flexure of double curvature which soon passes into an almost rectilinear trend very slightly oblique and anteriorly retrocurrent.

Traces of the colouring indicate a pattern of spirally disposed rows of dots or spots.

*Dimensions.*—

	mm.	mm.	mm.	mm.
Height . . . . .	54	36	28	19.7
Thickness . . . . .	37	22	19	13
Height of spire . . . . .	4.3	3.1	2.2	2.7
Height of body-whorl . . . . .	50.4	33	25.5	17.1

*Occurrence.*—Mekran beds, not the lowest horizons: south of Talar Range (highest beds of Talar section).

*Comparison with other species.*—Amongst recent forms, *Conus lotoisii* agrees exactly in shape with this fossil, being distinguished only by its lower spire from *Conus figulinus* Linn. of which it is often regarded as a variety. According to Martin, the wide-spaced spiral incisions of *Conus lotoisii*, such as exhibited by the Javanese fossil specimens, would constitute another distinction from *Conus figulinus*. In this respect the Mekran specimens, which have somewhat crowded spiral ornaments, would agree therefore with *C. figulinus* and not with *C. lotoisii*. It should be noticed, however, that Sowerby's illustration of *C. lotoisii* in the "Thesaurus" represents a shell with crowded striations, and that the anterior striations vary to such an extent in most species of *Conus* that they can seldom be made use of for specific discrimination. Moreover, it was above noticed, in the description of the Mekran fossil, that a slight degree of weathering suffices, in some instances, to bring out a pattern of wide-spaced spiral incisions quite similar to that exhibited by the Javanese specimens which, judging from the illustrations, appear mostly to be slightly weathered.

Much doubt is felt regarding the specific distinctness between *Conus lorisii* and *Conus berghausi* Michelotti, which occurs abundantly in a fossil condition in the Miocene and Pliocene of Europe. The available descriptions and figures do not indicate any precise distinction between the two forms. The convexity anterior to the level of the suture seems a little shorter in *Conus berghausi* than in the eastern shell, and the spire seems, generally, a little less extraconic, but these are differences thoroughly lacking in precision. The dimensions and proportions agree exactly.

One of the fossils from the Vienna region has been referred by R. Hoernes and Auinger to *Conus lorisii*, an identification regarded as incorrect by Sacco who, without stating the reasons for this opinion, has substituted, for this fossil, the name *erlorisii*, suggesting, moreover, that it may be a variety of *Conus berghausi*; which, after all, only tends still further to indicate the probable identity of *Conus berghausi* and *C. lorisii*.

*Conus hochsetteri* Martin, occurring fossil in the Tertiary formations of Java and of Burma, is closely related to the Mekran fossil, but it is smaller, with a relatively taller spire, a somewhat more slender shape, and, usually, a more ovoid outline.

#### TRIGONOSTOMA INDIUM n. sp.

Pl. XII, fig. 4.

Medium-size, somewhat elongate, with ovoid body-whorl, and with rather elongate, slightly conoidal, stepped spire measuring about five-ninths of the total height.

The imperfectly preserved protoconch is followed by four teebly convex spire-whorls, the height of which, at early and intermediate stages of growth, is equal to about half their width. In the last spire-whorl, the height reaches four-sevenths of the width as a consequence of the slightly conoidal outline of the spire caused by the slightly increased obliquity assumed by the suture as it approaches the aperture. The maximum width of the spire-whorls coincides with their anterior edge. The sutures are surrounded by a channel externally bordered by a raised rim, the spire thereby acquiring a characteristic scalariform appearance.\* The spire-whorls carry numerous straight ribs, slightly narrower than the intervening spaces, slightly oblique in an anteriorly retrocurrent direction. Their number is about twenty-four on each whorl except on the 1st

spire-whorl where it becomes reduced to twenty-one. Posteriorly, the ribs end in vertical blunt spines which contribute to the constitution of the rim bordering the circumsutural channel. The surface is further decorated with spiral threads which are much narrower than the ribs, and which swell slightly on crossing them. At earlier stages of growth there are three regularly spaced principal threads the intervals between which are bisected by threads of a second order; a thread of a second order likewise occurring in the interval between the posterior main thread and the rim of the circumsutural channel, as also, apparently, between the anterior main thread and the anterior margin of the whorl. Threads of a third order further bisect the secondary intervals thus produced. With increasing growth, the threads of the second order thicken relatively more rapidly than those of the first order, so that, on the last spire-whorl, we observe seven practically equal principal threads. Threads of a fourth order and even higher orders at the same time appear. When examined by means of a magnifying lens, these crowded subsidiary threads are seen to be minutely granulated by the intersection of the fine crowded lines of growth whose direction coincides with that of the ribs, that is: straight and slightly retrocurrent anteriorly.

The somewhat elongate, ovoid body-whorl measures slightly more than four-fifths of the total height. Anteriorly it exhibits a well developed umbilicus which is somewhat narrow and apparently deep. The exterior margin of the umbilicus is not swollen except to a slight extent on approaching the aperture. It may be described as a spiral blunt ridge rather than a spiral swelling. Although the shell is slightly damaged at its anterior extremity, it is sufficiently preserved to show that there is no appreciable terminal notch. The posterior portion of the body-whorl is shaped and ornamented like the spire-whorls of which it forms the continuation. The ribs which, as above noticed, decrease in number on the last spire-whorl, become still fewer on the body-whorl where their number is reduced to fifteen. Anteriorly to the level of the suture, their anteriorly retrocurrent obliquity slightly increases towards the umbilicus which they penetrate. The spiral threads, anteriorly to the level of the suture, become somewhat more crowded and sharper.

The rather tall, lanceolate rather than trigonal aperture is pointed both anteriorly and posteriorly, the posterior contraction being the more acute, and corresponding with the rim that surrounds the cir-



cumsutural channel. The columella and the posterior portion of the columellar lip are, unfortunately, concealed by a hard, adhering, rocky incrustation in the only available specimen. Anteriorly, the columellar lip is completely detached and forms the rim of the umbilicus. The outer lip is straight, oblique and anteriorly antecurrent, thickened externally by the last rib, frilled at its edge by the terminations of the spiral ornaments. Its internal characters are concealed.

*Dimensions.*—

Height . . . . .	mm.
Thickness . . . . .	26
Height of spire . . . . .	14
Height of body-whorl . . . . .	14
	21

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—Although, as happens too frequently with the fossils from north-western India, the internal characters of the aperture are concealed, yet the general appearance of this shell is so definite that it can be, without any hesitation, referred to the genus *Trigonostoma*.

The form nearest related is evidently the living *Cancellaria scalata* Sow. which abounds throughout the Indo-Pacific region. In the living form, the body-whorl is somewhat more ventricose, and the umbilicus perhaps narrower. There is also a distinct resemblance between the shell above described and *Trigonostoma crassicosta* Bellardi from the Miocene of Turin. The Indian species has more numerous ribs, more numerous and apparently sharper, spiral ornaments, a better defined circumsutural channel, and somewhat lower spire-whorls.

TRIGONOSTOMA CRISPATUM Sowerby.

1855. *Cancellaria crispata* Sowerby.—Thes. Conch., Vol. II, p. 452, Pl. 96, fig. 89.

1895. *Cancellaria (Trigonostoma) crispata* Sow.—Martin, Samml. geol. Reichsmus. in Leiden, new series, Vol. I, p. 51, Pl. VII, fig. 117.

1903. *Trigonostoma crispatum* [Sow.].—Cossmann, Journ. Conch., Vol. L, p. 108, Pl. III, figs. 5, 6.

The Mekran beds of Baluchistan contain a fossil which agrees with the available published figures and descriptions of the recent *Trigonostoma crispatum* [Sow.]. The Mekran fossil is umbilicated. According to Tryon, the presence of an umbilicus distinguishes *Trigonostoma creniferum* [Sow.] from *T. crispatum* [Sow.], though, at the same time, the thick ribs are regarded as specifically distinguish-

ing *Tr. crispatum*. Martin and Cossmann have referred to *Triyostoma crispatum* fossils respectively from Java and from Karikal which have a pronounced umbilicus. It is not improbable, considering the extreme variability of the Cancellariidæ, that both forms, both of which inhabit the Indian Ocean and Philippines, are but variations of a single species.

*Occurrence*.—North of the Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

UXIA NARICA n. sp.

Pl. VII, fig. 7.

Small-medium, moderately elongate, with somewhat slender spire measuring one-half of the total height, and obliquely trigonal-ovoid body-whorl.

The apex is missing in the solitary specimen available. The number of spire-whorls following the protoconch was probably four, of which only the last and a portion of the preceding one are preserved. The height of the spire-whorls is equal to half their width, the maximum thickness coinciding with their anterior margin. In general outline they are conical, with, at the same time, a moderate degree of convexity. Posteriorly, a narrow channel surrounds the sutures. The spire-whorls carry straight ribs, narrower than the intervening spaces, numbering seventeen or eighteen in each complete turn. They are rather strongly oblique with an anteriorly retro-current direction. Posteriorly they project beyond the rim bordering the circumsutural channel. At intervals of about one turn and a half, one of the ribs is thickened into a varix. The surface is further decorated with spiral ornaments much narrower than the ribs which they cross with scarcely any tendency towards thickening. There are four equidistant primary threads; the interval between the most anterior thread and the anterior margin being equal to the intervals between successive primary threads, while that between the most posterior primary thread and the rim of the circumsutural channel is only half that amount. A thread of a second order follows this rim, while all the other intervals are regularly intersected by threads of the second order. Threads of a third order also appear on the last spire-whorl. The spiral ornaments are very delicately granulated by the intersections of the fine crowded lines of growth which are straight and which approximately follow

the same direction as the ribs, with an anteriorly retrocurrent obliquity.

The large body-whorl, measuring five-sevenths of the total height, is somewhat ovoid in ventral aspect, sub-trigonal in dorsal aspect. The posterior portion of the body-whorl reproduces the shape of the spire-whorls of which it forms the continuation, and is therefore moderately convex. The level of the suture corresponds with the position of maximum width and therefore with the vertical trend of the surface. Anteriorly to the level of the suture, the shell gradually contracts, the curvature being continued at first regularly, but afterwards with a decrease of convexity on approaching the anterior termination which thereby assumes a somewhat tapering, turbinate appearance. Although there is no umbilicus, yet there is, anteriorly, on the ventral side, a slight flattening or sinking of the surface adjacent to the anterior border of the columellar lip, so that, in a ventral view of the shell, the portion externally bordering this slight depression resembles a feebly defined, steeply winding, terminal bulge; an illusory appearance which nearly, or completely, vanishes when the shell is viewed laterally or dorsally. The anterior extremity of the solitary available specimen is slightly damaged, and as the lines of growth, moreover, in this anterior terminal portion are not very distinct, the possible presence of a terminal notch remains uncertain. The ribs, on the body-whorl, become somewhat wider-spaced than on the spire, their number, consequently, being reduced to fifteen. Anteriorly they exhibit a very slight decrease of obliquity on approaching the terminal depression and vanish on reaching its border. The last rib, bordering the outer lip, is thickened into a varix. On the posterior portion of the body-whorl, forming the continuation of the spire, the spiral ornaments are disposed in three orders distributed as on the spire-whorls. Anteriorly to the level of the suture, the threads of the first order become more crowded and only alternate with threads of a second order, there being no longer any distinct development of threads of a third order. For a short space, on approaching the anterior termination, in that part of the shell where the convexity decreases, the spacing of the threads of the first order once more expands, and the spiral ornaments, consequently, are once more distributed in three orders. The total number of threads of the first order anteriorly to the level of the suture is twelve or thirteen. Very steeply winding threads of only one order, narrower than the intervening spaces, decorate the termi-

nal ventral depression. Under a magnifying lens, all the spiral ornaments of the body-whorl appear elegantly granulated by the intersections of the lines of growth whose direction coincides with that of the ribs. On crossing over into the terminal ventral depression, the lines of growth bend back into a posterior direction, terminating tangentially to the columellar lip.

The aperture is lanceolar. The columella, largely concealed by a hard, adhering, rocky incrustation, appears to be mostly vertical. Of the columellar folds, one only is partly visible. The columellar lip is thickened and greatly expanded posteriorly, anteriorly semi-detached. The outer lip is rather strongly oblique with an anteriorly retrocurrent direction, mostly straight, with a very feebly indicated sinuosity towards the anterior extremity. Its edge extends forward to a short distance beyond the terminal varix, and is frilled by the terminations of the spiral ornaments. The internal characters of the outer lip are concealed.

*Dimensions.*—

Height . . . . .	mm.
Thickness . . . . .	13
Height of spire . . . . .	11
Height of body-whorl . . . . .	15

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—It is with the greatest hesitation and reluctance that this shell has been specifically separated from *Cancellaria tumida* von Koenen, from the Oligocene of Lattorf. The shape, the dimensions and the main features of the ornamentation entirely agree. The possibly specific distinction, not shown in Koenen's illustration, which only gives a dorsal view of the Lattorf shell, resides in the structure of the columellar lip which, according to Koenen's description, is only slightly thickened and slightly expanded posteriorly, while the posterior thickening and expansion are very pronounced in the Indian shell. As the Lattorf species is only known from two individuals, and the Indian form from only a single specimen, the material at present available is insufficient to indicate whether the difference may be merely racial or even individual. The ribs are slightly more crowded in the Lattorf type than in the Indian specimen. In conclusion, the specific distinctness of the above described form must be regarded as quite provisional.

Cossmann, in the "Essais de Paléoconchologie," has referred *Cancellaria tumida* to *Bonellitia*. A complete monographic revision of the Cancellariidæ would probably lead to some amendment of the respective diagnoses of *Bonellitia* and *Uxia*, and to a certain amount of re-distribution of the forms attributed to these two divisions. The form above described shows more resemblance to *Cancellaria costulata* Lam., from the Eocene of Paris, the genotype of *Uxia*, than to *Cancellaria bonellii* Bell., from the Neogene of Piedmont, the genotype of *Bonellitia*.

OLIVA (NEOCYLINDRUS) MUSTELINA Lamarck.

Pl. V, figs. 18-20.

1810. *Oliva mustelina* Lamarck.—Ann. du Mus., Vol. XVI, p. 316.

1851 *Oliva mustelina* Lamk.—Reeve, Monograph of the genus *Oliva*, Pl. XIII, species 23.

1883. *Oliva mustellina* Lamk.—Tryon, Manual of Conchology, Vol. V, p. 78, Pl. XXII, figs. 6-14. •

1903. *Oliva (Neocylindrus) mustellina* Lamk.—Cossmann, Journ. Conch., Vol. L p. 112, Pl. III, figs. 12, 13.

Small, subcylindrical, with small, very short, extraconic spire.

The small neritoid or naticoid protoconch exhibits a minute, flattened, hook-shaped nucleus followed by one-and-a-half convex whorls, and forms a prominent bulb or knob at the apex of the spire. It is followed by three spire-whorls the combined outline of which is almost flat. The linear sutures are rather inconspicuous because the posterior margin of each whorl exhibits a spreading callosity encroaching considerably over the surface of the preceding whorl and representing the gradual growth of a callous thickening of the posterior end of the columellar lip. This callosity forms the posterior edge of a deep, spiral channel which, at the first glance, seems to represent the suture, but is, in reality, situated quite close to the anterior edge of the whorls, and is formed by the gradual growth of a deep channel at the posterior end of the aperture, posteriorly bounded by the above-described spiral callosity.

The large body-whorl, constituting almost the entire shell, is so feebly convex as to appear for the greater part, almost cylindrical. Towards its posterior termination it is contracted with a short pronounced convexity, while it contracts but slightly towards its anterior termination truncated by the deep terminal notch the zone of

accretions of which is slightly raised above the general level of the surface, and is bounded posteriorly by a well-marked rim or step.

The rather narrow aperture is practically vertical, with almost parallel margins, scarcely diverging in an anterior direction. It is posteriorly terminated by a narrow, spout-shaped channel communicating with the spiral groove of the spire. The straight, narrow, well demarcated columellar lip is terminated posteriorly by a callous ledge forming the inner rim of the posterior apertural channel, and almost as prominent, in some specimens, as the apex of the spire. Close to its outer edge, between its posterior termination and the anterior winding callosity of the columella, it exhibits a number of short, transverse, blunt ridges, slightly imbricated, with the raised edge facing posteriorly, gradually becoming more oblique in an anterior direction. Quite close to the posterior termination of the columellar lip they are indistinct, the total number of distinct ledges, along the above defined space being about eight, disposed in such a manner that the last but one is situated along the inward continuation of the posterior border of the sinus fasciole, the last one in the space between the fasciole border and the sharp raised rim of the terminal columellar callosity. Further, there is another similar ledge along the inward continuation of the aforesaid rim, and lastly, one, or occasionally two more, in the space between the aforesaid rim and the true columellar folds the number of which is about six. They have an imbricated disposition with the raised edge facing posteriorly, and rapidly decrease in strength in an anterior direction, the two first being more prominent and extending further and more distinctly outward than the remainder. The outer lip, at its posterior termination forms the outer edge of the posterior apertural channel, anteriorly to which it exhibits a short convexity, beyond which the greater part of its course is vertical and straight or feebly concave.

Some of the specimens exhibit remnants of a more or less spotted colour decoration the exact pattern of which cannot be deciphered.

*Dimensions.*—The largest available specimen measures 21 mm. in height and 10 mm. in thickness. The dimensions do not vary much and the proportions are very constant. A number of specimens with a height of 20 mm. vary in width from 8·8 mm. to 9·5 mm. Those of 19 mm. vary in width from 8·5 mm. to 9·5 mm. Those measuring 18 mm. vary in width from 8 mm. to 9 mm. Some

specimens of 17.5 mm. have a width of from 8 mm. to 8.7 mm. ; and lastly, one specimen of 17 mm. has a width of 7 mm.

*Occurrence.*—Mekran beds, north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—It is only by careful comparison of separate specimens that it has been possible to determine exactly the characters of this shell, the abundant specimens of which are always, to some extent, obscured by a hard, adhering matrix, and always, to some extent, distorted.

Much hesitation is felt as to whether this abundant fossil should be referred to *Oliva mustelina* Lamk. or to *Oliva rufula* Duclos, supposing that these two recent forms are really specifically distinct. *Oliva mustelina* appears to be generally somewhat more elongate than *Oliva rufula* and in this respect the Indian fossil is nearer to *Oliva mustelina*, though only moderately elongate. The Mekran shells agree closely in shape with a fossil from Java which Martin has referred to *Oliva rufula* (Samml. des geol. Reichs-Museums in Leiden, new series, Vol. I, p. 56, Pl. VIII, figs. 129—133) which, nevertheless, seems to exhibit some slight differences in the distribution of the ridges along the columellar lip, the space between the posterior border of the columellar callosity and the columellar folds carrying two or three of these ledges, while in the Mekran fossil their number is never more than two, and, in the vast majority of cases, only one. In this respect, as shown by the excellent photographic illustration, the Karikal fossil referred by Cossmann (Journ. Conch., 1903, Vol. L, p. 112, Pl. III, figs. 12, 13) to *Oliva mustelina*, agrees better with the Indian than with the Javanese fossil form. The body-whorl is rather sharply angulated posteriorly in the Karikal shell instead of being rounded as in the Indian and Javanese shells, in consequence of which there is less difference between the maximum width of the spire and the maximum width of the body-whorl in the case of the Karikal form than in that of the other forms here alluded to. Amongst the numerous living forms that have been referred to *Oliva mustelina*, while there are many that agree in shape with the Karikal shell, there are also many others that exhibit the more rounded shoulder of the Mekran fossil, for instance *Oliva arcata* Marrat and *Oliva cana* Marrat. Specimens of *Oliva mustelina* obtained by Mr. L. Hirase from Fukura A-waji in Japan, now preserved in the Indian Museum in Calcutta, correspond exactly in

shape and proportions, as also in the distribution of the apertural ridges, with the Mekran fossil, differing only in their rather larger dimensions, varying from 25 mm. to 30 mm. The smaller size of the Mekran fossil and perhaps the slightly thicker ridges of its columellar margin, may, if necessary, be looked upon as characteristic of a variety *mekranica*.

Many specimens of the Mekran fossil are identical in shape with *Oliva ickei* Martin, from the Tertiary formations of Java, in which the spiral groove is described as restricted to the body-whorl, being obliterated by a filling of callus along the spire. One of Mr Hirase's specimens of *Oliva mustelina* exhibits exactly the same structure. *Oliva ickei* is, therefore, perhaps also a varietal form of *Oliva mustelina*.

With reference to the obliteration of the spiral groove on the spire of *Oliva ickei* and of certain specimens of *Oliva mustelina*, it is here worth remarking that this feature has been regarded as the generic character of *Guleola* Gray (a name pre-employed in zoology and replaced by *Galeolella* Cossmann, 1899), the solitary hitherto recorded species of which is *Oliva carneola* Lamk. from the eastern seas. Considering the presence of this feature in certain specimens of *Oliva mustelina* and having regard, at the same time, to its variability and inconstancy, it seems reasonable to dispense with the section *Guleola* or *Galeolella*.

In consideration of the doubts above expressed as to the specific distinctness of *Oliva rufula* and *Oliva mustelina*, it should here be mentioned that certain Burmese fossils referred by Noetling to *Oliva rufula* (Pal. Ind., new series, Vol. I, part 3, p. 326), are not related to the shell of that name nor to any of the other forms above mentioned or discussed.

OLIVA (STREPHONA) AUSTRALIS DuClos var. INDICA nov. var. (vel species distinguenda).

Pl. VI, figs. 3-5.

1335. *Oliva australis* DuClos.—Chenu, Illustrations Conchyliologiques, Mon. Oliv., Pl. VIII, figs. 3, 4.  
 1851 *Oliva australis* DuClos.—Reeve, Monograph of the genus *Oliva*, Pl. XIX, species 42.  
 188 *Oliva australis* DuClos.—Tryon, Man. of Conchology, Vol. V, p. 85, Pl. XXXII, figs. 19, 20.



1899. *Oliva (Strephona) australis* Duclou.—Cossmann, *Essais de Paléozoconch.* comp. fasc. 3, p. 49.

1901. *Oliva (Strephona) rufula* Duclou (*sec. Nootling*), *pars.*—Pal. Ind., new series, Vol. I, part 3, p. 326.

Small, spindle- or barrel-shaped, with broadly conical or very slightly extraconic spire measuring from less than one-fifth to somewhat less than one-third of the total height, its most usual proportion being one-fourth.

The protoconch is relatively large, naticoid, sometimes slightly oblique to the axis of the remainder of the shell, consisting of a minute nucleus followed by three or four moderately convex whorls. The mode of its termination and of its junction with the spire proper, cannot be exactly ascertained because its later portion is always more or less encroached upon by the callus which spreads from the aperture of the definitive shell and which, although very thin, suffices nevertheless to obliterate the junction in such a manner as to convey the impression of a perfectly gradual passage from the protoconch to the remainder of the shell. The protoconch is followed by three spire-whorls marked off by a deeply incised, rather narrow, spiral groove. The slope between successive volutions of the groove is either exactly subulate, or it may exhibit a slight posterior concavity and anterior convexity. There are no distinctly visible sutures as the floor of the spiral groove does not contain any line of division between adjacent whorls, the posterior margin of the groove being constituted by the callous thickening of the columellar lip which extends over the surface of each previous whorl, almost or quite to the previous volution of the spiral groove, as an extremely thin coating, the exact limit of which, in most cases, cannot be detected.

The body-whorl measures from a little over four-fifths to a little over seven-eighths of the total height. It is somewhat unsymmetrically barrel-shaped, tapering more gradually and with a feebler degree of curvature towards its anterior extremity than towards the limit of the spire in the neighbourhood of which the convexity is much more pronounced, with the result that the maximum thickness of the shell is situated nearer to its apex than to its anterior termination. Nevertheless the posterior convexity is connected with the more gently tapering anterior outline by means of a perfectly continuous curvature without any tendency towards the formation of an angulation. The terminal notch is rather narrow and very deep, the

zone of its accretions forming a distinctly raised surface with a sharply demarcated posterior edge.

The narrow aperture is posteriorly contracted into a narrow channel continuous with the spiral groove of the spire. In an anterior direction the apertural margins diverge gradually. The inner border is steeply oblique and, for the greater part, very feebly convex, the obliquity becoming slightly more pronounced and the outline straight or very slightly convex along the anterior termination of the columella. The columellar lip is mostly extremely thin, its edge being recognisable only by the presence of a very thin line or by some slight difference in colour or texture of the surface. Near the posterior termination of the aperture the edge of the columellar lip is nearly vertical; it gradually becomes more anterior in an anterior direction. Beyond the posterior termination of the aperture it swells into the somewhat feeble callosity that constitutes the posterior margin of the posterior terminal apertural channel and of the spiral groove of the spire. The portion of the columellar lip immediately anterior to the posterior termination of the aperture is smooth. Beyond this smooth portion it carries short transverse ridges which increase in distinctness and in obliquity in an anterior direction. They vary a great deal in number, prominence, width, and distribution, in various specimens. Posteriorly to the anterior columellar swelling their number may be as few as four or as many as eleven, the specimens with numerous ridges being usually larger, but the number varying greatly amongst specimens of the same size. The portion carrying the ridges is usually of approximately uniform extent in all specimens, so that the ridges are wider-spaced when they are few than when they are numerous. Irrespective of their number they may be narrower or wider than the intervening spaces. They may be very feebly prominent or else sharply demarcated, simple or bifid. When they are broad, their posterior margin often exhibits a blade-like appearance, the ridges apparently overlapping one another like a series of scales, the posterior sharp edge of each ridge simulating the free edge of the scale. The last of the ridges posterior to the columellar swelling is usually situated on the inward continuation of the edge of the terminal zone of accretions which, towards the aperture, converges so strongly with the very sharply raised blade-like posterior edge of the columellar swelling, that these two features almost come into contact. Nevertheless, in the case of specimens with an ex-

ceptionally large number of ridges along the columellar lip, a thin additional ridge may yet intervene between the border of the zone of accretions and the border of the columellar swelling. Another short ridge is developed on the edge of the columellar swelling where it penetrates into the aperture, and the space between this ridge and the anterior columellar folds carries two or three more ridges, occasionally only one, especially in small specimens. There are two close-set, conspicuous, anterior, columellar folds of which the more posterior one is posteriorly as sharply demarcated with as blade-like a margin as the posterior edge of the columellar swelling. Anteriorly to this pair of folds the anterior termination of the columella may be smooth, or it may carry from one to four feeble folds of which only the first one is sometimes moderately prominent. The outer lip is steeply retrocurrent to the posterior channel, the greater part of its course being practically vertical and so feebly convex as to appear practically straight.

The surface of the shell is very highly glazed, sometimes with indications of what appears to have been a finely mottled pattern.

*Dimensions.*—This shell, by its great abundance, constitutes a very important fossil in the newer Tertiary beds not only in Kachh, but also in Burma. The Kachh and Burmese specimens agree in every particular and have therefore been treated together in the foregoing description. In order to give as complete a picture of the form as possible, the measurements of the specimens from Burma as well as of those from Kachh are here appended:—

	TITTABWE (BURMA).		
	mm.	mm.	mm.
Height . . . . .	21	19	18
Thickness . . . . .	9	8.7	8
Height of spire . . . . .	5	3.8	5
Height of body-whorl . . . . .	17.2	16.1	15

	THANGA (BURMA).			
	mm.	mm.	mm.	mm.
Height . . . . .	17	15	12.2	7.2
Thickness . . . . .	7	6.4	5.2	3.2
Height of spire . . . . .	4	3.3	3.2	2
Height of body-whorl . . . . .	13.8	13	10.2	6.2

		MYAUKTIN (BURMA).		
		mm.	mm.	mm.
Height	. . . . .	17.1	17	16.4
Thickness	. . . . .	7.7	7	8.1
Height of spire	. . . . .	3.2	5	3.6
Height of body-whorl	. . . . .	14.3	14	14
		DALABF (BURMA).		
		mm.	mm.	
Height	. . . . .	16.2	12.9	
Thickness	. . . . .	7.3	6	
Height of spire	. . . . .	3	3	
Height of body-whorl	. . . . .	13	11	
		KACHH.		
		mm.	mm.	
Height	. . . . .	17	16	
Thickness	. . . . .	7	6.9	
Height of spire	. . . . .	3.9	4.1	
Height of body-whorl	. . . . .	14.7	13.3	

*Occurrence.*—Gaj of Kachh; near Warsar (23° 21', 68° 49'); north of Jakao (23° 13', 68° 45'); numerous localities in Burma.

*Comparison with other species.*—As frequently happens with fossil forms of *Oliva*, the identification of this shell gives rise to a great deal of hesitation. Compared with *Oliva australis* Duclos from the eastern seas (Australia and New Guinea, according to Tryon), the above described fossil is smaller and not quite so symmetrically barrel-shaped, its maximum thickness being further from its anterior than from its posterior extremity instead of being placed approximately at half the length as in the living species. From the Tertiary formations of Java, Martin has described a form regarded as a variety of *Oliva australis* (Samml. des geol. Reichs. Museums in Leiden, new series, Vol. I, p. 60, Pl. VIII, figs. 137, 138) which does not attain the full dimensions of the living form, from which it differs more than the above described fossil. In shape it closely resembles the Indian fossil and, in this respect, is further removed from the typical *Oliva australis*, for not only is the region of maximum thickness shifted to the posterior side of the middle zone, but it is accompanied by a rudimentary angulation of the surface. With regard to the disposition of the inner border of the aperture, the

above described shell closely corresponds with the living type while the Javanese fossil exhibits a decided difference in the relative position of the borders of the anterior zone of accretions and of the columellar swelling, which remain wide apart on reaching the aperture instead of closely converging. It follows therefore that, apart from its dimensions, the Indian fossil is much closer related to *Oliva australis* than the Javanese shell, and, if the latter be accepted as a variety it scarcely seems possible to adopt a different course for the Indian shell.

Cossmann has referred *Oliva australis* to the section *Strephona*. Compared with the genotype *Oliva flammulata* Lamk. living in the West-Indies and fossil in the Miocene formation of the Vienna region the above-described shell is distinguished by the much sharper prominence of the columellar folds and of the borders of the columellar swelling and of the anterior zone of accretions. The feebleness of prominence of these features observed in the genotype cannot therefore be regarded as distinctive of the section *Strephona* neither can the breadth, small number and bifid disposition of the ridges along the columellar lip, for these latter characters, as may have been observed from the above description, are eminently variable. The other generic characters indicated by Cossmann, that is, the many-whorled protoconch, the feeble development of the posterior callosity of the columellar lip; the subulate spire-whorls, and the anteriorly diverging borders of the aperture are all characteristically developed in the above-described form.

*Oliva cylindracea* Born., from the Oligocene and Miocene of Europe, *O. dufresnei* Basterot from the Miocene of Europe, and the living *O. puniculata* Duclos as represented in the Indian Museum by specimens from the Andamans, all three resemble the above-described fossil in shape, but are all distinguished by the want of convergence of the borders of the anterior zone and of the columellar swelling. Moreover, *Oliva dufresnei* and *O. cylindracea* belong to the section *Neocylindrus* distinguished by its paucispirate protoconch.

*Remark.*—Amongst various forms from Burma referred by Noetling to *Oliva rufula*, that represented by the specimens from Kama is identical with the above-described fossil. The illustrations in Noetling's monograph represent a fossil from Yenangyat, belonging to the genus *Olivella*.

## OLIVANCILLARIA (AGARONIA) NEBULOSA Lamarck, var. PUPA J. de C. Sowerby.

1822. *Oliva nebulosa* Lamarck.—Histoire naturelle des animaux sans vertèbres, Vol. VII, p. 436.
1830. *Oliva pupa* J. de C. Sowerby.—Trans. Geol. Soc. London, series 2, Vol. V, Pl. XXVI, fig. 32.
1850. *Oliva pupa* J. de C. Sow.—d'Archiac, Histoire des progrès de la Géologie, Vol. III, p. 301.
1854. *Oliva pupa* J. de C. Sow.—d'Archiac and Haime, Descr. an fos-s. gr. numm. Inde, p. 336, Pl. XXXIV, fig. 1.
1871. *Oliva intricata* Marrat.—Sowerby, Thesaurus Conchyliorum, p. 27, Pl. XXI, figs. 344, 345.
1882. *Olivella major* Bellardi.—Moll. teiz. Picm. c. Lig., part III, p. 215, Pl. XII, fig. 29.
1895. *Oliva djocdjocata* Martin (sec. Noetling), pars.—Mem., Geol. Surv. Ind., Vol. XXVII, part I, p. 38.
1901. *Oliva (Strophona) rufula* (cc. Noetling), par.—Pal. Ind., new series, Vol. I, part 3, p. 326.

Medium-size, spindle-shaped, with moderately steep conical, subulate spire, measuring two-sevenths of the total height.

The remarkably small, somewhat *Turbo*-shaped protoconch has a button-shaped nucleus so minute as to be difficult to observe, followed by two moderately convex whorls. It is terminated by an undifferentiated oblique line, antecurrent to the posterior suture, retrocurrent to the anterior suture. It is followed by four conical, subulate whorls, the height of which measures, in different specimens, from one half to nearly two-thirds of their height, separated by a deep, sharply defined groove. There are no visible genuine sutures, on account of a coating of enamel connected with the posterior end of the columellar lip, which spreads from the posterior margin of each volution of the spiral groove to the anterior margin of its preceding volution, and which entirely obliterates the suture although too thin to affect the regularity of outline of the whorls.

The narrow body-whorl measuring six-sevenths of the total height is very regularly barrel-shaped. It is terminated by a rather narrow, rather deep notch, the accretions of which form a somewhat swollen zone very distinctly demarcated posteriorly. A more or less distinct, broad, raised margin surrounds the notch dorsally and merges, on the left side of the shell, into the anterior columellar swelling. The zone of accretions is followed by a second spiral zone, feebly raised and feebly though distinctly demarcated posteriorly, of variable width, sometimes measuring as much as one-third of the height of the body-whorl, differing in texture and in

colour from the remaining posteriorly situated surface of the body-whorl, the colour frequently deepening towards the posterior margin of this band. The lines of growth, visible only when the superficial varnish of the shell has been removed, are slightly retrocurrent to the suture anteriorly to which they soon assume a practically vertical course. On approaching the anterior differentiated band they exhibit a very feeble curvature with forward facing convexity; on entering the differentiated band, they first resume their vertical course, and then become gradually retrocurrent anteriorly towards the terminal zone of accretions.

The tall, moderately broad aperture, is posteriorly contracted into a narrow, angular channel continuous with the spiral groove of the spire, and gradually expands in an anterior direction. On a ventral aspect of the shell, the outer border is approximately straight and nearly vertical, the inner border steeply oblique, its straightness being, in a varying, but slight degree, sigmoidally modified by the anterior columellar swelling, the obliquity increasing but slightly along the terminal, steeply twisted, thick edge of the columella which terminates in a blunt point. The columellar lip is thin, narrow, with a feebly raised, though distinctly demarcated outer edge. It is slightly thickened at its posterior extremity where it contributes, internally, to contract the terminal channel, of which it forms externally the outer rim, while posteriorly to the termination of the aperture it forms a slight protuberance over the terminal slope of the last spire whorl, soon subsiding to the thin coating of enamel which spreads over the whorls of the spire and posteriorly bounds the spiral groove. Opposite the termination of the aperture the edge of the columellar lip exhibits a moderately prominent convexity so disposed that its anterior portion is anteriorly retrocurrent, after which it settles to a practically vertical course, scarcely expanding towards its junction with the anterior columellar swelling. It carries narrow, feebly prominent, transverse ridges, narrower than the intervening spaces, spreading inwards over a rather broad zone, the more posterior ones practically horizontal while anteriorly they become gradually more oblique, their number, between the posterior termination of the aperture and the anterior columellar swelling, varying in different specimens from seven to seventeen or more. In the specimens with the most numerous ridges, the difference in number is due partly to their being more crowded, but principally to their greater distinctness towards the posterior termina-

tion of the aperture quite close to which they extend in some specimens, though with greatly reduced prominence, while in others there is a broad, bare interval between the posterior end of the aperture and the first transverse ridge. The more anterior groups of these ridges are disposed in almost invariably the same manner: one lying in the continuation of the edge of the anterior differentiated band of the body-whorl, the other on the continuation of the edge of the terminal zone of accretions; three ridges usually occupy the interval between the respective borders of the differentiated band and zone of accretions, while one occupies the interval between the respective edges of the zone of accretions and of the columellar swelling. When the respective edges of the zone of accretions and columellar swelling converge closer than usual, the last-mentioned ridge may be missing; when they converge less than usual, instead of one, the interval may carry two such ridges. Posteriorly to these anterior groups, posteriorly therefore to limit of the anterior differentiated band, many specimens exhibit only one more ridge, while in others, between the aforesaid limit and the posterior termination of the aperture, their number may amount to nine, gradually becoming feebler in a posterior direction. Lastly, in an anterior direction, one additional ridge invariably intervenes between the edge of the columellar swelling and the anterior group of columellar folds. The columellar swelling terminates posteriorly in a blade-like edge overhanging the adjacent surface of the shell. Anteriorly, a pronounced, steeply-winding fold, especially clearly defined by the groove that demarcates its posterior border, isolates from the remainder of the swelling the terminal edge of the columella. It is posteriorly followed by from three to five columella folds. In specimens with more than three columellar folds, the three more anterior ones are homologous with those of the specimens with the smaller number, and the posterior ones are supernumerary. Anteriorly to the most anterior fold, certain specimens exhibit some very feeble plications.

The outer lip is retrocurrent to the suture, anteriorly to which, with the intervention of a short convexity, it soon acquires a practically vertical trend, almost straight but for a scarcely perceptible bulge posteriorly to the termination of the anterior differentiated zone.

*Dimensions.*—Like the previously described species, this is one of the most important post-Eocene fossils of India, being as abundant



in the Tertiary formations of Burma as in those of western India. To avoid unnecessary repetition, the Burmese specimens of this species have been studied together with those from north-western India, and a list of measurements of specimens from both regions is here subjoined :

	KACHU.					
	mm.	mm.	mm.	mm.	mm.	mm.
Height . . . . .	41	46	44	34	25	16
Thickness . . . . .	16.5	17	16	13	9	6
Height of spire . . . . .	13	13	12	10	7	5
Height of body-whorl . . . . .	36	33	37	23	21	14

The first specimen in the above measurements is Sowerby's original type

	TITTABWE (Burma).							
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Height . . . . .	23	22.5	21	20	18	16	11	11
Thickness . . . . .	8	7	7	7	7	5	4	4
Height of spire . . . . .	6	6.5	6	5	5.5	5	3	3.5
Height of body-whorl . . . . .	19.5	18	18	17	15	13	9	8

	MYAUKMIGON KYAUNGON				SINGU.	
					"F"	"N"
	mm.	mm.	mm.	mm.	mm.	mm.
Height . . . . .	43	30	39	37		
Thickness . . . . .	15	10	14	14		
Height of spire . . . . .	11	8	11	10		
Height of body-whorl . . . . .	36	25	33	31		

	MINBU.	
	mm.	mm.
Height . . . . .	27	25
Thickness . . . . .	10	10
Height of spire . . . . .	7	6
Height of body-whorl . . . . .	23	22

*Occurrence.*—Gáj of Sind: Karáchi (Blagrave collection, Gáj of Kachh: Teyra River near Rampur (23° 20', 68° 51'); Teyra River north of Naliya (23° 15', 68° 52') higher than the Pecten-bed of Sookpur; south bank of river from Teyra (23° 17', 68° 58'). Numerous localities in the Oligocene and Miocene beds of Burma.

*Comparison with other species.*—The living *Oliva nebulosa* Lamarck of Bombay and Karachi corresponds in every feature with the above described fossil, though it is apt to assume a more ventricose shape.

Nevertheless, many specimens of the living form have exactly the same shape as the fossil which, however, is very constant in its outline, and may be regarded as a particularly consistent narrow race or variety practically identical with the variety *intricata* Marrat, which, together with the typical form, is now found living at Bombay and which Melleville and Standen (Proc. Zool. Soc. Lond., 1901, Vol. II, p. 427) regard as possibly entitled to specific distinction, in which case it should be known by the prior name *pupa*.

Amongst other living species, *Oliva acuminata* Lamarck is closely related but is distinguished by its anterior columellar folds which are coarser, more callous, and differently disposed.

Amongst fossil forms, *Oliva clavula* Lamarck from the Miocene of Europe is also closely related, but is slightly smaller, with relatively a slightly longer spire and shorter body-whorl.

Judging from the illustration published by Bellardi, *Olivella major* from the Miocene of Turin is probably identical with *Oliva pupa* with which it agrees exactly in size, in the relative proportions of the spire, and in the pupoid shape of the body-whorl; the apertural side is not figured, but Bellardi's description answers exactly to the features exhibited by *Oliva pupa*.<sup>1</sup>

Many of the specimens from Minbu and Singu in Burma referred by Noetling (*loc. cit.*) to *Oliva rufula*, are specifically identical with *Oliva pupa*. Those from Yenangyat, illustrated under that same name in Noetling's monograph, represent a different species belonging to the genus *Olivella* occurring abundantly also at Minku.

#### OLIVELLA ELEGANTULA Rovereto.

1900. *Olivella elegantula* Rovereto. III Moll. foss. Tongr., p. 176, Pl. IX, fig. 4

Small, broadly ovoid to cylindraceous-elongate, with conical or slightly conoidal spire, moderately narrow to broad, usually mea-

<sup>1</sup> In Cossmann's "Essais de Paléoconchologie comparée," fasc. III, p. 57, *Oliva pupa* and *Oliva clavula* have both been referred to the genus *Lamprodoma*, a conclusion arrived at, in the case of *Oliva pupa*, from an examination of the illustrations in d'Archiac and Haime's monograph. The specific identification of *Oliva pupa* with *Oliva nebulosa* clearly transfers it into the subgenus *Agaronia* within the genus *Olivancillaria*, while a careful examination of *Oliva clavula* has shown that it possesses essentially the same characters. It may be mentioned as an easy means of discrimination, that *Oliva volutella* Lamarck, from Central America, the only authentic example of *Lamprodoma*, lacks the characteristic broad, differentiated, anterior, varnished band observed in every species of *Agaronia* and typically developed both in *Oliva pupa* and *Oliva clavula*, while in *Oliva volutella* the anterior differentiated band is extremely narrow, forming a mere marginal border to the anterior zone of accretions.

suring less than one-third of the total height except in unusually narrow specimens, in which it generally amounts to about one-third.

The small protoconch has a shape similar to that of a depressed *Turbo*. It includes a minute, centrally situated, button-shaped, flat nucleus and from one-and-a-half to two whorls, the later part of which is rather strongly convex. The junction with the remainder of the spire is indistinct. It is followed by three-and-a-half spire-whorls separated by a deeply channelled groove so disposed that, at the first glance, the posterior edge of each whorl appears to tend to overlap the anterior margin of the preceding one, as though the whorls fitted telescopically one inside the other. When the surface of the shell is well preserved there are no visible suture-lines, the junction between the whorls being concealed by a film of enamel connected with the posterior margin of the spiral groove and spreading over the surface of the preceding whorl till it almost reaches the edge of the preceding volution of the spiral groove. It is so thin that it does not materially interfere with the outline of the whorls which are either conical-subulate, or sometimes feebly convex.

The barrel-shaped body-whorl measures between four-fifths and five-sixths of the total height. Its greatest thickness, varying, in different specimens, from less than one-third to more than three-sevenths of the total height, is situated at a short distance from its posterior margin, and corresponds with a slight bend of the surface which affects, to an insignificant degree, the evenness of its curvature. The terminal truncation is moderately broad and deeply notched, the accretions to the notch forming a rather narrow and moderately swollen zone with a well-defined posterior edge. This terminal zone is posteriorly followed by another slightly raised differentiated band of moderate width, measuring about one-quarter of the total height of the body-whorl; it is also terminated posteriorly by a well-defined edge. The lines of growth are retrocurrent to the spiral groove only in its immediate neighbourhood, the continuation of their course being vertical as far as the posterior edge of the differentiated zone across which they assume a pronounced curvature retrocurrent towards the terminal zone of accretions to the edge of which they become practically tangent.

The moderately broad aperture is terminated posteriorly by a narrow, channelled angulation connected with the spiral groove of the spire, and gradually expands in an anterior direction, its outer border, when viewed ventrally, being practically vertical

while the slightly and evenly curved inner border is oblique. The anterior columellar callosity reaches only to about two-fifths of the height of the aperture measured from its anterior extremity; it is bordered by a prominent, blade-like edge, and is followed anteriorly, after a wide interval, by a second, similar, equally prominent, blade-like columellar fold beyond which the smooth terminal edge of the columella bears no trace of any spiral, raised, or depressed features, and ends in a blunt point. The posterior edge of the columellar callosity and the edge of the terminal zone of accretions converge on entering the aperture till they become almost tangent. The narrow, thin, straight columellar lip carries, opposite the posterior termination of the aperture, a narrow vertical callosity which shows no tendency to spread over the ventral surface of the shell, and which contributes to contract internally the posterior narrow angular termination of the aperture, while externally it forms the posterior rim of the terminal channel, and is connected, beyond the termination of the aperture, with the enamel film that spreads over the spire-whorls. It does not carry any ridges internally.

Except for its short retrocurrent curve towards the termination of the spiral groove, the outer lip, for the greater part of its extent, is straight and vertical as far as the termination of the posterior edge of the differentiated zone, beyond which it recedes, with a convex curve, into the terminal notch.

*Dimensions.*—

	mm.	mm.	mm.	mm.
Height . . . . .	17·3	16	15·1	10
Thickness . . . . .	7·1	7·1	4·9	4·1
Height of spire . . . . .	5·2	4·8	5·1	3
Height of body-whorl . . . . .	15	13·2	12·2	8·2

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks and comparisons.*—In its size, proportions, and in the details of its dorsal surface, this shell corresponds so entirely with *Olivella elegantula* Rovereto from the Oligocene of Liguria that it has been provisionally referred to that species although the all-important characters of the aperture of the European fossil have never been either figured or described. The Oligocene fauna of the Ligurian Alps contains such a large proportion of species undoubtedly identical with those of Bhagothoro Hill in Sind as to render this identification extremely probable. Should the Sind fossil eventually prove different, it may be distinguished as *Olivella narica*.

The occurrence of *Olivella elegantula* in the same beds and at the same locality as *Olivella affinis* Bellardi, at Sassello renders the specific distinctness of the latter totally improbable, while the simultaneous occurrence of *Olivella affinis* and *O. angusta* Bell, at Deigo again casts great doubt also on the specific distinctness of the form last-named. There seems to be very little doubt that *O. elegantula* and *O. angusta* are merely extreme forms of a species exhibiting a degree of variability such as is frequently observed in several recent species of *Olivella*. It may have been noticed that amongst the Sind specimens, the width varies from less than one-third to more than three-sevenths of the height, indicating a range of variation in shape comparable to that which exists between the outline of *O. angusta* and that of *O. elegantula*, though in the case of the Indian occurrences the characters of the aperture leave no possibility of a doubt as to the specific identity of all the specimens. The probable identity of the Indian form with one of the Ligurian fossils carries with it the further probability of the specific identity of all three European forms. Bellardi's specific names *angusta* and *affinis* are both prior to Rovereto's designation *elegantula*, but were published without figures, and are accompanied by descriptions so short and incomplete as to be quite insufficient for recognising the forms to which they refer at any other but the original locality. These names can scarcely be regarded otherwise than as "*nomina nuda*," and, on the supposition of identity of the three forms, would be particularly inappropriate for such a variable species. It seems preferable therefore, in the suggested case of identity, to adopt Rovereto's designation which is accompanied by the first illustrations of all three forms.

In addition to the above described fossil, three other species of *Olivella* are known from the Tertiary formations of India. Two of these, *Olivella hollandi* C. and P. (Pal. Ind., new series, Vol. III, Mem. 1, p. 20, Pl. II, figs. 21, 22, Pl. VII, fig. 49) and *O. vredenburgi* C. and P. (*op. cit.*, p. 21, Pl. III, figs. 8, 9), both from the lower Eocene of Sind, are not closely related to the form under consideration, and do not need detailed comparison. Another species occurs in Burma and has been figured by Dr. Noetling first as *Oliva djocdjocarta* Martin (Mem., Geol. Surv. Ind., Vol. XXVII, part 1, p. 38, Pl. IX, fig. 1), and later as *Oliva rufula* Duclou (Pal. Ind., new series, Vol. I, part 3, p. 526, Pl. XXII, figs. 4, 5). In the latter instance two other species have been united with it, both of which

have been noticed in the foregoing pages of the present work under the names, respectively of *Oliva australis* DuRoi var. *indica*, and *Olivancillaria nebulosa* Lamk. (Sowerby's *Oliva pupa*). The Burmese *Olivella* may be distinguished as *Olivella minbuensis*. It resembles the Sind species in size and shape, but is readily distinguished by the disposition of its anterior columellar callosity which spreads much further posteriorly along the aperture, and in which, on the broad space anteriorly to its raised margin, there is a pair of prominent columellar folds instead of the single fold of the Sind fossil, the terminal extension moreover carrying two subsidiary folds instead of being smooth as in the Sind form.

The recent fauna does not seem to contain any forms closely related to this species.

#### ANCILLA (SPARELLA) INDICA

##### Pl. IX, fig. 6.

Medium-size, slender, unsymmetrically spindle-shaped, with tale elongate conical or very slightly conoidal spire equal to half the total height of the shell, and large, ovoid body-whorl.

The protoconch is very small. Its nucleus, which is broken, is followed by one-and-a-half or two moderately convex whorls. These are followed by four spire-whorls entirely invaded by a coating of enamel with the exception, on the left side of the shell, of a small portion of the first whorl next to the suture of the protoconch. The height of the spire-whorls is equal to four-sevenths of their thickness, the maximum width coinciding with their anterior margin. They are scarcely perceptibly convex, with a scarcely perceptible swelling at about half their height corresponding with the anterior edge of the enamelled zone, causing a slight rise of the surface visible beneath the superficial callosity that coats the whole spire. A slight depression in this superficial enamel indicates the position of the sutures. The first spire-whorl, in its uncovered portion shows, along its posterior margin, a steeply sloping circumsutural concavity with two spiral grooves.

The large, ovoid body-whorl, measuring three-fourths of the total height, is considerably contracted anteriorly and exhibits a perfectly continuous curvature, scarcely interfered with, on the left side of the shell, by the slightly swollen zone of accretions of the terminal notch. The greatest width, situated a little nearer to the suture

than to the termination of the shell, corresponds with the maximum convexity, the degree of curvature gradually decreasing both towards the suture and towards the anterior termination. On the dorsal surface, the posterior enamelled band occupies less than one-fourth of the height of the body-whorl. It is followed by a bare zone extending anteriorly as far as the deeply undercut, posterior ridge of the fasciole. The terminal notch is very narrow and moderately deep. The moderately swollen zone of its accretions is posteriorly bordered by a somewhat prominent, blunt ridge, which divides the fasciole into two slightly unequal regions of which the posterior one is slightly the narrower. Another deeply undercut ridge, similar to the posterior border of the fasciole, and ending at the apex of the terminal notch, follows anteriorly the blunt ridge. A deep furrow divides the zone of accretions from the anterior terminal portion of the columella. At a short distance from the fasciole, the anterior margin of the bare zone is traversed by a sharp, spiral incision, across which the lines of growth are abruptly deflected into a sharp angulation pointing towards the right of the shell. Apart from this narrow angular deflection, the lines of growth, from the suture to the margin of the fasciole, are practically vertical. They become strongly oblique and anteriorly retrocurrent across the posterior band of the fasciole, and form a deep sinus across the zone of accretions.

The lanceolate aperture terminates posteriorly in a narrow angulation, and is strongly contracted anteriorly. The columella is somewhat hollowed out opposite the anterior border of the zone of accretions where this zone winds into the interior of the shell; it terminates anteriorly in a forward deflected twist divided into five steeply winding folds by four narrow furrows of which the outermost (that is, the one which, on winding round the axis, occupies the most posterior position), is deep, while the remainder are very shallow. The columellar lip is rather thick, especially posteriorly where it spreads laterally to a short distance over the ventral surface of the shell, while it extends posteriorly till it merges into the coating of enamel which covers the spire. The thin outer lip is slightly retrocurrent to the suture at its posterior termination. Throughout the greater part of its course it is practically straight and almost vertical. Anteriorly the uniformity of its outline is interrupted by a short, pointed prominence or spine opposite the termination of the spiral groove. On reaching the termination of the fasciole, it becomes strongly retrocurrent anteriorly till it joins the dorsal notch.

*Dimensions.*—

	mm.
Height . . . . .	41
Thickness . . . . .	18
Height of spire . . . . .	20
Height of body whorl . . . . .	29

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks and comparisons.*—Three occurrences of *Ancilla* referable to the section *Sparella* have, so far, been recorded from India in addition to the above-described form. One of them corresponds with the living *Ancilla cinnamomea* Lamk. and has been described and figured by Cossmann from the Tertiary formation of Karikal (Journ. Conch., 1903, Vol. L, p. 115, Pl. III, figs. 14, 15). The two others have, hitherto, been described from very imperfect material, being referred in the one case to *Ancilla olivula* Lamk., while the other is a Burmese shell compared by Noetling with *Ancilla vemedei* Sow. *Ancilla inopinata* C. and P. from the lower Eocene of Sind, belongs to the section *Alocospira* and therefore does not call for detailed comparison. A cast from the Eocene of Subathu has been referred by d'Archiac and Haime (Descr., p. 356) to *Ancilla olivula* Lamk., from the middle Eocene of the Paris region, which has a shorter, more conoidal, more thickly varnished spire than the fossil from Sind at present under consideration. The Sind shell bears a very close resemblance, perhaps amounting to specific identity, to a Burmese fossil which Noetling compared with a large Javanese shell identified by Martin with *Ancilla vemedei* Sow. (Pal. Ind., new series, Vol. I. part 3, p. 327, Pl. XXII, fig. 6). The specimens examined by Noetling are poorly preserved. A complete specimen lately obtained by M. R. Ry. Sethu Rama Rao clearly indicates that the shell is a *Sparella*, while the Javanese fossil is an *Ancilla s. str.*, moreover attaining double the size in linear dimensions. Compared with the Sind fossil, the Burmese shell has a slightly shorter spire, and slightly longer body-whorl. The outline of the last spire-whorl is more continuous with that of the body-whorl in the Sind shell than in the Burmese one. The earlier whorls of the Burmese shell are more distinctly divided off from one another by grooved pseudo-sutures and the apex is more conoidal. Lastly, the Sind fossil lacks the feeble angulation of the whorls which characterises the Burmese shell. Considering the great variability of the *Olividæ* it is somewhat doubtful whether any of the differences above enumerated can be



regarded as of specific rank. Nevertheless these differences are constant in all the specimens examined. The Burmese shell may therefore be distinguished as *Ancilla birmanica*, either as a distinct species, or, possibly, as a variety of *A. indica*. Both the Sind and Burma fossils are related to the living *Ancilla mamillata* Hinds of the Indo-Pacific region which has a more inflated body-whorl. *Ancilla ligustica* Bellardi, from the Oligocene of Liguria resembles the Indian fossils, though its size is smaller. Unfortunately neither the figure nor the description are sufficient to allow of detailed comparison.

Attention may be drawn to the spiral grooves of the earliest part of the spire suggesting a relationship to the section *Alocospira*.

HARPA (EOCITHARA) NARICA n. sp.

Pl. I, fig. 16, Pl. II, fig. 6.

Medium-size, elongate ovoid, with short, broadly conical spire measuring from less than one-sixth to less than one-fifth of the total height.

The small protoconch, imperfectly preserved in all the available specimens, is followed by three-and-a-half low, strongly convex, dome-shaped whorls, in consequence of which disposition the sutures are situated along a well-marked re-entering angulation. They are, however, concealed in consequence of a structure to be next described. The curvature of the surface is not quite even, exhibiting a slight bend not far from the posterior suture. The surface carries lamellar ribs the number of which is from fifteen to sixteen on each of the spire-whorls, anteriorly to the slight bend of the surface, the trend of the ribs is vertical. They exhibit a slight spinose projection at the level of the above-mentioned bend of the surface, posteriorly to which they become antecurrent to the sutures which they overreach, encroaching upon the anterior margin of the preceding whorl in the shape of a low arch which ultimately joins the next succeeding rib. All these structures become clearly intelligible on examining the peristome, of which they represent the position at each successive stage of growth, the main portion of the rib corresponding with the outer lip, while the arch-shaped posterior prolongations represent the posterior junction of the outer lip with the posterior edge of the thickened columellar lip; none of the apertural structures becoming

resorbed in the case of the shells of this genus. The rather broad spaces intervening between the ribs are decorated with a very delicate network of vertical and of spiral lines, equally spaced, and, when the surface is well preserved, of about the same degree of prominence.

The large body-whorl measures nine-tenths of the total height. It is elongate ovoid, continuously convex on the right side, while on the left side it exhibits a strong convexity followed by a shorter concavity. It is terminated by a narrow, rather deep notch, the accretions to which form a steeply winding, narrow swelling especially visible on the ventral side of the shell where an elongate narrow umbilical depression separates it from the edge of the columellar lip. Posteriorly the body-whorl exhibits, close to the suture, the same slight bend as the corresponding part of the spire-whorls, on crossing which the ribs exhibit the same slight spinose expansion. The ribs show a slight tendency to become wider-spaced on approaching the aperture, so that their total number on the body-whorl is only from fourteen to fifteen, instead of from fifteen to sixteen as on the spire-whorls. They exhibit the same structures in the sutural region as have already been described in the corresponding part of the spire-whorls. Anteriorly to the level of the suture, they are, for some distance, straight, and so feebly retrocurrent in an anterior direction as to appear practically vertical. Anteriorly, with a gradual curve, the convexity of which is directed forward, they recede towards the terminal zone of accretions. A delicate network, similar to that described on the spire, covers the whole surface in the interstices between the ribs.

The large aperture is somewhat semi-circular. The practically straight, feebly oblique, moderately elongate columella joins the base of the penultimate whorl at an angle of  $150^{\circ}$ . The moderately thickened columellar lip, sharply demarcated by a low, raised edge is rather broadly expanded posteriorly over the ventral surface of the body-whorl, anteriorly forming a sharply marked, rectilinear edge along the anterior umbilical depression. The thickened outer lip, corresponding with the terminal rib of the body-whorl is ante-current to the suture. It is slightly notched across the small space intervening between the suture and the apertural termination of the slight bend of the surface. Anteriorly to the slight spinose projection corresponding with this slight bend it is, for the greater part of its extent, practically straight and slightly oblique, receding more distinctly as it approaches its anterior termination.

*Dimensions.*—

	mm.	mm.
Height . . . . .	29·3	41
Thickness . . . . .	17	24
Height of spire . . . . .	5·4	6·5
Height of body-whorl . . . . .	26·5	38

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—The form closest related to the above-described fossil is *Harpa elegans* Deshayes from the upper Eocene of the Paris region, which is distinguished by the much more pronounced transverse striations in the intervals between the ribs. So far as can be judged from Grateloup's figures, the Oligocene *Harpa submutica* d'Orb. (= *Harpa mutica* Lamk. in *Grateloup*), from south-western France, also has the transverse decoration much more pronounced. *Harpa bellardii* Sacco, from the Oligocene of Liguria (Moll. terr. terz. Piem. e Lig., parte VII. p. 9; Pl. I, fig. 1), agrees in its general outline with the Indian species, but it also exhibits a pronounced, interstitial transverse decoration, while the posterior bend of its whorls is more angular, and it lacks the broad expansion of the columellar lip.

*Harpa morgani* C. and P., from the lower Eocene of Sind, has the posterior portion of the body-whorl much more inflated, its spire is relatively larger, and the intercostal intervals carry fewer and more prominent axial lines; the shell is somewhat smaller, its axial lamellæ wider-spaced, especially on the body-whorl, with a less distinct tendency to become posteriorly spinose. In several respects the Nari shell seems somewhat intermediate between *Harpa morgani* and the living *Harpa conoidalis* Lamk. of which it perhaps represents an ancestral form.

## MARGINELLA (GLABELLA) NARICA n. sp.

Pl. VI, fig. 15.

Small, more or less ventricose, ovoid-conical, with exceedingly short, broadly flat-conical spire.

The indistinct, flat protoconch consists of one to one-and-a-half whorls, followed by two flatly conical spire-whorls separated by inconspicuous sutures obscured by callus spreading from the posterior termination of the aperture.

The body-whorl, constituting practically the whole shell, is rather strongly convex posteriorly in the region of its maximum thickness situated a great deal posteriorly to half the height of the shell, while anteriorly it gradually assumes a practically conical outline as it contracts towards the anterior termination which is rounded, scarcely notched, without any dorsal rim or differentiated zone of accretions.

The aperture, in consequence of the inward reflected border of the outer lip, is rather narrow and expands only slightly in an anterior direction with a short, terminal, anterior widening bordered on one side by the terminal edge of the columella. At its posterior termination it is somewhat channelled and slightly notched. The inner border is oblique and practically straight. Anteriorly the columella carries four prominent, rather wide-spaced folds of which the most anterior one corresponds with its terminal edge and projects somewhat ventrally. When the shell is broken it is noticed that the most posterior of these prominent folds is followed at a short interval by two very close set, much feebler, spiral plications. The columellar lip is slightly thickened posteriorly where it merges into the terminal callosity of the aperture. Throughout the greater part of its course it is very thin, though distinctly demarcated, slightly expanding outward towards the anterior termination of the shell, so as to adapt itself to the terminations of the more anterior columellar folds which reach furthest outward. Except at its posterior extremity, where it slightly recedes to surround the feeble posterior apertural notch, the outer lip is practically straight and vertical. Its edge, as already mentioned, is somewhat bent inward, and it is externally thickened, though without a distinct rim. Posteriorly it merges into a callous thickening which extends beyond the termination of the aperture, in some instances almost to the level of the apex, and which encroaches considerably upon the spire, being connected with a thin film which spreads over the spire-whorls.

*Dimensions.*—

	mm.	mm.
Height . . . . .	12·2	10·1
Thickness . . . . .	7	6·7

A broken specimen, of which the exact thickness cannot be ascertained, has a height of 13 mm.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks and comparison.*—The exact classification of this shell gives rise to some hesitation. The supernumerary, posterior, parietal, spiral plications suggest some form of *Cryptospira*, but this genus, together with *Persicula*, is excluded by the absence of an anterior terminal notch and dorsal rim. The extension of the posterior apertural callosity or rim over a considerable part of the spire excludes *Marginella s. str.*, and the shell, therefore, is most probable referable to *Glabella* though it does not show any tendency towards the coalescence of the two most anterior columellar folds mentioned by Cossmann in the diagnosis of the sub-genus.

Except in its smaller size, the above-described shell appears to be practically identical with *Marginella burchardi* Dunker, which Tryon regards as specifically identical with *Marginella prunum*, the genotype of *Glabella*.

The genus, at the present day, is restricted to the Atlantic and the eastern coasts of the Pacific, but survived in India until a late period of the Tertiary as indicated by the presence of *Marginella oligoptycha* Cossmann in the Tertiary formation of Karikal.

#### ATHLETA (VOLUTOSPINA) SINDIENSIS n. sp.

Pl. II, figs. 9, 10, 11.

1850. *Voluta* indét.—d'Archiac, Hist. des progr. de la Géol., Vol. III, p. 298.

1854. *Voluta* indét.—d'Archiac and Haime Descr. an foss. gr. numm. Inde, p. 328, Pl. XXXII, fig. 6.

Medium-size, elongate with broadly conical spire equal to one-fifth of the total height, and large conical body-whorl.

The small protoconch, resembling a very globose *Turbo*, is disposed very obliquely, and consists of a globular nucleus followed by a single, convex whorl. The protoconch is followed by four spire-whorls, the height of which is equal to only one-third of their width. At about half their height, an angulation separates a posterior concave slope from the anterior, vertical, cylindrical portion. A slight swelling at the posterior margin of the whorls fits round the linear sutures. The angulation carries a number of granulations or short spines which represent the posterior terminations of vertical ribs. In certain specimens these ribs are prolonged, with a somewhat reduced thickness, across the posterior concave slope and once more swell into granules round the posterior suture, at least over the earlier whorls.

In many specimens, though not in all, this circumsutural crown of granules is duplicated by a spiral groove bisecting them. The ribs, in many specimens, are interrupted across the posterior concavity, though they reappear as the above-described circumsutural granules, at least on the earlier whorl. On the last spire-whorl, though the posterior marginal bulge or rim persists, the circumsutural granules become reduced or may entirely disappear. One or two, more or less distinct, spiral threads or grooves may be developed upon the posterior slope of the last spire-whorls. The number of spines differs greatly in different specimens and is apt to vary considerably at different stages of growth. In certain specimens the number is eighteen to one complete volution throughout the spire. In others it is twenty on the first spire-whorl succeeding the protoconch, increasing to twenty-six or twenty-seven on the last spire-whorl. In other instances again there are twenty spires to the first whorl increasing to twenty-five in the next, then gradually becoming wider-spaced, till their number dwindles to nineteen on the last spire-whorl and sixteen on the body-whorl.

The large body-whorl is equal to eight-ninths of the total height. Posteriorly it exhibits the same angulation as the spire-whorls. Anteriorly to the angulation, it tapers very gradually with an almost conical, somewhat rigid outline, to the narrow anterior termination: in most specimens the posterior elongate convexity, the very anteriorly situated feeble concavity of the neck, the imperceptible bulge of the very steeply winding, narrow zone of accretions of the anterior notch, all exhibit such an insignificant curvature as scarcely to interfere with the generally conical outline. In some specimens the curves are more distinct, but are nevertheless feeble. The circumsutural granules on the body-whorl occasionally persist in a very indistinct condition, but more usually completely disappear. The circumsutural rim, nevertheless, always remains very distinct, anteriorly bordered by a rather deep groove, and nearly always bisected by the spiral groove already mentioned in the spire-whorls. In addition to the sutural bulge, the posterior concave slope may carry as many as three, well-marked, spiral ridges, or else there may be a single, blunt, spiral ridge close to the spinose angulation, with or without the addition of delicate, crowded, spiral lines all over the surface of the slope. The ribs seldom extend over the posterior slope of the body-whorl, and are generally replaced by crowded curved lines of growth with forward directed concavity, antecurrent to the angulation

normal to the suture. Anteriorly to the angulation, the spiral decoration consists entirely of rather prominent, rather close-set, evenly spaced, imbricated bands with the raised edge facing posteriorly. On the anterior zone of accretions they assume more of the appearance of steeply winding threads or ridges. They are apt to increase in prominence over the neck where they also sometimes become locally subdivided. In certain specimens, over the whole body-whorl, each spiral band is subdivided by one or two subsidiary, spiral furrows and the whole shell thereby acquires a profusely striated appearance. The number of spines along the angulation of the body-whorl varies from as many as twenty-six to as few as thirteen. They are continued anteriorly by axial ornaments which either assume the appearance of distinct narrow ribs, or else are disposed as imbricated, vertical ridges or bands with their raised edge facing backward. In the latter instance, when these axial features are crowded, a rasp-like appearance is produced such as characterises the forms sometimes classified as "*Volutocorbis*." These axial ornaments whether they assume the form of ribs or of band-like ridges, cease anteriorly at the feeble concavity of the neck. In the intervals between these ribs, and also over their surface when they assume the form of imbricated bands, the entire shell is covered with crowded, fine, regularly spaced, imbricated lines of growth, which, together with the ribs, are practically vertical up to the posterior limit of the concave neck, anteriorly to which they become curved and gradually retrocurrent in an anterior direction. They tend to become scaly on the terminal zone of accretions over which they form a rather shallow sinus.

The aperture is tall, narrow, without a distinct posterior channel, anteriorly ending in a narrow, shallow notch. The columella is slightly concave opposite the excavation of the neck, straight and oblique throughout the remainder of its course. In full-grown specimens it carries at least seven spiral folds of which the four or five more posterior ones are almost transverse, the three last being very close together. The relatively thick columellar lip rises up the body-whorl far enough to cover the spines and spreads laterally, with a more or less definite margin, over nearly the entire ventral surface of the shell. The outer lip rises posteriorly to the level of the posterior angulation of the body-whorl. From the level of the apertural termination of the angulation to the posterior termination of the aperture, it forms a sinus of moderate depth. Anteriorly to

the angulation it is, for a considerable distance, straight and vertical, finally becoming convex and retrocurrent on approaching the anterior termination. Externally it has a narrow, raised rim, marked off by a groove from the dorsal surface. It is internally crenulate.

*Dimensions.*—The following measurements were taken from two different specimens the first one of which is much more elongate than the second :—

	mm.	mm.
Height . . . . .	45	33
Thickness . . . . .	22	20
Height of spire . . . . .	9	7
Height of body-whorl . . . . .	40	29

The species also reaches larger dimensions up to about  $53 \times 26$  mm.

*Occurrence.*—Naii of Bhagothoro Hill in Sind.

*Remarks.*—In the history of its individual development, this species, together with *Volutospina dentata* J. de C. Sow. and *Volutospina mekranica* next to be described, clearly illustrates the absence of any clear demarcation of the characters of the section "*Volutocorbis*" founded solely upon the peculiarities of the ornamentation. Up to an advanced stage of growth, these shells are usually characteristic examples of *Volutocorbis*, while the full-grown shell is generally a perfectly typical *Volutospina*. (See also Cossman, *Essais de Paléonchologie*, VIII, p. 410; Burnett Smith, *Proc. Acad. Sc., Philadelphia*, pp. 52-76. Pl. II.) Nevertheless, side by side with relatively large specimens measuring as much as  $28 \times 14$  mm., and exhibiting the features of *Volutocorbis* in their most typical aspect, there are much smaller specimens which never seem to have passed through a *Volutocorbis* stage; in such specimens the axial ribs are thin, wide-spaced, and not imbricated, the posterior spines prominent even at a relatively early stage of growth.

*Comparison with other species.*—Specimens in which the ribs of the body-whorl are wide-spaced, closely resemble *Voluta devesii* Beyrich from the Oligocene of North-Germany, which is closely related to *Voluta nodosa* Sowerby, from the upper Eocene of England. The ribs or spines on the spire-whorls are always much more numerous in the Indian species. In the case of specimens in which the spiral ornaments increase by subdivision, the body-whorl is apt to become very similar to that of *Athleta (Volutospina) annandalei* from Burma which recalls the Sind species by its crenulated aperture and its numerous columellar folds, but which is readily distinguished from most specimens of *Volutospina sindiensis* by the constancy, at successive stages of growth, of the number of ribs, which are not more numerous



upon the spire than upon the body-whorl. In the rare instances where the number of ribs, in *Volutospina sindiensis*, is constant at all stages of growth, this number is not less than eighteen for each complete volution. While, in *Volutospina annandalei* it is only thirteen or fourteen. The columellar folds in *Volutospina annandalei* are closer-set than in *Volutospina sindiensis*; they do not extend so far posteriorly and are posteriorly less transverse. The outline of the body-whorl in *Volutospina annandalei* is much more curvilinear. *Voluta dentata* J. de C. Sow., from the Gáj formation of Kachh and Sind is very closely related to *Volutospina sindiensis*, but is readily distinguished by the extraconic outline of its spire and especially by the terraced disposition of the later whorls in consequence of the deepening of the circumsutural concavity combined with the posterior elongation of the spires to an extent which is never observed in *Volutospina sindiensis*. *Volutospina sindiensis* and *V. dentata* are both remarkable for the globose shape of their protoconch. The Burmese fossil which Noetling has incorrectly referred to *Voluta dentata* (Mem., Geol. Surv., Ind., Vol. XXVII, p. 37, Pl. VIII, figs. 8-10; Pal. Ind., new series, Vol. I, part 3, p. 324, Pl. XXI, figs. 14, 15, Pl. XXII, figs. 1-3) which may be renamed *Athleta* (*Volutospina*) *jacobsi* resembles *Volutospina sindiensis*, from which it is distinguished by the absence, at all stages of growth, of the circumsutural granules, by the feebler prominence of the spines along the angulation, and by the much broader external rim of the outer lip which is not crenulated internally.

The unnamed fossil from Sind represented by d'Archiac and Haime in Pl. XXXII, fig. 6, of their monograph, clearly corresponds with the above-described fossil. Dalton has referred to the same species (Q. J. G. S., 1908, Vol. LXIV, p. 640, Pl. IV, fig. 5), as *Voluta d'Archiaci*, a fragment from Burma which, so far as can be judged from the description and figure, is a typical *Volutocorbis*.

#### ATHLETA (VOLUTOSPINA) DENTATA J. de C. Sowerby.

1839. *Voluta dentata* J. de C. Sowerby.—Trans. Geol. Soc., London 2nd. series, Vol. V, Pl. XXVI, fig. 26.

Non *Voluta dentata* Sowerby in Noetling, Mem., Geol. Surv. Ind., Vol. XXVII, Part I, '1895), p. 37, Pl. VIII, figs. 8-10.

Non *Voluta dentata* J. de Carlo Sowerby in Noetling, Pal. Ind. new series, Vol. I, part 3, (1901), p. 324, Pl. XXI, figs. 14, 15, Pl. XXII, figs. 1-3.

Medium size, with broadly extraconic spire equal to one-fifth of the total height, and with large, elongate, conical body-whorl

The small, globose, more or less obliquely disposed protoconch has somewhat the shape of a *Natica*, and consists of a button-shaped nucleus followed by a single convex whorl. It is followed by five very low spire-whorls, the height of which, about half-way through the spire, is only one-third of their width, and becomes proportionately still less with increasing growth owing to the extraconic outline of the spire. The four first whorls are decorated with two rows of granules respectively adjoining both sutures, the anterior granules representing the termination of axial ribs. The two rows of granules are separated by a concave surface bearing two very thin spiral incisions. On the last spire-whorl the posterior granules become blunt and indistinct, the concave surface and anterior granules, or ribs, continuing unaltered. The number of granules of either row is, in various specimens, from seventeen to twenty-one for each volution, or occasionally as many as twenty-four. Beyond the termination of the spire, the posterior granules disappear completely and are represented by a simple linear suture, while the concave slope and anterior nodes continue on the posterior portion of the large body-whorl which is equal to seven-eighths of the total height. Anteriorly to the angulation bordering the posterior concavity and carrying the nodes, the elongate body-whorl is nearly conical, with a slight convexity on the right side of the shell on approaching the extremity, and an equally feeble corresponding concavity on the left side. The accretions to the feeble terminal notch do not form anteriorly a distinct dorsal bulge. The whole body-whorl is divided into very flat, imbricated, spiral bands, the feebly raised edge of which faces posteriorly, and which are evenly and rather closely spaced except, in some specimens, on approaching the posterior angulation where the two last bands become much broader, and also, in all specimens, quite close to the anterior extremity on the feeble anterior concavity where they become slightly more crowded, somewhat less regularly distributed and somewhat more prominent. The three terminal bands on the undifferentiated zone of accretions of the termination of the aperture assume more of the appearance of raised, spiral threads. The nodes round the posterior angulation are wider-spaced than on the spire-whorls, their number becoming reduced to thirteen or fourteen, and they assume the shape of vertical spines or prongs. They are prolonged anteriorly upon the body-whorl in the shape of somewhat indistinct ribs, more or less merged into the somewhat unevenly distributed



which it recalls, not only by its elongate shape and the ornamentation of its spire, but also by the presence of the bulbous protoconch which usually characterises Australian forms.

Noetling has referred to *Voluta dentata*, a Burmese fossil which so completely differs from the Gáj species of Kachh and of Sind that any detailed comparison would be superfluous. Amongst such differences as are noticeable at the merest glance, may be mentioned the absence, on the body-whorl, of the characteristic circumsutural concavity instead of which the Burmese fossil exhibits, from the angulation to the suture, a straight sloping or even convex surface. The Burmese fossil also lacks the circumsutural granulations of the spire-whorls. The outer lip in the Burmese fossil has a broad rim limited dorsally by a deep groove, and is internally smooth, while in *Voluta dentata* it is scarcely prominent externally and is internally crenulated. The Burmese fossil bears the closest resemblance to *Volutospina mutata* Deshayes, from the Upper Eocene of Europe. It may be renamed *Volutospina jacobsi*. Compared with *Volutospina sindriensis*, *V. dentata* differs mainly by the more extraconic outline of its spire and the more terraced disposition of the later whorls.

**ATHLETA (VOLUTOSPINA) DENTATA var. SYKESI d'Archiac and Haime.**

1850. *Voluta dentata* J. de C. Sowerby.—d'Archiac, Hist. des progr. de la Geol. Vol. III, p. 297.
1854. *Voluta dentata* J. de C. Sowerby var.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 324, Pl. XXXII, fig. 2, Pl. XXXIII, fig. 11.
1854. *Voluta sykesi* D'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 324, Pl. XXXII, fig. 3.
- Non Volutospina sykesi* d'A. and. H. in Cossmann and Pissarro, Pal. Ind. new series, Vol. III, Mem. No. 1 (1909), p. 23, Pl. II, figs. 32, 33.

The above-described species occurs very abundantly in the Gáj of Sind. The specimens from Sind were regarded by d'Archiac and Haime as constituting a distinct variety. They usually bear more numerous spines than the majority of the Kachh specimens, the number in each row being twenty-five for one complete volution on the spire-whorls, and eighteen on the body-whorl. Specimens occasionally occur in Kachh with as many as twenty-four spines on each of the spire-whorls. The spire, in the Sind specimens is usually, though not always, taller than in those from Kachh.

The description given above for *Voluta dentata* coincides with d'Archiac and Haime's description of *Voluta sykesi*. d'Archiac and Haime attributed six whorls to the type of *Voluta sykesi* and regarded it

as a full-grown shell, of smaller size therefore, and, consequently, specifically distinct from *Voluta dentata*. If the type-figure be compared with the description, it will be noticed that the number of whorls is only four. It has been noticed above, in the description of *Voluta dentata*, that, in the earlier part of the spire, each whorl carries two rows of granules. In the later whorls the granules of the posterior row become much less prominent than those of the anterior angulation, but in the earlier whorls they are of the same size, and all the rows of granulations, whether of the same or of adjacent whorls, are so evenly spaced, and the sutures so indistinct, as to readily convey the impression that each row of granules coincides with one whorl. Consequently, on examining such a specimen as the one measured in the above description, the first impression is that, taking into account the protoconch and body-whorl, the whole shell consists of eleven whorls. There is no possible confusion as regards the protoconch, the body-whorl which has no posterior granules, and the last spire-whorl in which the posterior granules are indistinct. There remain apparently eight whorls represented by eight rows of granules. That they only represent four whorls can be readily ascertained by following one of the rows of granules round the spire towards the apex, when it will be noticed that, at each complete turn, a whole row of granules has been skipped. The full-grown shell therefore consists only of seven whorls. In the case of the type of *Voluta sykesi*, deducting the protoconch and body-whorl, there remain four rows of granules representing not four, but only two whorls. Therefore the specimen consists only of four whorls, which agrees with the type-figure and coincides with the number of whorls that would constitute an immature specimen of *Voluta dentata* of that size. The steepness of the spire alluded to by d'Archiac and Haime in contradistinction with the relatively broader spire of the full-grown *Voluta dentata*, is such as results inevitably from the extraconic shape of the spire, in consequence of which this part of the shell is always steeper in the aggregate in the case of immature individuals than in the full-grown shell.

The Ranikot shell referred to *Voluta sykesi* in Vol. III, part 1, of the *Palaontologia Indica*, though not unlike d'Archiac and Haime's type in general outline, is specifically and even sectionally distinct. It is a *Volutocorbis*, and may be distinguished as *Volutospina (Volutocorbis) eugenica*.

*Occurrence.*—Gáj of Sind, Karáchi (Blagrave or Baker collection).

*ATHELETA* (*VOLUTOSPINA*) *MEKRANICA* n. sp.

Pl. I, fig. 17; Pl. II, figs. 1-5, Pl. IV, fig. 4.

Medium size, with short, broadly conical or slightly extraconic spire reaching from slightly more than one-eighth to nearly one-sixth of the total height, and large, elongate, nearly conical body-whorl.

The small protoconch, protruding and globose, with a pronounced oblique tilt, consists of a minute, rather flat, nucleus followed by one to one-and-a-half, smooth-convex whorls. The protoconch is followed by four spire-whorls, the height of which is equal to only one-fifth of their width. They carry two circles of spines respectively adjacent to both sutures, separated by a broad concave slope. The sutures lie in the groove bordered respectively by the anterior and posterior spines of successive whorls. The spines of both circles in each whorl correspond in number, but are not connected by ribs, the concave slope being usually occupied only by crowded lines of growth, straight and radial between the two rows of spines, forming a small sinus between the posterior spines and the suture. In some specimens the concave slope carries a number of evenly spaced, very fine, raised, spiral lines forming minute granules at their intersections with the lines of growth. The spines in each row, in the case of a specimen measuring 28 mm. of maximum diameter, number fourteen in the first spire-whorl succeeding the protoconch, increasing to twenty-five in the third spire-whorl, and then becoming gradually wider-spaced so that their number dwindles to twenty on the fourth spire-whorl and thirteen on the body-whorl. The distribution varies considerably in different specimens. For instance, another specimen carries nineteen spines in one row of its last whorl at a diameter of 20 mm., while at that same diameter, the number in the above-mentioned specimen is only fifteen. The body-whorl of another specimen with a maximum diameter of 19 mm., only carries thirteen spines in each row.

The large body-whorl measuring about seven-eighths of the total height, carries, posteriorly, the same circles of spines as the spire-whorls, separated by the same concave slope. Anteriorly to the angulation which coincides with the anterior row of spines, which coincides also with the greatest thickness of the shell, the surface slopes anteriorly towards the axis with a very feeble concavity which, on the left side of the shell, is succeeded, at about half the distance between the angulation and the termination of the shell by the very feeble concavity of the neck from which, up to the narrow

termination of the shell, the outline is almost rectilinear, or subdivided into two scarcely perceptible convexities by the very shallow depression which posteriorly bounds the narrow, non-bulging zone of accretions of the terminal notch. On the right side of the shell the outline includes but two feebly convex elements separated by the very shallow depression of the neck situated further forward than on the left side. The curvature of these various elements is always very feeble, and, in many specimens becomes so reduced that the outline of the body-whorl is practically conical. The whole surface of the body-whorl, anteriorly to the angulation, is covered with conspicuous, evenly spaced, spiral, imbricated bands, sometimes showing a slight tendency to alternate in their degree of prominence. They are generally slightly more prominent and sometimes slightly more crowded on the neck than on the posterior convexity. They become decidedly more crowded on the zone of accretions of the terminal notch where they assume the appearance of steeply winding, narrow threads or ridges. On the posterior portion of the body-whorl, the spines of both rows become conspicuously prominent, projecting upwards and outwards. Those of the outer row are anteriorly prolonged upon the body-whorl by vertical ribs, generally angular and imbricated with margin facing backward, which cease at the concavity of the neck. When the specimens are immature, owing to the greater number of spines at early stages, the spacing of the ribs may be about equal to that of the spiral imbrications, and, when they are equally prominent, a rasp-like appearance is produced, such as characterises *Voluocorbis*. When the specimens are full-grown, the spacing of the ribs is always wider than that of the spiral bands. The whole surface, anteriorly to the angulation, is, moreover, covered with crowded, evenly distributed, close-set fine lines of growth, vertical and straight like the ribs over the posterior convexity, anteriorly to which they become moderately convex and gradually retrocurrent in an anterior direction. On crossing the zone of accretions to the apertural termination, they form an exceedingly shallow sinus. The aperture is tall, rather narrow, with parallel margins, posteriorly terminated against the suture by a feebly channelled angulation, anteriorly ending in a narrow notch so shallow that it might be described as a truncation. The almost rectilinear, oblique columella is very slightly sunken opposite the inward extension of the depression of the neck, very slightly convex opposite the inward extension of the anterior zone of accretions. Between its smooth anterior

torsion and the posterior convexity of the base it carries three prominent, evenly distributed, wide-spaced folds, the most anterior of which is steeply oblique. Whether any minor folds follow posteriorly cannot be ascertained, as the posterior portion of the aperture is internally more or less concealed by a rocky incrustation in the available specimens. The columellar lip is fairly thick, especially posteriorly, spreading over nearly the entire ventral surface of the shell, distinctly, though not sharply, demarcated round its edge. The outer lip is practically vertical except close to the anterior termination of the shell. Externally it is not thickened. It is strongly crenulate internally.

*Dimensions.*—The following are the dimensions respectively of a more elongate and of a more ventricose specimen:—

	mm.	mm.
Height . . . . .	34.5	31
Thickness . . . . .	19	10
Height of spire . . . . .	5.5	4
Height of body-whorl . . . . .	30.5	28

The species also reaches larger dimensions up to about 50 × 30 mm.

*Occurrence.*—Mekran beds: base of Talar section.

*Comparison with other species.*—The resemblance between this shell and *Volutospina sindiensis* is so great that it might be regarded as a variety of the Nari species. It is distinguished both from *Volutospina sindiensis* and from *Volutospina dentata* Sow., by the persistence, at later stages of growth, of the posterior circum-sutural spines, which become increasingly prominent upon the body-whorl instead of disappearing. The outer row of spines, on the body-whorl, project obliquely outwards as well as upwards, instead of being strictly vertical as in *Volutospina dentata*. The outer lip is externally simple instead of being thickened as in *Volutospina sindiensis* and *V. dentata*. The lines of growth are straighter and more nearly vertical or radial over the posterior concave slope than in either *V. sindiensis* or *V. dentata*. The spacing of the spiral bands is slightly wider than is usually with *Volutospina sindiensis*. The three conspicuous columellar folds of *Volutospina mekranica* are homologous with similarly situated folds in the two other species. Whether additional posterior folds are also developed could not be ascertained.

This species together with the Lower Miocene *Voluta dentata* J. de C. Sow., are geologically the latest forms so far known of the sec-



tion *Volutospina*, no examples of which have been observed in other countries from beds newer than Oligocene. The Miocene forms of Europe and America belong to the section *Athleta*, while the living *Voluta abyssicola* Adams and Reeve, from the Cape, is a *Volutocorbis*.

LYRIA JUGOSA [ J. de C. Sowerby ].

1839. *Voluta jugosa* J. de C. Sowerby.—Trans. Geol. Soc. Lond., [2], Vol. V, Pl. XXVI, fig. 25.  
 1850. *Voluta jugosa* J. de C. Sowerby.—d'Archiac, Hist. Progr. Géol., Vol. III, p. 298.  
 1850. *Voluta edwardsi* d'Archiac Hist. Progr. Géol., Vol. III, p. 298.  
 1851. *Voluta jugosa* J. de C. Sowerby var.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 323, Pl. XXXI, figs. 19-21.  
 1854. *Voluta edwardsi* d'Arch.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 323, Pl. XXXI, figs. 22-24.

Medium size, large for the genus, slender, with tall conoidal spire equal to two-fifths of the total height, and with large elongate-ovoid body-whorl.

The protoconch is small, tall and prominent, smooth, bulbous with flattened, excentrically situated summit and about two whorls, and is followed by five spire-whorls separated by rather broadly and deeply grooved sutures which give a somewhat stepped appearance to the spire. The height of the last spire-whorl, in different specimens, reaches from four-sevenths to three-fifths of its width. In consequence of the conoidal shape of the spire, the proportionate height in the earlier whorls is less, and may become equal to only half the width. The maximum thickness of the whorls corresponds with their anterior margin. Their outline is slightly convex. They are decorated with narrow, prominent, practically vertical ribs, generally of about the same width as the intervening spaces rarely narrower, sometimes broader. They are terminated posteriorly by rather prominent, vertical spines slightly bent inward at their terminations so that they tend to arch over the sutural groove round which they form a ring. Many specimens carry even-spaced, crowded spiral incisions which are well developed along the floor of the intervals between the axial ribs, but which seldom cross the ribs. There are just as many specimens in which the spire is without any spiral ornaments, and in which both the ribs and interspaces are equally smooth. The number of ribs to each complete volution, is constant in each specimen at successive stages of growth, and remains the same on the body-whorl as on the spire. In the Kachh

specimens, the most usual number for one complete whorl is nineteen, but it may be as low as thirteen, and as high as twenty-three. There is sometimes a varix on the last spire-whorl.

The large body-whorl equal to three quarters or more of the total height has a very regularly elongate-ovoid outline of very moderate curvature, with its greatest thickness at about half the distance between the suture and anterior extremity of the shell. On the left side of the shell, not far from the anterior termination, a slight concavity forms the posterior limit of the fairly broad zone of accretions to the anterior apertural termination which is differentiated by its ornamentation, though not distinctly raised. On the right side of the shell the outline remains convex throughout, though the curvature decreases considerably towards the anterior termination. The axial ribs extend over the entire base up to the border of the anterior zone of accretions upon which they may even slightly encroach. They exhibit a scarcely perceptible sinuosity immediately anteriorly to their spinose terminations with forward-directed concavity beyond which they are at first vertical, becoming convex on approaching the base and increasingly retrocurrent, until they impinge upon the terminal dorsal zone with a transverse direction. The steeply winding, anterior, dorsal zone of accretions carries close-set, spiral imbrications with their raised edge facing posteriorly. The concavity of the neck carries similar imbrications, less prominent and wider spaced, extending across the axial ribs and interspaces. With a further decrease of prominence, but maintaining the same spacing, they may be continued over the entire convexity of the body-whorl, either across the ribs and interspaces, or else in the interspaces only. In other specimens they cease to be distinct posteriorly to the concavity of the neck, so that both the ribs and interspaces are smooth over the greater part of the body-whorl. The entire surface of the body-whorl is covered with finer crowded lines of growth visible only with a lens. Their course corresponds with that of the ribs and they form a deep sinus on crossing the terminal zone of accretions. In many specimens, the body-whorl carries a varix situated at  $180^\circ$  or at  $240^\circ$  from the aperture. The aperture is tall, narrow, lanceolar, symmetrically tapering at both ends, posteriorly prolonged in a very narrow and very shallow channelled angulation, anteriorly terminated by a rather narrow and rather deep notch. The columella is slightly oblique and nearly straight, with a very feeble depression corresponding with the

inward extension of the concavity of the neck, and an equally feeble swelling coinciding with the posterior border of the anterior dorsal zone. A very prominent, rather steeply winding fold almost coincides with the anterior twist of the columella. It is followed by an equally prominent fold which is more transverse. The third fold, much more transverse, is much less prominent and is followed posteriorly by numerous practically transverse, thin threads or ledges, which, in some specimens, are continued throughout the entire height of the aperture when their number may amount to as many as eleven, only the five more anterior of which are continued spirally into the interior of the shell, while the remainder are interrupted inward usually at a very short distance from the outer edge of the aperture. The columellar lip is narrow, thin, very sharply demarcated, especially anteriorly, though not detached. The outer lip which rises slightly beyond the terminal suture posteriorly exhibits, close to its posterior termination, a very shallow short sinus, anteriorly followed by a convexity of very feeble curvature extending to the anterior termination of the shell. It is greatly thickened externally by the rather broad, smooth, terminal varix, and is internally smooth.

*Dimensions.*—The following dimensions were measured upon four specimens from Kachh :—

	mm.	mm.	mm.	mm.
Height . . . . .	48	41	45	40
Thickness . . . . .	22	21	19	19
Height of spire . . . . .	19	15	18	16
Height of body-whorl . . . . .	36	33	34	31

The shell also attains larger dimensions; Sowerby's original type measures about 65 × 29 mm.

*Occurrence.*—Gáj of Kachh; near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45'), Tyra River near Rámpur (23° 20', 68° 51'), Tyra River north of Naliya (23° 15', 68° 52') higher than the Pecten bed of Sookpur, south bank of river from Tyra (23° 17', 68° 58'), Gáj of Sind (Karachi, Blgrave collection).

*Remarks.*—This shell occurs abundantly in the Gáj beds both of Kachh and of Sind. The Sind specimens were referred by d'Archiac and Haime partly to a variety regarded as doubtfully connected with the Kachh type, partly to a form regarded as specifically distinct under the name of *Voluta edwardsi*. According to d'Archiac

and Haime, the Sind specimens which they regarded as only doubtfully referable to *Voluta jugosa* as a distinct variety, differ from the Kachh type in the characters of their columellar plication. The supposed distinction is the result of a misapprehension; according to d'Archiac and Haime the Sind shell carries eight columellar folds instead of the three folds shown in Sowerby's type-figure. In reality, the strong, anterior, revolving keels homologous with those figured by Sowerby are missing in the incomplete specimens studied by J'Archiac, while the folds illustrated in the figures of the "Description" are the subsidiary posterior ledges which are just as well developed and just as numerous in the typical *Voluta jugosa* as in the Sind fossils in d'Archiac's collection, but which are concealed by a rocky incrustation in the type specimen from Kachh. As to the Sind specimens figured as *Voluta edwardsi* they are admitted by d'Archiac and Haime to be very closely related to those regarded as a variety of *Voluta jugosa*, the only precise difference recorded depending on the number of ribs, said to be only twelve for one complete volution *Voluta edwardsi*; eighteen in the case of the specimens referred to *Voluta jugosa*. On verifying the number of ribs of the type of *Voluta edwardsi* it was found to amount, not to twelve, but to fifteen for one complete volution. Amongst the poorly preserved fossils referred by d'Archiac to *Voluta jugosa*, the number for one complete volution is seventeen in the only specimen in which they can be accurately counted. The number of ribs to one complete volution observed in five different Kachh specimens of *Lyria jugosa* amounts, respectively, to 14, 14, 17, 17-19, 22-23. The number of ribs varies, therefore within much wider limits than those which would differentiate two species, with every possible gradation between both extremes. All the Sind specimens examined by d'Archiac belong therefore to a single form which cannot be specifically distinguished from the typical *Voluta jugosa*.

*Comparison with other species.*—Owing to the presence of varices this shell recalls various species from the Oligocene of India, Burma and Liguria, distinguished, nevertheless, by their proportions or their ornamentation.

d'Archiac and Haime compared the Sind fossil with the recent *Voluta mitraformis* Lamk. The resemblance is probably superficial only, for none of the living species of *Lyria* exhibit the very peculiar and very characteristic varices of the fossil.

## LYRIA ANCEPS [Michelotti].

Pl. II, figs. 7, 8.

1861. *Voluta anceps* Michelotti.—Foss. Mioc. inf., p. 99, Pl. X, figs. 22, 23.  
 1890. *Lyria anceps* Michtt.—Bellardi, Moll. Terr. terz. Piem. e Lig., parte VI, p. 0, Pl. I, fig. 1.  
 1900. *Lyria anceps* Michtt.—Rovereto. III. Moll. Tong., p. 172.  
 1904. *Lyria anceps* Michtt.—Sacco, Moll. Terr. terz. Piem. e Lig., parte XXX, p. 89.

Medium size, slender, with tall elongate spire, conical in its earlier portion, becoming conoidal at later stages of growth, and with large, ovoid body-whorl.

The protoconch is small, short, trochoid, scarcely oblique, with a minute, button-shaped nucleus followed by a single, slightly convex, smooth whorl. It is followed by five feebly convex spire-whorls with narrow, slightly grooved, sutures. The height of the last spire-whorl, in full-grown specimens, measures from three-fifths to two-thirds of its width. In consequence of the conoidal outline of the later portion of the spire, the relative height is less at earlier stages of growth, and, in the first three whorls is fairly constant in each specimen, and equal to about half the width, sometimes less.

The following measurements in millimetres give the observed heights of whorls of various diameters:—

Diameter . . . . .	4	5	6	7	9	10	11	14
Height . . . . .	2	2	3	3	4	5	7	8.5

The greatest thickness of the earlier whorls coincides with their anterior margin. At increasing stages of growth, as the increasing obliquity of the suture uncovers more of their anterior portion, the surface contracts towards the anterior suture, the maximum width, in the last spire-whorl of full-grown specimens, being situated at about half the height of the whorl. The whorls are ornamented with thin, prominent, axial ribs, narrower than the intervening spaces, which are very slightly oblique and antecurrent towards the anterior suture, sometimes exhibiting, quite close to their posterior termination, a scarcely perceptible constriction coinciding with an equally rudimentary sinuosity, the concavity of which faces forward.

The ribs, towards their posterior termination, are bent towards the axis together with the general curvature of the surface of the whorls. They end in blunt swellings, scarcely raised beyond the level of the sutures, and practically in contact with the anterior

margin of the preceding whorls. The number of ribs to each whorl is constant in each specimen at successive stages of growth. The number for one complete volution most frequently observed is fifteen or sixteen; occasionally it may be as low as thirteen or as high as twenty-two. In all the specimens examined from Sind the last spire-whorl carries at least one thick varix, sometimes two. There is often a varix on the penultimate spire-whorl. Specimens from Baluchistan are occasionally devoid of varices. In some specimens the whorl surface of the whorls carries very fine, rather close-set, evenly spaced, spiral striæ traversing alike the ribs and interspaces. In many specimens they cannot be detected, a circumstance which, in many cases, does not seem to be referable to the weathering of the surface.

In consequence of the conoidal shape of the spire, the relative height of the large body-whorl varies considerably at different stages of growth: measuring nearly five-sixths of the total height in half-grown specimens, while, when the shell is full-grown, it scarcely exceeds two-thirds of its height. In shape, the body-whorl is ovoid, with an even convexity of moderate curvature extending from the suture to the anterior termination on the right side of the shell, while, on the left side, the convexity is succeeded, not far from the anterior termination, by the rather short, well defined concavity of the neck which separates it from the rather prominent, rather steeply winding, torose bulge formed by the accretions to the narrow, rather deep, terminal notch. Along the posterior margin of the body-whorl, the ribs exhibit the same characters as upon the spire-whorls, with the same blunt terminations and the same scarcely perceptible posterior sinus, beyond which they exhibit a very even convexity of very slight curvature which carries them forward up to a point situated at about half their length, anteriorly to which they become retrocurrent up to their abrupt termination against the well-defined margin of the dorsal zone of accretions. They are crossed, upon the neck, by four or five imbricated spiral bands, the raised margin of which, facing posteriorly, becomes shallower as the bands recede from the anterior extremity, and which are succeeded, over the convexity of the body-whorl, by very fine, spiral striæ spaced at the same intervals as the anterior imbrications, distinct over the whole body-whorl in some specimens where they cross both the axial ribs and interspaces, indistinct or absent in others. Close-set, spiral threads cover the terminal bulge. In addition to

the apertural varix, the body-whorl usually carries at least one prominent varix, very variously situated at any interval from 90° to nearly 360° from the aperture. Sometimes there are two varices in addition to the apertural varix. In rare instances, specimens from Baluchistan have been observed without supernumerary varices either on the spire or body-whorl. The aperture is elongate, narrow, symmetrically spindle-shaped, posteriorly prolonged into a narrow shallow channel anteriorly contracted and deflected into the narrow rather deep dorsal notch. Anteriorly to the convexity of the base of the penultimate whorl, the columella is almost straight and almost vertical, becoming more distinctly though only moderately oblique for a short distance at its anterior termination. Anteriorly it carries two very prominent, moderately oblique, spiral folds, the more anterior one almost coinciding with the columellar torsion separated from one another by a deep groove. They are followed by nine spiral folds occupying the entire height of the aperture, becoming very thin and very feebly prominent in a posterior direction, the greater number being practically transverse. The five most posterior ones, well defined near the aperture, become extremely thin as they wind round the interior of the shell. The columellar lip expands very slightly in front of the posterior terminal channel. Throughout the remainder of its course it is rather thin, narrow, very sharply demarcated, especially anteriorly.

The outer lip projects very slightly beyond the suture at its posterior extremity. It is very feebly convex and nearly vertical throughout the greater part of its length, becoming slightly retrocurrent quite close to its anterior termination. It is prominently thickened externally, smooth internally.

*Dimensions.*—The following are the measurements of two specimens illustrating different stages of growth :

	mm.	mm.
Height . . . . .	35	17
Thickness . . . . .	17	10
Height of spire . . . . .	14	6
Height of body-whorl . . . . .	26	14

*Occurrence.*—Nari of Sind: Bhagothoro Hill. Nari of Baluchistan: north-eastern spurs of Takatu near Quetta ( $K_{147}^{11}$ ); north of Kudiu, east of Kos Kats, further west than  $K_{144}^{11}$  ( $K_{355}^{11}$ ). In Europe this shell occurs in the Oligocene of Liguria.

*Comparison.*—This shell is distinguished from *Lyria jugosa* by its smaller size and by its narrow sutures, and the blunt terminations of the spines in consequence of which the spire does not assume the stepped appearance that characterises *Lyria jugosa*. The anterior dorsal bulge is also more prominent than in *Lyria jugosa*.

MITRA CHINENSIS Gray, var. SUBSCROBICULATA d'Orbigny.

1839. *Mitra chinensis* Gray.—Beechey's Voyage, p. 125, Pl. XXXV, fig. 2.

1840. *Mitra scrobiculata* Brocchi.—J. de C. Sowerby, Trans. Geol. Soc. London, 2nd series, Vol. V, Pl. XXVI, fig. 23.

1852. *Mitra subscrobiculata* d'Orbigny.—Prod. Pal. Vol. III, p. 54, No. 922.

Large, elongate, with aperture usually of the same height as the spire, or else slightly taller or slightly shorter. The slender spire is slightly conoidal, with slightly stepped sutures.

The protoconch, which is broken, is followed by six slightly convex spire-whorls. The height of the last whorl, in full-grown specimens, is equal to three-quarters of its width. The proportion of height to thickness is less in the earlier whorls in consequence of the slightly conoidal outline of the spire. The maximum height of the whorls corresponds with their anterior margin. They are separated by narrow grooved sutures. They carry from four to six thin, revolving grooves, the intervals between which, and also between the outer ones and the margins of the whorls, are either sub-equal or slightly increased in an anterior direction. On the later spire-whorls of full-grown specimens, the more anterior grooves are apt to become very faint. The lines of growth are, for the greater part of their length, steeply oblique and retrocurrent to the anterior margin, becoming practically vertical only in the immediate neighbourhood of the posterior suture.

The large, elongate body-whorl is equal to five-eighths of the total height in full-grown specimens, and to as much as five-sevenths at earlier stages of growth, owing to the relatively shorter spire of younger shells consequent on its slightly conoidal outline. Posteriorly the body-whorl exhibits a sub-spherical to ovoid convexity the degree of curvature of which is more or less pronounced according as to whether the specimens are short and stout, or else narrow and elongate. On the right side of the shell, the convexity is continued with a decreasing curvature up to the anterior termina-



tion, while on the left side, the convex portion is succeeded by a broad and sometimes somewhat deep concavity, anteriorly bordered by the sharply demarcated, wide, rather prominent, twisted, scaly bulge formed by the accretions to the very deep terminal notch. The spiral ornamentation of the spire is continued over the posterior portion of the body-whorl, with the addition of one more groove quite close to the suture. Anteriorly to the level of the suture, similar revolving grooves, with approximately the same spacing, may continue over the convex portion of the body-whorl, but are often very faint, while on some full-grown specimens, this part of the shell may become even quite smooth. They invariably reappear, at the same time becoming more crowded, upon the concavity of the neck. Rather crowded, spiral grooves are also observed on the anterior twisted bulge in the case of immature specimens, but, when the shell is full grown they are completely obliterated by the scaly accretions. The aperture is very narrow, usually equal to half the total height of the shell, posteriorly terminated by a very narrow angulation and only slightly contracted anteriorly. The columella is oblique, feebly convex. There are four very well developed columellar folds of gradually decreasing importance anteriorly. The presence of a fifth anterior fold is doubtful. The columellar lip is thin, narrow, non-spreading, nowhere detached, distinctly demarcated especially anteriorly along the twisted anterior bulge. Except against the suture, where it is vertical or even slightly retrocurrent, the outer lip is oblique, anteriorly retrocurrent, continuously convex with a very feeble curve, until it passes into the very deep dorsal notch. It is thin, and, so far as can be ascertained, is not internally crenulated.

*Dimensions.*—The following measurements illustrate the proportions of the shell at successive stages of growth:—

	mm.	mm.	mm.	mm.
Height . . . . .	70	61	40	36
Thickness . . . . .	19	17	13	13
Height of spire . . . . .	37	31	20	19
Height of body-whorl . . . . .	50	40	26	28

*Occurrence.*—Gaj of Kachh: Tyra River near Rampur (23° 20', 68° 51'); Tyra River north of Naliva (23° 15', 68° 52') higher than the Pecten bed of Sukpur; also in the Garo Hills of Assam, near Bagmara.

*Comparison with other species*—*Mitra scrobiculata* Brocchi, from the Pliocene of Piedmont, to which Sowerby provisionally referred the Indian fossil, is a much larger shell, relatively more elongate, with far more complex spiral decoration. *Mitra conjungens* Bellardi, also from the Pliocene of Piedmont, is distinguished both from *Mitra scrobiculata* and from the Indian fossil by the axial ribs of its earlier whorls. The Kachh fossil cannot be distinguished by means of any precise characters from the living *Mitra chinensis* Gray.

The dimensions of the specimen of *Mitra chinensis* represented in Sowerby's Thesaurus are:—

	mm.
Height . . . . .	87.5
Thickness . . . . .	29
Height of spire . . . . .	45.5
Height of body-whorl . . . . .	54

Comparing these dimensions with those given above for two full-grown specimens of *Mitra subscrobiculata* by taking the total height as a standard unity, the respective figures are:—

	Mitra chinensis.	Mitra sub-scrobiculata.
Height . . . . .	1	1
Thickness . . . . .	.297	.257
Height of spire . . . . .	.521	.528
Height of body-whorl . . . . .	.617	.714

The specimen illustrated in Sowerby's Thesaurus has a somewhat shorter body-whorl than the Indian fossil. In the case of Gray's original type, the body-whorl is exactly two-thirds of the total height, or 0.666. The ornamentation of the living shell is identical with that of the fossil and shows the same variations, becoming, similarly, partly obsolete on certain specimens. The fossil appears to be slightly more slender than the living shell when specimens of the same size are compared; which specimens, nevertheless, do not represent identical stages of growth, for the fossil is slightly smaller as is usually the case with an ancestral premutation.

The slightly smaller average size of the fossil, its more slender shape at identical dimensions, and also the somewhat more conical, less conoidal outline of the spire, may serve to distinguish it as a variety, though they seem insufficient for the establishment of a separate species.

## MITRA INQUINATA Reeve.

Pl. I, fig. 15.

1844. *Mitra inquinata* Reeve.—*Conchologia iconica*, Vol. II, Monograph of the genus *Mitra*, Pl. V, No. 29.

Medium size, moderately slender, with conoidal spire, equal to half the total height, and with body-whorl almost cylindrical posteriorly, gradually attenuated anteriorly.

The protoconch, which is broken in the available specimens, is followed by seven spire whorls the height of which, at the later stages of growth, is equal to three-fifths of their width, becoming somewhat less in the earlier whorls in consequence of the conoidal shape of the spire. The whorls are scarcely convex and slightly stepped, separated by grooved sutures. They carry four well-marked, equidistant thin, revolving incisions, and a fifth shallower one close to the posterior suture. The lines of growth are scarcely oblique, practically normal to the posterior suture.

The large, elongate body-whorl, equal to two-thirds of the total height, not greatly attenuated anteriorly, exhibits, on its right side, a continuous convexity with feeble curvature up to its anterior extremity, while, on its left side, the almost cylindrical posterior portion is followed anteriorly by a broad concavity limited anteriorly by the rather broad, not very prominent, but very sharply demarcated, rather steeply winding, scaly zone formed by the accretions of the deep terminal notch. The ornamentation of the spire is continued on the body-whorl, the revolving grooves becoming gradually more crowded on the anterior concavity as they approach the anterior scaly zone upon which no spiral ornaments are developed.

The aperture is tall and very narrow, very acutely angular at its posterior termination, while the anterior termination is but slightly contracted. The columella is slightly oblique, scarcely convex. It carries at least four folds which are very well developed and of decreasing prominence anteriorly. The presence of a fifth anterior fold is doubtful. The columellar lip is very thin, narrow, not spreading. The outer lip is practically vertical, or even slightly retrocurrent towards the suture at its posterior termination. The greater part of its course is practically straight and but slightly oblique, the outline becoming distinctly convex and receding dorsally only quite close to the anterior extremity, where it passes into the dorsal notch which is very deep and rather wide. So far as can be

made out from the available specimens, the interior of the outer lip is not crenulated. Remains of the coloured decoration are disposed in more or less irregularly subdivided, and irregularly terminated, rather broad axial streaks of a darker tint on a lighter back ground.

*Dimensions.*—The following measurements represent the restored dimensions of the least incomplete specimen :—

Height . . . . .	mm.
Thickness . . . . .	43
Height of spire . . . . .	14
Height of body-whorl . . . . .	22
	28

*Occurrence.*—Mekran beds : base of Talar section ; west of Gharh Hill.

*Comparison with other species.*—So far as can be judged from the available material which is all more or less fragmentary, this fossil does not appreciably differ from the living *Mitra inquinata* Reeve. *Mitra serpentina* Lamarck is also closely similar, but seems to have the revolving grooves less crowded on the anterior concavity, while its coloured decoration is differently distributed. This fossil closely resembles the previously described form referred to *Mitra chinensis*, but its revolving grooves are more pronounced and wider-spaced.

#### MITRA (CANCILLA) REMBANGENSIS Martin.

1906. *Mitra rembangensis* Martin.—Samml. des geol. Reichs-Museums in Leiden now series, Vol. I, p. 304, Pl. XLIV, figs. 722, 723.

Some fragmentary, evidently immature specimens in the Blagrove collection from the Gáj beds of the neighbourhood of Karáchi have been identified with the above-named Javanese fossil species by comparison with some well preserved fossil specimens from Burma.

#### MITRA (CANCILLA) FLAMMEA Quoy.

1832. *Mitra flamma* Quoy.—Voy. Astrol., II, p. 659, Pl. XLV, figs. 23-25.

1832. *Mitra flamma* Quoy.—Tryon, Man. Conch., Vol. IV, p. 140.

1883. *Mitra flamma* Quoy.—Martin, Samml. des geol. Reichs-mus. in Leiden, 1st series, Vol. III, p. 85.

1895. *Mitra (Cancilla)* Quoy.—Martin Samml. des geol. Reichs-mus. in Leiden, new series, Vol. I, p. 76, Pl. XI, figs. 170, 171.

1903. *Mitra (Cancilla) flamma* Quoy.—Cossmann, Jour. Conch., Vol. I, p. 123, Pl. IV, figs. 11, 12.

This species is represented by a solitary, almost shapeless fragment, the well-preserved ornamentation of which leaves, however,

no doubt as to its perfect agreement with the living form. The angular, principal, spiral ridges, the striated intervals, the proportions of the spire-whorls, all agree with the specific characters.

*Occurrence*.—Mekran beds: base of Talar section. The same species also occurs in a fossil condition in the newer Tertiary of Java and of Karikal. It is common at present all over the Eastern seas.

MITRA (CHRYSAME) SOWERBYI d'Orbigny.

1839. *Mitra fusiformis* G. de C. Sowerby.—*Trans. Geol. Soc. London*, 2nd series Vol. V, Pl. XXVI, fig. 24. (*Non Mitra fusiformis* Brocchi, 1814).  
1852. *Mitra sowerbyi* d'Orbigny.—*Prodr. Pal.*, III, p. 54, No. 921.

Medium size, moderately ventricose, symmetrically pupoidal with rather broadly conoidal spire equal to three-sevenths of the total height.

The protoconch is relatively large, probably consisting of a relatively large number of whorls, conical, and probably relatively tall. There only remains the last whorl which is smooth, not appreciably convex, and terminated by a very oblique rib retrocurrent to the posterior suture. The protoconch is followed by six spire-whorls, the height of which, at the later stages of growth, is equal to slightly more than half their width. At earlier stages of growth, their relative height is slightly less, in consequence of the conoidal outline of the spire. They are but slightly convex, the curvature exceeding that necessary to fit into the general conoidal outline only by the slight amount needed to allow for the slightly stepped disposition of the sutures, which are narrow and grooved. Revolving grooves, varying in number from four on the earlier whorls to six on the later ones, divide the surface accordingly into from five to seven broad, flat, raised bands. The grooves are broadest near the posterior margin of the whorls where they equal or even slightly exceed the bands in width, becoming gradually narrower towards the anterior margin where they are much narrower than the intervening bands. An additional narrow circumsutural space bounds the most posterior raised band along its posterior edge. A very thin intercalary thread sometimes bisects some of the broadest intervals, but they never assume the broad, flattened shape of the main bands: the increase in number of the grooves on the later spire-whorls is not due to any intercalation of additional bands, but is caused by the gradually greater uncovering of the shell surface along the anterior margin in consequence of the increase of obliquity

of the sutures dependent on the conoidal outline of the spire. The whole surface is beautifully trellised by exceedingly fine, crowded equidistant, raised lines of growth, very slightly oblique, and practically straight, which are particularly noticeable for the granules which they produce upon the raised bands on the earlier whorls, and for the conspicuous lattice which they form in the grooves of the later whorls.

The very large body-whorl, which reaches between three-fourths and four-fifths of the total height, is very elongate-ovoid, with such a feeble curvature as to appear almost conical anteriorly where it is but slightly contracted so that the shell remains broad at its anterior termination. The curvature remains everywhere convex, and is continuous to the anterior termination on the right side of the shell, while on the left side it is interrupted by the broad, very sharply demarcated, but feebly prominent, steeply winding, scaly zone formed by the increments of the very deep terminal notch. The spiral ornaments of the spire continue unaltered on the body-whorl, similar conspicuous revolving grooves being continued anteriorly to the level of the suture over the remaining anterior part of the body-whorl upon which they are narrower than near the posterior margin of the body-whorl. A slight increase in width recurs near the anterior termination. The spacing is everywhere even except in the immediate neighbourhood of the anterior scaly band where the three last grooves are set closer together. Narrow, spiral incisions also cross the scales of the anterior band. The whole surface of the body-whorl is delicately trellised, like the spire, by the raised lines of growth which become strongly convex and retrocurrent in the neighbourhood of the anterior band. At uneven intervals, thin, continuous imbrications, coinciding in direction with the lines of growth, represent former apertures of the shell during temporary arrests of growth.

The aperture is long and very narrow, very acutely angular at its posterior termination, not contracted anteriorly. The columella is steeply oblique, nearly straight. There are at least four, very thick, sometimes slightly bifid, columellar folds, much broader than their interspaces, of gradually decreasing prominence anteriorly very oblique, situated far forward. A fifth anterior thread perhaps also exists. The columellar lip is distinct but extremely thin, non-spreading. The outer lip is oblique throughout its entire course and is slightly antecurvent to the suture. For the

greater part of its length it is nearly straight, acquiring a strong convexity only quite close to its anterior termination where it passes into the broad, deep, dorsal notch. The interior of the lip is presumably crenulated, but is concealed by a hard, rocky incrustation in all the available specimens.

*Dimensions.*—The following dimensions were measured on a well-preserved specimen :—

	mm.
Height . . . . .	35·2
Thickness . . . . .	15
Height of spire . . . . .	15·2
Height of body-whorl . . . . .	27·2

The species also reaches larger dimensions, up to 46 mm. in height.

*Occurrence.*—Gaj of Kachh : Tyra River near Rámpur (23° 20', 68° 51'); Tyra River north of Naliya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur.

*Comparison.*—Sowerby compared this fossil with *Mitra adusta* Lamarck, which has a much more elevated spire. Another very closely related form is *Mitra ambigua* Swainson, in which the sutures are more canaliculate than in the fossil, the spire less conoidal and generally taller, the base more abruptly contracted. *Mitra caligena* Reeve, which occurs living at Karáchi, is also related, but is smaller and much more ventricose. *Mitra junghuni* Martin, from the Miocene of Java, seems related, but has much taller spire-whorls.

#### FUSUS (APTYXIS) RETICULATUS n. sp.

##### PL. IX, fig. 7.

Medium-size, moderately elongate, with moderately broadly conical spire measuring a little less than half the total height, and with ventricose body-whorl, anteriorly contracted into a moderately elongate, slightly twisted stem.

The protoconch, broken in the only available specimen, is followed by five or six spire-whorls, the height of which is equal to nearly three-fifths of their width, the maximum thickness being situated not far from the anterior margin. The sutures are linear though incised. At about half their height, the whorls exhibit a slight angulation dividing them into an anterior rather strongly convex portion, and a posterior slightly concave, fairly steep slope. A

spiral thread corresponds with the angulation, anteriorly to which there are three more equal-spaced main spiral threads of which the most anterior follows the anterior suture. The posterior slope also carries three main spiral threads of which the most posterior one is not far from the posterior suture. Of the intervals determined by these posterior threads, that nearest the angulation is of about the same width as the intervals on the anterior convexity of the whorls, while the two others are narrower, and are of the same width as the interval between the most posterior thread and the posterior suture. On the later spire-whorls, the anterior intervals, and also, amongst the posterior ones, that nearest to the angulation, are each bisected by an intercalary thread of a second order. Towards the end of the last spire-whorl, faint indications are seen, in some of the intervals, of threads of a third order. In addition to the spiral ornaments, the whorls carry crowded, thin, axial ribs, of the same width as the intervening spaces, or a little wider. They extend from suture to suture, their direction being very slightly oblique antecurrently from the angulation to the posterior suture, while anteriorly to the angulation, either the same feeble obliquity is continued in the same direction, or else the ribs become quite vertical. Their number, on the earlier spire-whorls, is approximately fifteen, increasing at first to twenty, and finally, on each of the two last spire-whorls, to twenty-four. On the later whorls, the spacing of the axial ribs exceeds so little that of the main spiral threads that the surface acquires a reticulated appearance. The spiral threads swell as they cross the ribs. The extremely delicate, crowded lines of growth follow the same course as the ribs, approximately vertical, or steeply antecurrent to the posterior suture.

The body-whorl slightly exceeds two-thirds of the total height. It consists of a ventricose spheroidal main portion with rapidly contracted base connected by a short concavity with the slightly twisted, moderately elongate terminal stem. The slight angulation of the spire-whorls is continued on the corresponding part of the body-whorl. The spiral decoration of the last spire-whorl is also continued on the body-whorl. Anteriorly to the level of the terminal suture, the convexity of the base carries four more main threads, closer-set than those continued from the spire, and without any intercalary threads in the interval. Three more main threads occur on the concavity of the neck, the spacing being again a little wider, with even, in the first space, the development of an intercalary



thread which, however, does not bisect the interval, the posterior subdivision being narrower than the anterior one. Similar spiral threads are continued on the terminal stem, the greater portion of which is missing, so that their exact number cannot be ascertained. The axial ribs exhibit generally the same characters as on the spire-whorls, with the same average spacing. They become very thin, nevertheless without disappearing, on the anterior concavity and stem where they tend to produce granules at the intersections with the spiral ornaments, their trend, as far as the shell is preserved, remaining vertical. A broad, feebly prominent, varix-like swelling, occurs at a short distance from the aperture. The lines of growth are disposed, posteriorly, as on the spire-whorls, and continue vertically, in an anterior direction, as far as the shell is preserved.

The aperture is moderately broadly oval-lanceolar, posteriorly angulated, anteriorly contracted in a canal which is probably slightly tortuous. The characters of the columella and columellar lip are much obscured by a hard, adhering, rocky incrustation. The outer lip is, posteriorly to the termination of the angulation, very steeply antecurrent to the suture. It is very feebly sinuous, and, for the greater part of its extent, practically vertical. Its edge is very thin. Its internal characters are obscured by the rocky incrustation.

*Dimensions.*—

Height . . . . .	mm.
Thickness . . . . .	13
Height of spire . . . . .	16
Height of body-whorl . . . . .	24

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—This elegant shell is probably an ancestral premutation of *Fusus australis* Quoy, a species widely distributed throughout the Indo-Pacific region, certain varieties of which are practically identical with the above described fossil, being distinguished only by their larger dimensions.

CLAVILITHES VERBEEKI Martin.

1895. *Fusus (Clavella) verbeeki* Martin.—Samml. des geol. Reichs-Mus. in Leiden new series, Vol. I, p. 85, Pl. XII, figs. 188-192, Pl. XIII, figs. 193-198.

(non *Fusus verbeeki* Mart. in Noetling, Pal. Ind., 1901, new series, Vol. I, part 3, p. 313.)

Large, with conical spire measuring from three-elevenths to one-third of the total height, and expanded body-whorl terminated by a long narrow stem.

The apex is missing in all the available specimens. The number of spire-whorls following the protoconch is probably about six. Their height is at first equal to nearly half their width, the maximum thickness being situated quite close to the anterior margin. The earliest whorls are moderately convex, with a few broad ribs crossed by conspicuous, raised, spiral threads. At a diameter of 4 or 5 mm., the whorls become nearly flat with only a very feeble anterior convexity and a very feeble posterior circumsutural concavity. The sutures become narrowly channelled and the ribs gradually disappear, so that the ante-penultimate spire-whorl only bears raised spiral-threads, wider-spaced on the posterior portion of the whorl where they are narrower than the intervening spaces, than on the anterior portion where the intervals become narrower than the threads. On the two last spire-whorls the spiral ornaments become entirely restricted to the posterior margin. These two last whorls are relatively lower than the preceding ones, the relation of height to breadth being three-sevenths in the penultimate spire-whorl, and only one-third in the last, the maximum width in either case actually coinciding with the anterior margin. The lines of growth, oblique and anteriorly retrocurrent in their aggregate course, are slightly sigmoidal; they are normal or slightly antecurrent to the posterior suture, anteriorly retrocurrent across the posterior slightly concave portion of the whorls, anteriorly to which they become gradually less oblique till they impinge normally on the anterior suture.

The last spire-whorl becomes slightly gibbous at its junction with the body-whorl which measures three-elevenths of the total height and which gradually becomes strongly shouldered towards the aperture. Anteriorly to this shouldering the body-whorl assumes a broad, tub-shaped outline, either feebly convex, or cylindrico-conical, or even slightly concave, generally slightly tapering in an anterior direction, and anteriorly connected by an abrupt, sub-angular bend with a basal concavity which rapidly merges into the terminal, feebly twisted, elongate, tapering, narrow stem exhibiting, on the left side of the shell, a very slight, elongate bulge which is situated more anteriorly on the right side. At its anterior extremity the stem is slightly deflected ventrally. The spiral striations which decorate the posterior marginal portion of the last spire-whorl are not continued upon the body-whorl, the main broad portion of which only carries some very faint, spiral grooves, obscurely visible with a slanting

illumination. Distinct spiral ornaments reappear on the basal concavity where they consist of spiral threads of feeble relief, separated by narrower intervals, and alternating in two sizes. They are continued on to the terminal stem on the most anterior portion of which, anteriorly to the slight bulge, they become somewhat fainter. On the posterior portion of the body-whorl, the lines of growth are disposed in the same manner as on the spire-whorls. Throughout the remainder of their course, anteriorly to the level of the suture, they either remain quite vertical, or else assume a very feeble anteriorly retrocurrent obliquity so slight as scarcely to depart from verticality.

The oval or rhombic aperture is contracted posteriorly by a thick callosity in which is grooved a narrow channel; another constriction occurs anteriorly at the junction with the narrow, elongate, nearly straight, nearly vertical canal. Opposite the commencement of the canal, the columella exhibits a distinct projection contributing to contract its orifice, anteriorly to which it is feebly oblique and feebly twisted, departing very little from straightness and verticality. The columellar lip is thin and narrow, but at the same time very well demarcated, with a raised or even semi-detached edge. In spite of the considerable, internal, posterior, callous thickening of the outer lip, its actual edge everywhere remains quite sharp. It is antecurrent to the suture, but, in an anterior direction, soon assumes a practically vertical, practically straight course. The internal walls of the shell are lirate.

*Dimensions.*—The following are the partly restored measurements of three specimens:—

	mm.	mm.	mm.
Height . . . . .	57	67	
Thickness . . . . .	23	26	
Height of spire . . . . .	19	19	
Height of body-whorl . . . . .	45	50	88

*Occurrence.*—Mekran beds. West of Gharh Hill, 21 miles north-west of Gwadar; 11 miles south-east of Bán; base of Talar section.

*Remarks and comparisons.*—In every detail this shell agrees exactly with Martin's descriptions and figures of *Clavilithes verbeeki* which, at its type locality in Java, near Kampong Odeng, is particularly abundant amongst strata which appear to be at the limit of Miocene and Pliocene. The Indian specimens especially coincide with those

Javanese forms in which the spire is relatively elevated. Their apical angle varies from  $42^{\circ}$  to  $46^{\circ}$ . Martin gives the apical angle of the Javanese forms as ranging between  $51^{\circ}$  and  $68^{\circ}$ . Nevertheless, in several of the illustrated specimens, for instance in that represented on Pl. XII fig. 191 of Prof. Martin's monograph, it is only  $45^{\circ}$ ; the same measurement also applying to the earlier whorls of the specimen shown in fig. 192.

*Clavilithes verbeeki* is very closely related to *Clavilithes seminudus* [Noetling], one of the most abundant fossils in the Tertiary formations of Burma. Just as in the case of *Clavilithes verbeeki*, the fossil form from Burma also assumes a rather different appearance according as to whether the callosity usually characterising the full-grown stage has been developed or not. Amongst the Burmese fossils, there are individuals, practically of maximum dimensions, apparently adult, in which the callosity has never been developed, and others, much smaller, in which it assumes the most exaggerated proportions. Both modes of development occur together and are connected by every intermediate gradation. With only a small amount of material at his disposal, Noetling came to the conclusion that these two modes or stages of development characterise different species, one of which was described as new under the name of *Fusus seminudus*, while the specimens with large callosity were referred to *Fusus verbeeki* Martin. It is now certain that all the Burmese specimens belong to a single species which, however closely related to *Clavilithes verbeeki*, must be regarded as a distinct species, or at least a very pronounced variety, the main difference being the much smaller size of the Burmese form which is like a miniature edition of *Clavilithes verbeeki* of which it perhaps represents an ancestral premutation. It is true that some exceptionally large specimens of *Clavilithes seminudus* are as large as some exceptionally dwarfed specimens of *Clavilithes verbeeki*. Nevertheless the distinction is usually obvious at the merest glance, and, if only for the sake of convenience, it is preferable to distinguish the Burmese form under a separate specific name, rather than to make use of the rather cumbrous denomination *Clavilithes verbeeki* var. *seminuda*.<sup>1</sup>

<sup>1</sup> As it is customary to regard *Clavilithes* as a genus distinct from *Fusus*, Noetling's specific denomination "*seminudus*" may stand since it has not been pre-employed within the genus *Clavilithes*. If *Clavilithes* be regarded as a subgenus of *Fusus*, Noetling's specific name clashes with *Fusus seminudus* Deshayes (at present transferred to *Siphonalia*); the Burmese fossil may, in that case, be distinguished as *Fusus (Clavilithes) noetlingi*.

## EUTHRIOFUSUS SUBREGULARIS [d'Archiac and Haime.]

1850. *Fusus* indéf.—d'Archiac, Hist. des progrès de la Géol., Vol. III, p. 293.1851. *Fusus subregularis* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde p. 307, Pl. XXIX, fig. 14.

Medium-size, moderately elongate, with conical spire measuring two-fifths of the total height.

The very minute protoconch, imperfectly preserved in all the available specimens, is followed by five spire-whorls which are very convex so that the sutures are deeply impressed. In the earlier part of the spire, the height of the spire-whorls equals, or slightly exceeds half their width. Towards the termination of the spire, the height may equal three-fifths of the width, or even, in the largest specimens, two-thirds. The degree of curvature of the whorls is not even: the maximum curvature corresponds with the maximum width which, except in the very early part of the spire, is situated closer to the posterior than to the anterior margin. From the zone of maximum width to the anterior margin, the surface contracts but slightly, and appears almost cylindrical on account of the feebleness of the degree of curvature in an anterior direction. Between the zone of maximum thickness and the posterior suture, the surface forms a shallow, conical slope, sometimes slightly concave. The extent of this posterior slope relatively increases with the growth of the shell, so that the later spire-whorls acquire a decidedly shouldered appearance. This explains why, in spite of the increased relative height of the whorls, in spite also of the consequent increase of obliquity of the suture, the general outline of the spire nevertheless remains conical without any tendency to become conoidal, the posteriorly situated zone of maximum thickness expanding at such a rate as to counteract the effect of the increased obliquity of the suture. The actual suture is grooved and narrow. The spire carries both spiral and axial ornaments. The spiral ornaments consist of delicate, sharply delineated threads, narrower than the intervening sunken intervals. Their number, on the first whorl following the protoconch, is three, and may increase to as many as eighteen on the last spire-whorl, the increase being caused partly by intercalation, partly by the disclosing of additional threads along the anterior margin of the whorls as a consequence of the increased obliquity of the suture. At the first appearance of each set of intercalations, the threads alternate in two sizes, but the additional

threads soon become equalised to the original ones. It may be noticed that, on the last spire-whorl, the intercalary threads, when they first appear, do not divide the intervals into two equal spaces as they do at earlier stages of growth, but that the anterior space divided off by them is broader than the posterior space. The axial ribs are rounded, somewhat narrower than the intervening spaces, vertical, and either practically straight, or with a slight posterior sinuosity, the concavity of which faces forward. Their number, on the earliest whorls following the protoconch, is generally twelve. With increasing growth it may increase to thirteen or fourteen, or else dwindle to eleven or ten. The ribs may remain of the same degree of prominence at all stages of growth, or else they may tend to become effaced on the last spire-whorl, especially along its anterior margin. In some specimens, the ribs, on the last spire-whorl, disappear entirely. The lines of growth are practically straight and practically vertical, with a very feeble, scarcely perceptible sigmoidal flexuosity by means of which they are very steeply antecurrent to the posterior suture, normal to the anterior suture.

The large, moderately elongate body-whorl measures nearly five-sixths of the total height. It is pear-shaped, posteriorly inflated, anteriorly gradually contracted into a rather broad, short stem. Judging from the disposition of the lines of growth, the anterior termination of the shell is not notched and its accretions do not form a differentiated zone. In the typical form of this shell, corresponding with d'Archiac's original type, the ribs either disappear entirely on the body-whorl, or tend to become effaced, becoming indistinct from a short distance anterior to the posterior shouldering of the body-whorl. When they are present, in this particular form of the shell, their number is about the same as on the last spire-whorl. The spiral ornamentation of the spire-whorls continues unaltered upon the corresponding portion of the body-whorl. Anteriorly to the level of the suture, similar spiral ornaments are continued over the basal concavity and terminal stem. On the posterior portion of the body-whorl, constituting the continuation of the spire, the lines of growth are disposed in the same manner as has already been described in the case of the spire-whorls. Anteriorly to the level of the suture they are vertical as far as the junction of the basal concavity and stem, at which level they are shifted very slightly backwards, once more resuming their vertical trend on the

anterior stem. Their final transverse termination is convex reproducing the shape of the apertural termination which is not notched.

The oval aperture is posteriorly terminated by a short, narrow angulated channel, anteriorly contracted into a canal of moderate length. At the origin of the canal the columella exhibits a bend posteriorly to which it is vertical and merges into the base of the penultimate whorl, and anteriorly to which it is steeply oblique towards the left of the shell. The columellar lip is distinctly demarcated though very thin and very narrow; its internal characters are unfortunately obscured in all the available specimens in consequence of the presence of a hard, adhering, rocky incrustation. The thin-edged, outer lip is practically straight.

*Dimensions—*

	mm.
Height . . . . .	30
Thickness . . . . .	14
Height of spire . . . . .	12
Height of body-whorl . . . . .	24

*Occurrence.*—Nari of Bagthoro Hill in Sind.

*Comparison with other species.*—The specific name bestowed upon this species by d'Archiac and Haime indicates that it belongs to the same zoological group as *Fusus regularis* Sow. from the upper Eocene of Barton. *Euthriofusus bezanconi* Cossmann, from the upper Eocene of the Paris region is still more closely related, but is distinguished by the feeble development of its axial ribs and the non-dimorphous, regular mode of growth of its spire.

EUTHRIOFUSUS SUBREGULARIS VAR. NARICA n. var.

Pl. VII, figs. 4 6.

This variety is distinguished from the type by the different disposition of its axial ribs, the number of which for one complete volution may be, at first, twelve, as in the previously described typical form, increasing to as many as sixteen on the two last spire-whorls upon which the ribs show no tendency to become less prominent. On the body-whorl, instead of becoming effaced, they increase in prominence, and, at the same time, their number becomes greatly reduced: the total number on the body-whorl being sometimes only nine when the last spire-whorl carries as many as sixteen. The ribs also extend further anteriorly than in the typical form,

remaining distinct as far as the junction between the basal concavity and anterior stem.

Although the shell thereby acquires a different appearance from d'Archiac's type, the differences are not precise enough to be regarded as of specific value, especially as both forms occur together in the same beds. Moreover, amongst the specimens of the more typical form, it has already been mentioned that there are some in which the ribs disappear at the beginning of the last spire-whorl and others in which they continue as far as the aperture, reduced in prominence though not in number, others again, in which they persist though reduced both in prominence and in number. There exists therefore a certain degree of gradation between the extreme forms, though there is generally no difficulty in referring the specimens either to the type form or to the variety at present under consideration. The difference is perhaps sexual.

*Dimensions—*

	mm.	mm.	mm.
Height . . . . .	21	23	31
Thickness . . . . .	10	12	18
Height of spire . . . . .	8	9	11
Height of body-whorl . . . . .	16	18	25

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*STREPTOCHETUS PSEUDO-WAELII* n. sp.

1863. *Fusus* Waelii Nyst, var.—Sandberger, *Conch. Mainz. tert. Beck., Pl. XI*, fig. 1.

Medium-size, with elevated conical spire measuring half the total height.

The apex is missing. The number of spire-whorls following the protoconch is probably seven or eight. Their height is equal to half their width, their maximum thickness being situated a little nearer to their anterior than to their posterior margin. The aggregate outline of each whorl is strongly convex with sometimes a suspicion of a median angulation caused by the greater prominence of one of the spiral threads, anteriorly to which the outline, up to the anterior margin, is convex, and posteriorly to which it forms a steep slope, tapering towards the posterior margin with a slight concavity lapping round the posterior sutures, a disposition which, in spite of the strong convexity of the whorls, softens away the abruptness of their junction, so that the sutures remain inconspicuous and rather lost amid the abundant spiral ornaments. The decoration



includes both axial and spiral ornaments. There are seven very prominent, practically vertical, rather broad costa to a little less than one whorl; they are a little narrower than the flat interstices and flatten out on reaching the concave posterior margin. The spiral ornaments consist of conspicuous threads, broader than the intervening spaces, and rather thicker from the slight angulation to the anterior margin than on the posterior concave surface. With increasing growth their number increases by intercalation, so that, at all stages of growth, they more or less distinctly alternate in size. Their number, on the two last whorls, is about twelve. The lines of growth are very steeply oblique, very steeply antecurrent to the posterior suture.

The body-whorl exceeds three-fifths of the total height. It consists of a broad, sub-spheroidal convexity rapidly contracted anteriorly into a rather narrow stem of probably moderate length. The anterior termination, so far as can be ascertained from the disposition of the lines of growth, is truncated without a distinct notch. The ribs fade away on the basal concavity without reaching the terminal stem. On the posterior portion of the body-whorl, forming the continuation of the spire, the spiral decoration of the spire-whorls continues unchanged. Anteriorly to the level of the suture, similar spiral ornaments are continued, of the same thickness as those decorating the convex portion anterior to the slight angulation. The lines of growth, anteriorly to the level of the suture, are practically vertical, receding into a transverse, convex curve only as they reach their anterior termination.

The oval aperture is posteriorly angulated, anteriorly contracted into a narrow canal. The columella is swollen opposite the origin of the canal, the anterior portion of which is missing in the only available specimen. A hard, adhering, rocky incrustation conceals the columellar lip. The thin-edged outer lip is slightly oblique, steeply antecurrent to the suture. The internal walls of the shell are delicately lirated as shown by the fine sulci on the cast in places where portions of the body-whorl have been broken off.

*Dimensions.*—The following are the partly restored measurements :—

	mm.
Height . . . . .	51
Thickness . . . . .	19
Height of spire . . . . .	25
Height of body-whorl . . . . .	32

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks and comparisons.*—Although the solitary Indian specimen is incomplete, there seems no doubt as to its identity with the Mainz form represented by Sandberger as *Fusus wælii* Nyst var on Pl. XIX, fig. 1, of his monograph on the Oligocène of the Mainz Basin. In the text this form has been united with *Fusus elongatus* Nyst (p. 219 of the text), but, as noticed by Cossmann and Lambert (*Étude paléontologique et stratigraphique sur le terrain Oligocène marin aux environs d'Étampes*, Mém. S. G. F. (3) III, p. 156), the smaller number and great prominence of the ribs, the pronounced convexity of the whorls and the irregular distribution of the spiral ornamentation clearly distinguish this form from the true *Fusus elongatus*. Sandberger's figure does not show the suspicion of angularity exhibited by some of the ribs of the Indian fossil, but this is so delicate a feature that it does not impair the appearance of perfect identity between the Indian fossil and the German one. In the true *Fusus wælii* of the Rupelian of Belgium, as illustrated by Kœnen (Pal. XVI, p. 16, Pl. VI, fig. 2), the spiral threads appear thinner and more uniform in thickness, the spire seems shorter. The canal of the solitary Indian specimen is broken, but in the form figured by Sandberger, the canal seems more flexuous than in the Rupelian specimens. The Mainz form, which may be distinguished as *Fusus pseudowælii*, appears to be distinct both from *Fusus elongatus* and from *Fusus wælii*.

## STREPTOCHETUS ? indet.

1854. *Fusus*, indét.—d'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 308.

Judging from the fossils with which it is associated according to the statement of d'Archiac and Haime (including *Tritonidea bucklandi* [d'Arch.]), this large cast is probably a Gáj fossil. d'Archiac and Haime have compared it with *Fusus reptagonus* Lamk. which is a *Streptochetus*, to which genus the fossil under consideration perhaps also belongs.

## FASCIOLARIA (PLEUROPLOCA) ? LÆVIUSCULA [J. de C. Sowerby.]

1839. *Fusus læviusculus* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, series 2, Vol. V, Pl. XXVI, fig. 13.

No other specimen is available besides Sowerby's original type, which is incomplete and greatly obscured by the rock in which it is embedded. The shape of the shell is not that characterising the

genus *Fusus* as restricted at the present day. The fossil may be provisionally referred to the genus *Fusciolaria*, its ornamentation, and apparently, the presence of an anterior swollen zone of accretions of the terminal notch indicating the sub-genus *Pleuroploca*. The living *Fusciolaria coronata* Lamk., from the eastern and Australasian seas, is perhaps related to this fossil.

*Occurrence.*—Gáj of Kachh.

#### LATHYRUS SINDIENSIS Vred:

Medium-small, with moderately elongate, conical spire measuring more than half the total height.

The apex is missing in all the available specimens. The number of whorls following the protoconch is about seven. They are rather strongly convex and are separated by somewhat deeply inset sutures which, in some specimens, are surrounded by a delicate rim and which have a wavy disposition both horizontally and vertically. The height of the whorls is equal to half their width, their maximum thickness being situated a little nearer to the anterior than to the posterior region. Each whorl carries six or seven prominent, rounded ribs of the same width as the intervening spaces. To a varying degree, they are generally distinctly though slightly oblique, retro-current towards the anterior suture. The surface is further decorated by four or five conspicuous, principal, spiral threads which expand on crossing the ribs. The intervals are bisected, each, by a thread of a second order, which, on the body-whorl of some specimens, becomes nearly as thick as the principal threads and nearly fills up the whole interval, while, in others, the difference remains more pronounced and an available space subsists on either side of the secondary thread for the development of yet a thread of a third order. The lines of growth, forming a moderate curve with forward facing concavity, are antecurrent to the posterior suture, normal to the anterior suture. They form a very delicate trellis in the intervals between the spiral threads.

The body-whorl, measuring three-fifths of the total height, consists of a globular or spheroidal convex portion, passing through a pronounced, short concavity into a tapering, moderately narrow, stem of moderate length. The anterior termination, judging from the disposition of the lines of growth, is truncated without being notched. The ribs which, in some specimens, occasionally become rather

strongly oblique, cease at the junction of basal concavity and terminal stem. The spiral ornaments of the last spire-whorl are continued unaltered over the corresponding portion of the body-whorl. Anteriorly to the level of the suture, similar spiral ornaments are continued over the concavity of the base and the terminal stem. On the posterior portion of the body-whorl the lines of growth are disposed in the same manner as on the spire-whorls. Anteriorly to the level of the suture they are very steeply oblique, with an anteriorly retrocurrent disposition, remaining straight across the concavity of the base and anterior stem until their termination when they bend transversely backward without forming a sinus.

The rather small aperture is obliquely oval, posteriorly channelled and angulated, anteriorly contracted into a narrow, slightly oblique canal. Opposite the origin of the canal the columella exhibits a slight angular bend posteriorly to which it is at first practically vertical and then curves round into the base of the penultimate whorl, while, anteriorly to the bend, it forms a steeply oblique, scarcely twisted edge. It carries three oblique folds of which the most anterior one coincides in position with the bend. The columellar lip is rather thin and narrow, but is well demarcated. At its posterior termination it carries a spiral ledge which contributes to contract the posterior channel. The outer lip is slightly oblique. Its internal characters are not visible in any of the available specimens. The walls of the shell are internally lirate.

*Dimensions.*—The partly restored measurements are as follows:—

	mm.
Height . . . . .	29
Thickness . . . . .	12
Height of spire . . . . .	16
Height of body-whorl . . . . .	18

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—It is only with the greatest diffidence that this shell has been regarded as specifically different from *Lathyrus retrorsicosta* [Sandberger] from the Oligocene marine sands of Weinheim in the Mainz tertiary region (Conch. Mainz. Tertiärbeck., p. 221, Pl. XVII, fig. 6). The only precise distinction is to be found in the number of columellar folds, three in the Indian form, while only two are mentioned in the description and represented in the illustrations of the fossil from the Mainz Tertiaries in Sandberger's monograph. The contrast in thickness between the

primary spiral threads and the interstitial threads is stronger in the Mainz form than in the Sind specimens.

LATHYRUS DUPLICATUS n. sp.

Pl. V, fig. 15.

Small, with narrow conical or slightly conoidal spire exceeding half the total height, and with elongate body. Whorl anteriorly contracted into a stem of moderate breadth and length.

The protoconch, missing in the only specimen at present available, is followed by six spire-whorls, the height of which is equal to about half their width, the maximum thickness being situated close to the anterior margin. The surface of the whorls is convex, except near the posterior margin, where, with a short concave inflexion, it passes into an almost vertical, narrow collar fitting round the wavy, incised sutures. The whorls carry prominent axial ribs of the same width as the intervening spaces. They are straight, either vertical, or with a slight obliquity so disposed that they are steeply antecurrent to the anterior suture. They do not reach the posterior suture as they cease rather abruptly against the posterior, marginal, contracted zone. Their number, to each complete volution, is seven on the early whorls, eight at later stages of growth. The ribs are intersected by three principal, spiral threads, of which the two posterior ones are nearest together, the most posterior one forming the anterior border of the contracted, posterior, marginal zone of the whorls. In the later part of the spire, a fourth main thread appears along the anterior suture where it is, to a great extent, concealed by the posterior margin of the next following whorl, except towards the termination of the last spire-whorl where, owing to the slightly conoidal shape of the spire connected with the marked increase of obliquity of the suture, it becomes fully exposed. On the last spire-whorl, the interval between the middle and anterior original main threads becomes bisected by a thread of a second order. The main threads swell on crossing the axial ribs. All the spaces between the above described spiral threads, as well as the posterior, contracted, marginal zone, are filled with extremely delicate, raised, spiral lines, all contiguous to one another. The extremely fine, crowded lines of growth are very steeply antecurrent to the posterior suture, practically vertical throughout the greater part of their course.

The body-whorl measures two-thirds of the total height. Its shape is elongate, the base contracting rather gradually, and with a moderately convex outline, towards the rather shallow moderately broad concavity forming the transition to the approximately vertical, rather broad, moderately elongate stem, on the ventral aspect of which the accretions to the termination of the canal form a very coarsely scaly, steeply twisted zone. The spiral decoration of the last spire-whorl is continued over the corresponding portion of the body-whorl. In addition to the four main threads continued from the last spire-whorl, there are, anteriorly to the level of the suture, three more similar main threads on the convex portion of the base and six more, slightly closer-spaced, on the anterior concavity and anterior stem as far as the somewhat bulging edge of the terminal zone of accretions on which the coarseness of the scales obliterates all traces of spiral ornaments. There are no clearly individualised intercalary threads of a second order other than the one between the second and third original main threads continued from the last spire-whorl, but all the intervals, just as on the spire-whorls, are filled with delicate, crowded, raised, spiral lines. The posterior portion of the ribs, on the body-whorl, exhibits the same characters as on the corresponding part of the spire-whorls, their number being increased to ten. Anteriorly to the level of the third main spiral thread, each rib breaks up into two, or sometimes, close to the aperture, into three, and the resulting fine ribs soon become all equally-spaced and are continued anteriorly on to the terminal stem as far as the limit of the terminal zone of accretions. Throughout the convex portion of the body-whorl, their spacing is about equal to that of the main spiral threads which swell into elongate nodes across each of these ribs, combining with them to give rise to a remarkably elegant, rasp-like decoration. The ribs, as well as the lines of growth, remain vertical, or slightly anteriorly retrocurrent between the level of the terminal suture and the anterior concavity, and exhibit a slight obliquity in the opposite direction, that is very steeply anteriorly retrocurrent, on the anterior stem, the lines of growth finally bending backward on the terminal twisted zone, the coarse scales or wrinkles of which are wider-spaced than the divided axial ribs, though, apparently, slightly more numerous than the undivided ribs of the posterior portion of the body-whorl.

The aperture is narrow, posteriorly angulated, anteriorly contracted into a moderately elongate, narrow canal, the exact outline

of which can no longer be ascertained owing to the complete exfoliation of the columellar lip; for which reason the direction of the anterior part of the columella equally cannot be ascertained. It exhibits, at the origin of the canal, a slight bend or angulation, posteriorly to which it is practically vertical. It carries three spiral folds, of which the two posterior ones are closest together, the anterior one coinciding with the above-mentioned slight angulation. The remnants of the columellar lip indicate that it must have been posteriorly narrow and thin, scarcely expanded over the base. Though it is anteriorly entirely missing, the pronounced twist of the terminal zone of accretions indicates that it was almost certainly anteriorly bordered by an umbilical slit. The outer lip is also broken. Judging from the disposition of the lines of growth, it must have been feebly sinuous, and, on an average, vertical.

*Dimensions.*—

	mm.
Height . . . . .	20
Thickness . . . . .	8
Height of spire . . . . .	11
Height of body-whorl . . . . .	13

*Occurrence.*—Mekran beds: north of the Talar Gorge, on the road from Kej to Gwádar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—Although this form is represented only by a solitary imperfect specimen, its specific distinctness from its congeners, either recent or fossil, seems well established by the characteristic bifurcation of the ribs on the body-whorl.

TURBINELLA EPISOMA [Michelotti].

- 1831. *Fusus ? episomus* Michelotti.—Foss. Mioc. inf., p. 180, Pl. XVI, fig. 5.
- 1884. *Turbinella episoma* [Michtti].—Bellardi, dboll. terr. terz. Piem. e Lig., IV, p. 52, Pl. II, figs. 34, 35.
- 1901. *Turbinella episoma* [Michtti].—Cossmann, Essais Pal. comp., IV, p. 64, Pl. VII, fig. 16.
- 1904. *Turbinella episoma* [Michtti].—Sacco, Moll. terr. terz. Piem. e Lig., XXX, p. 31.

Very large, with slightly extraconic, stepped spire measuring from nearly one-third to two-fifths of the total height. The protoconch is not preserved in any of the available specimens. It is followed by about eight spire-whorls, the height of which averages two-fifths of their width, separated by channelled sutures. The

whorls exhibit a pronounced angulation situated nearer to their posterior than to their anterior margin. Anteriorly to the angulation the surface slopes very steeply, almost vertically, with an almost rectilinear outline in the later spire-whorls, while at earlier stages of growth, this steep anterior slope has more of a double curvature or sigmoidal outline of which the anterior half is convex. Posteriorly to the angulation, the surface contracts with a concave slope towards the posterior margin along which a slight, narrow swelling forms a collar or rim round the narrow sutural channel. The anterior, nearly vertical portion of the spire-whorls, in most specimens, remains proportionately taller than the posterior slope at all stages of growth, though, in the later spire-whorls, its relative height decreases in consequence of the slightly extraconic shape of the spire. There are even specimens in which, on the latest spire-whorls, the portions on either side of the angulation become approximately equal in height. The spire-whorls carry blunt axial ribs or nodes especially distinct at the level of the angulation. On the earlier whorls, their number is seven to one whorl, increasing, on the two last spire-whorls, to from nine to fifteen, though, at the same time, they become much less distinct, and entirely restricted to the immediate region of the angulation. In addition to these axial ornaments, there are also some delicate, spiral threads alternating in two sizes on the anterior sub-vertical portion of the whorls upon which they are evenly spaced and more distinctly developed than on the posterior slope. They become rather indistinct on the later spire-whorls. In those parts where they are best developed, the number of main threads on the anterior part of the whorls is four, of which one nearly coincides with the angulation, and another nearly with the anterior margin. The lines of growth are rather strongly oblique on the posterior concave slope and are antecurrent to the posterior suture. They become more nearly vertical on the anterior portion of the whorls.

The body-whorl measures about three-quarters of the total height, a little more or less. Anteriorly to the circumsutural concave slope, it consists of a bulky, inflated, somewhat tub-shaped portion connected rather abruptly, by means of a short concavity, with the steeply tapering, rather broad, fairly elongate, terminal stem. The accretions to the terminal truncation form a steeply winding, somewhat scaly zone, very conspicuous ventrally, though feebly bulging, which may be separated from the columellar lip by a more or less



distinct, narrow, umbilical slit. The posterior angulation carries rather indistinct knobs similar to those of the last spire-whorl. The spiral ornaments of the spire become very indistinct on the corresponding portion of the body-whorl, and the broad, inflated portion is either without spiral ornaments, or else carries two or three wide-spaced, raised threads or bands. The basal concavity, and the terminal stem as far as the terminal zone of accretions, carry bold, though somewhat blunt, fairly broad, close-set, spiral threads which are either nearly all of one size with sometimes a tendency towards the development of an intercalary thread in some of the intervals, or else alternate regularly, throughout, in two sizes. The terminal zone carries fine, close-set, raised, spiral lines, generally more or less obscured by the scaly accretions. The lines of growth, on the posterior portion of the body-whorl, are disposed in the same manner as on the spire-whorls. They are vertical across the inflated portion of the body-whorl; they recede anteriorly across the basal concavity and become once more vertical across the terminal stem, finally receding transversely at their termination across the winding terminal zone of accretions.

The elongate aperture is posteriorly angulated, anteriorly contracted, rather gradually, into a rather broad canal anteriorly oblique towards the left of the shell. The columella exhibits a projecting bend at about the level at which the anterior winding zone of accretions penetrates into the interior of the shell. Posteriorly to this bend it exhibits a short concavity soon merging into the base of the penultimate whorl. Anteriorly to the bend it is oblique anteriorly towards the left of the shell, slightly sinuous and slightly twisted. The columellar lip is well demarcated though only moderately thickened, slightly spreading ventrally, more or less detached along its edge anteriorly, especially along the more or less distinct umbilical slit. Posteriorly to the bend of the columella there are three prominent, feebly oblique folds. The outer lip is not thickened. It has an average slightly oblique course, anteriorly receding, and is slightly flexuous, being antecurrent to the suture, slightly concave across the broadest part of the body-whorl, convex at the junction of the broad portion with the basal concavity, and then finally receding steeply. At more or less regular and often rather close intervals, the internal walls exhibit rather narrow, vertical swellings the presence of which, on the thickest part of the whorls, is indicated by corresponding depressions on the internal cast.

*Dimensions.*—

	mm.
Height . . . . .	120
Thickness . . . . .	55
Height of spire . . . . .	48
Height of body-whorl . . . . .	86

The species also grows to much larger dimensions, one of the specimens from Bhagothoro Hill in Sind reaching a total height of 22 centimetres.

*Occurrence.*—Nari of Bhagothoro Hill in Sind; Nari of Baluchistan.

It also occurs in the Oligocene of Liguria. The shell is one of the most abundant and most characteristic fossils of the Nari beds.

*Comparison with other species.*—This form exhibits the closest resemblance to a fossil characterising the Lower Gáj, *Turbinella affinis* Sow., of which it is to be regarded as the ancestral predecessor. In *T. affinis*, the blunt ribs of the spire become indistinct at an earlier stage of growth than in the form above described, and the angulation of the whorls shows a tendency to become obliterated with increasing growth, so that the body-whorl is less distinctly shouldered than in *T. episoma*. The number of internal folds of *T. episoma* is invariably three at all stages of growth. There are five internal folds in full-grown specimens of *T. affinis*.

The recent *Turbinella fusus* Sow. living in the Andaman Seas exhibits an extraordinarily close resemblance to the fossil above described. The only precise difference is to be found in the number of internal spiral folds which is always at least four in ordinary-sized specimens of the recent species, amounting to five in exceptionally large individuals.

## TURBINELLA AFFINIS J. de C. Sowerby.

1830. *Turbinella affinis* J. de C. Sowerby.—Trans. Geol. Soc. London, 2nd series Vol. V, Pl. XXVI, fig. 22.

1854. *Turbinella affinis* J. de C. Sow.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 306.

1854. *Fusus* ? indéf.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde., p. 308, Pl. XXIX, fig. 16.

Very large, with moderately broad conical, somewhat stepped spire, slightly extraconic towards the apex, measuring over three-eighths of the total height.

The protoconch is not preserved in any of the available specimens. It is followed by eight spire-whorls. The height of the two first whorls following the protoconch is one-half or nearly one-half of their width, their greatest thickness being situated at two-fifths of their height measured from the anterior margin. The maximum width corresponds with an angulation anteriorly to which, as far as the anterior margin, the outline is convex, while, posteriorly to the angulation, it forms a straight, or slightly concave slope as far as a rim or swelling surrounding the grooved, sutures. These two first whorls are decorated with broad, bulky, rounded, axial, ribs, especially prominent on a level with the angulation, their number being six on the first whorl, five on the second. In addition to these axial ornaments, there are also spiral threads which swell slightly on crossing the ribs. The most prominent thread coincides with the angulation. Another thread, nearly as prominent, runs close to the anterior margin, the interval between it and the angulation thread being bisected by a thread of a second order. The more or less concave slope posteriorly to the angulation carries two main threads which are narrower than the two principal threads hitherto described. Only one of the intervals, that nearest to the angulation, is bisected by a thread of a second order. The circumsutural rim carries two prominent threads and a third thinner thread immediately surrounding the sutural groove and situated quite close to the more posterior of the more prominent threads. In accordance with the extraconic shape of the earlier part of the spire, the height of the next succeeding whorl is equal to only one-third of its width, and its greatest thickness practically coincides with its anterior margin, as a result of the posterior margin of the next following whorl having encroached nearly as far as the angulation. Consequently the most anterior principal thread and the neighbouring thread of a second order have ceased to be visible. The remaining threads are disposed as on the preceding whorl. There are also five ribs or nodosities also disposed as on the previous whorls. A fresh change of outline commences with the next whorl: the original angulation has disappeared as it now comes to coincide with the anterior margin; but, at the same time, the sloping surface posterior to this primitive angulation, and now constituting the anterior part of the whorl, loses its concave shape and becomes steeper, while the original circumsutural rim now widens into a relatively broad slope, bearing four principal, spiral threads, and separated by an angulation from

the portion which has now become the anterior part of the whorl. There are now six ribs, much more effaced than those of the previous whorls. Five or six spiral threads, more or less alternating in size, now decorate the slope which has become the anterior portion. Of the two portions which now constitute the whorls the anterior one rapidly increases in steepness till it becomes practically vertical and slightly convex. The posterior one also increases in steepness and becomes somewhat concave, the two portions remaining separated by an angulation up to the termination of the spire. The maximum thickness, which now exactly corresponds with the anterior margin, eventually comes to exceed three times the height. The axial ribs increase in number to as many as fifteen, but are restricted to the new angulation and very feeble, and the spiral ornaments, with increasing size, also become indistinct. A distinct circumsutural or rim collar sometimes becomes developed on the two last whorls. The lines of growth, throughout the whole spire, are antecurrent to the posterior suture and practically normal to the anterior suture.

The body-whorl measures nearly three-quarters of the total height. Anteriorly to the steep posterior slope continued from the last spire-whorl, it consists of a bulky, inflated portion of sub-cylindrical or ovoid outline connected by a shallow concavity with the terminal, tapering, feebly twisted stem. The accretions to the terminal truncation form a steeply winding, scaly zone, very feebly prominent though well marked on the ventral side of the shell. The more or less developed circumsutural collar of the last spire-whorl and its feeble spiral and axial ornaments are similarly continued on the corresponding portion of the body-whorl. The basal concavity, and the neck up to the terminal zone of accretions, carry well developed, though flattish, revolving threads wider than the intervening spaces. The lines of growth, on the posterior portion of the body whorl, are disposed in the same manner as on the spire-whorls. They are vertical on the main, inflated portion of the body-whorl, anteriorly slightly retrocurrent across the basal concavity, once more nearly vertical on the terminal stem till they recede into their transverse termination across the terminal zone of accretions.

The elongate, moderately broad aperture is posteriorly angulated, slightly channelled, and sometimes slightly produced beyond the terminal level of the suture, while anteriorly it is rather gradually contracted into the moderately broad, slightly oblique canal anteriorly

deflected towards the left of the shell. The columella exhibits a slight bend at about the level where the terminal, slightly bulging zone of accretions winds into the interior of the shell. Posteriorly to this bend, a short concavity connects it with the base of the penultimate whorl. Anteriorly to the bend it is steeply oblique towards the left of the shell, slightly sinuous and slightly twisted. The columellar lip, rather thin, but well defined, expands moderately broadly ventrally over the inflated portion of the body-whorl. In an anterior direction its edge is rather prominently detached along the basal concavity and along the terminal zone of accretions. Posteriorly to the bend of the columella, there are five spiral folds of which the more anterior ones are rather feebly oblique, the two most posterior ones practically transverse; the two most anterior ones are situated very close together. The outer lip is not thickened; it is antecurrent to the suture, slightly oblique and anteriorly receding in its general trend.

*Dimensions.*—

Height . . . . .	mm.
Height . . . . .	200
Thickness . . . . .	97
Height of spire . . . . .	77
Height of body-whorl . . . . .	145

*Occurrence.*—Lower Gáj of Kachh, Sind, and Kathiawar.

*Comparison with other species.*—In describing *T. episoma* the differences that distinguish it from *T. affinis* have already been dealt with. The less shouldered, later whorls and more ovoid body-whorl of *T. affinis* constitute an approach towards the facies of the derived forms *Turbinella premekranica* and *T. mekranica* to be next described.

TURBINELLA PREMEKRANICA n. sp.

Pl. XI, figs. 1-5.

Large, with moderately slender spire measuring from a little over one-third to more than two-fifths of the total height, slightly extraconic in its earlier portion, with a slight tendency to become conoidal at later stages of growth.

The protoconch, very small relatively to the large size of the shell, is imperfectly preserved in all the available specimens. It is followed by eight or nine spire-whorls whose width is, at first, about

twice their height, but, with increasing growth, may eventually come to exceed three times the height. The sutures, in the earlier part of the spire are wavy and distinctly grooved, but, with increasing growth, the groove becomes relatively much narrower, until, at the latest stages of growth, the sutures may become almost or quite linear. In the earlier part of the spire, the greatest thickness of the whorls is situated at some distance from the anterior margin, and corresponds with an angulation anteriorly to which the outline is convex, while posteriorly to this angulation it exhibits a concavity extending as far as a raised rim or collar which encircles the circum-sutural groove. These early whorls carry from five to seven very broad, rounded ribs, slightly oblique and anteriorly retrocurrent, especially prominent at the level of the anterior angulation. In addition to these axial ornaments, the entire surface is covered with spiral threads, alternating in two sizes, swelling slightly as they cross the ribs. Two of these threads are more prominent than all the remainder: these are, respectively, the one corresponding with the anterior angulation, and the one at the junction of the convex portion of the whorls and of the circum-sutural collar. With increasing growth, the original angulation, in consequence of the slightly extraconic disposition of the early part of the spire, comes to lie quite close to the anterior margin, the maximum thickness of the whorls now coinciding with the anterior suture. At the same time this angulation becomes very blunt and finally disappears and the space between it and the circum-sutural rim, instead of convex, becomes cylindrical, and even eventually slightly concave. The circum-sutural rim broadens to a distinct slope, slightly concave at first, the steepness of which rapidly increases with increasing growth. Simultaneously with these changes of outline, other changes also take place in the ornamentation of the surface, both axial and spiral, both of which rapidly decrease in prominence. The ribs entirely disappear beyond a diameter of 25 mm. and the spiral threads soon become very indistinct. On the two last spire-whorls, the circum-sutural slope which replaces the original circum-sutural rim gradually loses the last traces of its concavity; its increasing steepness communicates a somewhat conoidal outline to the later portion of the spire which now completely loses the slightly stepped disposition which characterised its middle stages of growth, while the angulation separating the now steep posterior slope from the anterior, practically vertical, slightly convex portion of the whorls, becomes so blunt and

indistinct as to disappear almost completely. The disappearance of the circumsutural groove adds to the smoothness of outline of this later part of the spire, the resulting linear sutures being now but feebly inset. The final result is that each of the two last spire-whorls exhibits an almost continuous feeble convexity with a scarcely perceptible angulation situated nearer to the posterior than to the anterior margin. The moderately oblique lines of growth are antecurrent to the posterior suture, almost normal to the anterior suture.

The large body-whorl measures from five-sevenths to six-sevenths of the total height. It consists of a bulky ovoid or cylindrico-ovoid portion, scarcely modified posteriorly by the indistinct angulation continued from the last spire-whorl which, indeed, disappears entirely in some specimens; this ovoid portion being connected by means of a gradual concavity with the rather broad terminal stem steeply tapering with straight outlines. The steeply winding zone of accretions of the terminal truncation scarcely forms any distinct bulge. The ovoid inflated portion of the body-whorl is either smooth or with only some indistinct, spiral markings. On the basal concavity and terminal stem are some rather blunt, spiral threads of about the same width as the intervening spaces. The lines of growth, antecurrent to the suture, form a very shallow curve across the inflated part of the body-whorl, with forward facing concavity and with a very steep average obliquity, anteriorly retrocurrent. They recede across the basal concavity with a short, forward facing, convex disposition joined by a concave turn with the straight and slightly oblique, anteriorly retrocurrent course which they resume on the anterior stem, finally receding transversely at their termination across the final zone of accretions.

The moderately wide, elongate aperture exhibits posteriorly a slightly channelled angulation accompanied by a slight rise of the terminal portion of the suture. Anteriorly it contracts rather gradually into the terminal, broad, slightly oblique canal. The columella exhibits a slight bend corresponding with the level at which the terminal zone of accretions winds into the interior of the shell. Posteriorly to this bend, a feeble concavity joints it to the base of the penultimate whorl. Anteriorly to the bend it is slightly oblique anteriorly towards the left of the shell, slightly flexuous and slightly twisted. The rather thin columellar lip is moderately expanded over the ventral surface of the shell. In an anterior direction its edge is somewhat detached alongside of the terminal zone of accre-

tions. Posteriorly to the bend of the columella there are three prominent, internal folds. A fourth fold almost coincides with the bend. It is much feebler than the others and is absent from some immature specimens. The outer lip is not thickened. It is anterior to the suture. Its average direction is slightly oblique and anteriorly receding, its course slightly flexuous.

*Dimensions.*—

	mm.	mm.
Height . . . . .	57	132
Thickness . . . . .	27	62
Height of spire . . . . .	22	55
Height of body-whorl . . . . .	47	95

*Occurrence.*—Upper Gáj of Sind: beyond the variegated shales west of Bhagothoro, from the lowest fossiliferous stratum of the Upper Gáj and from the overlying bed (Vredenburg,  $K_{\frac{11}{485}}$ ,  $K_{\frac{11}{136}}$ ); south side of Eri Hill (Ram Singh,  $G_{\frac{3.0.2}{29}}$ , see Blanford, Mem., Geol. Surv. Ind., Vol. XVII, p. 157); base of scarp, four miles west of Trak Hill, along the southern continuation of the Mol Scarp (Ram Singh,  $G_{\frac{3.0.2}{32}}$ ).

*Comparison with other species.*—This mutation is distinguished from *Turbinella affinis* by the earlier disappearance of the axial ornaments, the absence of shouldering at later stages of growth and almost complete obliteration of the posterior angulation in the later spire-whorls and body-whorl resulting in a more nearly ovoid general outline of the shell. There are only four internal folds instead of five. So far as can be judged from the available specimens, this form does not attain such extremely large dimensions as either *Turbinella episoma* or *Turbinella affinis*.

It is distinguished from *Turbinella mekranica* by the greater persistence of the axial ornaments, being in this respect, exactly intermediate between *Turbinella affinis* and *T. mekranica*.

*T. pravovoidea* Maury, occurring in beds of Burdigalian age in San Domingo, resembles the fossil above described, but is much more elongate. It has only three internal folds.

TURBINELLA MEKRANICA n. sp.

Pl. XI, fig. 6; Pl. XII, figs. 1, 2; Pl. XIII, figs. 1, 2.

1916. *Turbinella ovoidea* Kien. var.—Vredenburg, Mem. Ind. Mus. Vol. VI, p. 123

Very large, with moderately slender, conical spire measuring more than one-third of the total height.



The small protoconch is missing in all the available specimens. It is followed by about seven spire-whorls, the height of which, at first, slightly exceeds twice their width, becoming gradually reduced to three-eighths of the width. The sutures are rather narrowly grooved. The three first whorls following the protoconch have an outline somewhat comparable to that of an inverted "quirked ogee," that is with a concavity situated between two convexities of which the anterior one is wide and prominent and includes the zone of maximum thickness, while the posterior one is narrow and corresponds with a small circumsutural rim or collar. Each of these early whorls carries six, broad, axial ribs crossed by spiral, raised threads. Beyond the third whorl, at a diameter of only 11 mm., the shape alters completely owing to the obliteration of the concave portion of the outline which now becomes a convex curve connecting the anterior and posterior convexities into one continuous convex surface. The ribs disappear completely beyond a diameter of 10 mm., and the spiral markings become very faint. In some specimens there is a suspicion of an angulation close to the posterior suture which sometimes may be surrounded by a rudimentary circumsutural rim not homologous with the convex circumsutural zone of the early whorls. The lines of growth are antecurrent to the posterior suture, practically normal to the anterior suture.

The body-whorl, measuring three-quarters of the total height, consists of a bulky, ovoid convexity, merging very smoothly, through a rather broad convexity, into the anterior, steeply tapering stem, the outlines of which are straight. The zone of accretions of the terminal truncation is steeply winding, scarcely bulging. The convex portion of the body-whorl is smooth or with wide-spaced, raised threads of very feeble relief. The basal concavity and anterior stem, as far as the terminal zone of accretions, carry feebly prominent, flattish, rather broad, spiral threads, of the same width as the intervening spaces or narrower, more or less distinctly alternating in two sizes. The lines of growth are generally antecurrent to the suture as in the case of the spire-whorls. Towards the aperture of some specimens in which the outer lip is posteriorly slightly thickened and in which the level of the suture encroaches upon the anterior margin of the last spire-whorl on approaching the aperture, the lines may locally become retrocurrent to the suture. Across the convex portion of the body-whorl, they form a very shallow curve with forward directed concavity. They are convex across the basal

excavation, while, on the anterior stem, they become straight and very slightly oblique, anteriorly retrocurrent, until they recede transversely across the zone of accretions at their termination.

The rather elongate aperture is terminated posteriorly by a slightly channelled angulation which may project beyond the average level of the termination of the suture; anteriorly it is contracted very gradually into the broad, slightly oblique, terminal canal. The columella exhibits a feeble bend at about the level at which the terminal zone of accretions winds into the interior of the shell. Posteriorly to this bend it exhibits a very shallow concavity merging into the base of the penultimate whorl. Anteriorly to the bend it is slightly oblique anteriorly towards the left of the shell, slightly flexuous and slightly twisted. The columellar lip expands rather broadly over the convex portion of the ventral part of the shell where it is very thin. It becomes thicker anteriorly and has a detached edge alongside of the terminal zone of accretions. Posteriorly to the bend of the columella there are four prominent spiral folds of which the two more anterior ones are moderately oblique, the two posterior ones almost transverse. A fifth rudimentary fold is sometimes developed anteriorly to the most anterior of the distinct folds, and close to it. The outer lip, slightly thickened posteriorly, is normal or retrocurrent to the suture. The remainder of its course is, in the aggregate, almost vertical, and slightly flexuous.

*Dimensions.*—

	mm.	mm.
Height . . . . .	160	165
Thickness . . . . .	80	90
Height of spire . . . . .	57	58
Height of body-whorl . . . . .	120	125

*Occurrence.*—Mekran beds; very abundant: base of Talar section.

*Comparison.*—The earlier disappearance of the axial ornaments, and the still greater evenness of the convexity of the spire-whorls and body-whorl, distinguish this shell from the previously described *Turbinella premekranica*.

*T. ovoidea* Kiener, living along the coasts of Brazil, is more elongate and has only three internal folds.

MELONGENA CORNUTA Agassiz

1825. *Pyruia melongena* Basterot (*non Linn.*).—Mem. Bord., p. 68.

1843. *Pyruia cornuta* Agassiz.—Molass. Pen. Schweiz, p. 89.

1856. *Pyruia cornuta* Ag.-Hörnes, Moll. Foss. Wien, Vol. I, p. 274, Pl. XXIX, figs. 1-3, Pl. XXX, figs. 1-3.

1867. *Pyrgula cornuta* Ag.—Pereira da Costa, *Gastor. terc. Port.*, p. 174.  
 1872. *Myristica cornuta* [Ag.].—Bellardi, *Moll. terr. terz. Piem. e Lig.*, I, p. 157.  
 1901. *Melongena cornuta* Ag.—Cossmann, *Essais Pal. comp.*, IV, p. 86, Pl. V, fig. 11.  
 1904. *Melongena cornuta* Ag.—Sacco, *Moll. terz. Piem. e Lig.*, XXX, p. 32, Pl. IX, figs. 18-22.

The species is represented by two specimens both of which are much obscured by enclosing or encrusting rock. One is adult, measuring about 150×85 mm., the other immature, with a diameter of only 26 mm. The adult specimen is remarkable for the great prominence of the spines of the body-whorl, and the pronounced concavity of the posterior slope of the body-whorl, probably largely a result of the great development of the spines. Both specimens exhibit a rather pronounced, angular bend at the junction between the inflated portion of the body-whorl and the basal concavity. The anterior spines seem to be absent.

The specimens especially correspond with those from the neighbourhood of Turin, illustrated by Sacco.

*Occurrence.*—Gáj of Kachh: Teyra River near Rampur (23° 20', 68° 51').

This is a most characteristic Miocene species in every part of Europe.

#### MELONGENA LAINEI [Basterot.]

1825. *Pyrgula lainei* Basterot.—*Mém. Bord.*, p. 67, Pl. VII, fig. 8.  
 1872. *Myristica lainei* Bast.—Bellardi, *Moll. terr. terz. Piem. e Lig.*, parte I, p. 159.  
 1901. *Melongena lainei* Bast.—Cossmann, *Essais pal. comp.*, fasc. IV, p. 86, Pl. IV, fig. 10.  
 1904. *Melongena (Myristira) lainei* Bast.—Sacco, *Moll. terz. Piem. e Lig.*, parte XXX, p. 32, Pl. IX, figs. 23-25.

Very large broad and biconical, with more or less terraced, rather broadly conical or slightly extraconic spire measuring from two-sevenths to one-third of the total height.

The imperfectly preserved protoconch is followed by seven angulated spire-whorls the height of which is nearly two-fifths of their width, the maximum thickness being situated at about half their height, or else a little nearer to the anterior than to the posterior suture. The posterior margin of each whorl fits rather tightly round the surface of the preceding whorl, so that the slightly wavy sutures are scarcely grooved, though they are sunken relatively to the general outline, in consequence of the angularity of the whorls. The spare-whorls consist of two vertically sub-equal parts, a posterior

concave portion sloping at a low angle, and an anterior, very steep, convex portion, overhanging with respect to the anterior suture. The angulation connecting these two portions carries, on each whorl, nine or ten sharp, horizontally flattened spines. The posterior sheath-like edge of the whorls forms a slight circumsutural rim, and is followed, on the excavated slope, by four equidistant, somewhat granular, revolving threads, separated from one another and from the edges of the concave slope, by extremely deep grooves, this system of threads and grooves occupying the whole space from the posterior sheath to the spines. Shallow, revolving grooves cross the anterior prolongations of the spines and the intervening spaces anteriorly to the angulation. The lines of growth are moderately oblique, antecurrent to the posterior suture.

The body-whorl measures from three-quarters to four fifths of the total height. Anteriorly to the angulation continued from the spire-whorls it is approximately conical. It is anteriorly terminated by a rather steeply winding bulge formed by the accretions to the relatively narrow terminal notch. A more or less distinct umbilical slit may be developed ventrally alongside of the winding bulge. The concave circumsutural slope, the angulation, and the spines, are continued from the last spire-whorl into the corresponding portion of the body-whorl. On approaching the aperture, in full-grown specimens, the last of the spines along the angulation are apt to become closer-set, somewhat foliaceous on their forward side, more prominent, and considerably elongated vertically, so that the angulation, instead of continuing its spiral trend in an anterior direction as it should according to the regular growth of the shell, rises considerably in the direction of the apex as it approaches the aperture. The axial ribs connected with all these spines extend anteriorly beyond the angulation for only a very short distance. On the anterior part of the body-whorl there is a second row of conspicuous spines, often connected together by a narrow, spiral ridge, and situated not far from the terminal winding bulge. The peculiar spiral ornaments of the concave slope of the spire-whorls are continued similarly over the corresponding part of the body-whorl. From the angulation to the terminal, winding bulge, the entire surface of the body-whorl is covered with revolving grooves, somewhat imbricated, the spaces which they isolate often showing a tendency to alternate regularly in two or three degrees of width and prominence according to various laws, which differ a great deal from one specimen to

another. They are also more or less effaced, more or less prominent, along various zones the disposition of which also varies considerably from one specimen to another. Raised, spiral lines decorate the terminal bulge upon which they are crossed by the sinuated, foliaceous accretions of the terminal notch. From the suture to the angulation, the course of the lines of growth is the same as has already been described for the corresponding portion of the spire-whorls. From the angulation to quite close to the terminal winding bulge, the general course of the lines of growth is almost straight and steeply oblique, anteriorly antecurrent; they finally bend back on entering the terminal zone. Those lines that meet the forward side of the spines bend back from either side (anterior and posterior) towards the apex of the spines which thereby, on their forward side, acquire the appearance of foliaceous cones formed by the wrapping or bending of a pliable or plastic substance.

The moderately broad aperture is posteriorly angulated and slightly channelled, anteriorly contracted gradually into a rather broad, slightly oblique, not very sharply differentiated canal. A little anteriorly to the level at which the anterior winding bulge penetrates into the aperture, the columella exhibits a feeble bend, very blunt at the actual aperture, but continued, in the interior of the shell, as a winding well-marked angulation, almost a columellar fold, visible only when the outer lip has been broken. Posteriorly to the above-mentioned slight bend, the columella is vertical and merges into the steep base of the penultimate whorl. Anteriorly to the angulation, it is straight and steeply oblique towards the left of the shell. The columellar lip is thin. It expands rather broadly over the ventral surface and has a more or less detached edge alongside of the terminal bulge, especially when there is a distinct umbilicus. At its posterior termination, it exhibits a feeble spiral fold which contributes to constrict the posterior apertural channel. The outer lip, antecurrent to the suture, is, in its general outlines slightly oblique and anteriorly retrocurrent.

*Dimensions.*—

	Kach (068)	Sind (G. $\frac{3}{8}$ °).
	mm.	mm.
Height . . . . .	59	130
Thickness . . . . .	33	90
Height of spire . . . . .	20	37
Height of body-whorl . . . . .	48	100

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45'). Gáj of Sind: south side of Uri Hill (Ram Singh G $\frac{3}{2}$ O $\frac{2}{9}$ , see Blanford, Mem., Geol. Surv. Ind., Vol. XVII, p. 157); base of scarp, four miles west of Trak Hill, along the southern continuation of the Mo! Scarp (Ram Singh G $\frac{3}{3}$ O $\frac{2}{2}$ ).

*Melongena lainei* is one of the most characteristic fossils of the Miocene in a most every part of Europe.

*Comparison with other species.*—*Melongena gigas* Martin from the Miocene of Java (Samml. des geol. R.-Mus. in Leiden, new series, Vol. I, p. 90, is closely related but has a relatively lower spire. The callous thickening of the body-whorl towards the aperture, together with the upward extension of the suture, observed in some full-grown specimens of *Melongena lainei* is also matched in *Melongena gigas* which nevertheless, lacks the very characteristic deep furrows of *Melongena lainei* on the spire-whorls and the corresponding circumsutural slope of the body-whorl.

There are not any closely related forms in the recent fauna.

MELONGENA GALEODES<sup>1</sup> Lamarck var. SINDIENSIS n. var.

Pl. XIII, fig. 3.

1817. *Murex calcaratus* Dillwyn.—Descr. Cat., Vol. II, p. 710.  
 1822. *Pyrrula angulata* Lamarck.—An. sans vert., Vol. VII, p. 145.  
 1843. *Pyrrula galeodes* Lamarck.—An. sans vert., 2d ed., Vol. IX, p. 517.  
 1843. *Pyrrula angulata* Lamarck.—An. sans vert., 2d ed., Vol. IX, p. 517.  
 1843. *Pyrrula squamosa* Lamarck.—An. sans vert., 2d ed., Vol. IX, p. 518.  
 1847. *Pyrrula galeodes* Lam.—Reeve, Monograph of the genus *Pyrrula*, Pl. VII, figs. 22, 23.  
 1881. *Melongena galeodes* Lamarck.—Tryon, Man. Conch., Vol. III, p. 108, Pl. XLII, figs. 204-208.

Of moderate size for the genus, broad and biconical, with a wide conical or slightly extraconic spire measuring two-sevenths of the total height.

The imperfectly preserved protoconch is followed by five spire-whorls the height of which is one-third of their width, the maximum thickness corresponding with their anterior margin. They are separated by channelled sutures surrounded by a circumsutural rim

<sup>1</sup> I am not sure that this specific name is correct, as it does not seem to date back further than 1822. It is the designation adopted by Reeve and by Tryon respectively in their monographs, but I do not know on what grounds these authors reject *Murex calcaratus* Dillwyn 1817, which they both mention in their synonymy.

anteriorly to which the whorls form a slightly convex, continuous slope. The circumsutural rim carries spinose projections mostly weathered away in the only available specimen. With the exception of these circumsutural denticulations, the spire-whorls do not carry any other spines or ribs. Three, moderately broad, shallow, spiral sulci divide the surface of the spire-whorls into flat bands. The oblique lines of growth are antecurrent to the suture.

The large, broad body-whorl equal to seven-eighths of the total height, is posteriorly shouldered or angulated, thus communicating to the whole shell its broadly bi-conical shape. This shouldering is, apparently, a character of the full-grown shell and does not occur in the concealed portion of the spire-whorls which, as already stated exhibit no clear indication of spines or nodes other than the circumsutural denticulations, while the shouldering of the full-grown body-whorl carries broad, rather prominent spines at rather wide intervals. Consequently, the posterior portion of the body-whorl corresponding with the spire-whorls does not coincide with them in shape. From the circumsutural rim to the shouldering, the surface of the body-whorl does not slope quite so steeply as that of the spire-whorls, thereby contributing to the extraconic appearance of the spire. Its outline is also less curvilinear, practically straight. Anteriorly to the shouldering, the body-whorl, in accordance with the broadly bi-conical shape of the shell, contracts rather rapidly, the surface being rather strongly convex as far as a slight constriction which carries a second row of nodes, anteriorly to which the short remaining portion of the anterior part of the shell continues to taper up to the slightly swollen, very oblique, narrow, spiral zone of accretions of the narrow, deep, terminal notch. Between this spiral zone and the columellar lip, the shell, on its ventral aspect, is narrowly and deeply umbilicated. The body-whorl carries a few, rather wide-spaced, shallow sulci on the posterior slope between the shouldering and the suture and also on the anterior part of the convexity close to the basal construction. The sulci are set somewhat closer together across the anterior row of nodes, and still nearer together between these nodes and the anterior, spiral swelling.

The tall aperture is narrow, posteriorly terminated by a narrow, angulated channel corresponding with the circumsutural rim, gradually contracted anteriorly to its junction with the narrow terminal notch. The columella, partly concealed by a rocky incrustation, is oblique and apparently practically straight. The moderately thick

columellar lip is narrow along the umbilical depression, while, posteriorly to the terminal spiral zone of accretions, it spreads broadly over the ventral surface of the shell. Posteriorly to the shouldering, the outer lip is oblique, its posterior termination being anterior and tangent to the suture. Anteriorly to the suture it is straight and steeply oblique as far as the anterior row of nodes anteriorly to which it is convex and increasingly retrocurrent till it passes into the terminal notch.

*Dimensions.*—The following are the measurements of the solitary available specimen:—

	mm.
Height . . . . .	56
Thickness . . . . .	37
Height of spire . . . . .	16
Height of body-whorl . . . . .	46

*Occurrence.*—Gáj of Sind: base of scarp, four miles west of Trak Hill, along the southern continuation of the Mol Scarp (Ram Singh, G<sup>3</sup><sub>3</sub><sup>2</sup>).

*Remarks.*—In none of the figured examples of *Melongena galeodes* are the spiral ornaments so effaced, along the angulation of the body-whorl and the region adjacently anterior to it, as in the above-described specimen, which may therefore be treated as a variety of the living species. *Melongena galeodes* occurs abundantly throughout the eastern seas.

#### MELONGENA (PUGILINA) PONDEROSA Martin.

1895. *Pyrula (Melongena) ponderosa* Martin.—Samml. des geol. R.-Mus. in Leiden, new series, Vol. I, p. 92, Pl. XIV, fig. 208.

As already noticed by Noetling (Pal. Ind., new series, Vol. I, part 3, p. 316), the difference between this fossil and the living *Melongena pugilina* lacks the degree of precision necessary for strictly defining a separated species. The fossil nevertheless constitutes a well-demarcated form which might be treated as a variety and is characterised by its robust growth, the relatively thick shell-wall even of small specimens, and the somewhat steeper slope of the posterior concave portion of the whorls, the margin of which encroaches upon the preceding whorl more than is usual with the



living form. Consequently the relative height of the anterior vertical portion of the spire-whorls is thereby slightly reduced.

The Burmese fossil referred by Noetling to *Melongena pugilina* is very closely related to *Melongena ponderosa* from which it is distinguished by its wider-spaced nodes. To avoid unduly extending the scope of *Melongena pugilina* it may be distinguished as a separate species under the name of *Melongena praeponderosa*. The same difficulty is experienced here as in the case previously dealt with of the fossil forms of *Turbinella*, in which immediately successive links of a chain of transformations differ from one another to an extent which is only varietal, but which assumes a specific degree if one of the connecting links be omitted.

*Dimensions*.—The height of adult specimens is from about 100 mm. to 115 mm.

*Occurrence*.—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains; north of the Talar Range, at a higher horizon than the lowest fossiliferous bed; south of Talar Range, at a still higher horizon; 4 miles N.N.E. of Mukh ( $25^{\circ} 27'$ ,  $62^{\circ} 33'$ ), 13 miles S.W. of the Talar Pass; 2 miles W.S.W. of Bán ( $25^{\circ} 30'$ ,  $62^{\circ} 45'$ ); junction of Belor, Chilari and Kauro Rivers ( $25^{\circ} 25'$ ,  $62^{\circ} 53'$ ), 9 miles S.E. of Bán.

This is one of the commonest and most characteristic fossils of the Mekran beds at their lower horizon.

SIPHONALIA (KELLETTIA) NODULOSA [J. de C. Sowerby.]

1840. *Fusus nodulosus* J. de C. Sowerby.—Trans. Geol. Soc. London, 2d series, Vol. V, Pl. XXXVI, fig. 14.

?1854. *Fusus nodulosus* J. de C. Sow.—d'Archiac and Haime, Deser. an. foss. Inde, p. 307.

non *Siphonalia nodulosa* A. Adams, Ann. Mag. Nat. Hist., Vol. XI, p. 206, (1863).

non *Fusciolaria nodulosa* J. de C. Sow. in Noetling, Mem. G. S. I., Vol. XXVII, part 1, p. 34, Pl. VIII, figs. 1-3, (1898); Pal. Ind., new series, Vol. I, part 3, p. 314, Pl. XX, figs. 10, 17, Pl. XXI, fig. 1 (1901).

O moderate size, with moderately narrow spire equal to nearly half the total height.

The small protoconch which is slightly though decidedly oblique, is shaped somewhat like a *Turbo* and consists of a depressed, feebly projecting, virguloid nucleus, followed by two smooth, convex, low

whorls. It is followed by six angulated spire-whorls, the height of which exceeds two-fifths of their width, the maximum thickness coinciding with the angulation situated at half the height of the whorls.

The wavy sutures, in consequence of the strong angulation of the whorls, correspond with a marked contraction of the surface; nevertheless they are linear and superficial. Posteriorly to the angulation, the surface forms a concave slope, and swells into a slightly prominent, rather narrow, circumsutural rim along the posterior margin. Anteriorly to the angulation, the surface forms a very steep, slightly convex slope, anteriorly overhanging. All the spire-whorls, subsequent to the protoconch, are decorated with moderately prominent, rounded, broad, axial ribs, much wider than the intervening spaces which on the later whorls, become reduced to mere shallow, linear grooves, the ribs, therefore, becoming practically adjacent to one another. Their strongest prominence is at the angulation; they decrease but slightly anteriorly, while they rapidly become lower posteriorly to the angulation and do not reach the posterior margin. Their direction, anteriorly to the angulation, is practically vertical, or very slightly oblique, retrocurrently to the anterior suture. They are antecurrent from the angulation towards the posterior margin. Their number is nine on each of the two first whorls succeeding the protoconch, being afterwards reduced to eight per whorl until the last spire-whorl, when the number again increases to nine. In addition to the above-described axial ornament, the whorls also carry spiral threads. There are four, even-paced, principal, spiral threads on the anterior part of the whorls, one of them coinciding with the angulation, another following the anterior suture and sometimes rather concealed by the posterior edge of the next succeeding whorl. They swell slightly on crossing the axial ribs. On the later part of the spire each of the intervals between these main threads is filled by a thread of a second order. Posteriorly to the angulation none of the spiral threads are as thick as the main threads of the anterior part of the whorls. The two thickest ones decorate the circumsutural rim. The concavity between the circumsutural rim and the angulation is divided, at early stages of growth, into three equal spaces by two fine threads. With increasing growth an intercalary thread appears in each of the spaces, and, on the newest part of the spire, these intercalary threads and the two original ones all become equalised. Between the angulation and the posterior margin, the

lines of growth are oblique and antecurrent to the suture. From the angulation to the anterior margin they are vertical

The body-whorl measures two-thirds of the total height. It consists of an inflated, somewhat spheroidal convexity, separated by a broad and deep concavity from a moderately long, somewhat twisted, terminal stem. The accretion to the terminal truncation form a steeply winding, narrow slightly swollen bulge. The anterior termination is incomplete in the specimens at present available, so that it has not been possible to ascertain whether an umbilicus is present. The angulation of the spire-whorls is continued on to the body-whorl, together with the ribs, which tend to become somewhat effaced and do not extend anteriorly beyond the level of the suture. The spiral ornaments of the last spire-whorl are continued unchanged over the corresponding part of the body-whorl. Anteriorly to the level of the suture, similar spiral ornaments, which may alternate in two sizes, are continued very regularly over the basal concavity and anterior stem. On the posterior part of the body-whorl the lines of growth are disposed in the same manner as on the spire-whorls. Anteriorly to the level of the suture they maintain a practically vertical course until they recede into the terminal zone of accretions.

The broadly oval aperture is narrowly angulated and somewhat channelled posteriorly, while anteriorly it is contracted into a well defined, narrow canal oblique anteriorly towards the left of the shell. Close to the level at which the terminal zone of accretions penetrates into the interior of the shell, the columella exhibits an angular bend, posteriorly to which it is concave and merges into the base of the penultimate whorl. Anteriorly to the angular bend it is steeply twisted and oblique towards the left of the shell. The bend of the columella, as it winds steeply into the interior of the shell, forms a prominent, spiral angulation or ridge covered with a continuous string of blunt, callous gemmules. The columellar lip is narrow and very thin. At its posterior termination it carries a small, raised ledge which borders the angular channel forming the posterior termination of the aperture, and is continued along the inner wall of the shell as a thin, spiral fold. Judging from the disposition of the lines of growth, the outer lip, posteriorly to the angulation is oblique and antecurrent to the suture. Anteriorly to the suture it is practically vertical until close to its anterior termination. The wall of the shell are internally lirate.

*Dimension*.—

	mm.	mm.
Height . . . . .	39	45
Thickness . . . . .	19	21
Height of spire . . . . .	18.5	23
Height of body-whorls . . . . .	26	32

*Occurrence*.—Gáj of Kachh: south bank of river from Teyra (23° 17', 68° 58').

*Comparison with other species*.—This shell exhibits the closest resemblance to *Siphonalia tjabaliungensis* Martin, from the newer Tertiary of Java. The Japanese shell lacks the circumsutural rim of the Kachh species, the posterior slope of its whorls is not distinctly concave, and the axial ribs maintain their full strength as far as the posterior margin; the spiral ornamentation of its base exhibits a dimorphous character quite different from the very even decoration of the body-whorl in the Kachh form.

It is not quite certain whether the poorly preserved fossil from Sind, apparently from the Gáj beds of Karachi, referred by d'Archiac and Haime to *Fusus nodulosus*, is truly identical with the above described species. It is larger, with a much broader and more depressed spire, it lacks the circumsutural rim and the median angularity of the spire-whorls, its axial ribs extend anteriorly over the basal concavity of the body-whorl, and its spiral ornamentation is much coarser. The internal walls are lirate, as in the above-described form. Should this shell prove to be specifically distinct, it may be distinguished as *Siphonalia archiaci*.

Under the designation "*Fasciolaria nodulosa* J. de C. Sowerby," Dr. Noetling has referred to the Kachh form, certain Burmese specimens belonging to two different species. The two specimens represented in Dr. Noetling's first monograph, (Vol. XXVII of the Memoirs), in figures 1 and 2 of Plate VIII, and again, in his second monograph (*Palæontologia Indica* in figure 16 of Plate XX, and figure 1 of Plate XXI, belong to the genus *Lathyrus* and may be distinguished as *Lathyrus indicus*. The third specimen is a *Siphonalia* which may be named *Siphonalia (Kelletia) irravadica*. It is smaller than *Siphonalia nodulosa*, with a relatively broader spire; the whorls are much less contracted at the sutures the ribs are less prominent and the anterior contraction of the base is much more gradual.

Owing to the transfer of the Kachh fossil from *Fusus* to *Siphonalia*, its specific name becomes duplicated in the case of *Siphonalia nodulosa* Adams (1863) which may be renamed "*Siphonalia adamsi*," but which does not appear to have been figured.

SIPHONALIA (KELLETTIA) MEKRANICA n. sp.

Pl. IX, fig. 8.

Medium-size, with conical spire measuring three-sevenths of the total height, and ventricose body-whorl, anteriorly ending in a terminal stem.

The protoconch, missing in the only available specimen, is followed by six spire-whorls, the height of which is equal to three-sevenths of their thickness. They are angulated a little nearer to the anterior than to the posterior suture. Posteriorly to the angulation, the surface forms a moderately inclined, concave slope. Anteriorly to the angulation, the surface slopes in the opposite direction, steeply, and with a slightly convex outline. Consequently each whorl is contracted towards both sutures. The slightly wavy sutures are therefore situated in a recess, but are nevertheless quite linear, the posterior margin of each whorl fitting quite lightly round the anterior margin of the next preceding whorl. The ornamentation consists of axial ribs and spiral threads. The number of axial ribs on the earlier whorls cannot be ascertained, as the two first whorls following the protoconch are missing, and the third one is incomplete. The fourth and fifth whorl each carry nine ribs, the sixth one, ten. The ribs are feebly prominent and are widest at the angulation where they are much wider than the intervening spaces and almost in contact with one another. Their width, proportionately to the interspaces, decreases towards both sutures, especially toward the posterior one, the ribs at the same time becoming less prominent. Posteriorly to the angulation, their direction is oblique, steeply antecurrent to the posterior suture. Anteriorly to the angulation they are either, still more steeply oblique, but in the opposite direction, antecurrent therefore to the anterior sutures, or else practically vertical. A well-developed, spiral thread, which swells as it crosses the ribs, corresponds with the angulation. The posterior slope carries three, principal, spiral threads with a thread of a second order in each of the intervals which they determine, the space between

the more posterior of these principal threads and the posterior suture being equal to the space between two principal threads. The posterior suture is not accompanied by a distinctly differentiated thread. Between the angulation and the anterior suture the threads are crowded and subequal, for, although they partly originate by intercalation, the secondary threads soon approach the primary ones in thickness. The first interval anteriorly to the angulation is a little wider than the others, the first thread anterior to the angulation corresponding in position with the widest part of the whorls. On the last spire-whorl, the number of threads situated anteriorly to the angulation is eight. The lines of growth follow the same course as the axial ribs being steeply antecurrent to the posterior suture still more steeply antecurrent or normal to the anterior suture.

The ventricose body-whorl measures seven-tenths of the total height. Posteriorly, the portion constituting the continuation of the spire exhibits the same shape as the spire-whorls, with the same circumsutural, concave slope between the angulation and the suture, while, anteriorly to the angulation, the surface contracts anteriorly with a convex outline which is continued by the base anteriorly to the level of the suture as far as the pronounced fairly broad concavity which marks the limit of the terminal stem. Throughout the posterior portion of the body-whorl forming the continuation of the spire, the ornamentation is the same as on the spire-whorls. The number of ribs on the body-whorl increases to eleven. Anteriorly they do not extend beyond the level of the suture. The spiral threads, anteriorly to the level of the suture, become wider-spaced and alternate very distinctly in two orders of magnitude, those of the first order being conspicuously prominent. The lines of growth, anteriorly to the angulation, are steeply antecurrent anteriorly as far as the anterior concavity, when they become vertical.

The broad aperture is posteriorly angulated and channelled. The columella is posteriorly vertical, merging gradually into the base of the penultimate whorl. Its anterior extension is missing in the solitary available specimen. The columellar lip is thin, posteriorly bearing a narrow ledge which contributes to constrict the posterior channel and which is continued in the interior of the shell as a spiral fold. The outer lip is antecurrent from the angulation to the suture. Anteriorly to the angulation it is very steeply anteriorly antecurrent, almost vertical.

*Dimensions.*—The following are the approximate restored dimensions :—

	mm.
Height . . . . .	50
Thickness . . . . .	25
Height of spire . . . . .	22
Height of body-whorl . . . . .	35

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison with other species.*—This shell differs only very slightly from the previously described *Siphonalia nodulosa* of which it might be regarded as a mutational variety. The most conspicuous difference consists in the more crowded, axial ribs. The later spire-whorls, in *Siphonalia mekranica*, each carry nine or ten ribs, while, on the corresponding portions of *Siphonalia nodulosa*, the number varies from six to eight. Their number on the body-whorl of *S. mekranica* is eleven. None of the available specimens of *S. nodulosa* have the body-whorl complete, but, judging from the width of the ribs and the manner in which they correspond with those of the last spire-whorl, their number cannot exceed eight or nine. On the body-whorl of *Siphonalia nodulosa*, the character of the spiral ornamentation does not alter anteriorly to the level of the suture as it does in *S. mekranica*. Compared with the very closely related *Siphonalia tjibaliungensis* Martin, from the Pliocene of Java, the differences in shape are about the same as those that distinguish *Siphonalia nodulosa*, the Javanese form lacking the concave disposition of the circumsutural slope, while the anterior convexity of the body-whorl is shorter and more abruptly contracted than in the Mekran shell. The spiral ornamentation of *Siphonalia tjibaliungensis*, like that of *S. mekranica*, is dimorphous, but is distributed differently, the surface with particularly crowded threads being that situated anteriorly to the level of the suture on the body-whorl, instead of posteriorly to it, as in the Mekran-shell. Lastly, the axial ribs, on the body-whorl of the Javanese shell become wider-spaced instead of more crowded as in the Mekran fossil.

Martin has compared the Javanese fossil with the recent *Siphonalia spadicea* [Reeve]. The Mekran fossil resembles the recent form still more closely, especially in its less abrupt'y contracted base. It is nevertheless distinguished from the living shell by its stouter build and more pronounced angulation.

Amongst living species, *Siphonalia varicosa* [Chemn.], the habitat of which is unknown, singularly resembles the above-described fossil, from which it appears to be distinguished by the narrower and wider-spaced ribs of the body-whorl, and the more abrupt contraction of the base.

COMINELLA ANNANDALEI n. sp.

Pl. VI, fig. 6.

Small, bucciniform, with conical spire, equal to two-sevenths of the total height, and large, inflated, ovoid body-whorl.

The protoconch, which is broken in the single available specimen, is followed by four spire-whorls whose height is equal to one-third of their width. They are angulated at about half their height. Posteriorly to the angulation, the surface forms a concave slope; anteriorly it is vertical. A slight swelling along the posterior margin of the whorls, tends to communicate a slightly grooved appearance to the linear sutures. The whorls are ornamented with thin, axial ribs which are feebly prominent though well demarcated, and which are narrower than the intervening spaces. They swell slightly upon the circumsutural rim. They are vertical, or very slightly antecurrent over the posterior concave slope, practically vertical over the anterior vertical surface. Their number, for each complete volution, increases from about fifteen on the earlier whorls to eighteen on the last spire-whorl. In addition to the axial decoration, the entire surface carries very fine, crowded, evenly distributed, raised, spiral lines, developed alike, over the ribs and interspaces.

The large body-whorl is equal to four-fifths of the total height. Posteriorly it is shaped in accordance with the angulation and circumsutural, concave slope of the spire-whorls. For a very short distance anteriorly to the angulation the surface is at first vertical, and then contracts with a somewhat conical, moderately convex outline. On the right side of the shell, the convexity reaches the anterior termination. On the left side, at about two-thirds of the distance from the angulation to the anterior termination, the convexity is interrupted by the concavity of the neck, posteriorly bordered by a narrow, thin ridge, anteriorly by a narrow, torose, scaly, steeply winding bulge representing the zone of accretions, not of the deep, narrow, terminal notch, but of its ventral margin; the accretions to the dorsal portion of the notch corresponding with the



concave space between the two above-mentioned winding ridges. There is a shallow, narrow umbilicus on the ventral side of the terminal, scaly bulge. The axial ribs on the body-whorl exhibit the same characters as on the spire. Their number is twenty. They continue anteriorly up to the posterior ridge of the neck. From the angulation to their anterior termination, they exhibit a moderate curvature with forward directed convexity, the summit of the curve, with respect to the axial direction, being situated at about half its length. Thin, crowded, raised, spiral lines, similar to those ornamenting the spire, cover the whole body-whorl, every fourth thread being slightly more prominent than the remainder.

The tall aperture is broadly and symmetrically lanceolar or lens-shaped, posteriorly ending in a short, constricted channel, anteriorly constricted into a rudimentary canal leading into the deep, narrow, deflected, dorsal notch. The details of the columella cannot be recorded as it is largely concealed by a hard, rocky incrustation. The columellar lip is narrow, thin, very sharply demarcated, semi-detached anteriorly along the narrow umbilical fissure. The outer lip is straight, oblique, antecurrent to the suture. Round the margin of the aperture it constitutes a very thin, sharp rim finely crenulated internally. Externally it is greatly thickened by a broad swelling, which gradually expands away from the margin of the aperture till it overhangs the dorsal surface from which it appears to be marked off by a groove the exact disposition of which is concealed by the rocky incrustation. The external swelling carries two or three axial grooves, and is entirely covered by the spiral threads.

*Dimensions.*—The following dimensions were measured on the only specimen at present available:—

	mm.
Height . . . . .	14
Thickness . . . . .	8
Height of spire . . . . .	4
Height of body-whorl . . . . .	11.2

*Occurrence.*—Nari of Bhagothoro Hill, Sind.

*Comparison with other species.*—This beautiful shell, which resembles a miniature *Voluta*, constitutes, up to the present, the only well-authenticated occurrence of the genus amongst the molluscan fauna, either fossil or recent of Asia. The other species, either fossil or recent, are well differentiated either by their shape or their ornamentation. *Buccinum bullatum* Philippi, from the Oligocene

of Northern Europe, is somewhat related, but has a much taller spire. *Cominella limbosa* (Lam.), living at the Cape of Good Hope, somewhat resembles the Indian shell in shape, but its ribs are often obsolete, or, when present, they are much less pronounced and wider spaced than in the Indian species.

*METULA MARTINI* n. sp.

Pl. IX, fig. 9.

Medium small, very slender, fusoidal, with narrow, somewhat conoidal spire equal to half the total height, and with elongate body-whorl contracted anteriorly into a rostrum-like termination.

The broken protoconch is followed by five spire-whorls, the last of which has a height equal to nearly three-quarters of its width. The proportion of height to width becomes gradually less in the previous whorls in consequence of the conoidal shape of the spire. The whorls are scarcely convex, the convexity being only such as will fit into the general conoidal outline of the spire, with merely a slight excess of curvature to allow for a slightly receding step round the posterior sutures. A narrow groove accompanies the sutures which, however, are not situated along the actual floor of this channel, but are in reality linear and on a level with the margin of the narrow depression on its inner side, the disposition being analogous to that observed in some other forms of the Buccinidæ, such as *Cyllene*. The outer rim of the groove is anteriorly marked off by another revolving depression, situated this time on the approximately vertical surface of the whorl instead of on the nearly horizontal, stepped recess. With the exception of the posterior circum-sutural band thus delineated, the entire surface is covered with extremely fine, numerous, evenly-spaced, shallow, incised lines, numbering as many as twenty on the last whorl, cutting across another very numerous though slightly wider-spaced set of rather deeper axial grooves isolating a crowded series of slightly oblique, flat ribs, retro-current towards the anterior suture, more or less interrupted by the groove that bounds the outer rim of the sutural channel, but reappearing on the rim itself in the shape of low, slightly scaly granules. At irregular, and distant intervals, some of the ribs swell into feebly prominent varices.

The body-whorl is very slender and very elongate, almost cylindrical in its thickest region, anteriorly to which it contracts with an

extended convexity of feeble curvature, reaching the anterior termination on the right side of the shell, while on the left side there intervenes a concavity, also of feeble curvature, which communicates a rostrated appearance to the extremity of the shell. There is no twisted dorsal zone and no umbilicus. The axial and revolving furrows of the spire are continued over the body-whorl and extend with similar characters over the convex portion of the base, the axial grooves remaining deeper and a little further apart than the spiral lines, so that the axial ribs appear more pronounced than the spiral ornaments. On the anterior concavity and rostrum the depth, width and spacing of the revolving grooves increase considerably, with the result that the intervening spaces now assume the appearance of distinct, revolving threads while the axial ribs lose their individuality, and can only be recognised by their limiting furrows, which, with a convex retrocurrent bend, cut across the threads upon which they isolate a series of elegant granulations.

The aperture is very narrow and slit-like, very narrowly angulated posteriorly, contracted more gradually anteriorly. The columella is smooth, slightly oblique, slightly concave, bending towards the right of the shell only in the immediate neighbourhood of its anterior termination. The columellar lip is very thin, somewhat spreading, not sharply demarcated. It is only at the posterior termination of the aperture that both apertural lips become slightly thickened with the formation of a very narrow, shallow, slightly notched channel. The outer lip is evenly convex, retrocurrent towards the suture.

The following dimensions were measured on the solitary available specimen:—

	mm.
Height . . . . .	22
Thickness . . . . .	7
Height of spire . . . . .	11
Height of body-whorl . . . . .	16

*Occurrence.*—Gáj of Karachi (Blagrave collection).

*Remarks and comparison.*—This specimen was lately found during the sorting of a collection of Gáj fossils, from the neighbourhood of Karachi, presented to the Asiatic Society of Bengal by Blagrave, and now in the custody of the Geological Survey of India.

The little-known genus *Metula*, mostly inhabiting deep water comprises two groups, one of relatively ventricose species including *Metula clathrata* Adams and Reeve, from the Cape of Good-Hope and *Metula cumingi* A. Adams from the West Coast of Africa: the

other, restricted to the Indo-Pacific region, consisting of four very slender forms of which *Metula mitrella* Adams and Reeve, inhabits the China Seas, *M. hindsii* H. and A. Adams, the West Coast of Veragua and is also found fossil in the Miocene of Java, while the two remaining species, *Metula boettgeri* Martin, also from the Miocene of Java, and the above described species from the Gáj of Karachi, are both fossil. The Gáj fossil is readily distinguished from the three other species constituting the slender shaped sub-division, owing to its relatively much more elongate body-whorl and shorter spire. It closely resembles *Metula boettgeri*, particularly in its distinctly developed varices, but cannot be united with it unless we admit a variability such as would necessitate the union into a single species of the four forms of the slender-shaped sub-division.

TRITONIDEA (CANTHARU-) BUCKLANDI [d'Archiac].

1850. *Fusus bucklandi* d'Archiac. Hist. des progr. de la Geol., Vol. III, p. 292.

1854. *Fusus bucklandi* d'Arch. d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 308, Pl. XXIX, fig. 13.

Medium-size to fairly large, with broadly conical spire measuring less than half the total height of the shell, consisting of rapidly increasing, low whorls separated by deeply re-entering sutures, and with rather elevated body-whorl consisting of a strongly inflated posterior portion and greatly attenuated, elongate, anterior portion.

The protoconch is very small, with a minute, prominent, globular, button-shaped nucleus, followed by two, smooth, convex whorls. It is followed by five spire-whorls the height of which is from four-ninths to two-fifths of their width. They are constricted towards both sutures, the contraction being specially abrupt towards the posterior suture in front of which the whorls are much flattened, almost terraced. Each whorl bears three particularly prominent threads the middle one of which is nearer to the posterior than to the anterior one. Both the anterior and posterior thread correspond with angulations from which the surface slopes inwards, steeply towards the anterior suture, almost horizontally towards the posterior suture. In consequence of the resulting convergence of the edges of adjacent whorls, the linear wavy sutures appear to be rather deeply impressed. Between the anterior main thread and the anterior suture, there is always at least one prominent thread, though less prominent than the three main threads. In certain specimens, each of the two intervals between the main threads is bisected by an

intermediate thread of a second order of magnitude, and there may be some still finer ones.

In other specimens the intervals are occupied by numerous close-set, very fine threads or lines. The feebly sloping, almost horizontal surface between the posterior main thread and the posterior suture, bears variously distributed threads of various size. In addition to the revolving ornaments, each whorl bears eight, broad, prominent rounded ribs rather contracted and, as it were, pinched, between the posterior main thread and the posterior suture throughout which portion of their course they are oblique and antecurrent towards the posterior suture. Anteriorly to the posterior main thread, they are almost vertical. The revolving ornaments swell slightly and become slightly more prominent on crossing the axial ribs. The whole surface is beautifully crinkled with extremely fine, crowded lines of growth, which decussate all the more minute, spiral ornaments. The body-whorl, which reaches more than two-thirds of the total height of the shell, is inflated posteriorly, but, from the level of the suture, contracts rather rapidly towards the rather shallow and rather elongate anterior concavity which is anteriorly bordered by a rather broad, scarcely prominent, and rather steeply twisted bulge formed by the accretions to the anterior notch. There is no umbilicus. The ornamentation of the spire is continued upon the body-whorl, and the base, including the neck as far as the anterior bulge, is likewise decorated with prominent, revolving threads which more or less alternate in size in those specimens in which the main intervals on the spire-whorl are bisected by subsidiary threads of a second order of magnitude, while in other specimens the main threads are all of one size with their intervals crowded with delicate, revolving lines. When this disposition is developed the main revolving ornamentation of the body-whorl produces the impression of being much less crowded and, at the same time, more prominent. The anterior revolving bulge, which is scaly, also bears similar revolving ornaments, but finer and more crowded.

The axial ribs, which become once more oblique and retrocurrent in an anterior direction upon the basal concavity, continue as far as the bulging zone of accretions against which they terminate.

The aperture is tall, shaped as an oblique oval with rather flattened sides, anteriorly contracted and terminating in a short canal twisted to the left of the shell and ending in a truncated notch. The columella is vertical and nearly straight, scarcely projecting

opposite the anterior twist, which is continued as a sharp, steep angulation round the axis in the interior of the shell. The columellar lip is very thin, adhering to the shell wall though its limit is sharply defined; it is vertically disposed without any tendency to spread beyond the limits of the aperture. It exhibits plications which are merely the revolving ornaments of the shell surface over which it is moulded, and is otherwise smooth except for one or two feebly prominent ledges quite close to its junction with the outer lip. The outer lip, which is oblique antecurrent towards the suture, and retrocurrent and slightly convex towards the canal, is, in full-grown specimens, externally bordered by a pronounced thickening, far more prominent than the normal ribs. Internally it bears a number of pronounced grooves corresponding with the terminations of the main revolving threads. These grooves are rather wide-spaced in those specimens in which the main threads of the body-whorl are particularly prominent and all of one size; they are, on the contrary, crowded when the revolving ornamentation includes threads of two alternating sizes. The marginal grooves are followed by five spiral lines for a considerable distance over the internal walls within the shell.

*Dimensions.*—d'Archiac's type from Sind is immature, and the other specimens available from the Miocene of Sind and Kachh are all more or less fragmentary. The following measurements are from some complete specimens from the Miocene of Burma where the species occurs in a beautiful state of preservation:—

	Dalabe.	Thanga.
	mm.	mm.
Height . . . . .	32	30
Thickness . . . . .	20	18
Height of spire . . . . .	14	13·6
Height of body-whorl . . . . .	24	21

The specimen from Da'abe is the only one in which all the prominent threads are of one size.

One specimen from Tittabwe, also in Burma, reaches a height of 35 mm.

When full-grown the Sind and Kachh specimens reach the same size as those from Burma. Amongst some fossils, formerly in the collections of the Asiatic Society of Bengal, gathered by Major Baker, from the same spot near Karachi from which many of d'Archiac's types were obtained, the largest specimen, when complete,

had the same dimensions as the one above recorded from Dalabe, that is, a height of about 32 mm., and a thickness of about 20 mm. The spire, which is well preserved, measures 13.5 mm.

*Occurrence*.—Gáj of Sind: near Karachi (Baker collection), probably from the same spot as d'Archiac's type: Gáj of Kachh: Teyra River near Rampur (23° 20'. 68° 51'). Also in beds of the same age in Burma

*Note*.—d'Archiac and Haime gave only a short diagnosis of this fossil, the genus of which they were unable to ascertain owing to the incompleteness of the type. All the available specimens from Sind and from Kachh are very incomplete, but are sufficiently preserved to establish their perfect identity with some beautifully preserved shells obtained by Rao Bahadur Sethu Rama Rao, from the Miocene of Burma, from which the above description has been compiled.

*Comparison with other species*.—It is only with the greatest difficulty that this shell has been separated from two living species of the eastern seas, *Tritonidea erythrostoma* [Reeve], and *Tritonidea tranquebarica* [Martini]. The relationship is especially close to *Tritonidea erythrostoma* which is rather feebly differentiated by the less pronounced posterior angulation of the whorls, the more prominently twisted terminal zone of accretions bordered ventrally by a distinct, though shallow, umbilical depression, and by the somewhat thicker more rounded, main, spiral threads with much feebler striated decoration in the intervening spaces. *Tritonidea tranquebarica* lacks the thickening both external and internal, of the outer lip, the posterior angulation of its whorls is rather more pronounced than in *Tritonidea bucklandi*, and its body-whorl exhibits, at the level of the suture, a slight angulation of which there is no trace either in *T. bucklandi* or *T. erythrostoma*, and to which corresponds a spiral thread slightly thicker than the remainder, which, in coloured specimens, is often emphasized as a white line.

#### TRITONIDEA (CANTHARUS) ERYTHROSTOMA Reeve<sup>1</sup>.

Pl. III, fig. 1. 2.

1849. *Buccinum erythrostoma* Reeve. Monograph of the genus *Buccinum*, Pl. III, sp. 14.

1881. *Cantharus erythrostoma* Reeve. Tryon, Manual of Conchology, Vol. III, p. 155.

Medium-size, ventricose, with broadly conical spire measuring three-sevenths of the total height.

The small protoconch, broken in all the available specimens, is followed by five convex spire-whorls, the height of which is equal to three-sevenths of their width. The maximum thickness is situated

nearer to the anterior than to the posterior margin. The wavy sutures, in consequence of the strong convexity of the whorls, are situated in a deep recess, but they are quite linear, not grooved. The continuity of the convexity of the whorls is slightly broken, to a varying but always slight degree, by two feeble angulations, one of which is situated close to the anterior margin, the other a little further from the posterior margin. There are even specimens in which these slight breaks are not appreciable, and in which the convexity appears quite continuous. Each whorl carries eight or nine axial ribs. In some instances nine ribs occupy a little less than one complete revolution, but in no instance have as many as ten ribs been observed fitting exactly in one complete turn. The whorls are broad, rounded, moderately prominent, of the same width as the intervening spaces or else a little narrower or a little wider. They are moderately oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture. In addition to these axial ribs, there are also spiral threads, three of which are especially conspicuous, two of them corresponding respectively with the rudimentary angulations, or at least with the level that these angulations should occupy in shells where they are not appreciable, the third thread being situated midway between these two. Towards the end of the spire, a fine, intercalary thread is developed in each of the two intervals determined by these three main threads. There are three other spiral threads, not quite so thick as the three main threads above mentioned, though much thicker than the two intercalary threads. Of these three supplementary threads, one is situated between the most anterior main thread and the anterior suture, while the two others are situated between the most posterior, main thread and the posterior sutures. There are never any intercalary threads developed in any of the intervals bounded by these supplementary threads, not even on the body-whorl. Sometimes an additional main thread may be obscurely visible along the anterior suture, but it is usually almost or completely overlapped by the posterior edge of the next following whorl. All the spiral threads swell considerably on crossing the ribs. The lines of growth are oblique like the ribs, and are slightly curved, so that the antecurrent obliquity towards the posterior suture is a little more pronounced than the retrocurrent obliquity towards the anterior suture.

The body-whorl measures three-quarters of the total height. It is inflated and ventricose, with a strong posterior convexity,



followed anteriorly to the level of the suture by a rather rapidly tapering, feebly convex surface which a very short, concave recess separates from the rather strongly twisted and rather strongly bulging zone of accretions to the terminal-notch, which zone, in some specimens, is ventrally bordered by a small umbilical depression. The axial ribs exhibit the same disposition as on the spire-whorls. Their number is eight or nine. They extend, in an anterior direction, up to, and on to the short concave neck. They are moderately oblique, anteriorly retrocurrent, and straight throughout almost their whole length, receding only as they fade away on the anterior neck. The spiral ornamentation of the last spire-whorl is continued, without any change, on the corresponding portion of the body-whorl. Anteriorly to the level of the suture, the whole surface, as far as the terminal zone of accretions, is similarly decorated with conspicuous, rounded, spiral threads of about the same average width as the intervals, either almost all of one size or alternating in two sizes. A few, fine, spiral striations may also be developed in the intervals. Four or five, fine, spiral threads or ridges decorate the terminal zone of accretions. The lines of growth are disposed like the ribs moderately oblique and anteriorly retrocurrent from the suture to the short anterior neck upon which they curve backward towards the terminal zone of accretions upon which they become slightly scaly and assume a deep sinuosity.

The somewhat leaf-shaped aperture is almost perfectly rounded posteriorly with scarcely any indication of a posterior angulation, and is feebly constricted anteriorly into a rudimentary canal. Not far from its anterior termination, the columella exhibits a slight bend anteriorly to which it is slightly oblique towards the left of the shell and slightly sinuous. Posteriorly to the angulation it is practically vertical and merges into the base of the penultimate whorl. A spiral fold is obscurely visible at about the level of the bend. The columellar lip is thin, with a well demarcated edge, detached anteriorly along the umbilical depression. The outer lip is antecurrent to the suture, moderately oblique and anteriorly retrocurrent, mostly straight, except near its posterior termination where it is slightly concave. It is thickened externally by the swollen last rib and is also thickened internally. Its actual edge is thin and slightly frilled by the terminations of the spiral ornaments. Internally it bears raised ledges.

*Dimensions.*—

	mm.
Height . . . . .	30
Thickness . . . . .	20
Height of spire . . . . .	13
Height of body-whorl . . . . .	23

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—The above-described fossil has, perhaps, slightly narrower ribs, and, at times, a slightly more profuse spiral decoration of the base than some of the recent specimens of *Tritonidea erythrostoma* living in the Indo-Pacific region. The differences, scarcely definite enough for the separation of a race or variety *mekranica*, are quite insufficient for distinguishing an independent species.

EBURNA SPIRATA<sup>1</sup> LINN.

1758. *Buccinum spiratum* Linn.—Syst. Nat. ed. 10, 739.  
 1817. *Nassa canaliculata* Schumacher.—Essai d'un nouveau système des habitations des vers testacés, p. 224.  
 1822. *Eburna spirata* Linn.—Lamarck, An. sans vert. Vol. VII, p. 281.  
 1849. *Eburna spirata* Lam.—Reeve, Monograph of the genus *Eburna*, Pl. I, sp. 7.  
 1880. *Eburna canaliculata* Schum., var. *Valentiana* Swainson.—Böttger, Tertiärform. von Sumatra, Theil II, p. 40, Pl. II, figs. 4, 5 (Palæontographica, Suppl. III).  
 1881. *Eburna spirata* Lam.—Tryon, Man. Conch., Vol. III, p. 212, Pl. LXXXII, figs. 466-468, Pl. LXXXIV, fig. 526.

<sup>1</sup> The name *Eburna* has been rejected by Rovereto (Moll. foss. tongr., p. 168) because Lamarck's definition of 1822 differs from the same author's definition of 1801. Although the amended definition has been adopted by most conchologists, and although the name has never been used again in the original sense, Rovereto has substituted *Latrunculus* Gray 1847. There seems to be no need to apply the rules of priority in a case like this one. The object of such rules being solely to avoid confusion, it has been considered unnecessary to adopt this alteration, as the use of the name *Eburna* cannot possibly give rise to any uncertainty, while it is disconcerting to omit a name which has become so familiar as designating one of the most characteristic of molluscan genera. Tryon's remarks regarding this generic appellation, extremely severe though they may seem, are not wholly undeserved: "If we observe the rule of taking the first species as the type of a genus, *Eburna*, Lamarck must become a synonym of *Aicillaria*, his first species being *A. glabrata*: Lamarck's assemblage of species, however, clearly indicate his intention. Naturalists have done much to render science and themselves contemptible by expending their time upon the nomenclature, instead of the structure and habits of animals. *Eburna* Lamarck is well understood and will answer my purpose." (Man. Conch., Vol. III, p. 210.)

1895. *Dipsacrus canaliculatus*, Schum.—Martin, Samml. des geol. Reichs mus. in Leiden, new series, Vol. I, p. 101, Pl. XVI, figs. 224–227.  
 1903 *Satranclites canaliculatus* Schum.—Cossmann, gouv. Conch., Vol. L, p. 136, Pl. V, fig. 24.

*Dimensions.*—

	mm.
Height . . . . .	. 42
Thickness . . . . .	. 28
Height of spire . . . . .	. 21
Height of body-whorl . . . . .	. 33

*Occurrence.*—Mekran beds: south of Talar Range. highest beds of Talar section. This species also occurs fossil in the upper Miocene to Pliocene of Java, Sumatra, and Karikal.

*Remarks.*—The spire-whorls of the Mekran specimens are less convex than those of the specimens from Java figured by Martin, in which respect they agree better with the available Recent specimen and with the fossil specimen from Karikal figured by Cossmann. The last spire-whorl is taller than in the available Recent specimens, the Karikal fossil, and the majority of the specimens illustrated by Martin, though not so tall as is represented in Martin's figure 224. The zone of accretions of the terminal notch, in the Mekran form, is rather deeply concave, and is bounded by two keels or ridges, one on either edge; in this respect it agrees with the Java fossil rather than with the Karikal and living forms. The fossil from Sumatra agrees better in shape with some of the Javanese fossils than with the Mekran and Karikal fossils and the living Indian specimens.

The coloured pattern of the Mekran fossil, distinctly visible, especially when the shell is moist, agrees with that of the Recent specimens. The sutural groove of the Mekran form is very deep and moderately wide. With regard to the supposed specific distinction between *Eburna canaliculata* and *Eburna spirata*, it may be mentioned that, amongst a series of Recent specimens lately picked up on the beach at Puri, every possible gradation can be observed from the deep narrow channel of *Eburna canaliculata* to the broad terraced disposition of *Eburna spirata*. According to Martin the Java and Sumatra fossils are smaller than their modern representatives. This may refer largely to choice specimens specially selected for purposes of exhibition. All the fossils, whether from Java, Sumatra, Karikal, or Baluchistan, are fully equal to the generality

of recent specimens commonly picked up on the sea-shore at the present day.

The Mekran form does not show the slightest indication of an umbilical depression. The umbilicus is similarly closed in all the adult specimens that I have observed either in India or at the British Museum, though it is widely open when the shell is not full grown. Considering that *Eburna spirata* is precisely the genotype of *Eburna*, the section *Pcrichipsaccus* Rovereto, established for non-umbilicated species may perhaps be regarded as superfluous. It may also be noticed that *Eburna valeniana* Swainson, genotype of *Pcrichipsaccus*, has been regarded by von Martens, Boettger and Martin, as specifically identical with *Eburna spirata*, genotype of *Eburna*. Tryon remarking that "it is quite possible that such is the case."

NASSA (TELASCO) FALCONERI [d'Archiac and Haime].

1850. *Buccinum serratum* Brocchi *sec.* d'Archiac.—Hist. des progr. de la Géol., Vol. III, p. 296.

1854. *Buccinum falconeri* d'Archiac.—Descr. an foss. ar. numm. Inde. p. 319, Pl. XXXI, figs. 10, 11.

This species, although recorded by d'Archiac and Haime as "common" is not represented amongst the collections of the Geological Survey of India.

The following is a translation of the original diagnosis:—

"Shell turreted, consisting of six convex whorls, separated by a sub-canalicate suture, covered with narrow, curved, axial ribs, equal and posteriorly ending in twin tubercles along the suture. The intervening spaces are twice as broad as the ribs, concave, and decorated with very delicate, linear, transverse striation crossed by lines of growth which are still more delicate and just as regular. The base of the body-whorl carries seven concentric striations, more pronounced, wider-spaced and continuous, crossing the ribs upon which they isolate small granulations, becoming more crowded until they reach the extremity of the columella. Aperture unknown. Probable height, 23 mm., diameter of the body-whorl, 10 mm.

"*Var. a.*—We regard as a separate variety, a shell distinguished by its shorter though steeper spire, and by its broader and wider-spaced ribs.

"*Var. b.*—This is distinguished by the opposite peculiarities, the spire is more elongate, the whorls less convex, the ribs slightly

more flexuous and more delicate. Nevertheless the characters of the base of the body-whorl remain constant in all three forms."

*Dimensions.*—The following are the measurements of the most complete specimen :—

	mm.
Height . . . . .	. 21
Thickness . . . . .	. 10
Height of spire . . . . .	. 13
Height of body-whorl . . . . .	. 15

*Occurrence.*—Gáj of Sind. Blagrove collection, probably from the neighbourhood of Karachi.

*Comparison with other species and remarks.*—By comparing the type-specimens with the recent shells of the collections of the British Museum, it has been ascertained that this fossil is very closely related to the recent species *Nassa hirta* Kiener, and its numerous varieties, (such as *Nassa crenulata* Reeve, *N. nodifera* Powis) and *Nassa scalaris* A. Ad. from the Indian or Malay regions. It is distinguished by its delicate, spiral striations in the intervals between the axial ribs: the related living species either have the intervals smooth as in *Nassa hirta* and *N. nodifera*, or else, as in *Nassa crenulata*, the striations are situated at much wider intervals. *Nassa scalaris* comes nearest the fossil in this respect.

*Nassa verbeeki* Martin from the Pliocene of Java and of Karikal is also very closely related, certain forms being identical in general appearance with d'Archiac and Haime's unfigured variety *a.* judging from the figures, the striations, in the Javanese fossil, just as in the living species, are much wider apart.

NASSA (TELASCO) MEKRANICA n. sp.

. Pl. IX, figs. 10, 11.

Small-medium, with fairly steep, slightly conoidal spire measuring from four-ninths to one-half of the total height.

The small protoconch, missing in the available specimens, is followed by five spire-whorls, the height of which, at advanced stages of growth, is equal to half their width, the proportion being somewhat less at earlier stages, in consequence of the slightly conoidal disposition of the spire. The sutures are somewhat incised. The maximum width of the whorls coincides with their anterior margin, and they exhibit a convexity the curvature of which decreases

in an anterior direction, a disposition frequently emphasized, at advanced stages of growth, by the presence of a slight angulation, close to the posterior margin, communicating to the spire somewhat of a stepped appearance. The whorls are decorated with oblique, axial ribs which are somewhat curved with forward facing concavity, so that they are rather strongly antecurrent to the posterior suture and very steeply retrocurrent to the anterior suture. They are rounded, moderately prominent, much narrower than the intervening spaces. On the earlier part of the spire, their number is, at first, about ten to each complete volution, gradually increasing, in some specimens, to fourteen on the last spire-whorl, or even to as many as sixteen on the penultimate whorl. In other specimens their spacing, at later stages of growth, remains the same as on the early whorls, or they may even become fewer, though maintaining the same prominence on the last spire-whorl, upon which, again, in other instances, they become indistinct, being reduced to mere bundles of lines of growth, or may even disappear entirely. Occasionally some of the axial ribs may swell into ill-defined varices. The axial ornaments are crossed by delicate spiral threads, slightly narrower than the intervening spaces. Their number is six or less on the earlier whorls, increasing to twelve or more on the later whorls, the increase in number resulting partly from the addition of intercalary threads, partly from the disclosing, with increasing growth, of an additional zone along the anterior margin, due to the increase of obliquity of the suture at later stages of growth, in accordance with the slightly conoidal shape of the spire. The most posterior thread immediately encircles the posterior suture to which it communicates its characteristic, somewhat incised, appearance. In consequence of the increase of number of the spiral threads by intercalation, they are apt to exhibit, on parts of the spire, a more or less distinct alternation in two, or even sometimes in three, orders of thickness, but there is always a tendency to equalisation with increasing growth. When the more or less pronounced posterior angulation makes its appearance, the circumsutural thread and the two neighbouring threads occupying the posterior, consequently somewhat stepped portion of the whorls, become more prominent than the other threads. In those specimens in which the ribs disappear on the last spire-whorl, the spiral threads disappear also, with the exception, usually, of the circumsutural thread and the neighbouring threads on the circumsutural, posterior step. The lines of growth

are disposed like the axial ribs, rather strongly antecurrent to the posterior suture, steeply retrocurrent to the anterior suture.

The large body-whorl measures from two-thirds to five-sevenths of the total height. It is sub-cylindrical, with a short posterior step, which, in some specimens, becomes quite horizontal, or even channelled, and with an anterior, somewhat rounded-off angulation bounding a rapidly contracting, somewhat flattened, anterior, basal slope separated by a short concavity from the sharp, narrow, prominent keel which posteriorly circumscribes the zone of accretions to the deep terminal notch. In some specimens the body-whorl may carry some rather wide-spaced axial ribs disposed in the same way as on the spire-whorls over that portion of the body-whorl which forms the continuation of the spire, while anteriorly to the level of the suture they are practically vertical as far as the anterior angulation, anteriorly to which, they recede on the contracting portion of the base upon which they soon disappear. In other specimens there are no axial ribs on the body-whorl. When ribs are present, the entire body-whorl is also decorated with spiral threads which are rather faint over the cylindrical portion, more distinct on the posterior step, and very well-marked, being more pronounced than on any other part of the shell, on the basal contraction and terminal concavity. When there are no axial ribs the spiral ornaments are always absent from the main cylindrical portion of the body-whorl, they are either absent or present on the circumsutural step, and are always well developed on the anterior basal contraction. The lines of growth are antecurrent to the suture, steeply oblique, approximately vertical on the cylindrical portion of the body-whorl, finally receding towards the terminal zone of accretions, across which they form a deep sinus.

The aperture is posteriorly angulated and channelled, anteriorly deeply-notched dorsally. The short vertical columella is anteriorly bordered by a spiral fold, posteriorly to which the specimens, in their present state of preservation, do not exhibit any further folds or wrinkles either on the columella or on the columellar lip. The edge of the columellar lip is well defined, posteriorly adhering to the base, while anteriorly it is detached across the anterior concavity. The outer lip is not completely preserved in any of the available specimens. Judging by the occurrence of occasional varices on the spire and body-whorl, it must be externally thickened in adult specimens, though probably not very prominent.

*Dimensions.*—

	mm.	mm.
Height . . . . .	26	21
Thickness . . . . .	13	12
Height of spire . . . . .	11	11
Height of body-whorl . . . . .	17	15

*Occurrence.*—Mekran beds : eight and a half miles south of Bán, a little to the west of the road to Gwádar, Kandelak-Garuki, eighteen miles north-west by west from Ormara.

*Comparison with other species.*—The resemblance between this shell and the living *Nassa arcularia* [Linn.] (with which *Nassa pulla* [Linn.] appears to be specifically identical), is so close as to cause some doubt as to its distinctness. Judging from available descriptions, the recent shell does not exhibit the more or less pronounced dimorphism of the fossil, and has a rather broader spire. The living *Nassa coronata* [Lamk.] also seems related, but its ribs are anteriorly interrupted in a manner which is not observed in the fossil.

*Nassa son'eiana* Martin from the Tertiary beds of Java. (Samm., des géol. Reichs-Mus., new series, Vol. I, p. 112, Pl. XVIII, fig. 257) referred by Martin to *Eione*, also exhibits some resemblance, but lacks the anterior angulation, and consequently the sub-cylindrical shape of the body-whorl. It is, however, founded on a single specimen, which might be exceptional, so that some doubt may subsist as to its distinctness, especially as the degree of dimorphism in the Mekran shell varies a great deal.

NASSA (ZEUXIX?) CAUTLEYI [d'Archiac and Haim].

1850. *Buccinum reticulatum* Brocchi sec. d'Archiac.—Hist. des progrès de la Geol., Vol. III, p. 206.

1854. *Buccinum cautleyi* d'Archiac and Haim.—Descr. an. foss. gr. numm. Inde, p. 320, Pl. XXXI, figs. 12, 13.

This shell is not represented amongst the collections of the Geological Survey of India

The following is a translation of the original diagnosis :

“Shell fusiform, inflated in the middle, attenuated towards its extremities, consisting of eight slightly convex whorls separated by linear sutures, ornamented with numerous, feebly prominent, flexuous ribs, compressed posteriorly towards the suture, and fading away anteriorly. Equal, equidistant, linear, transverse striations are



observed between the ribs. The body-whorl, the height of which is equal to that of the spire, only carries lines of growth. The concave portion of the base carries seven or eight, unequal, spiral striations followed by a sharp keel extending from the left side to the termination of the canal, succeeded by four or five more similarly disposed striations up to the columella. Columellar lip forming a thick and wide callosity from its junction with the outer lip to the recurved extremity of the canal. The outer lip is missing. Height, 27 mm., diameter of the body-whorl 13 mm.

"Var. *a*.—To this variety is provisionally referred a much shorter shell, with less pointed apex, the flexuous ribs of which remain very distinct as far as the spiral striations of the base."

*Dimensions*.—The following are the measurements of the most complete specimen:—

	mm.
Height . . . . .	27
Thickness . . . . .	13
Height of spire . . . . .	12
Height of body-whorl . . . . .	20

*Occurrence*.—Gáj of Sind.

*Comparison with other species*.—This shell is distinguished from *Nassa falconeri* principally by the conformation of its sutures, which are linear instead of canaliculated. In this respect it recalls *Nassa madiunensis* Martin from the Pliocene of Java. Owing to its resemblance to the Javanese shell, the Indian fossil has been provisionally referred to the sub-genus *Zeuxis*.

NASSA (HEBRA) BONNETI COSSMANN VAR. KACHHENSIS n. var.

Pl. VII, fig. 8.

- 1901 *Nassa (Hebra) bonneti* Cossmann.—Essais Pal. comp., IV, p. 209, Pl. IX, figs. 18, 19.  
 1903. *Nassa (Hebra) bonneti* Cossmann.—Journ. Conch., Vol. L, p. 144, Pl. V, figs. 4, 5.

Small, with moderately broadly conical spire measuring nearly one-half of the total height.

The protoconch, broken in the solitary available specimen, is followed by three convex spire-whorls the height of which is equal to nearly two-thirds of their width, the maximum thickness nearly coinciding with the anterior margin. In consequence of their

convex shape, the whorls are contracted towards the sutures, which are linear. The whorls are slightly angulated not far from their posterior margin. The first spire-whorl following the protoconch carries ten axial ribs, their number increasing to fourteen on the last spire-whorl. They are sub-angular, much narrower than the intervening spaces, slightly curved with forward facing concavity, and slightly oblique, so disposed that they are steeply antecurrent to the posterior suture, practically normal to the anterior suture. On the two first spire-whorls, they are crossed by three, thin, spiral threads, one of which coincides with the angulation, another with the posterior suture, while the third bisects the interval between the angulation and anterior suture and approximately corresponds with the maximum width of the whorls. The space between the middle thread and circumsutural thread is slightly narrower than the spaces between the middle and anterior thread, and between the anterior thread and anterior suture. There are no intercalary threads on the two first spire-whorls. On the last spire-whorl, a fourth main thread becomes partly visible along the anterior margin, being overlapped by the posterior edge of the whorls at earlier stages of growth. Throughout the greater part of the last spire-whorls there are two subsidiary intercalary threads, one in each of the intervals situated anteriorly to the angulation. All the threads swell into small granules as they cross the axial ribs. The very fine, slightly muricated lines of growth follow the same direction as the axial ribs.

The body-whorl measures two-thirds of the total height. It is globular, and its convexity, only broken posteriorly by the angulation continued from the spire, is continuous all over the base as far as the anterior edge where the accretions to the very deep, narrow notch form a scaly, very obliquely winding zone of accretions. On the posterior part of the body-whorl forming the continuation of the spire, the ornamentation is disposed exactly as on the last spire-whorl. The total number of ribs on the body-whorl is nineteen, and they are continuous up to the anterior extremity of the shell, the last rib being swollen into a prominent apertural varix. Anteriorly to the level of the suture, the ribs are, for the greater part of their length, straight, very slightly oblique and anteriorly retrocurrent bending appreciably only at their immediate junction with the terminal zone of accretions. The spiral threads are likewise continued all over the base, where they are rather prominent, all of one size,

constituting anteriorly, almost square meshes together with the axial ribs. As in the case of the spire there are granules at all the points of intersection. The spiral ornaments extend also over the apertural varix upon which the two posterior main threads become rather swollen. The lines of growth are disposed like the axial ribs.

The broadly oval aperture is posteriorly angulated, anteriorly constricted into the terminal notch. Its internal characters are unfortunately obscured by a hard, adhering, rocky incrustation. The slightly oblique outer lip is externally thickened by the swollen last rib.

*Dimensions.*—

	mm.
Height . . . . .	. 9
Thickness . . . . .	. 5.8
Height of spire . . . . .	. 4
Height of body-whorl . . . . .	. 6

*Occurrence.*—Gáj of Kachh : near Warsar ( $23^{\circ} 21'$ ,  $68^{\circ} 49'$ ) north of Jakao ( $23^{\circ} 13'$ ,  $68^{\circ} 45'$ ).

The type is from the Tertiary formation of Karikal.

*Comparison.*—The development of two subsidiary threads upon the last spire-whorls and body-whorl distinguishes the above-described fossil from *Nassa bonneti* Cossm. occurring at Karikal. While in the Karikal type the body-whorl carries eight spiral threads, there are ten in the Kachh specimen; but if we omit the two subsidiary threads, the remainder are distributed as in the type. The distinction may be regarded as merely varietal.

*NASSA (HIMA) VICARYI* [d'Archiac].

1850. *Cancellari vicaryi* d'Archiac.—Hist des progr. de la Géol., Vol. III, p. 291.

1854. *Buccinum vicaryi* d'Archiac and Haime.—Descr. an. foss. gr. numm. Indes, p. 318, Pl. XXXI, fig. 14.

This fossil is not represented in the collections of the Geological Survey of India. The following is a translation of the original diagnosis :

“Shell elongate-oval, turreted, consisting of six whorls ornamented, in their middle and anterior portions, with tubercular axial ribs, the posterior flattened portion of the whorls carrying obsolete folds connecting the posterior end of the tubercles with the anterior part of the ribs of the preceding whorl. The sutures are thus surrounded

by a stepped and crenulated border. The entire shell is covered with very crowded, spiral threads, alternately thicker and thinner, which, on crossing the ribs, rise into transversely elongate tubercles, sometimes pointed, or else foliaceous. On the base of the body-whorl, the axial ribs terminate against a granular, spiral ridge followed by two threads which border the twisted end of the columella. The intervening spaces are occupied by similarly granular, fine threads. Aperture somewhat oval, contracted at its extremities. Apertural lips imperfectly preserved. Canal slightly recurved, dorsally truncated."

*Dimensions.*—

	mm.
Height . . . . .	23
Thickness . . . . .	15
Height of spire . . . . .	12
Height of body-whorl . . . . .	16

*Occurrence.*—Gáj of Sind. Blagrave collection, probably from the neighbourhood of Karachi.

*Comparison with other species.*—In spite of the incomplete apertural characters, this shell has been provisionally referred to the sub-genus *Hima* on account of its extremely close resemblance to the living *Nassa pagoda* Reeve, the incomplete condition of the solitary type being the only circumstance that precludes deciding whether it should be united with the recent form. Compared with *Nassa decussata* Kiener and *N. acuta* Carpenter, both of which are united by Tryon with *Nassa pagoda*, the fossil has the angulation of the whorls situated slightly closer to the posterior sutures. *Nassa angulifera* A. Ad., also united by Tryon with *N. pagoda*, has the angulation situated similarly to that of the fossil, but its costæ are slightly more numerous, the spiral threads slightly less prominent and the carination of the neck less acute.

MUREX (HAUSTELLUM) NARICUS n. sp.

Pl. VII, fig. 13.

Small, shaped like a club or mace, with broadly conical, short spire, the main portion of the shell being sub-spherical, anteriorly continued by a stem which was probably long, narrow, and approximately straight,

The protoconch, imperfectly preserved in all the available specimens, is followed by about five spire-whorls the height of which is equal to two-fifths of their width. The outline is re-entering towards the linear sutures. The shape of the whorls is somewhat hemispherical, sloping moderately in the neighbourhood of the posterior suture, while close to the anterior suture the outline becomes vertical. The surface of the whorls forms a continuous curve at early stages of growth, while, on the last whorl of full-grown specimens, there is a slight angulation situated very slightly nearer to the posterior than to the anterior margin. Each whorl carries three, prominent, rounded varices which do not correspond very regularly from one whorl to another. The intervals between successive varices each carry three prominent ribs usually somewhat narrower than the intervening spaces. On the earliest spire-whorls, these intercalary ribs are usually reduced to two and there is scarcely any difference between them and the varices, so that, at the earliest stages of growth following the protoconch, each whorl carries nine approximately equal ribs. The earlier spire-whorls carry four spiral threads the number of which increases to eight or nine on the last spire-whorl where they partly alternate in two sizes. In those specimens where the outline is slightly angulated, the thread corresponding with the angulation is a little thicker than the remainder. All the threads swell as they cross the ribs and varices. The thickest thread coinciding with the angulation tends to raise small transversely elongate tubercles across the ribs, while, on crossing each varix, it gives rise to a small spine.

The somewhat spherical body-whorl, in its posterior portion forming the continuation of the spire, is shaped like the last spire-whorl. Anteriorly to the level of the suture it contracts rapidly and passes rather abruptly into the terminal stem. The posterior portion forming the continuation of the spire carries the same ornamentation as the last spire-whorl. Anteriorly to the level of the suture the ornamentation maintains the same characters, the varices being continued on the terminal stem, while the intercalary ribs reach the junction of the stem with the convex portion of the base. The rather crowded and very prominent, spiral threads are likewise continued in two alternating sizes over the convex portion of the base and also on the terminal stem on which they alternate very regularly in two or three strongly contracted sizes and become very oblique.

The small, oval to circular aperture is strongly contracted at its junction with the narrow canal. The columella projects slightly at the origin of the canal. The columellar lip forms a detached fold opposite the origin of the canal which it thereby contributes to contract. The outer lip is not preserved in any of the available specimens.

*Dimensions.*—The following are the approximate restored measurements of the largest available specimen:—

	mm.
Total height . . . . .	. 38
Height from apex to origin of stem . . . . .	. 21
Thickness . . . . .	. 16
Height of spire . . . . .	. 9
Height of body-whorl . . . . .	. 32

*Occurrence.*—Nari of Bagothoro Hill in Sind.

*Comparison with other species.*—This shell exhibits the closest similitude to *Murex recurvirostris* Broderip, living in the West Indies and along the western coast of Central America, which appears to be specifically identical with *Murex bantamensis* Martin, fossil in the upper Miocene and Pliocene of Java, and in the Miocene of Burma, and with *Murex bonneti* Cossmann from the Upper Tertiary of Karikal. Judging from the development of the spires and from the characters and ornaments of the spire and body-whorls, the Nari fossil attains the adult stage of growth at much smaller dimensions than *Murex recurvirostris*. At equal dimensions, the spiral threads are rather more prominent, thicker, more sharply defined, more crowded than in the recent shell.

#### MUREX (HAUSTELLUM) TCHIHATCHEFFI d'Archiac and Haime.

1850. *Murex*, indéterminé.—d'Archiac, Hist. des progrès de la Géol., Vol. III, p. 294.
1854. *Murex tchihatcheffi* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 311, Pl. XXIX, fig. 23.
1854. *Murex?* Halli d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 311, Pl. XXIX, fig. 22.
1854. *Murex?* rosméri d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 311, Pl. XXIX, fig. 21.
1856. *Murex cailloti* Petit.—Journ. Conch., Vol. V, p. 87, Pl. II, figs. 1, 2.
- non *Murex tchihatcheffi* d'Archiac nec *Murex ? Tchihatcheffi* d'Archiac and Haime in Noetling, Mem., G. S. I. Vol. XXVII, p. 36, Pl. VIII, fig 5, and Pal. Ind., new series, Vol. , part 3, p. 320, Pl. XXI, figs. 8, 9.

Medium-size to large, with short to moderately slender, conical, rather stepped spire, large inflated body-whorl, and elongate canal.

The relative height of the spire varies a great deal in different specimens owing to its variations in steepness, the apical angle ranging from  $64^{\circ}$  in slender specimens to as much as  $83^{\circ}$  in the more broadly conical ones.

The small, smooth protoconch is followed by six spire-whorls of rapidly increasing dimensions, whose height, in the later whorls, is from one-third of their width in specimens with broadly conical spire, to four-ninths when the spire is relatively slender.

The sutures are linear. The three, earliest, ornamented spire-whorls are relatively taller than the subsequent ones; they are evenly convex while the subsequent ones are angulated, the portion posterior to the angulation sloping at a low angle to the horizontal, while the anterior portion, from the angulation to the anterior suture, is almost vertical, in consequence of which the spire is apt to acquire a somewhat terraced appearance. The whorls, when nearing the later stage of growth, carry five, fine, muricated, equidistant, spiral threads, of which one corresponds with the angulation, while two others are anterior to it, and two posterior. On the early spire-whorls the number is four, of which it is the second, counting from the posterior margin, that later develops into the thread corresponding with the angulation. In large specimens the total number of spiral threads may rise to six, or perhaps seven. There are about twelve undifferentiated, practically vertical ribs on the first ornamented whorl. The following whorl carries nine ribs similar to those of the first. From the third whorl onwards, the axial ornaments become differentiated into varices and intermediate ribs. Each whorl carries three varices which are narrow, moderately prominent, torose. Each interval between two consecutive varices bears two ribs which, on the later whorls, tend to become broad, blunt, and nodose. The ribs are slightly antecurrent from the angulation towards the posterior suture. All the spiral ornaments have a tendency to become more prominent on crossing the varices. The thread running along the angulation develops moderately prominent spires as it crosses the varices, and shorter ones across the intercalary ribs.

The angulation of the spire-whorls is continued upon the body-whorl. The base slopes rather rapidly and with a rather feeble curvature towards the deep excavation of the neck. The stem is elongate somewhat deflected at first towards the left of the shell, afterwards probably approximately straight and approximately vertical. The spiral ornamentation of the base is similar to that of

the spire, with thin, equidistant, muricated threads, without appreciable intercalary threads in their intervals. The intercalary axial ribs become completely effaced from the margin of the base, while the varices continue upon the neck and stem.

The aperture is oval, with a slight posterior angulation or channel, while anteriorly it contracts abruptly into the canal. The columella is almost vertical. The columellar lip is thin, well-demarcated, detached at the origin of the canal where it approaches quite close to the outer lip and afterwards forms the ventral wall of the canal. The outer lip is externally thickened by the last varix; its margin, forming a thin rim round the aperture, is frilled by the terminations of the spiral ornaments. The narrow, elongate canal is at first slightly deflected towards the left of the shell, but afterwards, as mentioned with regard to its enclosing stem, it probably becomes nearly straight and nearly vertical.

*Dimensions.*—The restored dimensions measured on the best preserved specimen are :—

Total height . . . . .	mm.
Height from the apex to the origin of the canal . . . . .	38
Thickness . . . . .	22
Height of spire . . . . .	21
Height of body-whorl minus the canal . . . . .	10.2
Total height of body-whorl . . . . .	16.5
	32

The above specimen belongs to the variety with a wide-angle spire. In another specimen, in which the spire is relatively slender, the thickness is 16.5 mm., and the height of the spire is 14 mm. The specimens figured by d'Archiac and Haime are larger than those at present available in Calcutta.

*Occurrence.*—Gáj beds: Karachi, Blagrave collection and Baker collection.

*Remarks.*—d'Archiac and Haime have described four species of *Murex* from Sind. The first one, *Murex lyelli*, has the appearance of a *Favartia*. Its geological horizon is unknown, and it has not yet reappeared amongst the collections of the Geological Survey of India. As regards the three others, *Murex ichihatcheffi*, *Murex ? romeri*, and *Murex ? halli*, the two latter of which are even of uncertain generic affinity, d'Archiac and Haime mentioned that they may perhaps all three eventually prove to belong to one single species. They are all three poorly preserved, but *Murex ichihat-*



*cheffi* is the best defined. Amongst the old collections of the Asiatic Society of Bengal, at present in the custody of the Geological Survey of India, there are three somewhat immature specimens of *Murex tchihatcheffi* obtained by Major Baker at the same spot, near Karachi, that yielded many of the types of d'Archiac and Haime's monograph, and that show the characters of the species more distinctly than the specimens illustrated in the "Description".

The foregoing diagnosis shows that the relative height of the spire varies considerably. The difference in the height of the spire is the only precise distinction noticed by d'Archiac and Haime between *Murex tchihatcheffi* whose spire is relatively elevated, and *Murex ræmeri* which has a short spire. In the case of *Murex halli*, the spire is also short. In view of the variability now ascertained for the length of the spire, there remains practically no doubt as to the specific identity of *Murex tchihatcheffi* and *Murex halli*. The case of *Murex ræmeri* is more uncertain, for the ribs seem more oblique than in *M. tchihatcheffi* and *M. halli*, and the whorls lack the angulation exhibited by both these types.

*Comparison with other forms.*—It does not seem possible to detect any precise difference between these fossils and *Murex caillieti* Petit, now living on the west coast of Africa. The latter species is regarded by Tryon as a variety of *Murex motacilla* Chemnitz. If this view be adopted, the Indian fossil would also have to be united with *Murex motacilla*.

Amongst fossil species, *Murex sismondæ* Bellardi, from the Miocene of Northern Italy, is extraordinarily similar but seems to have broader spiral threads.

*Note.*—As has already been noticed (Rec. Geol. Surv. Ind., Vol. LI, pp. 274, 275, 285), the specimens from Burma which Dr. Noëling referred to *Murex tchihatcheffi* (*loc. cit. in syn.*) represent a different species which belongs to the section *Muricantha* and has been named *Murex irravadicus*.

#### MUREX (ACUPURPURA) VERBEEKI Martin ?

1893. *Murex verbeeki* Martin.—Samml. des geol. Reichs, Mus. in Leiden, new series, Vol. I. p. 123, Pl. XIX, figs. 278–281.

A specimen in Blagrave's collection from the Gáj of Karachi exhibits the characters of the above-mentioned Javanese species. Some uncertainty remains as to its exact identification, owing to its incomplete state of preservation.

## MUREX (ACUPURPURA) TROSCHELI Lischke.

1809. *Murex troscheli* Lischke.—Jap. Moll., p. 41, Pl. I, figs. 1, 2.

The shape and ornamentation, as well as the grooved sutures, establish the identity of this fossil with the living *Murex troscheli* occurring at the present day, along the coasts of Japan. The angulation of the whorls distinguishes this shell from the closely related *Murex verbeeki* Martin, occurring in the Miocene and Pliocene of Java and in the Miocene of Sind.

*Dimensions.*—The specimens reach handsome proportions, measuring about 110 × 45 mm.

*Occurrence.*—Mekran beds : nodular shales of Ormara (Townsend).

## MUREX (MURICANTHA) IGHINÆ Bellardi.

1861. *Murex rudis* Borson.—Michelotti, Foss. Mioc. inf., p. 118, Pl. XII, fig. 13.

1872. *Murex ighinæ* Bellardi—I moll. dei terr. terz. del Piemonte e della Liguria, part I, p. 49.

1904. *Murex (Haustellum) ighinæ* Bell.—Sacco, I moll. dei terr. terz. del Premontee della Liguria, part XXX, p. 18, Pl. IV, fig. 30.

The available specimens agree in every respect with Sacco's illustration of this species, though it is of much smaller dimensions, not having reached nearly so advanced a stage of growth. In Bellardi's description the axial swellings corresponding with the varices are said not to reach the posterior suture. This is the case only on the body-whorl of full-grown specimens, like the one illustrated by Sacco. This illustration clearly indicates that on the spire-whorls the ribs continue between the angulation and the posterior suture. According to Bellardi, the number of varices in each whorl is from eight to nine. In the Indian specimen, it varies from seven to nine.

Bellardi has classified this species within the section *Haustellum* and has compared it with the Miocene forms *Murex sismondæ* Bell, and *Murex borsoni* Michelotti, both of which are typical *Haustella* with a small number of varices in the intervals between which there are subsidiary costæ. In *Murex ighinæ* there are no costæ other than those corresponding with the actual varices, and the fossil

belongs to the sub-genus *Muricantha*. It is a precursor of the very variable *Murex trunculus* Linn. living in the Mediterranean and Atlantic. one of the principal species used in ancient times for manufacturing the Tyrian purple.<sup>1</sup> Certain varieties of the living shell are practically identical with the fossil except for their somewhat more foliaceous varices. The latter character also distinguishes *Murex hoernesii* d'Ancona, from the Ligurian Pliocene. Broader spiral ornaments characterise *Murex taurinensis* Michelotti, and *Murex subasperrimus* d'Orbigny, both from the Miocene of the neighbourhood of Turin, the latter being moreover distinguished by thicker ribs. The Pliocene *Murex rudis* Bors., and *Murex tapparonii* Bellardi, from the Pliocene of Asti, are both distinguished by their thicker ribs and the want of spines. In the case of the living *Murex rosarium* Chemnitz, from the west coast of Africa, the convexity of the body-whorl, anteriorly to the level of the suture, is more elongate and the spiral ornaments are thicker, while *Murex turbinatus* Lamarck, from the same region, is more spinose.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

<sup>1</sup> Lacaze-Duthiers, Mémoire sur la pourpre (Ann. des sciences naturelles, Zoologie, 4ème série, Vol. XII).

#### MURICOPSIS EXHEXAGONUS nom. nov.

1839. *Fusus* (*Murex* ?) *hexagonus*.—J. de C. Sowerby.—Trans. Geol. Soc. Lond., 2nd ser., Vol. V, Pl. XXVI, fig. 15.  
 1854. *Fasciolaria hexagona* J. de C. Sow.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 306, figs. 11, 12.

Large, tall, slender, with elongate hexagonal-pyramidal spire equal to less than half the total height of the shell, and large body-whorl anteriorly produced into a long, vertical, straight stem.

The smooth protoconch, incomplete in the available specimens, is followed by six spire-whorls the height of which is equal to half their width. They are angulated at about one-third of their height from the posterior margin. Anteriorly to the angulation they are nearly vertical with only a slight convexity; posteriorly to the angulation, the surface is sloping and concave. Each whorl carries three, sharp, narrow, prominent, revolving threads or keels, one of which coincides with the angulation, another with the anterior suture, while the third is situated exactly midway. A somewhat less prominent keel occurs on the posterior slope close to the pos-

terior margin. The posterior slope, at about half-way between the angulation and the posterior main thread just mentioned, carries a group of two or three much finer threads. The suture fits exactly against the anterior side of the anterior main thread and is, consequently, quite inconspicuous, and sometimes even difficult to detect, the posterior main thread of one whorl forming, together with the three keels of the previous whorl, an apparently homogeneous group. All the intervals between the above-described spiral ornaments are occupied by extremely tenuous, revolving, raised lines, of which the one bisecting the interval between two main keels is sometimes a little more prominent than the remainder. Extremely thin, raised lines of growth, antecurrent towards the posterior suture, cover the whole surface, and raise delicate, scaly murications over all the spiral ornaments. Each whorl carries six varices forming broad, rounded ribs which become slightly posteriorly antecurrent to the angulation and flatten out almost completely before reaching the posterior suture. The three main keels swell into horizontally-flattened expansions on crossing the varices, that corresponding with the angulation showing a tendency to rise into spines. The ribs correspond slightly obliquely from one whorl to another, so that the spire has the shape of a very slightly twisted, hexagonal pyramid.

The large body-whorl exhibits an extensive slight convexity in front of the angulation by means of which the surface slopes inward gradually towards the shallow, but well-marked, excavation of the neck which is connected with a long, almost cylindrical, vertical stem. The accretions to the anterior extremity of the canal form a narrow, torose, closely scaly, steeply sloping zone which does not perceptibly bulge dorsally, while anteriorly, it leaves a rather deep, narrow, elongate, umbilical slit along the anterior extension of the columellar margin. The ornamentation of the spire continues unaltered upon the body-whorl. Anteriorly to the three main keels corresponding to those of the spire-whorls, there are three more similar, equidistant keels up to the excavation of the neck. There are six or seven main threads along the stem. As in the case of the spire, fine, intermediate, revolving, raised lines fill all the intervals, the middle one tending to use into a secondary thread in some of the broader intervals, for instance that on the excavation of the neck. The entire surface, up to the anterior zone, is moreover covered, as in the case of the spire, with delicate, crowded lines

of growth likewise determining minute murications as they cross all the spiral elements. The scaly accretions of the anterior zone are crossed by some fine, raised, spiral lines. The varices continue upon the base including the stem, up to the anterior zone of accretions. They are practically vertical over the greater part of the convex portion of the base, they become retrocurrent in an anterior direction over the excavation of the neck, and rather abruptly shifted backward at the origin of the stem along which they resume a straight, slightly oblique course. Each varix is accompanied by one slightly raised foliation, sometimes two. All over the convex part of the body-whorl, the main threads, on crossing the varices, form horizontally flattened expansions in the same way as on the spire, that corresponding with the angulation being particularly prominent. Over the anterior stem, each principal thread raises a short, oliaceous thorn on each successive varix.

The aperture is elongate, leaf-shaped, posteriorly ending in a narrow, slightly posteriorly lengthened channel, anteriorly contracted rather gradually into the canal which has a very narrow, somewhat twisted, ventral slit. The columella is nearly straight and nearly vertical, slightly bulging along the portion corresponding with the aperture proper, that is posteriorly to the origin of the canal. This bulge carries four rather prominent, moderately oblique, spiral folds, three of which, close to the origin of the canal, being close together, the fourth one being situated further apart, nearer to the posterior termination of the aperture. The columellar lip forms a very thin, smooth or slightly wavy lamella, in contact with the shell walls along the margin of the base, and, almost immediately, in an anterior direction, becoming quite detached and extremely prominent for the greater part of its course. Where it follows the canal it winds steeply in a slightly retrocurrent direction together with the canal slit, but without interfering with the straightness of the stem. The outer lip is thickened externally by the last varix, shifted backwards at the commencement of the canal and slightly oblique along the stem, as just described for the columellar lip with which it comes into very close proximity all along the canal. Its internal characters are obscured in all available specimens by a hard, rocky incrustation. The canal is narrow, rather long steeply tortuous, but winding in such a manner that the straightness of outline of the anterior stem is everywhere preserved. Its anterior termination is very narrow.

*Dimensions.*—The following dimensions were measured from an almost complete specimen :—

	mm.
Height . . . . .	57
Thickness . . . . .	25
Height of spire . . . . .	24
Height of body-whorl . . . . .	42

*Occurrence.*—Gáj of Kachh : Teyra River near Rampur (23° 20' 68° 51') Gáj of Sind ; Karachi, Blaggrave collection.

*Remarks and comparison.*—This species was originally determined from an imperfect fragment in Grant's collection from Kachh which G. de C. Sowerby indicated as possibly belonging to the genus *Murex*. d'Archiac and Haime noticed the columellar folds which induced them to refer the fossil to *Fasciolaria*. The surface of the Gáj specimens from Sind is somewhat worn, but Wynne's collection from Kachh includes several specimens in which the murications are beautifully preserved, leaving no doubt as to the affinities of the shell with the Muricidæ. Moreover, the columellar folds are now known to be specially characteristic of the genus *Muricopsis*. *Murex hexagonus* Lamarck is precisely a *Muricopsis*, and therefore Sowerby's specific name is pre-employed both in *Murex* and in *Muricopsis*, and it is proposed to replace it by *ex-hexagonus*.

This remarkably beautiful shell is the largest known species of *Muricopsis*. It is not unlike *Murex cristatus* Brocchi of the Mediterranean and Atlantic, but it is much larger and relatively more slender, with a relatively longer stem ; moreover the Indian fossil has four columellar folds, while only two are described in the Mediterranean shell.

#### RAPANA BULBOSA [Solander].

1817. *Pyrula bulbosa* Solander.—Dillwyn, Cat., II, p. 631.  
 1847. *Pyrula bulbosa* Sol. Reeve, Monograph of the genus *Pyrula*, sp. 14.  
 1880. *Rapana bulbosa* Sol. Tryon, Man. Conch., Vol. II, p. 203, Pl. LXIII, fig. 336.  
 1899. *Rapana bulbosa* Sol. (?) Martin, Samml. des geol. Reichs. Museums in Leiden, new series, Vol. I, p. 133, Pl. XXI, fig. 307.

*Dimensions.*—The solitary available specimen which is probably not full-grown, measures 35 × 30 mm.

*Occurrence.*—Mekran beds : hills bordering the Faleri River west of Gwadar.

*Remarks.*—The fossil agrees in every particular with the Recent form which is common along the coasts of India at the present day. The well-authenticated occurrence of this shell in a fossil condition practically removes what little doubt might have still subsisted regarding the specific identity of the internal cast figured by Martin from the Newer Tertiary beds of Java as probably belonging to this species.

PURPURA (STRAMONITA) ANGULATA Dujardin.

Pl. II, fig. 12.

1837. *Purpura angulata* Dujardin.—Mém. Soc. Géol. Fr., sér. 1, Vol. II, p. 297, Pl. XIX, fig. 4.  
 1903. *Purpura (Stramonita) angulata* Duj.—Cossmann, Essais de Paléoconchologie comparée, Fasc. V, p. 72, Pl. III, figs. 12-13.

Medium-size, biconical, with broadly conical spire measuring half the total height.

The protoconch, missing in the solitary available specimen, is followed by three to four conical spire-whorls, the height of which is equal to three-sevenths of their width. The earlier whorls carry thirteen, steeply oblique, feebly prominent, axial ribs, antecurrent to the posterior suture, retrocurrent to the anterior suture. On the later whorls their number is reduced to seven, and they become accordingly broad. At all stages of growth they are best developed near the anterior margin of the whorls which, consequently, appears somewhat nodulous, fading away towards the posterior margin. At half the height of the whorls is a prominent, spiral thread which swells into flattened nodes at its intersection with the axial costæ. Close to the anterior margin is a similar thread of the first magnitude which also swells into similar, flat nodes on crossing the ribs. Between these two threads, but nearer to the one that marks the middle of the whorls, there runs another principal, spiral thread which differs from those above-mentioned in that it crosses the axial ribs unaltered, without swelling into nodes. It is separated from the middle principal, spiral thread by one thin thread of a second order of magnitude, and from the anterior, nodular, principal thread by two such subsidiary threads. Anteriorly to the anterior, nodular thread, quite close to it and without any subsidiary thread in the interval, there runs another thread of the first magnitude which, however, is frequently concealed beneath the posterior suture of the next follow-

ing whorl. The posterior part of the whorls, upon which the ribs are only feebly developed, is decorated with two principal, spiral threads, one of which coincides with the posterior suture. The interval between these two posterior, principal threads is occupied by one subsidiary thread; two more occurring between the more anterior of the posterior pair of principal threads and the middle, nodular thread. The crowded, delicate lines of growth share the steeply oblique disposition of the ribs.

The large body-whorl measures seven-ninths of the total height. Posteriorly, the portion forming the continuation of the spire shares the conical shape of the spire-whorls. Anteriorly to the level of the suture, the surface contracts also with a conical outline, the shell thereby assuming its characteristic biconical appearance. A slight concavity on the left side of the shell isolates the steeply winding bulge formed by the accretions to the terminal notch, ventrally bordered by a slight, umbilical depression. The posterior portion of the body-whorl bears the same ornaments as the spire-whorls. Anteriorly to the level of the suture, the ribs are continued almost to the anterior concavity. The continuation, on the body-whorl, of the anterior nodose, spiral thread of the spire-whorls, coincides with the angulation which divides the two conical surfaces that constitute the shell. Anteriorly to this thread, and quite close to it, is the continuation of the non-nodular, principal thread which, on the spire-whorls, is frequently concealed by the sutures on the body-whorl, a very minute, subsidiary thread separates it from the nodular thread of the angulation. Anteriorly to it, upon the conical, feebly convex, base, there are four more, principal threads, the broad intervals between which are each occupied by three subsidiary threads. The foremost of these four, principal, basal threads is closely followed by a final ridge, followed in its turn by the broad, steeply winding, convex, rope-like, terminal swelling which also carries some spiral threads. The lines of growth, on the posterior part of the body-whorl forming the continuation of the spire, are steeply oblique as on the spire-whorls. The same obliquity is maintained anteriorly to the level of the suture, the lines becoming curved and more distinctly retro-current anteriorly as they approach the terminal, swollen zone, over which they are strongly diverted backward in accordance with the shape of the accretions to the terminal notch.

The aperture is rather broadly oval-lanceolar, posteriorly channelled, anteriorly contracted into a rudimentary canal leading into the



terminal notch. The columella is posteriorly vertical, merging gradually into the base of the penultimate whorl. Anteriorly to the level at which the twisted zone of accretions penetrates into the interior of the shell, it is bent anteriorly towards the left of the shell. Its anterior extremity is smooth. The middle portion carries a number of steeply oblique wrinkles. The columellar lip is thin posteriorly, not distinctly detached anteriorly. The outer lip is steeply oblique, antecurrent to the suture. Its internal characters are not preserved.

*Dimensions.*—

	mm.
Height . . . . .	. 26
Thickness . . . . .	. 15
Height of spire . . . . .	. 13
Height of body-whorl . . . . .	. 20

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Remarks.*—Taking into account the great variability of the Purpuridæ, there is not sufficient difference between this shell and the European fossil to establish a precise line of specific demarcation. There do not appear to be any very closely related living forms.

PURPURA (THALESSA) MEKRANICA n. sp.

Pl. X, fig. 1.

Medium-large, with somewhat stepped spire measuring one-quarter of the total height, and with large ventricose body-whorl.

The apex is not preserved. The number of whorls following the protoconch is probably about three. Their height is equal to one-third of their width. The sutures are slightly incised. At about two-fifths of their height, measured from the anterior margin, the whorls exhibit a pronounced angulation which corresponds with their maximum thickness. Anteriorly to this angulation the surface contracts rather steeply, while posteriorly it exhibits a double slope due to the presence of a second angulation situated somewhat nearer to the posterior suture than to the main angulation. Between

this second angulation and the suture, the surface is somewhat concave and slopes at a very low angle. The angulations are each accompanied by a prominent, spiral thread which tends to swell, at wide intervals, into scaly spires. A similar, main, spiral thread borders the anterior suture. The surfaces between these main threads are each divided into four spiral bands by well-marked linear incisions. Two, or sometimes three, shallower incisions are also observed on the circumsutural, posterior, concave slope, between the posterior angulation and the posterior suture. The lines of growth are steeply oblique, antecurrent to the posterior suture, retrocurrent to the anterior suture.

The large body-whorl measures six-sevenths of the total height. It is somewhat biconical in shape, the portion posterior to the main angulation being constituted in the same manner as the corresponding portion of the spire-whorls, while anteriorly to the angulation, the surface contracts anteriorly with a moderate degree of curvature and therefore a somewhat conical outline, slightly broken by three more, about equally-spaced angulations one of which corresponds with the main thread which, on the spire-whorls, accompanies the anterior margin. On the right side of the shell, the outline remains convex to its anterior termination, but, on the left side, a rather broad, shallow, but very distinct concavity intervenes between the most anterior angulation and the rather narrow, distinctly bulging zone of accretions of the terminal, narrow notch. Each of the angulations of the body-whorl is accompanied by a spiral thread of which the most prominent are the most anterior of all and the one corresponding with the main angulation of the spire-whorls, both of which show a particularly pronounced tendency to develop scaly projections. All the intervals are divided into spiral bands by spiral incisions similar to those of the spire-whorls and similarly spaced, except on the broad anterior concavity where the spacing is a little wider. An occasional intercalary band may be added on the newest part of the body-whorl. The lines of growth exhibit about the same obliquity as on the spire, the obliquity becoming increasingly retrocurrent anteriorly on the anterior concave zone until they sharply recede into the zone of accretions of the terminal notch. On the later part of the body-whorl, on approaching the suture, they are sharply bent backward into a rather deep sinuosity, the posterior edge of which is practically tangent to the suture, this sinuosity corresponding with the posterior channel of the aperture.

The solitary available specimen only shows the dorsal aspect of the shell, and does not exhibit therefore the details of the aperture which, judging from the outline of the shell and from the direction of the lines of growth, must be large, posteriorly angulated and channelled, anteriorly contracted into a short canal terminated by a narrow, deep, dorsal notch.

*Dimensions.*—The following are the restored measurements:—

	mm.
Height . . . . .	. 48
Thickness . . . . .	. 35
Height of spire . . . . .	. 13
Height of body-whorl . . . . .	. 42

*Occurrence.*—Mekran beds: nodular shales of Ormara.

*Comparison with other species.*—This shell closely resembles *Purpura mancinella* [Linn.] in which the body-whorl carries only four spiral keels instead of the five which characterise the above described fossil.

#### CYMIA SACELLUM [Chemnitz].

1788. *Murex sacellum* Chemnitz.—Conch. Cab., Vol. X, p. 267, t. 163, figs. 1561, 1562.
1846. *Purpura sacellum* [Chemn.].—Reeve, Monograph of the genus *Purpura*, sp. 58.
1848. *Purpura javanica* Philippi. Zeit. Malak., Fünfter Jahrgang, p. 27.
1880. *Cuma rugosa* Bom.—Tryon, Man. Conch., Vol. II, p. 201, Pl. LXIII, figs. 328, 329, 331, 334.
1884. *Bapana carinifera* Lam. var.—Martin, Samml. des geol. Reichs. Mus. in Leiden, ser. I, Vol. III, p. 109, Pl. VI, fig. 110.
1884. *Purpura undatiformis* Martin.—Samml. des geol. Reichs. Mus. in Leiden, ser. I, Vol. III, p. 110, Pl. VI, fig. 111.
1899. *Purpura (Cuma) carinifera* Lam.—Martin, Samml. des geol. Reichs. Mus. in Leiden, new series, Vol. I, p. 136, Pl. XXI, fig. 313.
1903. *Melongena proteiformis* Cossmann.—Journ. Conch., Vol. L, p. 130, Pl. IV, fig. 26, Pl. V, fig. 10.

From the synonymy above recorded, it would appear that some confusion has taken place between this species and *Cymia carinifera* Lamarck, to which a number of Javanese fossils have been

referred, which Professor Martin identified by direct comparison with specimens of Recent shells from the coasts of Java. It is clear however that these specimens all correspond with one or other of the numerous varieties of *Cymia sacellum*, a shell occurring indeed abundantly on the Java coast, after which country one of the living forms has actually been named. None of these shells ever exhibit the very broad, very steep, posterior slope of the whorls which characterises *Cymia carinifera*. Professor Martin has figured several forms without spires which correspond exactly with the non-spirose varieties commented upon by Tryon. Considering the great variability of this species, it seems that the Karikal fossil described by Cossmann as *Melongena proteiformis* may also be referred to *Cymia sacellum* with which it agrees in all essential features.

Lastly, there is a fossil, next to be dealt with, from the Mekran beds, which has been referred by Newton to the genus *Neptunea*, but which the material now available indicates to be a *Cymia* apparently also specifically identical with *Cymia sacellum*.

Perhaps the beautiful *Purpura lineata* [Lamk.] might also represent a variety of the same species.

#### CYMIA SACELLUM [Chemnitz], var. BURROWSI Newton.

1905. *Neptunea burrowsi* R. Bullen Newton.—Geol. Mag., dec. V, Vol. II, p. 300, Pl. XVII, figs. 5-7.

Medium-size, with conical, stepped spire measuring one-third of the total height.

The apex is not clearly visible. The number of spire-whorls following the protoconch is probably three. They are angulated at more than half their height measured from the anterior margin. Posteriorly to the angulation they slope at a moderate angle, while anteriorly the surface is practically vertical. A keel accompanies the angulation while a slight bulge surrounds the posterior suture. Five or six spiral incisions divide the posterior slope into sub-equal, spiral bands, while the anterior, vertical surface is similarly sub-divided by about nine, similar, spiral grooves, wider-spaced towards the middle of the surface than nearer to angulation and to the anterior margin. Posteriorly to the angulation, the lines of growth appear to be steeply oblique and antecurrent to the

posterior suture. Over the anterior, cylindrical surface, they are vertical. They may produce a slight waviness of the surface, but do not give rise to distinct ribs.

The large body-whorl measures six-sevenths of the total height. It includes two conical surfaces, a shorter posterior one, and a longer, steeper anterior one connected by the cylindrical surface representing the continuation of the anterior portion of the spire-whorls. A very feebly median angulation sub-divides the anterior conical surface into two portions of slightly unequal slope. Anteriorly the anterior conical surface grades into a shallow, concave-cylindrical zone of moderate vertical height and transversely rather broad, bordered anteriorly by the rather narrow, bulging, oblique and strongly twisted zone of accretions of the terminal notch. The keel which accompanies the angulation on the spire-whorls is continued on to the body-whorl and is followed anteriorly, at the level of the terminal suture, by a similar keel along the angulation forming the anterior margin of the cylindrical surface. Anteriorly to this angulation, at intervals somewhat narrower than that between the two angulations, there are two other pronounced, spiral keels, one of which coincides with the very feeble angulation that sub-divides the anterior conical surface, while the most anterior one is at the limit of the anterior conical surface and anterior concavity. Some waviness is observed along the two keels bounding the cylindrical surface and also along the most anterior keel, without, however, the formation of definite nodes, except on the posterior angulation, where they show a slight tendency to rise into scales or spires. The spiral ornamentation of the spiral-whorls is continued over the corresponding portion of the body-whorl. Anteriorly to the level of the terminal suture, the whole surface, between the keels, and in the interval between the most anterior keel and terminal twisted bulge, also carries similar, spiral grooves dividing it into bands of somewhat unequal and sometimes more or less alternating width. There are also some indistinct, spiral markings on the somewhat carinated, terminal bulge.

The above described specimen only exhibits the dorsal aspect of the shell, so that the details of the aperture cannot be ascertained. Its anterior termination is nevertheless exposed, indicating that it is anteriorly contracted into a short canal dorsally terminated by a deep, narrow, angular notch deflected towards the left of the shell.

*Dimensions.*—

	mm.
Height . . . . .	37
Thickness . . . . .	24
Height of spire . . . . .	12
Height of body-whorl . . . . .	32

*Occurrence.*—Mekran beds: nodular, calcareous clays of Ormara. (Townsend).

*Remarks.*—The shape and ornamentation of the spire, and the angulations of the body-whorl, leave no doubt as to the identity of this shell with the fossil described by Bullen Newton as *Neptunea burrowsi*. Only, while the anterior part of the shell is imperfectly preserved in the originally described specimen, its disposition is very distinctly seen in the above-described example, in which the deep terminal, strongly deflected, almost transverse, angulated notch completely removes the shell from any possible relationship with the chrysodomidæ and clearly establishes its classificatory position as a *Cymia*.

Its resemblance to the non-spinose forms of *Cymia sacellum* is so complete that it does not seem possible to distinguish it specifically, though the name *burrowsi* may be maintained provisionally as indicating a variety distinguished by its general smoothness, the non-spinose variety *javanica* Phil., exhibiting a vertically disposed waviness not observed in the fossil under consideration. The variety *undataeformis* Martin, from the Tertiary beds of Java, does not seem to be distinguishable from the Mekran fossil except by its much smaller size, but is perhaps founded on an immature specimen.

The removal of this form from *Chrysodomus* (= *Neptunea*) to *Cymia* affords a welcome escape from the difficult physiographical and climatic problem raised by the supposed presence of an arctic shell amidst a fauna of so emphatically torrid a facies as that of the Mekran beds.

## TRITONIUM indet.

A fragmentary, immature specimen in the Blgrave collection from the Gáj of the neighbourhood of Karachi resembles the specimens referred by Martin to *Tritonium (Lampusia) pileare* Linn., and also recalls *Tritonium (Lampusia) olearium* Linn. The columella is not clearly visible, and, pending the discovery of better material the exact subgeneric position of this fossil must remain uncertain, Gáj of Sind. *Occurrence.*

## TRITONIUM (SASSIA) INDICUM n. sp.

Pl. IX, figs. 12-14.

Medium to small, with rather broadly conical spire measuring five-ninths of the total height.

The protoconch, imperfectly preserved in all the available specimens, is followed by four spire-whorls, the height of which is equal to two-fifths of their thickness, the maximum width being situated close to the anterior margin. They are strongly convex so that the somewhat grooved sutures are rather deeply inset. Anteriorly the whorls carry two prominent, spiral threads, one of which is situated at about half the height of the whorls, while the more anterior one coincides with the maximum thickness of the whorl. The spaces between these two threads, and adjacent to the anterior suture are each bisected by a thin, intercalary thread. The posterior slope carries three spiral threads, the spacing of which contracts towards the posterior suture, while their thickness is intermedate between that of the two sets of the anterior portion. The spiral ornaments are intersected by feebly curved, thin, axial ribs, steeply antecurrent to the posterior suture, normal to the anterior suture, whose spacing is wider than that of the two, main, spiral threads, so that a trellis is produced with oblong meshes. Raised granules are observed at their intersections with the two, main, spiral threads. Their number over the greater part of the spire, is about fourteen to each complete volution, dwindling to ten or eleven on the last spire-whorl. The later part of the spire carries some narrow, moderately prominent varies, distributed at intervals of less than one complete volution. The lines of growth follow the same course as the axial ribs, in the intervals between which they may combine with the smaller, spiral elements to give rise to a subsidiary, fine trellis.

The ventricose body-whorl exceeds two-thirds of the total height. It includes a main globose portion connected, by means of a well marked concavity, with the terminal, vertical stem. Posteriorly, the portion forming the continuation of the spire-whorls carries the same ornamentation as the spire. Anteriorly to the two main spiral threads continued from the spire, the convex portion of the base carries four more, principal threads, similarly spaced, slightly decreasing in thickness anteriorly. A thin, intercalary thread is present in each interval. Two more, somewhat closer-spaced

threads occupy the concavity at the junction of the basal convexity and terminal stem, the spaces which they determine not carrying intercalary threads. The terminal stem is covered with crowded, fine, spiral threads sometimes obscurely alternating in two sizes. The axial ribs, anteriorly to the level of the suture, rapidly fade away without reaching the anterior concavity. Their number dwindles to ten or less, and, on the last portion of the body-whorl they are apt to degenerate into ill-defined, broad swellings, or even to disappear entirely. The body-whorl carries one varix situated at  $220^\circ$  from the aperture. The lines of growth, posteriorly, are disposed in the same manner as on the spire-whorls. Anteriorly to the level of the suture, they are vertical.

The rounded-oval aperture is not channelled posteriorly. Anteriorly it is contracted into a narrow canal the greater part of which is missing in all the available specimens, in which, moreover, the characters of the columella and columellar lip are concealed by a hard, adhering, rocky incrustation. At its posterior termination the outer lip is antecurrent to the suture. It is vertical throughout the greater part of its course. Its edge is frilled by the terminations of the spiral ornaments. Externally it is thickened by the terminal varix. Its internal characters are concealed.

*Dimensions.*—

	mm.
Height . . . . .	26
Thickness . . . . .	15
Height of spire . . . . .	14
Height of body-whorl . . . . .	18

The largest available specimen, when complete, must have measured 30 mm. in height.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—Compared with *Tritonium flandricum* de Kon., a common fossil of the Bracklesham and Barton beds of England, occurring also at all horizons of the Oligocene in Belgium, the Paris region, and Germany, the above-described shell appears so closely related as to give rise to considerable hesitation as to whether it should not be specifically united with the western fossil. With regard to its relatively small dimensions it especially closely resembles the English Eocene form. Its somewhat more broadly conical spire distinguishes it from all the figured specimens of *Tritonium flandricum*.



PERSONA RETICULATA [Linnæus] cum var. SUBCLATHRATA  
d'Orbigny et METABLETA Cossmann.

1767. *Murex reticularis* Linnæus.—Syst. Nat., ed. 12, p. 1218.  
 1767. *Murex clathratus* Linn.—Syst. Nat., ed. 12, p. 1223.  
 1776. *Tritonium clathratum* Linn.—Muller, Zool. Dan. Prodr., 243.  
 1805. *Murex cancellinus* de Roissy.—Buff. Moll., p. 56.  
 1833. *Triton constrictus* Broderip.—Proc. Zool. Soc., 5.  
 1840. *Triton clathratum* Linn.—Grateloup, conch. foss. terr. tert. bassin Adour, Pl. XXIX, fig. 12.  
 1843. *Triton clathratum* Linn.—Lamarch, An. Sans vert. sdit. Deshayes, Vol. IX, p. 637.  
 1844. *Triton constrictus* Brod.—Reeve, Monograph of the genus Triton, sp. 41.  
 1844. *Triton cancellinus* Roiss.—Reeve, Monograph of the genus Triton, sp. 45.  
 1844. *Triton ridens* Reeve.—Monograph of the genus Triton, sp. 46.  
 1844. *Triton decipiens* Reeve.—Monograph of the genus Triton, sp. 102.  
 1852. *Triton subclathratum* d'Orbigny.—Prodr., III, p. 77, No. 1420.  
 1870. *Tritonium subclathratum* d'Orb.—Fuchs, Denkschr. k. Ak. Wiss., m.-n. cl. XXX, part 2, p. 175, Pl. 1, figs. 7, 8.  
 1881. *Distorsio cancellinus* Roiss.—Tryon, Man. Conch., Vol. III, p. 35, Pl. XVI, figs. 175-178.  
 1884. *Nassa* (?) *lunonnanan* Martin.—Samml. des geol. Reichs-mus. in Leiden, series I, Vol. III, p. 125, Pl. VII, fig. 128.  
 1899. *Persona reticulata* Linn.—Martin, Samml. des geol. Reichs-mus. in Leiden, new series, Vol. I, p. 145, Pl. XXIII, fig. 336.  
 1903. *Persona metableta* Cossmann, an *Persona cancellina* Roissy. vel varietas?—Journ. Conch., Vol. L, p. 159, Pl. VI, figs. 4, 5.

Medium-size, gibbous and seemingly distorted, with moderately slender spire measuring about one-half the total height, slightly more or less.

The protoconch, imperfectly preserved in all the available specimens, is followed by about six spire-whorls, the height of which averages three-eighths of their width, the maximum thickness being situated at some distance from the anterior margin. The sutures are linear, though deeply inset in consequence of the strong convexity of the whorls. The first two or three whorls following the protoconch exhibit a continuous convexity. With increasing growth they develop an angulation corresponding with the zone of maximum width. The slope between this angulation and the posterior suture tends to become concave. The ornamentation includes both spiral and axial elements. The earliest whorls following the protoconch carry three equidistant, equal, main, spiral threads, of which the more posterior one is situated close to the posterior suture, the more anterior one a little further from the anterior

suture. With increasing growth the two anterior main threads maintain their relative distance from one another, or else come relatively closer together, and combine to form a band coinciding with the characteristic angulation of the later whorls, while the space separating this pair from the anterior margin, and especially that separating them from the posterior main thread show, relatively, a considerable increase; a distinct space also developing between the posterior main thread and the posterior suture. The wide slope thus originating between the posterior thread and the main angulation tends to become slightly concave, the posterior thread still forming, at first, a subsidiary angulation separating it from the posterior suture. On the last spire-whorl of full-grown specimens, the entire slope between the main angulation and the posterior suture, is apt to assume the appearance of a continuous slightly concave surface. Intercalary threads of a second order gradually set in, bisecting each of the intervals, the one between the posterior and middle principal threads being the first one to appear. With increasing growth some minute threads of a third order may also appear, or even, on the broad expanse between the posterior main thread and the angulation, the last spire-whorl of full-grown specimens may show threads of a fourth order, while, at that same stage of growth, between the posterior main thread and the posterior suture, one observes a series of crowded, minute, spiral ripples. Lastly, the main threads themselves, or even sometimes those of the second orders, show a more or less pronounced tendency to break up into bundles of spiral lines, without, nevertheless, losing their distinctness or individuality. The spiral ornaments are intersected by crowded, axial ribs of the same thickness as the main spiral threads, very slightly curvilinear, steeply antecurrent to posterior suture, still more steeply retrocurrent or else normal to the anterior suture. On the earlier whorls their spacing is equal to that of the main spiral threads, so that the trellis thereby produced consists of approximately square meshes. On the later part of the spire, the spacing usually remains equal to that of the anterior pair of main threads, though, in some specimens, they become wider-spaced, sometimes very much so, on the last spire-whorl; the extent of this change varying a great deal in different specimens, in some of which it does not occur at all. There are nodules at all the intersections with the main spiral threads. The crowded, delicate lines of growth are disposed like the axial ribs. The inconspicuous varices succeed

one another at intervals of about two-thirds of a volution. They have the appearance of a slightly thickened and broadened rib, accompanied, on the forward side, by a few crowded, slightly, crispate lines, the junction of which with the posterior suture is rather more antecurrent than that of the normal lines of growth. A narrow groove borders each varix dorsally. On the earlier spire-whorls the presence of the varices does not in any way affect the regularity of outline. At later stages, from a point situated about  $180^\circ$  behind each varix, the suture, as it is followed towards each varix, first exhibits a considerable increase of obliquity, which subsequently decreases, and is lastly replaced by an obliquity in the opposite direction, the suture reaching the varix with an upward trend towards the apex of the shell. At the same time, the surface of the whorl, on approaching the varix, becomes strongly flattened. Immediately beyond the varix, the suture abruptly resumes its normal obliquity, and the surface becomes strongly swollen to counterbalance the flattening behind the varix. It is this alternate flattening and swelling that communicates to the later part of the spire its characteristic gibbous appearance, while the changes of obliquity of the suture produce the distorted appearance generally misinterpreted as caused by supposed changes in the direction of the axis. Irrespective of the individual variations in average spacing above alluded to in the case of the later portion of the spire, the ribs are relatively wider apart on the gibbous than on the flattened portion\* of the whorls.

The large body-whorl measures from three-fifths to five-eighths of the total height. In consequence of the structures above described for the later part of the spire, it is dorso-ventrally flattened, and gibbous on the left side. Its outline, on the right side, exhibits a continuous, convex curve, while, on the left side, a short concavity intervenes between the gibbous convexity and the terminal, somewhat tortuous stem deflected anteriorly towards the right of the shell. The posterior portion of the body-whorl, forming the continuation of the spire, exhibits the same shape and the same ornamentation as the later spire-whorls. Anteriorly to the level of the suture, the convex portion of the base carries usually six, or, occasionally, only five, main, prominent, spiral threads separated from one another by equal intervals which are somewhat narrower than the interval between the more posterior of the group and the more anterior of the pair of main threads accompanying the angulation

The anterior concavity corresponds with a relatively broad interval, anteriorly to which the neck carries two more main threads spaced like those of the basal convexity, and followed by a few more principal threads of decreasing thickness distributed at close intervals. All the intervals are occupied by variously distributed, subsidiary, spiral threads of various orders, crowded, but not conspicuous. As in the case of the last spire-whorl, the axial ribs may either be distributed at the same intervals as on the earlier part of the spire, or else they may become much wider-spaced. They persist up to the anterior extremity of the shell, their course being vertical from the level of the suture to the anterior concavity beyond which they become anteriorly retrocurrent. Their prominence and thickness decrease a great deal anteriorly to the level of the suture; nevertheless, their course is well accentuated by the conspicuous nodules which they raise at their intersections with the main, spiral threads. On the posterior part of the body-whorl, forming the continuation of the spire, the lines of growth are disposed in the same manner as on the spire-whorls. Anteriorly to the level of the suture, they are, like the axial ribs, vertical over the convex portion of the base. Anteriorly to the anterior concavity, they gradually become increasingly retrocurrent, and finally transverse, with a continuous curvature, indicating that the anterior extremity has no notch. At about  $260^\circ$  from the aperture (for about  $100^\circ$  if measured ventrally) the body-whorl carries a varix generally concealed by the columellar lip with the exception of its posterior termination.

The tall, narrow, irregularly triangular aperture exhibits posteriorly a rather broad, shallow channel, while anteriorly it is contracted into a short, narrow canal anteriorly oblique towards the left of the shell, in the opposite direction therefore of the dorsal aspect exhibited by its outer surface. The anterior portion of the columella is straight and steeply oblique anteriorly towards the left of the shell. At its junction with the base of the penultimate whorl it is deeply concave and, at the same time, considerably sunken into the ventral surface. The anterior portion, all along the edge of the aperture, as far as the terminal canal, carries a narrow ridge bearing nine ledges or crenulations which become gradually smaller in an anterior direction. There are also two or three ledges across the sunken concavity at the junction with the base of the penultimate whorl, but they appear to be outgrowths of the columellar lip rather than of the true columella. The columellar lip is

very thin, the main ornaments of the base all clearly appearing through its substance, but it spreads broadly over the ventral surface entirely covering the penultimate varix with the exception of its posterior termination. Its edge, though not detached, is distinctly demarcated, and carries, anteriorly to the anterior concavity of the body-whorl, five or six wrinkles which are apparently succeeded, posteriorly, at some distance from the edge, by the above mentioned ledges of the sunken portion of the columella. Close to the posterior termination of the aperture, there is also a prominent, slightly oblique ledge, which contributes to define the posterior channel. The outer lip, at its posterior termination is somewhat antecurrent to suture and merges into the edge of the broadly spreading columellar lip. It is feebly sinuated posteriorly by the posterior channel, and, throughout the greater part of its length, is straight and vertical. Its inner edge, along the border of the aperture carries nine, sharply defined, thin ledges, of which the most posterior one contributes to circumscribe the posterior channel while the most anterior one indicates the commencement of the terminal canal. The third ledge, counting from the posterior end, is especially prominent and juts out opposite the sunken concavity of the columella. The outer edge of the outer lip, on its ventral aspect, also carries a row of wrinkles, separated by a smooth zone from the internal ledges. Externally, the outer lip is slightly thickened by the terminal varix.

*Dimensions.*—

	Bhagothoro.	Kachh.	Myaungu (Burma).
	mm.	mm.	mm.
Height . . . . .	30	40	41
Thickness . . . . .	18	23	26
Height of spire . . . . .	16	18	18
Height of body-whorl . . . . .	18	25	26

*Occurrence.*—Nari of Bhagothoro Hill in Sind Gáj of Kachh : one mile east of Syra or Sainra (23° 26', 68° 57') near Kotara.

The species also occurs both in the Oligocene and Miocene beds of Burma, in the Newer Tertiary beds of Karikal, and in the Upper Miocene and Pliocene of Java.

*Remarks and Comparison.*—After taking into the most careful consideration all the accessible facts in connection with these interest-

ing shells, the conclusion forces itself upon us that it is quite impossible to distinguish specifically the Indian fossils from the living shells, at least from those occurring in the Indian seas and constituting the race or variety *cancellina* de Roissy.

A few words are necessary to justify and explain the above recorded synonymy. The Indian shells agree in every respect with the description which Fuchs has published of an Oligocene fossil from Santa-Trinitá in the Vicentino, regarded as identical with a form occurring in the Oligocene of Gaas and Lesbarritz in south-western France, which Grateloup considered to be specifically identical with the recent species from which it was separated by d'Orbigny under the name of *Triton subclathratum*. Fuchs' description is accompanied by an illustration representing a specimen from Gaas, with which the Oligocene specimen from Bhagothoro agrees particularly closely. It may even be noticed that the Gaas specimen figured by Fuchs, like the Bhagothoro specimen here described, carries only five main spiral threads on the basal convexity. Only, while in the Miocene of southern France, and in the Miocene and Pliocene of Piedmont and of Liguria, this form is succeeded by the specifically distinct *Persona tortuosa* Borson, the genus having now disappeared from the Mediterranean and adjacent Atlantic region, it continues, practically unchanged in the Miocene of India and survives without any essential alteration throughout the eastern hemisphere at the present day. The form described by Cossmann from the Pliocene Karikal as *Persona metableta*, and regarded as possibly only a variety of the living species, coincides in every respect with the other Indian fossil specimens. It is true that, on very close inspection, it is possible to distinguish between the Oligocene and Miocene specimens; so far as can be judged from the material at present available, the contrast in thickness between threads of the first and other orders is a little more pronounced in the Miocene than in the Oligocene specimens; this is accompanied by a greater tendency, in the Oligocene specimens, for the main threads to break up into bundles of component fine lines; the intercalary threads also appear first at rather an earlier stage in the Oligocene specimens.

In Recent Indian shells from the Andamans, Vizagapatam, Puri, there is sometimes a tendency for the contrast between the primary and other threads to be still more pronounced than in the Miocene specimens. In rare instances the basal convexity carries seven

main threads instead of six as appears to be invariably the case with the Indian Miocene specimens. Shells collected in 28 to 30 fathoms of water off the Ganjam coast exhibit a group of three close-set threads on the anterior concavity instead of this region being occupied by a relatively broad interval as in all the other Recent and fossil examples. The length of the terminal canal varies a great deal in the recent specimens without its ever becoming truly elongate; the variations taking place independently of the size of the individuals. The angulation of the whorls first becomes distinct perhaps at a slightly more advanced stage of growth in the Recent than in the fossil specimens. The same variations in the spacing of the ribs on the last spire-whorl and body-whorl are observed in the living shells and in the fossil ones.

If it were so desired, the Oligocene form might be distinguished as *var. subclathrata* d'Orbigny, the Miocene form and the living Indian form as *var. cancellina* de Roissy, but the differences are of a trifling and fleeting character, and certainly not of specific value; at most can they be regarded as mutational races, not ranking even as true varieties.

As noticed by Fuchs, the above-described shell is very closely related to the European Miocene and Pliocene form *Persona tortuosa* [Borson] (= *Triton personatum* de Serres) which shares the angulation of *P. reticulata*, but in which the ornamentation is much less sharply delineated, the spiral threads and axial ribs frequently becoming broadened and flattened out till they lose all distinctness, their place remaining indicated principally by the broad, nodular swellings at their intersections. It is also more gibbous than *Persona subclathrata*, besides its frequently attaining much larger dimensions. According to Fuchs, its columellar lip is apt, also, to be more callous.

In conclusion, we have here a most interesting instance of a form which originated either in the eastern seas, or at least in the combined Indo-Mediterranean of Tertiary times, as early as the Oligocene, and that has survived up to the present day, with scarcely any alteration all over the Indian and Pacific Oceans as well as the Caribbean Sea, thanks, no doubt, to the uniformly unchanged conditions of that vast area, while, in the western seas, the physical and climatic changes inaugurated with the advent of the Miocene, influenced its characters much more profoundly, leading eventually to its extinction.

## HINDSIA NIVEA [Gmelin.]

1790. *Buccinum niveum* Gmelin.—Syst. Nat. 3504.  
 1844. *Triton niveus* Gmel.—Reeve, Monograph of the genus Triton, sp. 75.  
 1844. *Triton carduus* Reeve.—Monograph of the genus Triton, sp. 95.  
 1881. *Nassaria nivea* Gmel.—Tryon, Man. Conch., Vol. III, p. 221, Pl. LXXXIV,  
 figs. 535-538.  
 1883. *Hindsia affinis* Boettger.—Palæontographica, Suppl. III, 2nd part, p. 41,  
 Pl. II, fig. 6.

This beautiful species, the genotype of *Hindsia*, occurs abundantly as a living shell, all round the Bay of Bengal. *Hindsia affinis* Boettger, from the Miocene of Sumatra, appears to be specifically identical. From a comparison of a fine series of specimens from the coast of Vizagapatam and from the Gulf of Martaban, in the collections of the Indian Museum, it has been found impossible to rely on any of the characters enumerated by Boettger as differentiating the solitary specimen of *H. affinis* from *H. nivea*, such as peculiarities in the shape or proportions of the spire, body-whorl, canal, or aperture, the number of ribs, the presence of intercalary, spiral threads, or differences in the degree of prominence of the intersection nodes; even the absence of varices, upon which Boettger laid special stress, is matched by some of the specimens from the Gulf of Martaban, in which they differ so little from the normal ribs as to be practically undistinguishable.

The Oligocene of Sind contains two fossil forms, both evidently belonging to a single species, both of which it will be convenient to treat as varieties of *Hindsia nivea*.

## HINDSIA NIVEA [Gmelin] var. NARICA n. var.

Pl. VI, figs. 11-13.

Small-medium, with broadly conical spire equal to half the total height, and with globose body-whorl ending anteriorly in a short stem.

The very small protoconch which, in all the available specimens, is incomplete, is followed by five spire-whorls the height of which is slightly less than two-fifths of their width, the maximum thickness coinciding approximately with the anterior margin. Although the convexity of the whorls is slight, the linear, wavy sutures, nevertheless, seem impressed in consequence of the disposition of the raised, spiral decoration. The whorls bear four, principal, sharply defined, spiral threads of which the two hindmost are closer together



than the others. A space intervenes both between the most anterior and most posterior thread and the respective neighbouring sutures. Each interval is bisected by a very fine, intercalary thread. The spiral ornaments are intersected by numerous, broad, axial ribs, slightly narrower than the intervening spaces. They are very feebly oblique and still more feebly curved, the retrocurrent obliquity to the anterior margin being slightly steeper than the antecurrent obliquity to the posterior suture. Their number is about ten to one complete volution in the portion of the spire immediately following the protoconch, and gradually increases to as many as seventeen on the last spire-whorl. The spiral threads swell slightly as they cross the axial ribs. The fine, crowded lines of growth follow the same disposition as the axial ribs. Some of the axial ribs swell into rather inconspicuous varices. There are about three of these varices to each whorl, distributed at rather uneven intervals.

The body-whorl, equal to three-fourths of the total height, is inflated, globose, convex as far as the rather marked excavation marking off the very short neck. The zone of accretions of the anterior extremity of the canal forms a conspicuous, though feebly prominent, strongly-twisted bulge, covered with close-set, spiral keels. The body-whorl with the base, including the anterior concavity, is ornamented, like the spire, with two sizes of threads alternating fairly regularly; in the intervals between the primary and secondary threads, one sometimes notices still finer threads of a third order of importance. The axial ribs exhibit the same characters as on the spire-whorls, their number increasing to as many as twenty. They extend anteriorly as far as the anterior bulge. They become retrocurrent on the anterior concavity, so that their general outline on the body-whorl is sigmoidal. The crowded lines of growth raise extremely delicate granulations at their intersections with all the spiral ornaments. On the terminal bulge they are sinuous in accordance with the outline of the shallow notch at the extremity of the canal. The body-whorl carries an inconspicuous varix at about  $240^{\circ}$  from the aperture.

\* Owing to their close proximity to one another, and to their situation on the least sloping portion of the whorls, the two posterior threads, as an effect of foreshortening, necessarily appear partly to overlap one another in a vertical view of the shell. Nevertheless, they are quite distinct in M. Mémier's beautiful photographs. Unfortunately it has not been possible to reproduce the plates in collotype, and many of the finer details are inevitably lost in the half-tone process. Hence, in the reproductions herewith published, the spire-whorls seem to carry only three spiral threads.

The aperture is oval, anteriorly contracted into the rather short canal which is deflected towards the left of the shell, and dorsally notched at its termination. The columella is convex where it meets the twisted anterior bulge. The columellar lip is not expanded over the base; it is well demarcated, anteriorly detached, with the consequent formation of an umbilical slit between its raised edge and the anterior twisted bulge. The internal details of the columella and columellar lip are obscured by an adhering, hard, rocky incrustation. The outer lip is antecurrent to the suture and is straight and oblique with an anteriorly retrocurrent disposition. It is internally denticulated. Externally, the ribs, on approaching the aperture, become broad and flat, and, at the same time thickened and more or less confluent thus giving rise to a broad, raised zone without the individualisation of a distinct apertural varix.

*Dimensions.*—

	mm.
Height . . . . .	17
Thickness . . . . .	10
Height of spire . . . . .	9
Height of body whorl . . . . .	12

The shell also reaches larger dimensions up to 19 × 12 mm.

*Occurrence.*—Nari of Sind: Bhagothoro Hill.

*Comparison with other forms.*—This shell is slightly smaller than the recent form of *Hindsia nivea*, and its spiral threads are rather thicker and more prominent, the threads of the second order appearing first at a somewhat earlier stage of growth.

*HINDSIA NIVEA* [Gmelin] var. *BHAGOTHORENSIS* n. var.

In this variety the spire-whorls carry only three main, spiral threads instead of four. On the body-whorl the decoration consists of a very elegant lattice with square meshes caused by the remarkably equal spacing of the main axial and spiral ornaments, with the production of distinct, raised granules at the points of intersection. The intercalary threads are much finer than in the variety *narica* so that they cannot be detected without the help of a lens. Each interval between the main, spiral threads contains at least one extremely fine, intercalary thread, while each interspace between the axial ornaments contains from one to three fine, raised lines of growth of exactly the same thickness as the intercalary threads.

Consequently a second, extremely fine latticed structure is developed within the meshes of the main lattice. In all other characters, this variety agrees with the one previously described.

*Dimensions.*—

	mm.
Height . . . . .	12
Thickness . . . . .	7.2
Height of spire . . . . .	6
Height of body-whorl . . . . .	9

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

HINDSIA GRANOSA [J. de C. Sowerby].

1840. *Fusus* ? *granosus* J. de C. Sowerby.—Trans. Geol. Soc. London, 2nd series, Vol. V, Pl. XXVI, fig. 12.
1854. *Banlla viperina* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 310, Pl. XXX, fig. 2.
1854. *Triton davidsoni* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 312, Pl. XXX, fig. 3; (*non Cancellaria davidsoni* d' A. and H., in Noetling, 1901, Pal. Ind., new series, Vol. I, part 3, p. 331, Pl. XIX, fig. 23, Pl. XX, fig. 1).
1838. *Tritonium batarianum* Martin.—Samml. de- Geol. Reichs.-Mus. in Leiden, 1st ser., Vol. III, p. 134, Pl. VII, fig. 135.

Small, with slightly conoidal, moderately slender spire, exceeding half the total height.

The small protoconch is shaped like a *Turbo* and consists of a minute, button-shaped, prominent nucleus and of three smooth, convex whorls. It is terminated by a curved rib, with forward-facing concavity, normal to the posterior suture, very obliquely antecurrent to the anterior suture. It is followed by five spire-whorls, the last of which has a height equal to half its thickness, the relative height being a little less at earlier stages of growth in consequence of the slightly conoidal disposition of the spire. The maximum thickness is situated close to the anterior margin. The wavy sutures are impressed in consequence of the contraction of the surface of the whorls towards both margins. The earliest part of the first whorl following the protoconch continues the convex outline of the terminal portion of the protoconch, and carries a few thin, curved ribs analogous to the rib terminating the protoconch. The profile, from this continuously convex curvature, soon alters to a broken line, with two angulations, each marked by a spiral thread. Between the two spiral threads, the surface forms a very steep

slope, almost vertical. From both angulations it contracts rapidly towards the respectively neighbouring sutures. On the second whorl, an additional primary thread appears on the posterior slope, while the posterior angulation disappears. The profile now exhibits only one angulation, anteriorly situated and corresponding with the original anterior angulation, anteriorly to which the surface contracts rapidly towards the anterior suture, while posteriorly to the angulation it forms a continuous curve as far as the posterior suture. On the third or fourth whorl two more main threads appear in the spaces respectively adjacent to the anterior and posterior suture. Lastly, on the last spire-whorl, in consequence of a slight increase of obliquity of the suture, yet another main thread appears along the anterior margin. At this stage, there are six main, spiral threads, of which the two posterior ones form a closer-spaced pair than the remainder, the more posterior of the pair being almost adjacent to the suture. Over the greater part of the spire, the thread accompanying the original anterior angulation remains a little thicker than the remainder; towards the end of the last spire-whorl, the angulation disappears, and the corresponding thread becomes equalised with the others. Minute, crowded, spiral lines occupy the intervals. In some specimens one thread of a second order may appear in the interval posterior to the main thread corresponding with the original anterior angulation. The spiral ornaments are intersected by axial ribs. With the exception of the first few transitional ribs immediately following the protoconch, these axial ribs are thicker than the spiral threads. They are sharply defined and very slightly curved steeply anterior to the posterior suture, normal to the anterior suture. In the earlier part of the spire, their number is nine to each complete volution, increasing to twelve on the last spire-whorl. In each whorl two of the ribs swell into inconspicuous varices, sometimes corresponding in position from one whorl to another, in which case the arrangement recalls that observed in a *Ranella*. The spiral threads, at their intersections with the axial ribs, swell into elongate granules. The lines of growth are very indistinct and are disposed like the axial ribs.

The body-whorl measures two-thirds of the total height. It consists of a spherical main portion anteriorly followed by a rather short stem, the transition to which is not abrupt. The zone of accretions to the moderately oblique zone of accretions to the terminal notch does not form a distinctly bulging surface respect-

ively to the remainder of the terminal stem, although the actual edge of the notch is slightly deflected, spout-like, dorsally. The spiral ornaments of the last spire-whorl are continued over the corresponding posterior portion of the body-whorl. Anteriorly to the level of the suture, there are four more, similar, main, spiral threads on the basal convexity and two more on the terminal stem, the spacing remaining consistently even. In some specimens, some of the intervals are bisected by threads of a second order. The minute, spiral striations described in the case of the spire, are also visible in the intervals all over the body-whorl. The number of axial ribs, on the body-whorl, increases to eighteen. They are therefore relatively closer-spaced than on the spire, the spacing, consequently, not greatly exceeding that of the main, spiral threads even on the broadest portion of the shell, so that the entire body-whorl is covered by a remarkably elegant trellis of almost square meshes, with raised granules at the points of intersection. In an anterior direction, the ribs maintain their full strength as far as the edge of the terminal zone of accretions. Their direction, on the posterior part of the body-whorl is the same as already described in the case of the spire-whorls. Over the convexity of the base their trend is practically vertical. Over the anterior concavity and anterior stem, they become steeply retrocurrent anteriorly, consequently, their total shape, on the body-whorl, is very elongately sigmoidal. A moderately prominent varix accompanies the aperture. A second, much feebler varix is situated at  $180^{\circ}$  from the aperture. The terminal zone of accretions carries about six, more or less rugose, spiral threads of variously alternating thickness. The lines of growth, over the greater part of the body-whorl, are very inconspicuous and disposed like the axial ribs. On the terminal zone of accretions they become more distinct, slightly scaly, and form a sinus in accordance with the shape of the terminal notch. The aperture is oval-lanceolar, with a posterior channelled angulation, anteriorly contracted in a rather short canal, very narrow at its origin and widening anteriorly, obliquely deflected anteriorly towards the left of the shell, and at the same time moderately deflected dorsally, terminated by a shallow dorsal notch. The columella forms a projecting angulation opposite the origin of the canal. Posteriorly to the angulation it is concave and merges into the base of the penultimate whorl. Anteriorly to the angulation, it is oblique towards the left of the shell in accordance with

the disposition of the canal. A thick, slightly bifid fold accompanies the angulation. The columellar lip is thin, narrow, with a prominent detached edge, and carries a number of prominent, thick ledges all along its course between the origin of the canal and the posterior channel. The most posterior of these ledges is particularly prominent and elongate, and contributes to demarcate the posterior channel. The outer lip is steeply antecurrent to the suture and maintains this obliquity as far as the level of the main, spiral thread corresponding with the original anterior angulation. Anteriorly to this point, it is, at first, for a considerable distance, vertical, and finally anteriorly retrocurrent towards its anterior termination. It has a thin, narrow, prominent edge, frilled by the terminations of the spiral ornaments. Externally it is thickened by the last varix. Internally it carries prominent transverse ledges or denticulations.

*Dimension.*—

	mm.
Height . . . . .	17
Thickness . . . . .	9
Height of spine . . . . .	9
Height of body-whorl . . . . .	11

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45'); Gáj of Sind, Karachi (Blagrave and Baker collections).

*Remarks.*—The characters of this species are so well defined that there is no risk of confounding it with other shells with which, therefore, a detailed comparison is superfluous.

The greatly weathered specimen figured by d'Archiac and Haime as *Ranella viperina* seems to be a large individual of the above-described species. The ranelloid varices shown on the figure are a restoration and cannot be distinctly recognised on the original specimen. Associated with the numerous specimens of *Hindsia granosa* and *Triton davidsoni* in Blagrave's and in Baker's collections, are imperfect fragments of *Ranella bufo* Sow., the early whorls of which closely resemble case of *Hindsia granosa* and may have influenced the authors of the "Description" in interpreting some of the specimens as representing a species of *Ranella* different from *R. bufo*, which they have not recorded amongst the Sind fossils, though present, in imperfect specimens, amongst the material which they studied.

The Burmese shell identified with the above described shell by Noetling, first under the name of *Triton davidsoni* (1895, Mem.,

Geol. Surv. Ind., Vol. XXVII, part 1, p. 29, Pl. VI, fig. 6), and later as *Cancellaria davidsoni*, is also a *Hindsia*, but differs greatly from the shell under consideration in consequence of its much more globose shape and its more numerous and rather more prominent varices. It may be distinguished as *Hindsia birmanica*.

The diagnosis and illustrations of *Tritonium batavianum* from the Tertiary beds of Java, published by Martin, agree in every point with the characters of the Kachh and Sind fossil.

### HINDSIA MEKRANICA n. sp.

#### Pl. VII, figs. 1-3.

1903. *Hindsia tjemorocensis* Martin *see*. Coşsmann.—Journ. Conch., Vol. L, p. 158, Pl. VI, figs. 2, 3.

1903. *Hindsia tjemorocensis* Martin *see*. Coşsmann.—Essais de Paléoconchologi, comparée, fasc., V, p. 106, Pl. V, fig. 3.

Medium size, fairly slender, with conical spire measuring one half to three-fifths of the total height, and somewhat globular body-whorl contracted anteriorly into a rather short stem.

The small, somewhat naticoid protoconch is followed by about six, moderately convex, spire-whorls, the height of which is equal to three-sevenths of their height. Their convexity is so disposed as to give them a slightly bulbous shape, the greatest width being at a short distance from the anterior suture so that they contract slightly towards the anterior suture, the surface sloping more obliquely towards the posterior suture. Each whorl carries three, prominent, equidistant, revolving threads. The interval between the last main thread of one whorl and the first of the next is broader than the interspaces between the threads of one whorl so that the sutures, which are linear and wavy, appear to lie embedded along the floor of a revolving trough. Subsidiary threads bisect the interspaces between successive main threads as well as those between the main threads and the sutures. The spiral ornaments are crossed by slightly oblique straight ribs, the obliquity being so disposed that they are retrocurrent towards the anterior suture. They number ten to twelve in each whorl and form continuous, slightly oblique series from one whorl to the next. On each whorl two of these ribs thicken into a varix, though, as a general rule, the varices are not conspicuous and can scarcely be detected in some

specimens. At every intersection with the ribs, the main threads rise into lamellar nodes.

The body-whorl, measuring from five-ninths to two-thirds of the total height, is spherical or ovoid according to the varying degree of elongation of the specimens. It is connected by a moderately broad concavity with the terminal stem which is moderately long, straight and vertical. The zone of accretions to the terminal notch forms a flattened, projecting, obliquely-twisted bulge. The posterior portion of the body-whorl, forming the continuation of the spire, is decorated, like the spire-whorls, with three principal, spiral threads and intercalary secondary threads. Another, equally-spaced, principal thread coincides with the level of the suture, and three more, equal and equally-spaced, main threads occupy the convexity of the base. After a slightly wider interval another main thread is developed in the anterior concavity exactly at the line of junction of the main portion of the body-whorl and of the terminal stem, and there are three more of such threads on the terminal stem. As on the posterior part of the body-whorl, so also anteriorly to the suture, each space generally carries one thread of a second order, with an occasional thread of the third order. Four or five slightly rugose, raised, spiral lines, angular and narrower than the intervening spaces, decorate the terminal, twisted bulge. The axial ribs maintain the same characters and the same spacing as on the spire-whorls, with only, in a few specimens, a slight tendency to become a little narrower. They are posteriorly oblique and retrocurrent from the posterior margin to the level of the suture anteriorly to which they are vertical as far as the anterior concavity. They become indistinct on the terminal stem where they are replaced by lines of growth, curved and increasingly retrocurrent towards the terminal bulge which they cross with a sinuosity disposed in accordance with the shape of the terminal notch. As in the case of the spire, the spiral threads swell into elongate nodes on crossing the ribs. In addition to the strong apertural varix, the body-whorl carries a second prominent varix situated usually at about  $180^\circ$  from the aperture, sometimes a little less, occasionally much more, in which case it may come to be orthogonal to the aperture, on the ventral surface.

The aperture situated in an approximately vertical plane is unsymmetrically oval-lanceolate or almost semi-circular, the columellar lip being often almost rectilinear. Anteriorly it contracts



abruptly into the very narrow canal which is almost closed ventrally moderately elongate, deflected and twisted dorsally, anteriorly deflected towards the left of the shell, curved, with concavity facing towards the left of the shell, terminated by a shallow flattened dorsally protruding notch. The columella forms a moderately protruding, angular bulge close to the origin of the canal. Posteriorly to this angulation it is nearly vertical with a feeble concavity merging into the base of the penultimate whorl. Anteriorly to the angulation it is concave and anteriorly deflected towards the left of the shell, in accordance with the shape of the canal. A strong, spiral fold accompanies the angulation.

The columellar lip and outer lip form a thin, raised margin round the aperture. The columellar lip is thin posteriorly, slightly expanding over the base, anteriorly detached along the neck and leaving an umbilical slit between its raised edge and the anterior bulge. It is transversely ridged along the oval of the aperture and is also rugose along the canal. A conspicuous, spirally elongate ridge rises quite close to the junction with the outer lip, constituting a channel or groove at the posterior termination of the aperture. The outer lip is externally thickened by the last varix. It constitutes, round the margin of the aperture, a thin, raised rim frilled by the termination of the spiral ornaments. Interiorly it bears transverse ledges of two alternating sizes, of which the most posterior one is the most prominent, and contributes to define the posterior channel.

*Dimensions.*—The following dimensions were measured on three specimens, the second of which represents the average form, while the first is more ventricose, the third more elongate:

	mm.	mm.	mm.
Height . . . . .	23	26	25
Thickness . . . . .	14	14.5	12
Height of spire . . . . .	12	15	14
Height of body-whorl . . . . .	16	16.5	16.5

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison with other species.*—There is no doubt that the fossil from the Tertiary of Karikal referred by Cossmann to *Hindsia tjemoroensis* Martin, from Java, corresponds with the Mekran shell above described, and not with the Javanese fossil. It should be mentioned that Cossmann had to depend solely on the illustrations

of the Javanese form when first identifying the Karikal fossil. The figures illustrating *Hindsia tjemoroensis* were published in 1899, and the Karikal fossil was described in 1903, but it was only in 1906 that Prof. Martin published the descriptive text to the original illustrations. The Karikal and Mekran form lacks the characteristic, duplicated, spiral thread observed along the posterior portion of the whorls of *Hindsia tjemoroensis*; its axial ribs are somewhat more crowded, its terminal stem a little longer, its canal somewhat less twisted; its aperture is relatively a little larger; the base contracts more gradually towards the neck.

Judging from an illustration published by Martin (Samml. des Geol. R.-Mus. in Leiden, Ser. 1, Vol. I, Pl. IX, fig. 9), *Hindsia javana* Martin, from the upper Miocene of Java, is distinguished from the Karikal and Mekran form by a much more deflected canal. Nevertheless, the available diagnosis does not disclose any precise difference from the above-described shell, and the possibility of specific identity must therefore be kept in consideration.

#### HINDSIA ? VARICIFERA A. Adams.

1853. *Hindsia varicifera* A. Adams.—Zool. Proc., 183.

A fragmentary specimen perhaps represents the above-named species, but is in rather too weathered a condition to ascertain its exact characters.

*Occurrence*.—Mekran beds: Kandelak-Garuki, eighteen miles north-west by west of Ormara.

#### RANELLA TUBERCULARIS Noetling.

1895. *Ranella tubercularis* "Lam."—Noetling, Mem., Geol. Surv. Ind., Vol. XXVII, part 1, Pl. VII, fig. 1.

1901. *Ranella protubercularis* Noetling (*pars*).—Pal. Ind., new series, Vol. I, part 3, p. 300, Pl. XX, fig. 9 (*non* fig. 8).

Small, with rather broadly conical spire, exceeding half the total height, and with posteriorly inflated body-whorl rapidly flattened towards the neck, anteriorly ending in a moderately elongate, practically vertical, slightly twisted stem. The moderately small, naticoid protoconch consists of a minute, flattened, coiled nucleus, and of three, smooth, convex whorls, the last of which is relatively large and elegantly globose. It is followed by three-and-a-half to four rapidly increasing spire-whorls, the height of which is slightly

less than half their width, irrespective of the varices. The whorls are convex, receding towards the posterior suture, and vertical to slightly receding towards the anterior suture. With the exception of the first whorl, they are distinctly angulated, the angulation being nearer to the posterior than to the anterior margin. The sutures are linear, and appear sunken in consequence of the rather prominent, spiral ornaments. Prominent, externally rounded varices follow one another at intervals, usually of about half a whorl, never less, but often more, especially in the later stages of growth. Consequently, while in the earlier spire-whorls the varices are diametrically opposed, and are continuous from one whorl to another as in a typical *Ranella*, the apertural varix in the specimens from Bhagothoro in Sind and from Minbu in Burma, is always in advance of the last spire, varix, sometimes only slightly so, at other times by as much as  $90^{\circ}$ . In the specimens of the same species from Yenangyat in Burma, the varices are diametrically opposed, and are continuous throughout the spire and body-whorl as in a normal *Ranella*. Each whorl carries three, prominent, fillet-shaped, principal threads, one of which corresponds with the angulation. Very fine, intercalary threads, numbering one or two, occur in each interval. The interval between the angulation and the posterior thread always contains two of these very fine, intercalary threads. Their distribution in the other intervals varies in different specimens. The spiral ornaments are crossed by axial ribs of about the same thickness as the main threads, slightly obliquely antecurrent from the angulation towards the posterior suture, practically vertical from the angulation to the anterior suture. They produce raised granules where they intersect the main threads. Their number between two consecutive varices on the first whorl is 6; on the second, from 6 to 8; on the third, 8 or 9; on the fourth, from 8 to 11. On the body-whorl the ribs become much wider-spaced, and there are only 5 or 6 between two successive varices; sometimes there are only three in the final interval. All the revolving ornaments extend fan-wise upon the varices.

The body-whorl reaches more than two-thirds of the total height. It is posteriorly globose. The base contracts rapidly or even becomes flattened towards the deeply excavated, narrow neck. The zone of accretions to the anterior termination of the canal is narrow, scarcely prominent, revolving rather steeply, not appreciably scaly, and covered with fine, spiral lines. The decoration of the spire is

continued all over the body-whorl. Anteriorly to the three posterior main threads that correspond to those of the spire the convex portion of the base carries four or five more main threads up to the junction with the excavation of the neck. Upon the neck the main threads become more crowded. The axial ribs, in many specimens, extend as far as the edge of the anterior zone of accretions; they become obliquely retrocurrent in an anterior direction upon the neck.

The aperture is oval lanceolate ending posteriorly in a narrow channelled angulation anteriorly contracted into a rather short canal. The columella is oblique, with two concavities corresponding respectively with the oval of the aperture and with the canal joined by a projection which corresponds with the winding of the zone of accretions. The columellar lip forms a thin, raised edge encircling the aperture and very distinctly defined, semi-detached from the base and neck, completely detached anteriorly from the zone of accretions along which it leaves a rudimentary, umbilical groove. Some spiral folds are developed at the median angulation of the columella. At its junction with the outer lip at the posterior end of the aperture, the columellar lip forms a slight callous prominence which is slightly channelled. The outer lip, externally thickened by the last varix, is slightly oblique, straight except quite at its anterior extremity where it passes into the canal. The edge of the outer lip forms a thin rim encircling the aperture, and frilled by the terminations of the spiral ornaments. Its internal features cannot be studied as all the specimens, both from Sind and from Burma, have the aperture filled with a hard, rocky incrustation. The canal is of moderate length, oblique towards the left of the shell and slightly deflected, dorsally greatly constricted ventrally by the extension of the columellar lip, feebly notched at its extremity.

*Dimensions.*—The following dimensions were measured upon Noetling's type from Minbu and upon two of the Nari specimens from Bhagothoro Hill, and upon another specimen of the same species from Yenangyat :

	Minbu.	Bhagothoro.		Yenangyat.
	mm.	mm.	mm.	mm.
Height . . . . .	19	18	17	17
Thickness (minus varices) . .	10	10	9	9.5
Thickness across varices . .	11.5	...	11.5	14
Height of spire . . . . .	10	10	10	9
Height of body-whorl . . . .	13.6	13.2	12	13.5

The greater width measured across the varices, in the Yenangyat specimen, is due to their being only opposed diametrically, so that the full thickness of two of these structures is taken into account in the measurement.

*Occurrence.*—Nari of Bhagothoro Hill in Sind; also in Burma, at Minbu and Yenangyat.

*Remarks.*—This interesting fossil was first described by Noetling, in 1895, from some specimens obtained at Minbu and at Yenangyat in Burma. Noetling named it "*Ranella tubercularis* Lamarck." The fossil was again referred to by Noetling in his enlarged monograph of 1901, when its name was altered to *Ranella prototubercularis* and with the Minbu and Yenangyat shell was united another species closely related to *Ranella bitubercularis* Lamarck obtained from a third locality, and which may be distinguished as *Ranella antiqua*. Noetling's description of 1895 is only a short diagnosis, while the more detailed description of 1901 is vitiated by the fact that it unites the characters of two distinct species. It has therefore been considered necessary to give a new description, in which Noetling's original type of 1895, which is from Minbu, has been used as well as the Nari specimens from Sind which are numerous and well preserved, and also the well preserved specimens from Yenangyat.

As has already been noticed by Martin (Samml. des Geol. R.-Mus. in Leiden, new series, Vol. I, p. 150), there is no such species as *Ranella tubercularis* Lamarck, though there is a *Ranella tuberculata* Broderip. As the name *tubercularis*, which is sufficiently distinct from *tuberculata*, does not appear to have been pre-employed in the genus *Ranella*, Noetling's designation of 1895 may be maintained for the fossils corresponding with the Minbu type, first described under that name.

*Comparisons.*—The base, posteriorly to the concavity of the neck, is more abruptly flattened in the Sind and in the Yenangyat specimens than in the Minbu type, in consequence of which their aperture is somewhat shorter. Apart from the much more regular distribution of their varices, the Yenangyat specimens, together with those from Minbu, agree in every character, down to the most minute details, with those from Sind.

The want of correspondence of the varices in the Minbu specimens, from one whorl to the next was alluded to by Noetling (Pl. Ind., *loc. cit.*, p. 307). Compared with the second species which Noetling, in 1901, united with the above-described shell, and which it is pro-

posed to distinguish as *Ranella antiqua*, the fossil under consideration is distinguished by its more elongately oval aperture, its smaller size, and, in many instances, by the want of correspondence of the varices at later stages of growth. In spite of the smaller size of the shell, the spire-whorls, in *Ranella tubercularis*; tend to be more numerous than in *R. antiqua*.

### RANELLA BITUBERCULARIS Lamarck.

1843. *Ranella bitubercularis* Lamarck.—An. sans vert., edit. Deshayes, Vol. IX, p. 548.  
 1844. *Ranella bitubercularis* Lam.—Reeve, Monograph of the genus *Ranella*, sp. 40.  
 1881. *Ranellabitubercularis* Lam.—Tryon, Man. Conch., p. 42.  
 1883. *Ranella raninoides* Martin.—Samml. des Geol. Reichs.-Mus. in Leiden, 1st series, Vol. I, p. 203, Pl. IX, fig. 6.  
 1884. *Ranella bitubercularis* Lam.—Martin, Samml. des Geol. Reichs.-Mus. in Leiden, 1st series, Vol. III, p. 136.  
 1899. *Ranella (Apollo) bitubercularis* Lam.—Martin, Samml. des Geol. Reichs.-Mus. in Leiden, new series, Vol. I, p. 149, Pl. XXIII, figs. 349-351.  
 1901. *Ranella karikalensis* Cossmann.—Journ. Conch., Vol. L, p. 150, Pl. V, figs. 20, 21.

*Occurrence*.—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains; also in the Tertiary beds of Karikal.

### RANELLA (BIPLEX) BUFO<sup>1</sup> J. de C. Sowerby.

1839. *Ranella bufo* J. de C. Sowerby.—Trans. Geol. Soc. London, 2nd ser., Vol. V, Pl. XXVI, fig. 16.  
 1839. *Ranella pulchra* Gray.—Jay, Catalogue of shells.  
 1841. *Ranella pulchra* Gray.—Sowerby, Conch. Ill., fig. 19.  
 1884. *Ranella (Euplema) pulchra* Gray var.—Martin, Samml. d. Geol. R.-Mus. in Leiden, Vol. III, p. 135, Pl. VII, fig. 136.

Large, with elevated spire, globose body-whorl, and winged expansions to the varices.

<sup>1</sup> The oldest published figures and descriptions of *Ranella pulchra* Gray appear to be those in Sowerby's work of 1841. In Jay's catalogue of 1839, of which I have not seen a copy, the name seems to have been merely mentioned. If the assimilation of the Gáj fossil with the living species is correct, the name "*bufo*" published with a figure and description in 1839, would therefore take precedence.

The naticoid protoconch is followed by five spire-whorls the height of which is equal to three-sevenths of their width irrespective of the varices. They are rather strongly convex which causes them to recede towards both margins so that the somewhat grooved sutures are rather deeply inset in the re-entering angle between adjacent whorls. The whorls are decorated with four, principal, fillet-shaped, revolving threads, the interval between the first and second being greater than the intervals between the three others. The first principal thread is quite close to the posterior suture, the fourth almost coincident with the anterior suture. Nodes occur at the intersections of the main threads with slightly oblique axial ribs, the obliquity being so disposed that they are antecurrent towards the posterior suture. The axial ribs are very unevenly distributed, being very wide-spaced on the portion succeeding the apertural or originally ventral side of a varix, while they become crowded on approaching the dorsal aspect of the next varix: thus in a specimen with only two or three ribs in the quarter-whorl succeeding a varix there are six on the remaining quarter-whorl towards the next varix. Fine subsidiary threads, occur in the intervals between two successive main threads. Usually the interval is bisected by a subsidiary thread of a second order of magnitude and the two subdivisions thus formed are often, themselves, bisected by still finer threads of a third order of magnitude. Occasionally there are indications of yet finer threads of a fourth order. Sometimes the main interval between two principal threads instead of being cut into two subdivisions by one thread of a second order, is cut into three by two such subsidiary threads. All the spiral ornaments extend fan-wise upon both faces of the broad, wing-shaped expansions of the varices, which are rendered palmate by the extensions of the main threads forming digitations between whose extremities the margins of the wing are concave.

The body-whorl is spherical, greatly contracted and horizontally flattened at the junction with the concave narrow neck. The anterior stem appears to be elongate, but is broken in all the available specimens. The greater part of the body-whorl is a continuation of the part of the shell exposed in the spire-whorls, with the spiral ornamentation similarly disposed. There are three more main threads between the fourth main thread and the excavation of the neck, and another in the middle of the excavation where the winged expansion terminates, anteriorly to the fourth principal thread the

main threads of the base do not form digitations after spreading upon the wing.

The axial ornamentation varies a great deal on the body-whorl of different specimens. Sometimes it is reduced to a few, broad, blunt nodosities, and there are no granules on the spiral threads. In other specimens the axial ribs become very narrow and extremely crowded all over the surface, completely granulating all the main threads and all those of a second order of magnitude.

The aperture is in a vertical plane, oblique and broadly oval, the columellar lip and outer lip uniting round it in a thin, raised rim. There is scarcely any prosterior angulation. The anterior canal is narrow and apparently somewhat elongate, the portion preserved in the available specimens being deflected towards the left of the shell, but forming part of a curve the missing part of which must have been vertical or even deflected towards the right of the shell. The columella forms a blunt, projecting angulation opposite the origin of the canal. Posteriorly to this angulation it is slightly concave and merges into the base of the penultimate whorl. Anteriorly to the angulation it forms a second concavity in accordance with the outline of the canal. A pair of rather feebly prominent folds follow posteriorly close on to the angulation, followed posteriorly by one or two feebler ones. The thin, narrow columellar lip has a detached, projecting, foliaceous, narrow edge. The vertical outer lip, like the columellar lip has a projecting, thin edge which is frilled by the terminations of the spiral ornaments. Its internal characters, in all the available specimens, are concealed by a hard, adhering, rocky incrustation. Externally it carries the large wing-like apertural varix.

*Dimensions.*—The following are the partly restored measurements of a full-grown specimen from Kachh :

	mm.
Height . . . . .	48
Width across the varices . . . . .	20
Thickness without the varices . . . . .	31
Height of spire . . . . .	24
Height of body-whorl . . . . .	32

*Occurrence.*—Gáj beds, Kachh; Teyra River near Rampur (23° 20', 68° 51'); one mile east of Sainra (23° 26', 68° 57') or Syra near Kotara, Sind: Karachi (Blagrave and Baker collections).

*Remarks.*—There does not appear to be any precise difference between this fossil and *Ranella pu'chra* Gray of the eastern sea,



the genotype and only living representative of *Biplex*, a section which appears to have acquired an intense development during the Miocene in the eastern hemisphere. The fossil from the Tertiary of Java regarded by Martin as a variety of *Ranella pulchra* (Samml. des Geol. Reichs-Mus. in Leiden, 1st series, Vol. III, p. 135, Pl. VII, fig. 136) is very closely related but is distinguished by its more regularly trellised ornamentation, especially on the body whorl.

RANELLA (APOLLON) MORRISI d'Archiac and Haime.

1854. *Ranella morrisoni* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 309, Pl. XXX, fig. 1, Pl. XXXI, fig. 3.

There are no other available specimens besides the two originally figured by d'Archiac and Haime. The form seems distinct from any other, living or fossil, though the available specimens are in too weathered a condition to establish detailed comparisons. It may be noticed that the varices appear to have been more prominent than would appear from the illustrations, as they have been almost entirely worn off from the original specimens.

Occurrence.—Gáj: Karachi. (Blagrove collection).

RANELLA (APOLLON) ELEGANS Beck.

1841. *Ranella elegans* Beck.—Sowerby jun., Conch. Illus., *Ranella*, fig. 17.

1844. *Ranella elegans* Beck.—Reeve, Monograph of the genus *Ranella*, sp. 22.

1905. *Lampusia* cf. *affinis* Deshayes, sec. R. B. Newton.—Geol. Mag., Dec. V, Vol. II, p. 300, Pl. XVII, fig. 4.

The shell corresponds in every detail with those picked up on the sea-shore along the coasts of India at the present. The fossil was originally described as a *Tritonium* from some imperfect internal casts which did not clearly exhibit its characters.

Occurrence.—Mekran beds: plentiful in the nodular clays of Ormara (Townsend).

RANELLA (BUFONARIA) SPINOSA Lamarck.

1822. *Ranella spinosa* Lamarck.—Anim. sans vert., edit. Deshayes, Vol. VI, p. 545.

1844. *Ranella spinosa* Lam.—Reeve, Monograph of the genus *Ranella*, sp. 7.

1881. *Ranella spinosa* Lam.—Tryon, Man. Conch., Vol. III, p. 37, Pl. XVIII, fig. 1.

1883. *Ranella spinosa* Lam., var. *granosa* Martin.—Samml. des geol. Reichs-Mus. in Leiden, 1st ser., Vol. I, p. 201, Pl. IX, fig. 5.

1899. *Ranella* (*Bufonaria*) *spinosa* Lam. var. Martin.—Samml. des geol. Reichs-Mus. in Leiden, new series, Vol. I, p. 147, Pl. XXIII, figs. 343-345.

The specimens, while sharing the excessive dorso-ventral compression of the upper Miocene variety from Java, represented in

figures 343 and 344 of the second monograph, above-quoted of Martin's, are, nevertheless, more delicately granulated than even the least conspicuously granular fossil forms from Java, and, indeed, than many Recent specimens.

*Occurrence*.—Mekran beds: south of Talar Range, highest beds of Talar section.

*CASSIDEA MAMILLARIS* Grateloup, var. *NUMMULITIPHILA* Sacco.

1840. *Cassis mamillaris* Grateloup.—Atlas conch. foss. Adour, Pl. XXXIV, figs. 4, 19.

1890. *Cassis mamillaris* var. *nummutiliphila* Sacco.—Moll. terr. terz. Piem. Sig., parte VII, p. 11, Pl. I, figs. 4, 5a, 5b.

Large, with broadly conical, low spire measuring from a little over one-quarter to slightly more than two-sevenths of the total height.

The protoconch, missing in all the available specimens, is followed by four or five very low whorls, forming a very shallow: continuous slope, separated by feebly impressed sutures. The earliest whorls carry crowded, oblique ribs, antecurrent to the posterior suture, retrocurrent to the anterior suture, very slightly curved with forward directed convexity. On the second whorl following the protoconch, the extremities of the ribs swell into blunt, rounded nodes along both the anterior and posterior margin, and, with increasing size, the nodes, without becoming prominent, expand in diameter in such a way as to become almost contiguous, the ribs, thereby, practically disappearing. On the last spire-whorl of full-grown specimens, a third intercalary row of granules becomes developed, corresponding approximately with those of the posterior row, but not with those of the anterior row which now become much more swollen and much fewer in number than those of the two other rows. The lines of growth are not visible on the available specimens. The later portion of the spire carries several extremely oblique, rather narrow, moderately prominent varices, at intervals of three-quarters of a volution.

The large body-whorl constitutes the greater part of the shell, measuring from six-sevenths to eight-ninths of the total height. Posteriorly it exhibits an angulation coinciding with the anterior row of nodosities of the spire-whorls. Posteriorly to the angulation is a short, shallow slope forming the continuation of the spire-whorls. Anteriorly to the angulation, the large base, forming the greater part of the body-whorl, forms an extensive ovoïdo-conical surface,

anteriorly separated, on the left side of the shell, by a sharp constriction, without any transition, from the dorsally reflected, notched termination of the canal, while, on the right side of the shell, the convexity is continuous to the anterior termination. Anteriorly to the angulation the entire surface is decorated with moderately prominent, angular ribs of the same thickness as the intervals which reproduce their shape in inverted fashion. Their number varies from twenty-three to thirty. They continue anteriorly without any contraction other than that due to the narrowing of the surface, their trend being mostly vertical and becoming only slightly oblique and anteriorly retrocurrent towards their anterior termination. In the case of very small specimens, each rib, where it crosses the posterior angulation, carries one node corresponding with those of the anterior row of the spire-whorls, a second circle of nodes surrounding the suture. In larger specimens only every alternate rib carries a node along the angulation, these nodes being much larger than those of the circumsutural row, and an additional row of relatively small nodes being developed along the posterior slope. These intercalary nodes or granules are not distributed strictly in the ratio of two to one relatively to the nodes of the angulation, but may be more numerous. In very large specimens, the nodes accompanying the angulation become very massive, completely intercepting, along the angulation, the intervening non-nodular ribs, and a second row of massive, blunt, vertically elongate swellings becomes developed, at about one-third of the distance between the angulation and the anterior extremity of the shell, on each of the ribs that carry the coarse swellings of the angulation. When this disposition becomes typically developed the ribs cease to be equal, but show a tendency to alternate in two sizes, those carrying the nodes tending to expand throughout their whole length, and, thereby to compress the intervening ones. At the same time, a slight tendency to gibbosity, or to the development of nodes, may be observed along the posterior edge of the anterior constriction. In addition to the apertural varix, the body-whorl carries, ventrally, a second varix, at about 90° from the termination of the spire.

The large, tall aperture has callous margins and is anteriorly terminated by a very short, narrow canal strongly bent outward dorsally, and terminated by a deep notch with outward reflected margin, deflected, on the dorsal aspect, towards the left of the shell. The posterior termination of the aperture and the columella are

obscured by a hard, adhering, rocky incrustation in all the available specimens. The columellar lip is very broadly expanded over the ventral surface of the shell. It has a detached edge towards its anterior termination. Internally, it is finely, profusely, and closely transversely wrinkled. The outer lip is antecurrent to the suture. For the greater part of its length it is quite straight, and is slightly oblique in a direction that is anteriorly retrocurrent. Its thickened, callous edge forms a moderately prominent, smooth varix which extends considerably beyond the level of the terminal anterior suture of the last spire-whorl, and which unites with the broad flat expanse of the posterior termination of columellar lip. Internally, along its entire length, the outer lip carries sharply prominent, narrow, rather wide-spaced, transverse ridges, the total number of which is from eight to ten.

*Dimensions.* —

	mm.	mm.	mm.
Height . . . . .	69	46	31
Thickness . . . . .	49	32	22
Height of spire . . . . .	22	13	8
Height of body-whorl. . . . .	38	41	27

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks and comparisons.*—All the specimens exhibit the relatively slender shape exhibited by the Ligurian fossils illustrated by Sacco as *var. nummulitiphila*. The series of developmental stages exhibited by the Sind specimens contributes, moreover, to confirm the correctness of certain points which appeared slightly doubtful to Sacco in his original description of this shell. Two Oligocene varieties have been described by Sacco: *var. apenninica*, which is larger, more ventricose and with extremely flattened spire with three rows of large nodules which are vertically flattened, horizontally expanded, and which, along the angulation, tend to lengthen into spires; and *var. nummulitiphila*, smaller, more elongate and with relatively slender spire, with only two rows of large nodules which are rounded or vertically slightly elongate, blunt and somewhat depressed. On account of the considerable amount of alteration observed in the appearance of *Cassidea* shells at successive stages of growth, Sacco considered that a slight doubt still subsisted as to whether *var. nummulitiphila* might be an immature stage of *var. apenninica*. The large dimensions of the evidently adult Indian specimens,

measuring 69 mm. by 58 mm., approach sufficiently closely to the dimensions of *var. apenninica* without showing any tendency to approach its characters either in the shape of the spire and body-whorl or of the ornamentation, as to leave no doubt as to the complete distinctness of the two varieties. Furthermore, the gradual transformations observed in the Indian shells settle the second point left doubtful by Sacco, as to whether the immature specimens represented in his figures 5a and 5b really represent the same species. There remains no doubt as to the correctness of Sacco's interpretation on this point also, for the Sind specimens prove the perfectly gradual transition from immature specimens analogous to the one represented in Sacco's figure 5a, to the adult one analogous to that represented in his figure 4. The two series, from Sind and from Liguria, are mutually complementary: for instance no Indian specimens have been gathered small enough to exhibit the spiral striations observed at the earliest stages of growth in the Ligurian form, for instance in the specimen illustrated in figure 5b of Sacco's monograph. It is probable that the European specimens never reach the same size as the Indian ones which may be regarded as constituting a race which can be distinguished as *subvarny indica*. The Ligurian fossil was named *nummulitiphila* on account of its frequent association with *Nummulites fichteli*, a synonym of *Nummulites garansensis* which occurs abundantly in the rocky incrustation of the Indian specimens, and which is the megaspheric form of *Nummulites intermedius*, the most characteristic species of the Oligocene.

Amongst Indian fossils, the one nearest related is a shell from Burma which Nœtling has described as *Cassis d'Archiaci*, a name pre-employed by Bellardi in 1851, for a fossil from the neighbourhood of Nice allied to *Cassidea (semicassis) Thesei* Brongniart, and which may be replaced by *Cassidea birmanica*. It has a lower spire than *Cassidea mamillaris* var. *nummulitiphila*, and, while the ornamentation of *Cassidea mamillaris* is mainly axial, that of the Burmese shell is mainly spiral. Just as the mainly European *Cassidea mamillaris* is closely related to the living *Cassis flammea* Linn., of the West-Indies, so is *Cassidea birmanica* equally closely related to *Cassidea cornuta* Linn., the type of the genus *Cassidea*, one of the most abundant shells of the Indo-Pacific region, which also has reached the West-Indies, presumably through a former connection with the Pacific. Though reaching larger dimensions than the specimen figured by Nœtling it is only its much smaller size that

distinguishes the Burmese fossil from the recent species, one of the largest of living shells.

It should here be mentioned that Nøetling has erroneously identified the Burmese shell with a Sind fossil tentatively referred by d'Archiac and Haime to *Cassidaria carinata* Lamarck, and which has been described in the *Palæontologia Indica* by Cossmann and Pissarro under the name of *Cassidaria archiaci* (Pal. Ind., new series, Vol. III, Memoir No. 1 (1909), p. 39, Pl. IV, figs. 8, 9), from the lower Eocene of that province. The fact that the Eocene fossil is a *Cassidaria* disposes of any need for comparison. The improbability of the assimilation proposed by Nøetling was already noticed in 1899 by Martin (Samml. des geol. Reichs-Mus. in Leiden, new series, Vol. I, p. 158).<sup>1</sup>

*CASSIDEA MAMILLARIS* Grateloup, var. *PEDEMONTANA* Sacco.

1890 *Cassis mamillaris* var. *pedemontana* Sacco.—Moll. terz. Piem. e Lig., parte VII, p. 13, Pl. I, figs. 6-10.

A specimen from Kachh, though only in the condition of a cast, exhibits nevertheless sufficiently distinct characters for identification with the above-mentioned variety from the Miocene of Piedmont. It is a very ventricose shell with very low spire and belongs to the races recorded by Sacco as bearing only two rows of distinct tubercles.

Occurrence: Gáj of Kachh: Karreari, south-west of Lakpat.

*CASSIDEA* (*SEMICASSIS*) *OL'GOCALANTICA* n. sp.

Pl. III, figs. 3-5; Pl. IV, fig. 5.

Medium-size, globular-ovoid, with broadly conical, sometimes more or less extraconic or conoidal spire measuring one-quarter of the total height.

The rather small, somewhat depressed, turbinoid protoconch includes a minute, depressed nucleus and three, smooth, convex

<sup>1</sup> In his second monograph in the *Palæontologia Indica* (new series, Vol. I, part 3, p. 291), Nøetling has given an erroneous synonymy in reference to his first monograph (Mem., G. S. I., Vol. XXVII, part 1), indicating the original name of the fossil as "*Cassidaria*" *d'Archiaci*, while the shell was correctly identified from the first as a *Cassis*. It is important to draw attention to this error because, judging from the synonymy as given in his second work, the name *Cassidaria Archiaci* now used for the lower Eocene shell would appear to be also pre-employed, which is not really the case.

whorls. It is followed by three or four, broad, low whorls, the maximum thickness of which corresponds with their anterior margin. The first whorl following the protoconch is evenly convex. The succeeding whorls exhibit a posterior angulation posteriorly to which the surface, as far as the posterior suture, forms a broad, very low, conical slope, while the portion between the angulation and anterior suture, constituting the greater part of the height of the whorl, is convex. The sutures are crenulated and incised. The whorls are decorated with five spiral threads of which the most posterior one encircles the posterior suture, while the most anterior one, along the anterior suture, is generally more or less concealed by the posterior margin of the next succeeding whorl. On the first whorl succeeding the protoconch, the threads are evenly spaced, but on the following whorls the interval between the posterior circum-sutural thread and the second thread stretches considerably and develops into the already-described posterior slope, the second thread itself coinciding with the simultaneously developed angulation. Of the three other intervals, which are now situated on the anterior convexity, that nearest the anterior margin maintains its original width, while the two others become stretched, especially that nearest the angulation, though not so much as the posterior interval. On the first whorl following the protoconch, each interval between two main threads is bisected by an intercalary thread of a second order. With increasing growth, threads of a third order, and even fine lines of a fourth order, gradually appear. The spiral threads are intersected by oblique ribs, antecurrent to the posterior suture and retrocurrent to the anterior sutures, forming with the main, spiral threads a network of approximately square or rhombic meshes with prominent granules at the points of intersection. The intervals between the ribs are occupied by similarly disposed, crowded lines of growth amongst which that bisecting the intervals between the original main ribs also develops into an intercalary rib near the anterior margin of the whorls, also raising granules at the intersections with the two anterior, main threads, and re-establishing the even squareness of the meshes which, otherwise would tend to become oblong on the anterior portion of the whorls owing to the narrowing of the spacing of the main spiral threads. It follows, from the above-described disposition, that the granules are more numerous on the anterior than on the posterior spira threads. The spire whorls never carry any varices.

The angulation of the later spire-whorls is continued on the corresponding part of the large ovoid body-whorl reaching from five-sixths to seven-eighths of the total height, which exhibits a continuous regular curvature from the posterior angulation to the relatively narrow, spiral channel which separates the convexity of the base from the torose, strongly twisted, short, anterior bulge formed by the accretions to the very deep, rounded-oval, terminal notch of the aperture which has an outward-reflected, spout-like edge. The ornamentation of the last spire-whorl is continued without any change, in some specimens, over the corresponding portion of the body-whorl. In others, the circumsutural thread tends to become swollen and rugose, while in some instance the third main spiral thread becomes broader than the remainder, and its granules become, at the same time, more prominent and wider-spaced. Anteriorly to the third main spiral thread, the convexity constituting the main portion of the body-whorl is entirely covered with a net-work of spiral threads and axial ribs, with granules at the points of intersection, thereby communicating to the whole surface a shagreened or rasp-like appearance; the spacing of the spiral threads being uniform and equal to that between the fourth and fifth original main threads continued from the spire. In some instances, the threads are even in size; in other cases they tend to alternate more or less distinctly in two sizes. The ribs, on the posterior portion of the body-whorl forming the continuation of the spire, exhibit the same obliquity as in the case of the spire-whorls. Anteriorly to the level of the suture, the obliquity becomes steeper, without, nevertheless, the trend actually reaching verticality, and they are practically straight as far as their termination against the narrow anterior concavity. In some specimens they form, together with the spiral threads, a very even net-work, the squareness of the meshes being maintained in an anterior direction by the gradual omission of some of the ribs. In other instances, the more posterior meshes are square, while, anteriorly the number of ribs being maintained, they come closer together and the more anterior meshes are consequently vertically elongate. In other specimens again, anteriorly to the third spiral thread, all the ribs are much more crowded and much thinner than the spiral threads, in consequence of which the decoration, instead of forming a trellis, consists essentially of the spiral threads with extremely crowded, vertically elongate granules. Anteriorly to the level of the terminal suture,



the intercalary, spiral lines between the spiral threads are either very feebly developed or absent. Spiral grooves, of various depth and variously distributed, decorate the anterior dorsal bulge. In rare instances the body-whorl may carry a varix at about  $210^{\circ}$  from the aperture.

The aperture is elongate, rather narrow, crescentic. Its posterior termination is either bluntly angulated or quite rounded off without becoming channelled. At its anterior extremity, both apertural margins, with a very oblique trend towards the left of the shell, approach very closely to one another at the entrance to the very short, strongly recurved canal. The columella posteriorly merges into the convexity of the base where it carries some close-set, transverse ridges. It is concave or re-entering where it meets the inward extension of the anterior channel bordering the dorsal bulge. The anterior termination of the columella forms a convex protuberance carrying several thick folds, the exact number of which cannot be ascertained. The columellar lip expands moderately posteriorly where it is thin though well demarcated; anteriorly it is detached. Posteriorly, it carries, internally, a number of close-set, transverse ridges. The outer lip is feebly oblique, antecurrent to the suture, straight for the greater part of its length except in the immediate neighbourhood of the suture to which it tends to become tangent and at its anterior termination where it joins the rim of the terminal notch. It is thickened externally by a flat, rather broad, but not very prominent varix, carrying a few lines of growth on its flat, external surface, and dorsally bounded by a groove. It is internally crenulated.

*Dimensions.*—The dimensions are as follows:—

	mm.	mm.
Height . . . . .	30	39
Thickness . . . . .	20.2	29
Height of spire . . . . .	7.8	10.5
Height of body-whorl . . . . .	25	34

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison with other species.*—This beautiful shell agrees so completely with *Cassidea calantica* Desh., from the upper Eocene of the Paris region that it might almost be treated as a variety of the European form, in which, nevertheless, the spire whorls appear to be more subulate, exhibiting neither the anterior convexity nor the posterior angulation observed in the Sind specimens.

The living *Cassidea semigranosa* Wood, from South-Australia and Tasmania, is not unlike in shape, and certain specimens of the living form have the spire not unlike the Indian fossil, but the base is smooth, and the aperture toothless.

CASSIDEA (SEMICASSIS) MEKRANICA n. sp.

Pl. III, figs. 7-9.

Small to medium, inflated, with very short, flattened spire, measuring only one-seventh of the total height, or even less, and with globose body-whorl, anteriorly terminated by a strongly recurved, short, deeply notched canal.

The somewhat depressed protoconch, recalling in shape a *Delphinula* or *Turbo*, consists of a small, flat nucleus followed by two or two-and-a-half, convex, smooth whorls. It is followed by three very low, convex, whorls separated by slightly grooved sutures. Each whorl is decorated with four, sub-equally spaced, spiral threads, one of which encircle the posterior suture, while a fifth thread is more or less concealed, along the anterior suture, by the posterior margin of the next whorl. With increasing growth, intercalary threads are more or less distinctly developed in various specimens. The intervals between the threads are somewhat channelled near the posterior suture, and become gradually flatter towards the anterior margin. The threads are delicately granulated at their intersections with crowded, narrow, oblique ribs, antecurrent towards the posterior suture. There is occasionally a slightly prominent varix at 180° from the termination of the spire.

The large, globose-ovoid body-whorl, constituting the greater part of the shell, exhibits posteriorly a slight bend in its convexity corresponding in position with the third spiral thread continued from the spire as above described, thereby communicating a slight appearance of angulation near the posterior margin of the body-whorl. Elsewhere the curvature is everywhere even, and, without the intervention of any concave neck, is immediately succeeded by the thick, torose, strongly twisted, scaly zone of the accretions to the deep terminal notch, separated from the convexity of the base by a deep furrow. The notch has an outward-reflected, spout-like, narrow edge. The ornamentation of the spire is continued over the corresponding part of the body-whorl with varying additions of intercalary, revolving threads or furrows. Over the whole of the base

proper, constituting the greater part of the body-whorl, the character of the ornamentation differs from that continued from the spire: the revolving threads become so broad and so flat, and the intervening spaces so narrow, that the ornamentation should be described as consisting of sulci rather than of threads, the bands isolated by the sulci being of two alternating widths. The axial ribs become straight, with greatly decreased obliquity on entering the base, over which they are continued as very flat bands often becoming indistinct. With the same straightness and feeble obliquity they are carried to the very edge of the anterior twisted bulge. Occasionally the body-whorl may carry a varix at about  $150^{\circ}$  from the aperture. In most specimens there is no other varix but the one bordering the final aperture.

The aperture is tall, large, unsymmetrically shallow pear-shaped with an angulated channel posteriorly, while anteriorly it terminates in the short slit opening out into the short, strongly recurved notch. Anteriorly to its somewhat angular junction with the base of the penultimate whorl, the columella is feebly convex and almost vertical as far as the anterior sharp bend, beyond which its twisted termination is very obliquely deflected towards the left of the shell and carries a spiral fold posteriorly followed by four or five, prominent, transverse ridges which are to be regarded as dependencies of the columellar lip rather than of the columella, especially as the one or two most posterior ones are situated beyond the termination of the true columella, on the commencement of the convexity of the base of the penultimate whorl. The columellar lip is posteriorly widely expanded with a well-demarcated though thin edge adhering to the convexity of the base. Anteriorly it becomes thicker, detached, and, in addition to the internal ledges already described, it carries, on its flatly expanded outer surface, variously disposed, transverse folds or wrinkles, more or less broken up into short ridges or elongate granules. There are also some short, internal, transverse ledges near the posterior termination of the aperture. The outer lip, antecurrent to the suture, exhibits, quite close to its posterior termination, a slight zigzag waviness due to presence of the posterior terminal channel, the remainder of its course being straight and very steeply oblique, the trend being anteriorly retrograde. Externally it is thickened by the moderately prominent, somewhat narrow, apertural varix which rises, posteriorly, well beyond the terminal suture and which has a flat, smooth, lateral surface upon which the spiral

ornaments are not continued, while it is deeply undercut dorsally. Along its internal edge, the outer lip carries, throughout its entire length, crowded, transverse denticulations, of which the most posterior one, defining the limit of the posterior channel, appears to be a little more prominent than the remainder.

*Dimensions.* —

	mm.	mm.	mm.
Height . . . . .	28.5	36	28.5
Thickness . . . . .	21	27	21
Height of spire . . . . .	3.5	5	4.5
Height of body-whorl . . . . .	26	32	25.2

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison with other species.*—This shell, like several other fossil forms, illustrates the difficulty of distinguishing, at times, between *Semicassis* and *Bezoardica*. It resembles *Cassidea* (*Semicassis*) *bisulcata* Schub. and Wagn., from the Philippines, from which it is distinguished by its much more depressed spire, and also *Cassidea* (*Bezoardica*) *decussata* [Linn.] which has a much more elongate body-whorl. *Cassidea* (*Semicassis*) *rembangensis* Martin, from the lower Miocene of Java, corresponds in shape with the form above described, but it exhibits, on the spire-whorls, a very distinct angulation not observed on the Mekran shell, and its spiral ornaments are all much feebler.

CASSIDEA (SEMICASSIS) ORMARENSIS n. sp.

Pl. X, fig. 4.

Medium-size, globose, thin-shelled, with depressed, broadly conical spire measuring one-quarter of the total height.

The protoconch, missing in the solitary available specimen, is followed by three, low, moderately convex spire-whorls. So far as can be ascertained, the sutures are not sunken. The spire-whorls are ornamented with spiral threads the details of which cannot be exactly ascertained as they are obscured by adhering grains of the originally enclosing rock. Their number is probably three or four. There are no varices.

The large, sub-spherical body-whorl constitutes the greater part of the shell. Its curvature is not everywhere even, being slight over its posterior portion forming the continuation of the spire-whorls, while, at about the level of the terminal suture, there is a considerable increase in the degree of curvature, not amounting to an angulation, yet sufficient to give a distinctly shouldered appearance to the outline of the body-whorl. Anteriorly to this level the surface gradually contracts anteriorly with a helmet-shaped, ovoido-conical outline such as is frequently observed in the Cassididæ. On the right side of the shell, the convexity reaches the anterior termination. On the left side of the shell, a deep, narrow sulcus separates the termination of the convexity from the very deep, very oblique, terminal, dorsal notch, and, to the left, from the very oblique, torose, bulging zone of its accretions. The terminal notch is strongly deflected towards the left, somewhat angulated at its apex, bordered by a thickened, outwardly reflected rim. The ornamentation of the body-whorl consists of seventeen or eighteen spiral threads, sub-equal and evenly spaced, of about the same width as the intervening grooves. A number of spiral grooves decorate the terminal zone of accretions. The surface is not exposed clearly enough to disclose the characters of the lines of growth. There are no varices other than the terminal, apertural thickening.

The large aperture is angulated posteriorly, though the possible presence of a posterior channel cannot be ascertained owing to the presence of a hard, adhering, rocky incrustation. Anteriorly the aperture is contracted into the rudimentary, terminal canal deflected almost transversely towards the left of the shell and opening into the deep dorsal notch. The columella appears to be approximately vertical, but is much obscured by the rocky incrustation. The columellar lip is widely expanded posteriorly, but extremely thin, with its edge adhering to the base. Anteriorly it becomes detached on crossing the groove between the basal convexity and the terminal bulge. Owing to incomplete preservation or concealment by rocky incrustation, its internal characters cannot be ascertained. The outer lip is antecurrent to the suture, straight, rather strongly oblique, with an anteriorly retrograde direction. Externally it is thickened by the rather narrow, moderately prominent, terminal varix. It is strongly crenulated internally. Owing to the extreme thinness of the shell, all the external ornaments are reproduced, in the reversed order, on the internal walls.

*Dimensions.*—

	mm
Height . . . . .	41
Thickness . . . . .	32
Height of spire . . . . .	10
Height of body-whorl . . . . .	36

*Occurrence.*—Nodular shales of Ormara (Townsend).

*Comparison with other species.*—In spite of its imperfect state of preservation, the solitary specimen, described above, exhibits such pronounced characters as to leave no doubt as to its specific distinctness. It apparently belongs to the group of *Cassidea saburon*, amongst which, nevertheless, none of the species hitherto described exhibit so pronounced a tendency towards a shouldered outline of the body-whorl. The spiral ornamentation of most of the species of the *saburon* group, as indeed of most species of *Cassidea*, consists essentially of spiral incisions, rather than of distinct, spiral ribs as in the present instance. In this respect, *Cassidea Pfeifferi* Hidalgo, regarded by Tryon as a variety of *C. saburon*, exhibits some resemblance to the above-described fossil, but its spiral threads are more numerous, as are indeed the spiral ornaments, whether raised threads or sunken bands, in all the forms of the *Saburon* group. In *Cassidea canaliculata* Bruguière, the number of spiral ornaments on the body-whorl is exactly the same as in the fossil above-described, but they consist merely of extremely thin, extremely shallow incisions. The convexity of the body-whorl, moreover, is more even in *Cassidea canaliculata* than in the shell above-described, which, moreover, so far as can be judged, does not exhibit the deeply channelled sutures characterising *Cassidea canaliculata*. Moreover, the internal walls of *Cassidea canaliculata*, in spite of the extreme thinness of the shell, are not spirally sulcate. In the latter character the Ormara fossil recalls *Cassidea sulcosa* and *C. arakanensis*, with neither of which it is otherwise sufficiently closely related to require detailed comparison.

CASSIDEA (BEZOARDICA) SCULPTA J. de C. Sowerby.

1839. *Cassis (Cypræussis) sculpta* J. de C. Sowerby.—Trans. Geol. Soc. London; ser. 2. Vol. V, Pl. XXVI, fig. 21.

1903. *Semicassis (Bezoardica) strigata* [Gmelin] ser. Cossmann.—Journ. Conch., Vol. L, p. 160, Pl. VI, fig. 9.

Medium-size, ovoid, with broadly conical terraced spire equal to one-quarter of the total height of the shell, and with large, somewhat elongate, ovoid body-whorl.

The small, broadly conical to slightly conoidal protoconch resembles a *Turbo*, and consists of a flattened, coiled, button-like nucleus followed by two, moderately convex, smooth whorls. It is followed by three-and-a-half to four spire-whorls, the height of which is equal to one-quarter of their height. The greatest width of the whorls coincides with their anterior margin. They are angulated at about two-thirds of their height from the anterior suture. Anteriorly to the angulation, the surface slopes at a steep angle towards the anterior suture and is slightly convex, while the surface slopes at a low angle and is very slightly concave from the posterior suture to the angulation.

The sutures are linear, with a tendency to be slightly grooved. The posterior slope carries four spiral threads, broader than the intervening spaces, two of which, on the steeply sloping posterior marginal portion, are closer-set than the remainder and form a rim enclosing the sutures. Numerous ribs, much broader than the interstices, and of about the same width as the spiral threads, obliquely antecurrent to the posterior suture, divide the threads into crowded strings of granules. On the anterior, steeply sloping portion of the whorls, the revolving threads are a little thicker and a little wider spaced, similarly divided into crowded granules by the rather steeply oblique ribs. Their number is three, including the one that corresponds with the angulation, a very narrow intercalary thread sometimes almost fills each interspace.

The angulation of the spire is continued on the large body-whorl which is equal to five-sixths of the total height. Anteriorly to the angulation it is somewhat elongate ovoid with a very even curvature reaching to the rather deep, spiral groove which separates the anterior termination of the convexity from the rather thick, torose, strongly twisted, rather short zone of accretions to the deep terminal notch of the aperture. The ornamentation of the spire continues with the same character over the corresponding portion of the body-whorl. The three granulated bands, occupying the angulation and the space anterior to it, are followed, on the body-whorl, by a fourth band of the same character which is not seen on the spire-whorls on account of its being concealed by the sutures. This fourth band is rather flatter, with more depressed granules than the three preceding ones. Anteriorly to this fourth band, the remaining revolving bands are so flat, and the intervening spaces so narrow that the ornamentation is best described as consisting of regularly distributed

moderately close-set, revolving sulci. There are no granulations anteriorly to the fourth band, counting from the angulation, on account of the complete or nearly complete obliteration of the axial ribs. The floor of the sulci is very delicately trellised by crowded lines of growth. From the posterior angulation to the anterior deep groove bordering the terminal dorsal bulge, the total number of revolving bands, including the four posterior granulated ones, is seventeen. Rather crowded, spiral incisions decorate the twisted, anterior, dorsal bulge which is not appreciably scaly.

The aperture is tall, rather narrow, somewhat crescentic, posteriorly angulated but not channelled, while anteriorly the apertural margins approach closely to one another at the entrance to the strongly recurved notch. There is no truly differentiated canal. From the level of its junction with the base of the penultimate whorl to the point at which it meets the inward continuation of the spiral channel encircling the dorsal twisted bulge, the columella is concave, its remaining anterior portion forming a slight convex protuberance. The occurrence of columellar folds cannot be ascertained owing to concealment by a rocky incrustation. The columellar lip is posteriorly moderately expanded, thin and well demarcated, anteriorly detached.

The outer lip is straight and oblique, antecurrent to the suture. It is externally thickened, anteriorly with internal crenulations, spreading outward on to its ventral surface.

*Dimensions.*—

	mm.	mm.
Height . . . . .	30	46
Thickness . . . . .	20	25
Height of spire . . . . .	8	11
Height of body-whorl . . . . .	25	3

*Occurrence.*—Gáj of Kachh : Soomrow ; Teyra River near Rampur (23° 20', 68° 51').

*Remarks and comparison.*—In spite of the absence of varices other than the terminal apertural thickening (which, indeed, is developed only in adult specimens), the elongate ovoid shape of this shell forbids its reference to *Semicassis*. The absence or presence of varices cannot be relied upon as an absolutely definite character for distinguishing some of the genera of Cassididæ, for they are almost invariably present in *Cassidea japonica* Reeve which is a typical *Semicassis*, while they may be absent in *Buccinum*



*glaucum* Linn., the genotype of *Bezoardica*. It has already been noticed that they occasionally occur in *Cassidea oligocalantica*, a typical *Semicaassis* from the Nari of Sind.

In his original description, Sowerby classified this shell in the genus *Cypræicassis* Stutchbury, regarded by Cossmann as a subgenus of *Bezoardica*. The aperture, in the Kachh fossil, corresponds with that of *Bezoardica sensu stricto*, not with the contracted aperture of *Cypræicassis*. An error of transcription appears to have crept into Sowerby's remarks on this subject, which are worded as follows: "Strongly resembling *Cassis* (*Cypræicassis*, Stutchbury), *testiculus* (Bucc. *Testiculus*, Linn.), but smoother, and with a narrower aperture." (*Loc. cit.*) It seems evident that the clause "smoother and with a narrower aperture" refers to the recent species which is a true *Cypræicassis* and not to the fossil.

The shell under consideration exhibits the closest resemblance to the living *Bezoardica strigata* [Gmel.], from the Pacific region, which grows to larger dimensions and which is distinguished by the presence of varices even at very early stages of growth. Varices are absent also in the Karikal fossil referred by Cossmann to *Bezoardica strigata*, which, in every particular, coincides entirely with the above-described species. The fossil is probably to be regarded as an ancestral premutation of *Bezoardica strigata*.

#### CASSIDARIA DESORI d'Archiac and Haime.

1851. *Cassidaria desori* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 317, Pl. XXXI, fig. 2.

Rather small, ventricose, with broadly conical, stepped spire, somewhat exceeding one-quarter of the total height.

The protoconch is followed by four spire-whorls of which the earlier ones are evenly convex, while the later ones are angulated at about two-thirds of their height measured from the anterior suture, thereby communicating to the spire its characteristic terraced appearance. The whorls are at first decorated with five spiral threads of which the middle one, with increasing growth, comes to correspond with the angulation, while subsidiary intercalary threads also appear.

The body-whorl measures five-sixths of the total height. It consists of a main, approximately spherical portion connected by a

pronounced concavity with the strongly deflected, terminal rostrum. The curvature of the approximately spherical, main portion is not continuous but consists of a series of elements of approximately rectilinear profile, connected by slight angulations. The pronounced angulation of the posterior portion of the spire-whorls is continued unaltered on the body-whorl. Another slight angulation appears at the level of the termination of the suture. An interval equal to that between the suture and the first angulation separates the slight angulation just mentioned from another one situated more anteriorly and corresponding approximately with the maximum width of the shell. Two more similar angulations, at slightly closer intervals, follow anteriorly on the anteriorly contracting, convex surface, and a last one, forming a re-entering angle, occurs at the junction between the convexity of the base and the anterior concavity. The entire surface of the body-whorl is ornamented with flat, fillet-shaped threads of two alternating sizes, somewhat wide-spaced, and narrower than the intervening spaces; those corresponding with the angulations being scarcely more prominent than the remainder.

The details of the aperture are not preserved in the original and only specimen.

*Dimensions.*—

	mm.
Height . . . . .	26
Thickness . . . . .	19
Height of spire . . . . .	7
Height of body-whorl . . . . .	22

*Occurrence.*—Gaj of Sind, near Karachi (Blagrove collection).

*Remarks and comparisons.*—The original figures of this fossil do not convey a very exact idea of the appearance of its ornamentation: the angulations have been accentuated in the drawing in a manner which would seem to indicate that they are accompanied by keels which, nevertheless, are not observed in the original specimen. In reality the ornamentation closely resembles that of *Cassidaria pamotanensis* Martin, from the lower Miocene of Java (Samml. des geol. Reichs-Mus. in Leiden, new series, Vol. I, p. 157, Pl. XXIV, fig. 365) also known only from a single specimen, which as already noticed by Martin, is less globose than the Sind fossil, with a less twisted terminal rostrum.

The shell under consideration also bears some resemblance to certain forms from the lower Miocene of the neighbourhood of

Tarin such as *Cassidaria tauropysulata* Sacco and *C. tauropomum* Sacco, in which the angulations are less pronounced.

SCONSIA BEYRICHI [Michelotti].

Pl. III, fig. 6.

1861. *Cassis beyrichi* Michelotti.—Etude Mioc. inf. p. 132, Pl. XIII, figs. 7, 8.

1890. *Sconsia beyrichi* Micht.—Sacco, Moll. terr. terz. Piem. e Lig., parte VII, p. 71, Pl. II, fig. 28.

1904. *Sconsia beyrichi* [Micht.].—Sacco Moll. terr. terz. Piem. e Lig., parte XXX, p. 99, Pl. XXI, fig. 22.

Medium-small, with rather broadly conical or slightly extraconic spire measuring about one-quarter of the total height, and with elongate, ovoid body-whorl.

The rather tall, conical protoconch includes a small nucleus imperfectly preserved in all the available specimens, and two or three rather tall, conical, feebly convex whorls. It is followed by three spire-whorls, the height of which slightly exceeds one-quarter of their width, conical, so feebly convex as to be practically subulate, separated by narrowly grooved sutures. The first whorl following the protoconch carries six or seven, thin, spiral threads of which the most posterior one surrounds the posterior suture. They may be all of one size or else may alternate in two slightly different sizes. With increasing growth of the spire, an occasional intercalary thread may appear, raising the number of threads on the last spire-whorl to as many as nine, which are not exactly equal in width, though not regularly alternating. They become relatively much thicker than on the early part of the spire, their width greatly exceeding the average width of the intervals. The most posterior interval becomes conspicuously wider and deeper than any of the others, thereby accentuating the importance of the circumsutural thread which also increases in width at a faster rate than any of the other threads, and which, on the last spire-whorl, assumes the character of a relatively broad, crenulated, circumsutural band. The entire spire is covered with lines of growth, the spacing of which is about equal to that of the spiral threads upon which they give rise to a remarkably elegant system of granules at all the points of intersection. They are very slightly curved with anteriorly facing concavity, very steeply antecurrent to the posterior suture, normal to the anterior suture. Occasionally the last spire-whorl

may carry a rather broad, though feebly prominent varix, though, in most specimens, the entire spire is without varices.

The large body-whorl, constituting the greater part of the shell, measures five-sixths of the total height. It consists, mostly, of an elongate, ovoid, main portion, passing into a concavity where it contracts into the termination of the canal which is moderately deflected dorsally. The ornamentation of the last spire-whorl is continued on the corresponding portion of the body-whorl with scarcely any alteration except on approaching the aperture when the thin axial ribs, and the granules accompanying them become somewhat less prominent, at least on the spiral threads furthest from the suture. Anteriorly to the level of the termination of the suture, there are three more spiral threads of the same average width as those continued from the last spire-whorl, beyond which they become closer-spaced, and continue thus to the extremity of the shell, the body-whorl thereby acquiring a very closely striated appearance. In some specimens their width is somewhat broader than the intervening spaces in about the same ratio as on the later part of the spire. In others they acquire the character of flat bands separated by mere incisions, so that the ornamentation comes to consist of spiral grooves rather than threads. The spacing may remain approximately even to the anterior termination, or else, on the anterior concavity the spaces, or the threads, may be alternately of two dimensions. Anteriorly to the level of the terminal suture, the lines of growth remain practically straight until the close neighbourhood of the terminal notch, and are very steeply oblique with an anteriorly retrograde direction. In some specimens they are fairly prominent and, at their intersections with the spiral thread, they may determine granulations that are quite distinct though less conspicuous than those of the spire and of the posterior part of the body-whorl. In other specimens they are indistinct, and the spiral threads or bands are consequently practically smooth. In some specimens there may be a moderately prominent varix at  $180^\circ$  from the aperture, but usually there is no varix except the terminal apertural thickening.

The rather narrow aperture is posteriorly angulated, anteriorly contracted into the narrow, short, terminal canal, slightly deflected dorsally and towards the left of the shell. The columella is practically vertical and straight. The columellar lip spreads, rather broadly, over the base posteriorly and has a thin, though well demar

cated edge, adhering to the convexity of the base, while anteriorly, where the columellar lip becomes narrower, the edge is detached. Internally, the columellar lip carries pronounced, transverse ridges throughout its entire length. The outer lip is slightly antecurrent to the suture, anteriorly to which it exhibits a very shallow, short sinus beyond which its main portion is slightly convex and is at first vertical or slightly oblique and anteriorly antecurrent, after which it becomes anteriorly retrograde. It is thickened externally by the moderately prominent, rather narrow, terminal varix upon which the spiral ornaments continue until quite close to the actual edge. The internal characters are concealed by a hard, adhering, rocky incrustation in all the available specimens.

*Dimensions.*—

	mm.
Height . . . . .	26
Thickness . . . . .	18
Height of spire . . . . .	7
Height of body-whorl . . . . .	22

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Remarks.*—The Sind specimens agree with Sacco's figures and description of *Sconsia beyrichi* Micht., from the Oligocene of Liguria, with which they particularly correspond as regards the large number of threads or striations on the body-whorl; their number, according to Sacco, being about sixty in the European form, while, in the the Indian specimens, which are generally smaller, the number is from fifty-three to fifty-five. The crowded, spiral ornaments and the relatively small dimensions constitute the only distinction from *Sconsia striata* [Lamk.], living in the West-Indies, the only living representative of this genus. The living form exhibits exactly the same variations of ornamentation as the above-described fossil, while various fossil forms from various horizons in various countries, which have been either referred to *Sconsia striata* or regarded as varieties of that species, also exhibit similar variations, and, moreover, are often intermediate between the above-described fossil and the recent form as regards the number of spiral ornaments on the body-whorl. For instance, the specimen of *Sconsia striata* represented in Reeve's monograph, carries apparently thirty-one spiral threads on the body-whorl; while in a fossil from the Pliocene of Java, referred by Martin to the living species, the number of striations on the body-whorl is apparently forty-three, and Sacco

has described, from the Miocene of the neighbourhood of Turin a variety *miocenica* of *Sconsia striata*, also distinguished from the recent shell by the somewhat more numerous striations of its body-whorl. From the above it seems evident that *Sconsia beyrichi* scarcely differs more than varietally from *Sconsia striata*. Nevertheless, it is probably not an ancestral premutation of the living shell, but more probably a collateral variation, for a fossil is known from the Oligocene of Burma, in which the spiral ornaments of the body-whorl are no more crowded than in many forms referred to *Sconsia striata*. It seems therefore that the recent form already existed in Oligocene times simultaneously with *Sconsia Beyrichi* which it is therefore at least convenient to treat as a separate species.

#### DOLIUM VARIEGATUM Lamarck.

1822. *Dolium variegatum* Lamarck.—An. sans vert. Vol. VII, p. 261.

1849 *Dolium variegatum* Lamk.—Reeve, Monograph of the genus *Dolium*, sp. 7

1899. *Dolium variegatum* Lamk.—Martin, Samml. des geol. Reichs—mus. in Leiden, new series, Vol. I, p. 162, Pl. XXV, fig. 376.

*Occurrence*.—Mekran beds: Koh-i-Dumak (one specimen).

*Remarks*.—This species which, in the Recent fauna, was until lately regarded as characteristic of the Australian region has latterly been identified amongst some Recent shells from Maskat in the collections of the Indian Museum (Journ. As. Soc. Bengal, new ser., Vol. XIV, 1918, p. 449).

The distribution of the shell, discontinuous at the present day, was more extensive than now in former geological times. It is found in a fossil condition not only in the Mekran region, but also in the Pliocene of Java.

#### DOLIUM MACULATUM (Lam.) Deshayes.

1685-1692. *Buccinum* sp.—M. Lister, Historia Conchyliorum, Pl. 899, fig. 19.

? 1758. *Buccinum dolium* Linnæus.—Systema Naturæ, Ed. X, p. 735.

1770. *Buccinum dolium* Linn. sec. Huddesford.—Martini Lister, M.D., historie sive synopsis methodice Conchyliorum et tabularum anatomicarum editio altera, Pl. 899, fig. 19.

? 1822. *Dolium maculatum* Lamarck.—Hist. nat. des animaux sans vertèbres, Vol. VII, sp. 3, p. 260.

18 . *Dolium maculatum* Lam.—Kiener, Iconographie des coquilles vivantes, Pl. III, fig. 4.

1845. *Dolium maculatum* Lam. sec. Deshayes.—An. sans vert., 2nd ed., Vol X, p. 140.

1849. *Dolium maculatum* Lam.—Reeve, Monograph of the genus *Dolium*, sp. 4.

1837. *Dolium maculatum* Lam.—Küster, Systematisches Conchilien-Cabinet von Martini und Chemnitz, Vol. III, 1st section, 2nd part, p. 73, Pl. LXII, fig. 3.
1835. *Dolium costatum* Monke, var. *maculatu* Lam., sec. Tryon.—Man. Conch., Vol. VII, p. 264.
1919. *Dolium maculatum* Dosh—Vriedenburg, Mem. Ind. Mus., Vol. VII, p. 150, Pl. IV, figs. 1—3, Pl. V, figs. 4—6.

*Occurrence.*—Mekran beds: Pohr Sunt, at a high horizon, probably just underlying the uppermost conglomerates (198). The species is also known from the post-Tertiary deposits of the Pulicat Lake.

*Remarks.*—*Dolium modjokasriense* Martin (Samml. des geol. Reichs-Museums in Leiden, new series, Vol. I, p. 160, Pl. XXV, fig. 370) from the upper Tertiary of Java is perhaps identical.

#### DOLIUM LOSARIENSE Martin.

##### var. MEKRANICA n. var.

1899. *Dolium losariense* Martin.—Samml. des geol. Reichs-mus. in Leiden, new series, Vol. I, p. 163, Pl. XXV, figs. 377, 378.

Large, pear-shaped, with very low conical spire measuring less than one-fifth of the total height.

The imperfectly preserved protoconch is followed by three very lowspire-whorls which are angulated close to their anterior margin; being vertical between the angulation and the anterior margin, while posteriorly to the angulation the surface forms a broad, low slope, the direction of outline of which is continuous from one whorl to another, so that the spire has generally a subulate appearance. Close to the posterior margin, a spiral rib surrounds the sutural depression; another one coincides with the angulation and is practically adjacent to another raised band bordering the anterior suture.

The large elongate body-whorl constitutes the greater part of the shell. Its posterior portion constituting the continuation of the spire exhibits the same low slope and the same pronounced angulation as the spire-whorls. Anteriorly to the angulation, the surface constitutes an elongate, pear-shaped convexity, the curvature of which, on the right side of the shell, is continuous to its anterior extremity, while, on the left side of the shell, the convexity is inflected into an elongate, shallow concavity connecting it with the

vertical profile constituted by the zone of accretions to the terminal notch. The circumsutural swelling is continued from the spire whorls on to the body-whorl which also exhibits the continuation of the broad, spiral rib accompanying the angulation, anteriorly to which the surface, up to the limit of the band of accretions of the terminal notch, carries twelve revolving ribs which generally become narrower and closer-set in an anterior direction; the only slight unevenness being as regards the rib situated next anteriorly to the angulation rib, which is slightly narrower than the next anterior rib. These ribs are bulky, moderately prominent, practically adjacent to one another, being separated by mere grooved channels. The lines of growth, which are particularly prominent where they cross these intercalary grooves, are straight and oblique with an anteriorly retrograde disposition. The terminal zone of accretions carries rather faint, spiral markings.

The wide aperture is not channelled posteriorly, while anteriorly it ends apparently directly into the terminal notch. The columella, anteriorly to the base of the penultimate whorl, is at first vertical, subsequently to which it is, presumably, steeply oblique anteriorly towards the left of the shell. The columellar lip is not preserved in the available specimens. The outer lip is straight and oblique.

*Dimensions.*—

	mm.
Height . . . . .	110
Thickness . . . . .	80
Height of spire . . . . .	20
Height of body-whorl . . . . .	100

*Occurrence.*—Mekran beds: Koh-i-Dumak.

*Remarks.*—This shell is represented by two casts from which, nevertheless, all the main characteristics can be clearly made out. Except for heir much larger dimensions, they agree so thoroughly with *Dolium losariense* Martin, from the Pliocene of Java, that there is no doubt as to their specific identity. They share with the Javanese shell the pronounced angulation which distinguishes this form from all other known species of *Dolium*, while the ornamentation agrees in every feature, even in the particular detail of the slightly inferior thickness of the revolving rib anteriorly adjacent to the rib accompanying the angulation. The Mekran shell would not even be treated as a separate variety but for one remark of Martin who notices that the angulation shows a tendency to dis-



appear on approaching the aperture of the largest available Javanese specimen; which suggests that this dwindling of the angulation might represent an adult characteristic. If this is really the case, the Javanese specimens would not be immature, but would represent a race or variety much smaller than the Mekran shell which, even at the considerable size which it attains, does not show any noticeable weakening of the angulation in the apertural region.

DOLIUM (EUDOLIUM) TESSELLATUM Bruguière.

- ? 1757. "Le Minjac" Adanson.—Histoire naturelle du Sénégal, Pl. VII, fig. 6  
 1789. *Buccinum tessellatum* Bruguière.—Encyclopédie méthodique, Vol. VI, sp. 4, pp. 236, 246.  
 1790. *Dolium tessellatum* Bruguière.—Encyclopédie méthodique, Pl. 403, figs. 3 a, b.  
 1823. *Dolium fimbriatum* Sowerby.—Genera of shells, fig. 2.  
 1830. *Dolium costatum* Menke.—Synopsis methodica, 2nd ed., p. 63.  
 18 . *Dolium fasciatum* Brug. var. *sec.* Kiener.—Cog. viv. *Dolium*, Pl. IV, fig. 6.  
 18 . *Dolium variegatum* Lam. (*junior* sec. Kiener)—Icon. des cog. viv., Pl. II, fig. 3.  
 1845. *Dolium costatum* Deshayes.—An. sans vert., 2nd ed., Vol. X, p. 144  
 1845. *Dolium minjac* Adanson *sec.* Deshayes.—An. sans vert., 2nd ed., Vol. X p. 145, no. 9.  
 1845. *Dolium ampullaceum* Philippi.—Zeit. Mal., p. 147.  
 1849. *Dolium fimbriatum* Sow.—Reeve, Monograph of the genus *Dolium*, sp. 3  
 1849. *Dolium costatum* Desh.—Reeve, Monograph of the genus *Dolium*, sp. 8.  
 1849. *Dolium ampullaceum* Phil.—Abbild. III, 4, *Dolium*, p. 12, Pl. II  
 1857. *Dolium costatum* Mke.—Küster, Conch.-Cab. von Martini und Chemnitz, Vol. III, 1st section, 2nd part, p. 61, Pl. LVI, fig. 3, Pl. LVII, fig. 3.  
 1857. *Dolium lischkeanum* Küster.—Conch.-Cab., p. 71, Pl. LXII, fig. 1.  
 1857. *Dolium fimbriatum* Sow.—Küster, Conch.-Cab., p. 72, Pl. LXII, fig. 2.  
 1879. *Dolium costatum* Desh.—Martin, Die Tertiärschichten auf Java, p. 40, Pl. VII, figs. 9, 10.  
 1899. *Dolium costatum* Desh.—Martin, Samml. des geol. Reichsmus. in Leiden, new series, Vol. I, p. 161, Pl. XXV, figs. 371—373.  
 1919. *Dolium (Eudolium) tessellatum* Bruguière.—Vredenburg, Mem. Ind. Mus., Vol. VII, p. 156, Pl. VI, fig. 7, Pl. VII, figs. 8—10, Pl. VIII, figs. 11—13.

This species is represented by two specimens, one of which measures about 47×40 mm., the other about 115×85 mm. In neither case does the body-whorl show any intercalary ribs.

*Occurrence*.—Mekran beds: Koh-i-Dumak.

As in the case of *Dolium variegatum*, the geographical range of this shell extended, in former geological times, over regions where the shell is not now found living. At the present day, it is not

known to extend further west than the eastern region of the Bay of Bengal.

DOLIUM (EUDOLIUM) ORMARENSE n. sp.

Pl. X, figs. 2, 3.

? 1882. *Dolium costatum* Mke. var. *Martini* Boettger.—Die Tertiärformation von Sumatra, Theil II, p. 84, Pl. VI, figs. 4, 5 (Pal. Suppl. III).

Medium size to fairly large, globose, with small depressed spire measuring one-sixth of the total height.

The protoconch, imperfectly preserved in the available specimens, is followed by two depressed spire-whorls separated by impressed sutures. They carry three principal revolving ribs, one of which is close to the posterior suture, another close to the anterior margin. The two flat intervals between these main ribs are each intersected by a spiral thread of a second order, still finer threads, of at least one more order, being visible where the ornamentation is best preserved. The lines of growth are oblique, antecurrent towards the posterior suture.

The large, sub-spherical, body-whorl constitutes the greater part of the shell. Its even convexity, on the right side of the shell, is continued without interruption as far as the broad, deep, terminal notch. On the left side of the shell the spherical, convex outline is connected by a short, concave bend with the vertical border of the zone of accretions which is steeply twisted but not bulging; the actual termination of the outline on the left side of the shell is anteriorly steeply oblique towards the right and is formed by the anterior border of the zone of accretions to the terminal notch. The ornamentation of the body-whorl consists of a number of regularly distributed, relatively broad, moderately prominent, spiral ribs, the number of which is twelve in the case of immature specimens, increasing to fourteen when the shell is full-grown; the increase taking place by additions near the anterior extremity close to the terminal zone of accretions of the anterior notch. The spacing of the revolving ribs decreases anteriorly, the width of the ribs also decreasing at the same time; only the rate of decrease is more marked in the spacing than in the size of the ribs, so that, although the more posterior ribs are narrower than the intervening spaces, the more anterior ribs are as broad, or even broader than the intervals. The three posterior ribs are the

same as those of the spire-whorls continued on the corresponding portion of the body-whorl. With the exception of the narrowest anterior interspaces, each interval is bisected by a thread of a second order. Although these intercalary threads are much thinner than the main, spiral ribs, yet, owing to the relatively narrow proportions of the intervals over the greater portion of the shell, they fill most of the available space, leaving no room for any threads of a third order, such as are seen very rarely, in only a few specimens, very faintly developed in one or other of the broader posterior intervals continued from the spire. When the ornamentation is exceptionally well-preserved, fine, spiral striations may be observed on the surface of the broad primary ribs. There are a few, rather feeble, spiral markings on the terminal zone of accretions. The lines of growth are oblique, anteriorly retrocurrent and practically straight until close to the terminal zone towards which they curve backwards, traversing it with a deep sinuosity in accordance with the terminal notch.

The large aperture terminates directly, without any intervening canal, in the deep, wide, dorsal notch only slightly deflected towards the left of the shell. The columella, anteriorly to its junction with the base of the penultimate whorl, is at first approximately vertical, while, anteriorly to the inward extension of the terminal zone of accretions, it becomes steeply oblique anteriorly towards the left of the shell, and slightly twisted. The columellar lip is indistinct posteriorly. Anteriorly to the accretions of the notch it becomes detached forming a narrow, tubular, thin-walled umbilicus continued as a fold into the interior of the shell. The outer lip is antecurrent and tangent to the suture, straight and rather strongly oblique. It has a thin, rather strongly fimbriated edge, anteriorly to which it exhibits a moderately prominent, moderately broad thickening parallel to the edge. The spiral ornaments of the external surface, which, owing to the thinness of the shell, are reproduced in reversed order on the inner walls, are also continued over the interior, marginal swelling of the outer lip, while, along the thin, fimbriated edge, there is a ventrally situated, strongly prominent tubercle at the termination of each of the principal, internal ledges, corresponding therefore to each of the main, sunken intervals of the outer surface; in consequence of which they often appear somewhat bifid, being bisected by the termination of the internal ribs coinciding with the external intercalary threads.

*Dimensions.*—

	mm.
Height . . . . .	46
Thickness . . . . .	36
Height of spire . . . . .	8
Height of body-whorl . . . . .	43

The shell also reaches larger dimensions up to 75×58 mm.

*Occurrence.*—Mekran beds: nodular shales of Ormara (Townsend).

*Remarks.*—Amongst the fossils stated to have been obtained from the nodular shales of Ormara, Newton has described, under the name of *Dolium townsendi* (Geol. Mag., dec. 5, Vol. II, p. 301, Pl. XVII, fig. 1), a species remarkable for the irregularity and uneven spacing of the ribbed decoration on the body-whorl. Another specimen described and figured as *Dolium* cf. *Hochstetteri* Martin (*loc. cit.*, p. 302, Pl. XVII, fig. 2) exhibits a somewhat similar irregularity.

The specimens from Ormara available in Calcutta are very numerous, but in no single instance do they show any indication of the irregularity or inconstancy of the ribbed ornamentation figured and commented on by Newton. At the same time, such peculiarities of ornamentation are frequently shown by the specimens from another spot on the Mekran coast, Koh-i-Dumak, near Gwadar. There is reason to think, therefore, that the specimens figured by Newton, at least those represented in figures 1 and 2 (*loc. cit.*) are not from Ormara, but from the neighbourhood of Gwadar. Until it can be definitely ascertained whether any of these specimens truly correspond with the type of *Dolium Townsendi*, it will be safer provisionally to give distinct names both to the Ormara and Gwadar forms.

*Comparison with other species.*—This shell belongs to the group of *Dolium tessellatum* Brug., which it resembles in shape, but from which it is distinguished by the invariable presence, at all stages of growth, of well-defined, intercalary ribs, while, in *Dolium tessellatum*, the intercalary ribbing exists only at the earliest stages of growth or on the body-whorl of full-grown specimens, the majority of medium-size shells being devoid of intercalary ornaments.

The spire of the Ormara fossil resembles that of *Dolium maculatum* more than that of *Dolium tessellatum* in which the spire-whorls may carry four, visible, primary ribs instead of three, or in which

a space remains between the third rib and the anterior margin, while the intercalary decoration is feebler and differently disposed as compared with *Dolium maculatum*. The specimens from the later Tertiary of Sumatra, described by Boettger (*loc. cit.*) as *Dolium costatum* var. *martini*, probably coincide with the above-described fossil which, in case this identification be verified, should be distinguished as *Dolium martini* Boettger. The Sumatra form has been referred to *Dolium costatum* (= *Dolium tessellatum*) as a variety on the strength of an observation by Martin who records (*Tertiärsch.*, p. 40) the occurrence of varieties, both fossil and living, in which intercalary ribs appear on the posterior portion of the body-whorl. Although Martin does not allude to the dimensions of the specimens exhibiting this peculiarity, the fact that it is mentioned as characterising the body-whorl indicates that the feature is, in all probability, one of adult growth such as characterises many Recent specimens of *Dolium tessellatum*. As already explained, the intercalary ribs which are observed on the earliest whorls following the protoconch of *Dolium costatum* very soon become faint or indistinct or even disappear entirely; this constituting one of the most noticeable differences between *Dolium tessellatum* and *D. maculatum*, in which latter species the intercalary ornamentation continues without any essential alteration as far as and throughout the body-whorl. Medium-size specimens of *Dolium tessellatum* are generally without any distinct interstitial decoration. It is only on full-grown shells that the intercalary ribs reappear, and then with characters different from those of *D. maculatum*, being of one order only and filling the greater part of the available space, instead of consisting of several alternating sizes as in *Dolium maculatum*. Taking into account the dimensions of the two Sumatra specimens figured by Boettger, the interstitial ribs are far too well developed to represent the continuation of those that decorate the earliest whorls, while the specimens are far too small to allow them to be regarded as representing the adult decoration. Martin has figured one small specimen (new series, Vol. I, Pl. XXV, fig. 372), with very faint interstitial ribs which may represent the persistence of those of early growth, while all the other figured specimens (both in *Tertiaerschichten* and in the new series) are of medium size and without intercalary ornaments. So far as can be judged from the figures, the spire of the Sumatra shell is similar to that of the Ormara fossil, with three primary ribs of which the

most anterior one coincides with the anterior margin, while in *Dolium tessellatum* the third rib is almost always distant from the anterior margin, along which even a fourth rib may become visible.

There is very little doubt therefore that the Sumatra form is identical with the one from Ormara, the only remaining hesitation being caused by the relative thinness of the intercalary ribs as shown in the figure of the larger of the two specimens described by Boettger. Pending the opportunity of establishing a fuller comparison, the Ormara form may provisionally be treated as a distinct species.

Owing to its fimbriated, thickened and internally denticulate outer lip, *Dolium ormarensis* is here referred to the subgenus *Eudolium*. The state of preservation of the columella is not sufficient to show whether the rugosities characteristic of *Eudolium* are also present.

*DOLIUM* (*EUDOLIUM* ?) *ARABICUM* n. sp.

Pl. X, figs. 5, 6.

? 1905. *Dolium townsendi* R. Bullen Newton.—*Geol. Mag.* dec. 5, Vol. II, p. 301, Pl. XVII, fig. 1.

? 1905. *Dolium* cf. *Hochstetteri* Martin sec. Newton.—*Soc. cit.*, p. 302, Pl. XVII, fig. 2 (? fig. 3).

Medium-size, ovoid, with depressed slightly conoidal spire measuring one-sixth of the total height.

The protoconch, imperfectly preserved in the available specimens, is followed by three, low, convex spire-whorls separated by sunken sutures. They are decorated with flat, revolving ribs of which the principal ones are narrower than the intervening spaces. The spacing of these principal ribs varies relatively to the width of the spire-whorls, so that their number also varies in different specimens. In some instances four of these main ribs are visible on the spire-whorls, one of them encircling the channelled sutures, another coinciding with the anterior margin. When the spacing of the ribs is wider, this more anterior rib may become concealed by the edge of the next succeeding whorl, while, with a still wider spacing, the third rib, counting from the posterior margin, may come to coincide with the anterior margin, or may even disappear beneath the margin of the next following whorl, in which latter instance only two ribs may remain visible. The intervals between the principal ribs each carry one or two very fine, thread-like, subsidiary ribs which tend to become indistinct with increasing growth.

The large, globose to ovoid body-whorl constitutes the greater part of the shell. Its outline, on the right side of the shell, exhibits a continuous convexity, while on the left side the continuity of the curve is interrupted anteriorly at the junction of the main globose portion with the zone of accretions of the terminal notch. The zone of accretions is narrow, steeply twisted, and anteriorly bordered by an umbilicus. On the posterior part of the body-whorl constituting the continuation of the spire, the decoration of the spire-whorls continues unaltered, the thread-like, intercalary ribs either disappearing entirely or becoming very faint, in which case there does not remain more than one in each interval. Anteriorly to the portion forming the continuation of the spire, the character of the revolving, ribbed decoration changes. On the spire and on the corresponding portion of the body-whorl, the main, spiral ribs are considerably narrower than the intervening spaces. On the contrary, anteriorly to the level of the suture, the ribs, on an average, are much wider than the intervening spaces which sometimes become almost linear.

Moreover, instead of being approximately equal in thickness and evenly spaced (either equally or in anteriorly decreasing ratio) as on the spire and corresponding portion of the body-whorl, the ribs, anteriorly to the level of the suture, vary irregularly in thickness and exhibit an irregular distribution varying considerably in both respects in different specimens. In the specimen in which the irregularity of the ornamentation is least pronounced, the total number of ribs on the body-whorl is thirteen, of which the four most posterior ones are continued from the spire and are regularly spaced. The most pronounced irregularity is exhibited by the fifth rib which is narrower than the fourth and sixth between which it is inserted and from both of which it is separated by narrow spaces. Anteriorly to the sixth rib the remaining ribs are distributed with a fair amount of regularity; they are broader than the intervening spaces and they somewhat decrease in width, at a fairly even rate, in an anterior direction. It can be distinctly ascertained, in this particular specimen, that the conspicuously irregular fifth rib has originated as an intercalary rib tending, with increasing growth, to become equal to the primary ribs. In another specimen, the number of ribs on the body-whorl that can clearly be interpreted as primary is eleven, while, if the obviously secondary or intercalary ribs be taken into account, the total number is sixteen. The

three most posterior primary ribs are continued from the spire and are separated by wide intervals, each one of which is bisected by a faintly visible, intercalary thread. A space, almost as broad as the posterior spaces just mentioned, intervenes between the third and fourth primary thread, but is occupied by an intercalary thread which, on the later part of the body-whorl, increases in thickness to such an extent as to assume almost the proportions of a primary thread and fills the greater part of the interval. The fourth primary thread is followed by three more, broad threads wider than the intervening spaces, but uneven in width and spacing. The remaining anterior portion of the body-whorl carries threads regularly alternating in two orders of strongly contrasted thickness. In another specimen, the total number of main threads on the body-whorl is sixteen. There is but one intercalary thread, faintly developed in the most posterior interval. The three most posterior intervals separating the four most posterior ribs, are equal to one another, and broader than the ribs. The interval between the fourth and fifth rib is of about the same width as the rib. The fifth to tenth ribs are so close together that the intervals between them are almost linear. The remaining ribs are approximately of the same width as the intervening spaces, evenly distributed, and gradually decreasing in thickness and spacing in an anterior direction. Lastly, another specimen exhibits on the body-whorl, leaving out of account the more obviously secondary ribs, twelve conspicuous ribs of which, however, ten only can truly be regarded as primary. The most posterior space is exceptionally broad and carries a conspicuous, sharply marked, subsidiary thread. The space between the second and third rib is of about the same width as the ribs themselves. Apparently another very broad space intervenes between the third and what appears to be the fourth primary rib, but this space is largely filled by two secondary ribs which, however, are narrower than the true primaries. A broad subsidiary rib, evidently of secondary origin, occupies the greater portion of the space between what has above been referred to as the fourth main rib, and what would follow as the fifth. The remaining anterior ribs are regularly distributed and of about the same width as the intervening spaces. While, in other instances, the most conspicuous irregularities appear to be due to the abnormal development of an intercalary thread, in the specimen now under consideration, the main irregularity is caused by the bifurcation of one of the



original main ribs, that originally constituting the fourth primary rib. The rib which, on the later part of the body-whorl, appears to be the fourth primary was originally the fifth, while the original fourth, owing to its breaking up, is no longer recognisable as a primary. Moreover the spacing of some of the main ribs varies, in this specimen, at different stages of growth. All the available specimens are in the condition of internal casts, so that the more delicate ornaments that may have diversified the anterior zone of accretions are not preserved.

The aperture is large and semi-circular, the columella steeply oblique anteriorly towards the left of the shell, slightly and steeply twisted, the columellar lip very thin, the outer lip straight and oblique.

*Dimension*.—

	mm.
Height . . . . .	65
Thickness . . . . .	58
Height of spire . . . . .	11
Height of body-whorl . . . . .	62

*Occurrence*.—Mekran beds: Koh-i-Dumak, east of Gwadar.

*Remarks and comparison*.—This shell has been named provisionally in case of its being distinct from *Dolium townsendi* Newton, described as from Ormara. In dealing with the form of *Dolium*, which occurs abundantly at Ormara, attention has been drawn to the fact that none of the numerous specimens from that locality available in Calcutta resemble the published figure and description of *Dolium townsendi*. It has therefore been suggested that the type of *Dolium townsendi* may originally have been obtained near Gwadar and not at Ormara. If this should be really the case, the shell above described must correspond with *Dolium townsendi* and will resume this name as soon as its identity can be definitely verified.

The species seems to be related to *Dolium tessellatum* with which it agrees as to the general shape of the shell and the ornamentation of the spire. The above-described fossil is nevertheless clearly distinguished by the irregular decoration of its body-whorl from *Dolium tessellatum* which is, on the contrary, particularly remarkable for the regularity and constancy of its ornamentation.

If *Dolium tessellatum* is regarded as a member of the subgenus *Eudolium*, the same is probably the case with the above-described

fossil, though, in the absence of specimens with well preserved aperture, it is not possible to be certain on this point.

PIRULA FICUS [Linnæus].

1822. *Pyrula ficus* Linn.—Lamaick, Hist. Nat. An. sans vert., Vol. VII, p. 141.  
 1767. *Bulla ficus* Linnæus.—Systema Naturæ, 12th ed., p. 1184.  
 1799. *Pyrula ficus* [Linn.].—Lamarok, Mém. Soc. Hist. Nat. Paris, p. 73.  
 1847. *Ficula lævigata* Reeve.—Monograph of the genus *Ficula*, sp. 4.  
 1885. *Pyrula ficus* [Linn.].—Tryon, Man. Conch., Vol. VII, p. 266.

Some attention is needed to distinguish between *Pirula ficus* [Linn.] and *Pirula dussumieri* Valenciennes, when in a fragmentary condition. Recent specimens are readily distinguished by the shape, which is more piriform or fig-like, that is: more expanded posteriorly in *Pirula ficus*, more ovoid in *Pirula dussumieri*. The proportions of *P. dussumieri* are more elongate. The spiral threads, in adult specimens, are more prominent and less crowded in *P. dussumieri* than in *P. ficus*; their width, on an average, being equal to or inferior to that of the intervals in *P. dussumieri*, while they are, on an average, broader than the intervals in *Pirula ficus*. In immature specimens, the differences in the ornamentation are particularly distinct, *Pirula ficus* exhibiting intercalary, spiral threads at a very early stage of growth at which, in *Pirula dussumieri*, the spiral threads are all of one dimension and constitute, together with the axial ornaments, a remarkably even trellis analogous to that of the fossil *Pirula geometra* Borson of Europe.

The fossils at present under consideration are all fragmentary and immature, but can unhesitatingly be referred to *Pirula ficus* from the characters of their ornamentation, and so far as the shape is preserved, from their outline.

*Occurrence*.—Mekran beds: North of Talar Gorge on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains. Also in strata of the same age in Ramri island.

The shell is also known in a fossil condition from the Pliocene or upper Miocene of Java.

PIRULA MENENGTENGANA Martin.

1899. *Ficula menengtengana* Martin.—Samml. des geol. Reichs. mus. in Leiden new, series, Vol. I, p. 164, Pl. XXVI, fig. 380.

This species is represented by a single specimen which is largely in the condition of cast, as is also the case with the Javanese original

type with which it appears to agree completely, both in shape and in ornamentation, the spacing and even distribution and thickness of the spiral ornaments similarly intersected by crowded, spiral striations. Over the greater part of the shell the crowded, spiral decoration consists of threads of two alternating sizes, as described and figured by Martin. Over the posterior part of the broadest zone of the shell, the threads are all of one size, the available figures and description leaving it uncertain whether a similar peculiarity characterises the solitary Javanese specimen.

*Dimensions.*—The approximate thickness is 45 mm., and the probable height 80 mm.

*Occurrence.*—Mekran beds: Koh-i-Dumak.

*Comparison with other species.*—In shape, this shell resembles *Pirula ficus*, from which it is distinguished by the coarser, spiral threads and the extremely crowded, vertical striations with which the threads are covered.

#### PIRULA CONDITA Brongniart.

1823. *Pirula condita* Brongniart.—Mém. terr. séd. sup. Vicentin, p. 75, Pl. VI, fig. 4.
1891. *Ficula condita* Brongn.—Sacco, Mall. terr. terz. del Piemonte e della Liguria. Parte VIII, p. 23, Pl. I, figs. 27—32.
1895. *Ficula Theobaldi* Noetling.—Mem., G. S. I., Vol. XXVII, part 1, p. 28, Pl. VI, fig. 5.
1901. *Ficula theobaldi* Noetling (*pars*).—Pal. Ind., new series, Vol. I, part 3, p. 298, Pl. XIX, fig. 21 (*non* fig. 20).

This species, one of the commonest fossils of the Oligocene and Miocene of Europe, is equally abundant in the Oligocene of India. The Indian specimens agree exactly with the European Oligocene forms of the species. The specimen from Yenangyat described by Noetling in 1895 under the name of *Ficula Theobaldi*, also agrees perfectly with *Pirula condita*, with which, in his first monograph, Dr. Noetling regarded it as closely allied. In his second monograph, without alluding to the comparison made in his previous work, Dr. Noetling dismissed the discussion of the relationship of the fossil with the mere remark that "*Ficula Theobaldi* bears no similarity to any fossil or living species." It should be observed, however, that in the second monograph, Dr. Noetling, in addition to the original type, figured a second specimen the surface of which is completely weathered, but the shape well preserved of which numerous more or less complete specimens are now avail-

lable with the ornamentation distinctly preserved. Though the shell may be regarded as specifically identical with the Yenangyat fossil, yet, owing to certain characters of its ornamentation, it may be distinguished as a separate variety.

*Occurrence*.—Nari of Bhagathoro Hill in Sind. Nari of Baluchistan: Kudin.

Yenangyat "Zone of *Paracyathus coeru'ens*." The locality "Minbu," cited in Noetling's second monograph, is doubtful, and the shells from that locality, referred to "*Ficula theobaldi*," belong to another species, *Pirula concinna* Beyrich, of which they constitute a local variety.

PIRULA PAMOTANENSIS Martin, var. KACHHENSIS n. var.

Pl. X, figs. 7, 8.

1899. *Ficula pamotanensis* Martin.—Samml. des geol. Reichs. mus. in Leiden, new series, Vol. I, p. 164, Pl. XXVI, fig. 379.

PIRULA KACHHENSIS n. sp.

Medium-size, slender, elongate-ovoid, with broadly conoidal, slightly stepped spire and very large body-whorl.

The relatively large, depressed, obliquely disposed protoconch, shaped like a very flat *Trochus* or *Natica*, consists of a small, button-like nucleus, followed by one-and-a-half rapidly increasing whorls, smooth but for some obscure, convex lines of growth near the junction with the spire proper, which are oblique and slightly curved, with forward facing convexity, antecurrent to the posterior suture, retrocurrent to the anterior margin. The protoconch is followed by two-and-a-half whorls the height of which is equal to about one-quarter of their width. The first whorl following the protoconch is evenly convex. The following ones are also convex, with a slight angulation near their posterior margin, the portion situated between the angulation and the posterior suture being without curvature and sloping very low. The sutures are at first linear and assume the appearance of a narrow, shallow channel with increasing growth. The channel, however, does not always strictly correspond with the suture, as it is sometimes overstepped by the posterior margin and is followed posteriorly by a narrow, extremely thin, foliaceous extension closely fitting round the anterior margin of the previous whorl. The decoration of the whorls consists of

thin, raised ornaments, both axial and spiral. The axial ornaments are thin, crowded ribs which, throughout the greater part of the spire, and for the greater portion of their length, are oblique, antecurrent to the anterior suture, slightly convex with forward directed convexity, and which, with a pronounced hook-like bend, quite close to the posterior margin, become antecurrent to the posterior suture; the complete course being, therefore, unsymmetrically sigmoidal. Where there is a foliaceous rim beyond the sutural channel the ribs, on this extension, become reduced to more or less irregularly prominent lines of growth still more obliquely antecurrent to the final suture. The first few ribs following the protoconch are oblique in the opposite direction to those of the greater part of the spire, that is retrocurrent to the anterior margin, in accordance with the direction of the lines of growth of the protoconch. The spiral ornaments are threads which, beyond the termination of the first whorl following the protoconch, alternate in two orders not differing greatly in thickness, and evenly spaced. Between the posterior angulation which corresponds with a principal thread, and the posterior suture, the interval is equal to nearly twice the average space between two consecutive threads, or, in other words, nearly equal to the interval between two threads of the first order; nevertheless no secondary thread is developed within this exceptionally broad space. On the first whorl following the protoconch, the appearance of the spiral ornaments is somewhat different, as they consist of six equal, equidistant threads. With increasing growth, the posterior suture gradually encroaches upon the anterior margin of the preceding whorl. Consequently, the more anterior original threads become successively overlapped by the posterior margin of the next following whorl. Consequently, although the last spire-whorl exhibits five or six spiral threads, only three of these correspond with the three posterior, original threads: namely, the most posterior thread bordering the broad circumsutural zone, and, anteriorly to it, each alternate, principal thread. All the ornaments, both spiral and axial, have a flat surface and are fillet-shaped in section. The axial ribs are about as thick as the spiral threads of the first order, or else intermediate in thickness between the two not very different orders, and, as their spacing is equal to the spacing of the spiral ornaments, the whole surface is very regularly reticulated into remarkably even meshes, which are approximately square near the anterior margin, while owing to the slight increase

of obliquity of the ribs, they become rhombic towards the posterior angulation. The intersections between the two classes of ornaments are marked by raised, flat, square or squarish knobs.

The very large, slender, body-whorl, constituting by far the greater portion of the shell, consists of an extremely elongate ovoid convex portion, which passes very gradually into the canaliculated anterior extremity so that the anterior concavity, only developed on the left side of the shell, is extremely shallow. The ornaments of both orders are continued with the utmost regularity over the entire body-whorl, the spiral threads becoming very oblique on approaching the anterior extremity. The intersection nodes become increasingly prominent on approaching the anterior termination. But for their hook shaped termination along the suture, such as has been described for the spire, the axial ribs exhibit a very extended, forward—directed convexity of very feeble curvature the most prominent point of which is at about one third of the height of the shell from the apex. Anteriorly to this point the curvature carries the ribs retrocurrently in an anterior direction with a gradually increasing obliquity which never becomes great.

The aperture is narrow, not sharply angulated posteriorly, very gradually contracted anteriorly. The columella, merging very gradually into the base of the penultimate whorl, is almost straight and almost vertical. There is no appreciable columellar lip. The thin, outer lip exhibits a very short, shallow sinus next to the suture, the remainder of its course being convex in conformity with the already—described shape of the axial ornaments.

*Dimensions.*—The dimensions of the shell are as follows, the height being restored :

	mm.	mm.
Height . . . . .	46	47
Thickness . . . . .	21	21
Height of spire . . . . .	4	6
Height of body-whorl . . . . .	44	44

*Occurrence.*—Gàj of Kachh : near Warsar (23° 21', 68° 49') north of Jakao (23° 13', 68° 45'); Teyra River near Rampur (23° 20', 68° 51').

*Comparison with other species.*—The elongate, ovoid, non-piriform shape, the absence of shouldering, the length of the spire, and the simplicity of the reticulation, communicate a remarkably archaic appearance to this shell which, so far as is known, belongs to an

exclusively eastern group represented also by *Pirula birmanica*, a form shortly to be described, from the Oligocene of Burma; by *Pirula pamotanensis* Martin from the Miocene of Java; by *Pirula promensis* (Rec., Geol. Surv. Ind., Vol. LI, pp. 270, 291) from the Miocene of Burma, and which has survived to the present day in *Pirula investigatoris* E. A. Smith (Ann. Mag. Nat. Hist., (6), XIV, 1894, p. 367; Illustrations of the Zoology of the Investigator, 1897, Pl. VI, fig. 2). Compared with Martin's type, the Indian fossil is larger, with the posterior convexity of the body-whorl still more elongate, and the concavity of the neck and columella still shallower. All other features are strictly identical. The characters of the Indian form are constant in the available specimens. The Javanese form is known from only a single specimen, and it is possible therefore that further material may merge it into complete identity with the Indian shell which, in the meanwhile, can scarcely be considered to differ otherwise than varietally. A considerable range of variation is observed in the shape of the closely related *Pirula promensis*. *Pirula birmanica*, though no more shouldered than the Kachh fossil, and with quite as prominent a spire, is, nevertheless more ventricose, while its reticulation is yet more even, as the spiral threads are all of one order over the greater part of the shell.

*Pirula investigatoris* agrees almost exactly in shape with the Burmese Oligocene fossil, and therefore differs likewise from the Kachh shell from which, moreover, it is distinguished by its larger dimensions. Its ornamentation, however, is practically identical with that of the Kachh shell.

#### CYPRÆA PRUNUM J. de C. Sowerby.

1839. *Cypræa prunum* J. de C. Sowerby.—Trans. Geol. Soc. London, 2nd series, Vol. V, Pl. XXVI, fig. 28.  
 ? 1839. *Cypræa digona* J. de C. Sowerby.—Trans. Geol. Soc. London, 2nd series, Vol. V, Pl. XXVI, fig. 29.  
 1890. *Cypræa willcoxi* Dall.—Trans. Wagner Free Inst. Sci. Philad. Vol. III, p. 166, Pl. V, fig. 12.  
 1899. *Cypræa (Aricia) simplicissima* Martin.—Samml. des geol. Reichsmus. in Leiden, n. F., Vol. I, p. 167, Pl. XXVI, fig. 384.  
 non *Cypræa prunum* J. de C. Sow., in d'Archiac, Hist. progr. Géol., III, p. 296, (1850).  
 non *Cypræa prunum* J. de C. Sow., var. *minor*, in d'Archiac and Haimé, Decree. an. foss. gr. numm. Inde, p. 332, Pl. XXXII, figs. 11, 12 (1854).  
 non *Cypræa digona* J. de C. Sow., in d'Archiac, Hist. progr. Géol., III, p. 296, (1850)

*non Cypræa digona* J. de C. Sow., ?, in d'Archiac and Haime. Descr. an. foss. gr. numm. Inde, p. 332, Pl. XXXII, fig. 13 (1854).

Medium-size, regularly elongate ovoid, feebly rostrated anteriorly, and obscurely rostrated posteriorly, moderately convex ventrally, strongly convex dorsally with the greatest thickness scarcely nearer to the posterior than to the anterior extremity.

The spire is concealed by the callous growths of the body-whorl which constitutes the entire visible portion of the shell. The connection between the dorsal and ventral surfaces usually forms a quite continuous curve, though, on the right side of the shell, especially in small specimens, there is sometimes a scarcely appreciable bend forming a rudimentary rim to the dorsal convexity along its right margin. Viewed sideways, the dorsal surface exhibits a very smoothly convex curve, the posterior slope being steeper and shorter than the anterior one, the anterior extremity appearing gently rostrate and truncated. The dorsal view is oval and even more regularly curved, the rate of contraction being but slightly more pronounced posteriorly than it is anteriorly towards the gentle anterior rostration. Both outlets of the aperture are dorsally notched. The anterior notch is narrow and oval, with its apex slightly deflected towards the left of the shell; it is ventrally contracted by the close approach to one another of the narrow, ridge-like terminations of the apertural margins. The posterior notch is moderately narrow, moderately deep, with apex slightly deflected towards the left of the shell, in a direct line with the apex of the spire; it has parallel margins of which that constituted by the outer lip projects posteriorly a little more than that constituted by the columellar lip.

The junction between the dorsal and ventral surfaces is evenly rounded without any tendency to form a dorsal rim. The moderately convex, ventral surface is unequally divided by the narrow, curved aperture which exhibits a fairly pronounced bend at one-third of its length measured from the posterior end; in consequence of which the posterior portion of the aperture is oblique posteriorly towards the left, the anterior portion anteriorly oblique also towards the left. The aperture is moderately expanded anteriorly until it is again contracted by the close, mutual approach at a steep angle, of the narrow, pinched terminations of the apertural lips, constricting the entrance to the terminal notch. The columella, where it joins the base of the penultimate whorl, is very steeply oblique,



the direction of obliquity being anteriorly towards the left. The terminal edge forms a thickened, prominent ridge, rather strongly twisted, anteriorly oblique both ventrally and towards the left. The junction of the columellar lip and of the ventral surface forms a somewhat sharply angulated edge internally to which the surface falls inward very steeply. The crowded, transversely very elongate folds are situated entirely anteriorly to the above-mentioned edge, without any tendency to spread over the ventral surface. In an anterior direction, a widely excavated, spoon-shaped fossula is bounded by the edge of the columellar lip, the nearly vertical portion of the columella, and the terminal edge of the columella. The apertural plications are continuous across this broad depression and on to the columella. The junction between the outer lip and the ventral surface constitutes an edge similar to that of the columellar lip. The transverse denticulations are, likewise, situated entirely anteriorly to this edge. There are twenty-three to twenty-five folds along the columellar lip, slightly more or less along the outer lip.

*Dimensions.*—The following dimensions have been measured upon two specimens from Kachh:

	mm.	mm.
Height . . . . .	41	?
Width . . . . .	27	31
Dorso-ventral thickness . . . . .	23	27

The larger of these two specimens, which is incomplete anteriorly has exactly the same size and shape as Sowerby's original type which measures 48 mm. by 32 mm.

*Occurrence.*—Gaj beds of Kachh: Teyra River near Rampur (23° 20', 68° 51'); Teyra River north of Naliya (23° 15', 68° 52') higher than the Pecten bed of Sookpur; south bank of river from Teyra (23° 17', 68° 58').

*Remarks.*—*Cypræa* shells occur abundantly in the collections from the Miocene of Kachh, but only include three forms: *Cypræa prunum*, *nasuta* and *humerosa*. All these species were first described by J. de C. Sowerby who also included a fourth species, *Cypræa digona*, the type of which has been lost. Sowerby's type-figure of this form so closely resembles the smaller specimens of *Cypræa prunum* that there is every reason to believe that it also represents a small individual of the same species, perhaps slightly distorted, as is so frequently the case with fossil shells of *Cypræa*.

d'Archiac, who was not acquainted with the internal characters of the aperture of the Kachh species, referred to it a Sind fossil *Cypræa* as a variety *minor*. The Sind fossil is not unlike *Cypræa prunum* in shape, but is distinguished by the disposition of the apertural denticulations which tend to spread to a short distance over the ventral surface which merges into the apertural margins more gradually than in the case of *Cypræa prunum*. The shape also slightly differs, being less evenly oval, with the maximum width and maximum thickness a little nearer to the posterior than to the anterior extremity, instead of being situated at about half the length of the shell as in *Cypræa prunum*. The Sind fossil is described below as *Cypræa subexcisa* Braun.

*Comparison with other forms.*—Compared with the somewhat similar *Cypræa leporina* Lam., a very common fossil in the lower Miocene of Europe, the shell above described shows a tendency to be more rostrated anteriorly, while the posterior notch is invariably somewhat deeper, the anterior notch much larger and deeper, with a more sharply defined rim.

The closest alliance of the above described fossil is with certain living shells of the Indian or Indo-Pacific region, principally *Cypræa mappa* Linn., *C. nivosa* Broderip, and *C. vitellus* Linn. Compared with the fossil, *C. vitellus*, from the Indo-Pacific region, has the spire better exposed. Compared with the living *Cypræa nivosa* Linn., from the Indian Ocean, the resemblance of the aperture and apical portion is still closer, only, in a lateral view, the anterior portion of the dorsal outline slopes more abruptly in the living shell than in the fossil.

The resemblance to *Cypræa mappa* Linn. from the Indo-Pacific region, is also very close, though *Cypræa mappa* is larger than the fossil, with a better exposed spire, better defined posterior rostration, and less unsymmetrical ventral surface. The boundary between the outer lip and ventral surface is marked, as in *C. mappa*, by a sharper edge than in *C. vitellus* and *C. nivosa*. The fossula, as in *C. mappa*, is broader and deeper than in *C. vitellus* and *C. nivosa*. The aperture is posteriorly deflected more than in *C. mappa*, *C. vitellus* and *C. nivosa*.

Judging from the published descriptions and figures, *Cypræa simplicissima* Martin, from the Rembang series of Java (probably Aquitanian), and *C. willcoxi* Dall from the Chipola beds of Florida (Aquitanian or Burdigalian), are identical with *C. prunum*.

## CYPRÆA PRUNUM SOW. VAR. NASUTA SOW.

1839. *Cypræa nasuta* J. de C Sowerby.—Trans. Geol. Soc. Lond., 2nd series, Vol. V, Pl. XXVI, fig. 30.
1850. *Cypræa granti* d'Archiac.—Hist. des progr. de la Géol., Vol. III, p. 299.
1854. *Cypræa granti* d'Arch.—d'Archiac and Haine, Descr. an. foss. gr. numm. Inde, p. 332, Pl. XXXII, fig. 14.
- non *Cypræa granti* d'Arch., in Noetling, Mem., G. S. I., Vol. XXVII, part. 1 (1895), p. 25, Pl. V, fig. 12.
- non *Cypræa granti* d'Arch., in Noetling, Pal. Ind., new series, Vol. I, part 3 (1901), p. 290, Pl. XIX, fig. 12.
- non *Cypræa* (*Bernayia*) *granti* d'Arch., in Cossmann and Pissarro, Pal. Ind., new series, Vol. III, part 1 (1909), p. 42, Pl. IV, figs. 15—17.

Rather small to medium. ovoid-amygdaloidal, with slightly produced posterior extremity and somewhat rostrate anterior extremity.

In specimens that have not reached their complete development, the small spire is visible at the bottom of a narrow, circular depression which becomes completely concealed by callus with fuller development. The dorsal surface exhibits a strongly pronounced, ovoid convexity. The ventral surface is more moderately convex. The curvature connecting the two surfaces is continuous on the left side of the shell, while on the right side it exhibits a more or less distinct bend forming an obscure rim to the right side of the dorsal surface. The maximum height of the dorsal convexity is situated a little nearer to the posterior than to the anterior extremity of the shell, at the same level as the maximum width. Both apertural outlets are dorsally notched. The anterior notch is sub-circular, moderately wide, with apex slightly deflected towards the left of the shell; it is ventrally constricted by the projecting, pointed terminations of the apertural margins, and dorsally surrounded by a raised rim which, together with the elongated apertural terminations, contributes to the rostrate appearance of the anterior termination. The posterior notch is somewhat narrow, moderately deep, with apex deflected to the left of the shell towards the spire; it has parallel, raised margins, of which the one corresponding with the outer lip is more prominent than the other.

The moderately convex ventral surface is unequally divided by the narrow aperture which is moderately bent at one-third of its length, measured from the posterior extremity, and which is scarcely expanded anteriorly towards its anterior termination feebly constricted by the approach to one another of the ridge-like termina-

tions of the apertural margins. The columella, at its junction with the base of the penultimate whorl, is practically vertical. Its anterior edge forms a narrow, twisted ridge strongly oblique anteriorly in a ventral direction, but feebly oblique anteriorly to the left, so that in a ventral view of the shell it appears very steep towards its pointed junction with the almost vertical, terminal edge of the columellar lip. The junction of the columellar lip with the ventral convexity is marked by a well defined edge anteriorly to which are from twenty to twenty-five close-set, well developed, transverse ridges greatly elongated into the depths of the aperture. Anteriorly a broad fossula is bounded by the edge of the columellar lip, the approximately vertical portion of the columella and the terminal columellar edge, and is traversed uninterruptedly by the apertural ridges which are also continued across the columella. There is a definite edge also at the junction of the outer lip with the ventral surface. Owing to the curvature of the aperture, the outer lip is a little longer than the inner lip, and its denticulations are more constant in number, amounting generally to twenty.

*Dimensions.*—

	Teyra River near Rampur.	Dalabe (Burma)
	mm.	mm.
Height . . . . .	26	17
Width . . . . .	17	11
Dorso-ventral diameter . . . . .	13	9

There are also somewhat larger specimens. The maximum limit of the dimensions cannot be stated with precision in the case of the Kachh specimens owing to the insensible manner in which they grade into the typical specimens of *Cypræa prunum*. The largest specimen from Sind (Karachi) measures 32 mm. in height. The largest specimens from Burma (Myankmigon) measures 2½ mm.

*Occurrence.*—This form occurs abundantly in the Gaj beds of Kachh, Kathiawar and Sind, and in the corresponding Kama Stage of Burma.

The following localities have been recorded

Kachh :

Soomrow (Grant).

Teyra River near Rampur (23° 20', 68° 51').

Teyra River north of Naliya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur.

Kathiawar.

Sind.

Karachi (Blagrave collection).

Burma.

Dalabe, Kyudawon, Myaukmigon Thanga.

*Remarks and comparison.*—Sowerby's original type of *Cypræa nasuta* cannot be traced, but the available collections from Kachh contain specimens clearly coinciding with the original figure and description. These specimens correspond exactly with d'Archiac's *Cypræa granti* represented in the Blagrave collection preserved in Calcutta by numerous specimens from Karachi, undoubtedly from the same locality as d'Archiac's type. The absence of any precise distinguishing feature forbids treating this form as specifically different from *Cypræa prunum* of which it represents a smaller race which, at some of the Kachh localities, merges insensibly into *Cypræa prunum*, while in Sind and in Burma, and perhaps in Kathiawar, it never appears to reach the relatively large dimensions of the typical *Cypræa prunum*. Analogous cases, in which certain forms give rise to minor varieties the length of which may be only one-quarter of the typical dimension, are so frequent amongst recent species that the existence of two varieties of *Cypræa prunum*, widely differing in size, is by no means abnormal. (See Melvill, in Mem. and Proc. Manch. Lit. and Phil. Soc., 4th ser., Vol. I, pp. 209—210). The feature upon which d'Archiac based the distinction of this form (under the name of *Cypræa granti*), namely, the more numerous denticulations of the columellar lip, is unreliable as the number varies greatly from one specimen to another, frequently not exceeding that observed in the outer lip. The degree of anterior rostration alluded to by d'Archiac is also extremely variable.

When the adult characters are not yet fully developed, the shell is apt to appear rather different owing to the absence of a posterior prolongation of the columellar lip which communicates to the posterior termination of the shell a much more unsymmetrical disposition than when the apertural characters are fully developed. The apical depression, in which is sunk the spire of these immature specimens, also becomes obliterated when the full-grown characters are developed.

The Burmese shell described by Noetling (*loc. cit. in synon.*) under the name of *Cypræa granti* is specifically different and has

been distinguished as *Cypræa oppenheimi* (Rec., Geol. Surv. Ind., Vol. LI, pp. 268, 291).

A shell from the lower Eocene of Sind likewise referred to *Cypræa granti* by Cossmann and Pissarro (*loc. cit. in synonym.*) is also different. It belongs to the genus *Gisortia* and may be distinguished as *Gisortia jhirakensis*.

CYPRÆA (BERNAYIA) SUBEXCISA Braun.

Pl. III, figs. 10—12; Pl. IV, fig. 6.

1820. *Cypræacites inflatus* Lam. *sec.* Schlotheim.—Petrefactenkund., Vol. 1, p. 117.
- ? 1840. *Cypræa splendens* var. *foveola* Grateloup.—Conch. foss. terr. tert. bass. Adour., Pl. XLI, fig. 14.
1850. *Cypræa subexcisa* Braun.—Walchn. Geogn. II, Aufl. p. 1132.
1850. *Cypræa prunum* J. de C. Sow. *sec.* d'Archiac.—Hist. progr. Géol. III, p. 296.
1850. *Cypræa digona* J. de C. Sow. *sec.* d'Archiac.—Hist. progr. Géol. III, p. 296.
1854. *Cypræa prunum* J. de C. Sow. var. *minor* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 332, Pl. XXXII, figs. 11, 12.
1854. *Cypræa digona* J. de C. Sow. ?—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 332, Pl. XXXII, fig. 13.
1854. *Cypræa jenkinsi* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 333, Pl. XXXII, fig. 15.
1854. *Cypræa pinguis* Conrad (*non* Bonelli 1838).—Wailles, Geol. Miss., p. 289, Pl. XVII, fig. 3.
1855. *Cypræa pinguis* Conrad.—Proc. Acad. Nat. Sci. Philad., VII, p. 262.
1861. *Cypræa anhaltina* Giebel.—Zeitschr. f. ges. Naturwiss., XVII, p. 31.
1863. *Cypræa (Luponia) subexcisa* Braun.—Sandberger, Die Conchylien des Mainzer Tertiärbeckens, p. 255 (? Pl. XIX, fig. 9).
1864. *Cypræa anhaltina* Giebel.—Fauna von Latdorf, p. 11, Pl. III, fig. 2.
1870. *Cypræa splendens* Grat. *sec.* Fuchs.—Denkschr. der kais. Ak. der Wissensch., Vol. XXX, 2nd part, pp. 172, 183, 206, Pl. VIII, figs. 23, 24.
1880. *Cypræa subexcisa* Braun.—Stanislas Meunier, Nouvelles Archives du Muséum, 2ème série, Vol. III, p. 256, Pl. XIV, figs. 39, 40.
1884. *Cypræa subexcisa* Braun.—Cossmann et Lambert, Mem. Soc. geol. Fr., sér. 3, Vol. III, p. 180, Pl. V, fig. 23.
1887. *Cypræa tumulus* Heilprin.—Trans. Wagner Inst., I, p. 111, Pl. VI, fig. 49.
1890. *Cypræa pinguis* Conr.—Dall, Trans. Wagner Inst., III, p. 164, Pl. XI, fig. 1.
1890. *Cypræa heilprini* Dall, Trans. Wagner Inst., III, p. 166, Pl. XI, fig. 2.
1890. *Cypræa iniquidens* von Koenen.—Abhandl. z. geol. Specialkarte von Preussen und den Thüringischen Staaten, Vol. X, P. 538, Pl. XXXIX, fig. 4.
1890. *Cypræa anhaltina* Giebel.—Von Koenen, Abhandl. z. Specialkarte von Preussen und den Thüringischen Staaten, Vol. X, p. 560, Pl. XXXIX, figs. 6, 7.

1894. *Cypraea (Zonaria) subexcisa* Braun var. *exsplendens, ovatoitalica, postspiraeroules, subiniquulens, inaequilabiata* Sacco.—Moll. terr. tert. Piem. e Lig. parte XV, p. 14, Pl. I, figs. 22—26.
1894. *Cypraea media* Desh. sec. de Gregorio, var. *Fuchsi, turgidiuscula, propean-gusta*.—Ann. Geol. et Pal., livr. 13, p. 28, Pl. V, figs. 106—110.
1903. *Cypraea (Adusta) subcarisa* Braun.—Cossmann, Ess. Pal. comp., livr. V, p. 159.
- ? 1903. *Cypraea (Adusta) petrafiænsis* Cossm. and Lamb.—Cossmann, Ess. Pal. comp., livr. V, p. 159.
1903. *Cypraea (Umbilia) ventripotens* Cossmann.—Ess. Pal. comp., livr. V, p. 161.

Medium-size, smooth, ovalar globose, convex both ventrally and especially dorsally, scarcely rostrated anteriorly, with the maximum width and maximum dorso-ventral thickness situated somewhat nearer to the posterior than to the anterior termination of the shell. The spire is usually concealed, sometimes faintly visible through the callous varnish, occasionally completely exposed when it is observed to be small and much depressed, consisting of a small protoconch followed by three flat whorls. On the left side of the shell there is no separate margin to the very convex dorsal surface, the convexities of the ventral and dorsal aspects being quite continuous; on the right side the extension of the callosity of the outer lip forms a feebly developed border to the dorsal surface.

When the shell is viewed either on its dorsal or ventral surface, the outline is unevenly oval, gently rostrated at both extremities, the anterior rostration being longer than the posterior one, the greater width of the oval being situated posteriorly to the middle and corresponding with the region of maximum, dorso-ventral thickness. Both apertural outlets are notched, the anterior notch being relatively shallow and broad, semi-circular, with apex scarcely deflected towards the left of the shell, ventrally constricted by the narrow terminations of the apertural lips, dorsally surrounded by a low rim. The posterior notch is deeper than the anterior one, though of moderate depth, with apex moderately deflected to the left of the shell towards the more or less completely concealed spire, or slightly to the right of it, with a somewhat indistinctly demarcated raised rim formed by the prolongations of the apertural margins neither of which projects much, the extension of the columellar lip projecting less than that of the outer lip.

The ventral surface sinks towards the apertural lips which have a well-defined edge where they sink into the interior of the shell.

The aperture is only slightly sinuous, with a short anterior expansion of very moderate width anteriorly to which the apertural

margins, becoming slightly angular and forming a feeble rostration, once more approach nearer to one another, thus constricting the entrance to the terminal notch.

The columella is approximately straight and vertical at its junction with the base of the penultimate whorl. Its twisted anterior edge constitutes a ridge strongly oblique anteriorly in a ventral direction, but only slightly oblique anteriorly towards the left, so that, in a ventral view of the shell, it seems scarcely deflected. A broad, shallow fossula is bounded by the edge of the columellar lip, the approximately vertical portion of the columella and the anterior columellar edge. The denticulations of the outer lip are interrupted along the axis of this fossula, but re-appear along the columella. Posteriorly to the fossula, the crenulations of the columellar lip are rather broad, but they are not sub-divided by a groove, neither do they extend inward beyond the depression which forms the inner limit of the columellar lip.

The crenulations on both lips are moderately wide-spaced. Their number along the columellar lip averages sixteen. There are usually from two to four more crenulations along the outer lip than along the columellar lip.

*Dimensions.*—The following dimensions were measured on two of the Gáj specimens :

	mm.	mm.
Height . . . . .	38	26
Width . . . . .	26	19
Dorso-ventral thickness . . . . .	23	16

The Nari specimens from Sind are of about the same size, as is shown by the following measurements :

	mm.	mm.	mm.
Height . . . . .	38	31	27
Width . . . . .	27	23	19
Dorso-ventral thickness . . . . .	23	17	13

Specimens from the Nari of Baluchistan attain larger dimensions up to  $40 \times 27 \times 23$  mm.

*Occurrence.*—Nari of Sind: Bhagothoro Hill (Fedden  $G_{76}^{226}$ , Noetling 318); Pokhan, 50 miles south-south-west of Sehwan (Fedden, 1874-5,  $G_{90}^{226}$ , see Blanford, Mem., Geol. Surv. Ind., Vol. XVII, p. 120).



Nuri of Baluchistan: near Kudin, north of Mulazai, northern branch of syncline (348 =  $K_{45}^{1\frac{1}{2}}$ ).

Corresponding beds in Burma:  $K_{757}^{1\frac{4}{7}}$  Minbu; Mindegyi; Ngahlaingdwin ("Lower Tuyu clay"); Singu, D, M, P.

Gáj of Sind: immediately overlying the variegated shales west of Bhagothoro; base of scarp, four miles west of Trak Hill, forming the southern continuation of the Mol Scarp (Ram Singh  $G_{33}^{5\frac{0}{3}}$ ).

In the Vicentine the fossil occurs both in the Sangonini beds, where it is very abundant, and in the overlying Castel-Gomberto beds, where it is less common. It also occurs in the Oligocene of Siguria.

*Variation.*—Some of the specimens from Minbu have exceptionally wide-spaced crenulations. They may be regarded as constituting a race *minbuensis*. Others from Ngahlaingdwin are distinguished by their much smaller dimensions, and may be regarded as constituting a race *ngahlaingdwinensis*. At Mindegyi these small specimens accompany others of normal size.

*Remarks and comparison.*—The type of *Cypræa jenkinsi* d'Archiac and Haime belongs to the species at present under consideration. During its fossilisation, the fragmentary specimen has been subjected to compression which accounts for the curiously inflated shape of its anterior extremity. The apertural characters, so far as preserved, agree with those of the species under consideration.

Most of the specimens of this shell were regarded by d'Archiac as a variety of *Cypræa prunum* with which he was acquainted only through the illustration and short description of Sowerby, who has not figured the oral aspects. It is distinguished from *Cypræa prunum* by its somewhat less regularly ovoid shape in which there is more of a contrast between the broader posterior portion and the more tapering anterior extremity. The ventral surface, in the form above described, is not so unsymmetrically divided by the aperture as in *Cypræa prunum*. The aperture of the form under consideration is more sunken into the ventral surface than in *Cypræa prunum*, the denticulations are somewhat coarser, with more of a tendency to spread outward beyond the edge of the apertural margins. Lastly, the disposition of the columellar fossula is different, its axis being smooth instead of being traversed by the apertural plications as in that of *Cypræa prunum*. In consequence of this disposition, *Cypræa prunum* is closely related to the group of the more typical *Cyprææ*, such as *Cypræa mappa*,

while the smooth axis of the fossula, in the form at present under consideration, recalls the disposition observed in many fossil species, amongst which is *Cypræa media* Desh., the genotype of *Bernayia*, from the upper Eocene of the Paris region. The dorsal rim surrounding the anterior notch has a sharper edge than in *C. media* in which it is surrounded by callus. On an average, the dorsal surface is perhaps more convex than in *C. media*, from which the species under consideration is further distinguished by its crenulate columella.

*Cypræa subrostrata* Gray (= *C. bartonensis* Edwards), from the upper Eocene of the Anglo-Parisian region, is also closely related, but is distinguished by the more prominent posterior extensions of the apertural lips.

Some specimens of *Cypræa fabagina* Lam., a species occurring abundantly in the Miocene of Europe, are not unlike the form under consideration, but they have the greatest width and greatest thickness situated more nearly at half the length of the shell, so that the anterior portion of the shell exhibits less of a subrostrate appearance. The posterior extensions of the columellar lips are less prominent in *Cypræa fabagina* than in the shell under consideration, which, in this respect, is intermediate between *Cypræa fabagina* and *Cypræa subrostrata* (= *C. bartonensis*).

The above-described shell appears to correspond with a form occurring abundantly in the Oligocene of the Vicentine, where it was described by Fuchs as *Cypræa splendens* Grateloup, and in the Oligocene of Liguria (Moll. ten. tert. Piem. e Lig., parte XV, p. 14), where Sacco has referred it to *Cypræa subexcisa* Braun. Nevertheless the numerous forms figured by Sacco from the Oligocene of Liguria, while, to all appearance, strictly identical with the Indian fossil, differ widely from Sandberger's figure of *Cypræa subexcisa* which seems to represent a rather abnormal specimen. There appears to be every reason for regarding the Indian fossil as identical with the Vicentine and Ligurian form.

*Cypræa alabamensis* de Gregorio, from the Eocene of Claiborne (Ann. Géol. et Pal., 7eme livr., p. 59, Pl. IX, figs. 8—10, 1890; Cossmann, Ann. Géol. et Pal., 12ieme livr., p. 31, 1893; Cossmann, Ess. pal. comp., 5ieme livr., p. 157) closely resembles the form under consideration, with which it is perhaps specifically identical: the description and the illustrations representing the solitary imperfect type do not reveal any precise differences.

## CYPRÆA (BERNAYIA) HUMEROSA J. de C. Sowerby.

1893. *Cypræa humerosa* J. de C. Sowerby.—Trans. Geol. Soc. Lond., 2nd series, Vol. V, Pl. XXV., fig. 27.
1850. *Cypræa humerosa* J. de C. Sow.—l'Archiac, Hist. des progrès de la Géol. Vol. III, p. 299.
1854. *Cypræa humerosa* J. de C. Sow. var.—l'Archiac and Haimc, Descr. an. foss. gr. numm. Indc, p. 331, Pl. XXXII, figs. 8—10.
- Non Aricia humerosa* Sow. sec. Noetling, Pal. Ind., new series, Vol. I, part 3 (1901), p. 291, Pl. XIX, fig. 11.

Medium-size, sub-symmetrical, heart-shaped, with elevated gibbous dorsal surface and flattened ventral surface.

The almost flat spire is entirely concealed by the callous growths of the body-whorl which constitutes the entire visible shell. The maximum width is situated close to the posterior termination and is marked by two tuberculated angulations posteriorly to which the surface is bounded by two sub-rectilinear to concave lines converging at a very wide angle towards the apex, while, from the postero-lateral angulations to the slightly rostrate anterior termination, the sides converge at a much narrower angle and are either evenly convex or else exhibit a slight bend at less than half their length measured from the anterior termination. Both outlets of the aperture are dorsally notched. The anterior notch is surrounded by a feebly raised dorsal rim contributing to the slightly rostrate appearance of the anterior termination. It is very small, narrow and deep, practically perpendicular to the vertical axis so that it is not visible when the shell is viewed dorsally; it is not appreciably deflected from the plane of symmetry. The posterior notch, bordered by parallel edges, is very narrow and very deep, indenting the dorsal surface for a considerable distance. Owing to the posterior deflection of the aperture, it is situated a little to the left of the general plane of symmetry. Nevertheless, its sides are either parallel to that plane, so that, in a dorsal view, the notch appears vertical, or else there is a scarcely appreciable obliquity anteriorly towards the left. The elevated convexity of the dorsal surface has its regularity much interfered with by the callous protuberances. The greatest height of the convexity proper is situated about half-way between the anterior and posterior extremities of the shell, only, as there is a strongly elevated protuberance rising further anteriorly, the maximum thickness of the shell comes to be situated at one-third of its length measured from the anterior extremity. A large, quadrilateral to pentagonal area, dorso-cen-

trally situated, is free of callus, and, along its borders rise three protuberances, of which the postero-lateral ones are somewhat conical and are situated slightly anteriorly to the level of the swollen postero-lateral angulations to which they are united on each side by a ridge, while the anterior protuberance forming the anterior border of the dorso-central area, is in the shape of a strongly elevated, transverse ridge.

The narrow aperture, in the typical specimens from Kachh and Kathiawar, is rather strongly bent towards the right of the shell at one-third of its length measured from its posterior extremity, and is thus divided into two portions, oblique in opposite directions, the obliquity of the posterior portion being, on account of its shortness, more pronounced than that of the anterior portion. The curvature of the aperture is less pronounced in the specimens from Sind than in those from Kachh and Kathiawar. The aperture is moderately expanded close to its anterior termination where it is again constricted by the close, mutual approach of the ridge-like anterior terminations of the apertural lips. The columella, where it joins the base of the penultimate whorl, appears vertical. Its anterior terminal edge is oblique anteriorly in a ventral direction, and is, at the same time, oblique anteriorly towards the left of the shell, towards its angular junction with the anterior termination of the columellar lip. There are fourteen or fifteen coarse, elongate denticulations along the columellar lip, of which the more posteriorly situated ones become excessively oblique; those situated at half the length of the aperture extend transversely to some considerable distance over the ventral surface. Between the anterior edge of the columellar lip and the anterior edge of the columella is a broad, elongate, flattened area, scarcely excavated enough to deserve the name of fossula, across which the ridges are continuous, and may become internally bifid or reduplicated by intercalation. The outer lip resembles the columellar lip, with a similar, anteriorly situated, flattened, expanded area. It carries about eighteen denticulations.

*Dimensions.*—The following are the measurements of two specimens from Kachh :

	mm.	mm.
Height . . . . .	33	43
Width . . . . .	30	32
Dorso-ventral diameter . . . . .	20	23

The species also attained much larger dimensions, as is indicated by a fragment, also from Kachh, with a height of 53 mm. Sowerby's original type measures 51 × 39 mm.

*Occurrence.*—Sowerby's original type was obtained by Grant at Soomrow in Kachh. Other specimens preserved in Calcutta are from the following localities:

Gáj of Kachh:

One mile east of Syra or Sainra ( $23^{\circ} 26'$ ,  $68^{\circ} 57'$ ) near Kotara.

Teyra River near Rampur ( $23^{\circ} 20'$ ,  $68^{\circ} 51'$ ).

Teyra River north of Naliya ( $23^{\circ} 15'$ ,  $68^{\circ} 52'$ ) higher than the Pecten-bed of Sookpur.

South bank of river from Teyra ( $23^{\circ} 17'$ ,  $68^{\circ} 58'$ ).

Gáj of Sind:

Karachi (Blagrave collection).

Beyond the variegated shales west of Bhagothoro, from a bed overlying the lowest fossiliferous stratum.

Gáj of Kathiawar:

*Remark.*—d'Archiac and Haime, Martin, and Noetling have all been misled by a confusion arising from a slight peculiarity in Sowerby's beautiful drawing of the original type of this remarkable shell. The anterior ridge in the type has an obscurely tripartite appearance, partly caused by weathering, and faithfully reproduced with perhaps slight emphasis in the drawing. There is no mention of any such tripartite division in the text where the shell is stated to exhibit "3 protuberances upon the back, and one on each side". All the above-mentioned authors have understood the "3 protuberances upon the back" to signify the single anterior ridge, and the "one on each side" to signify the two posterior ones which, in the type, far from being "on the side" are quite close to the middle line. It is perfectly evident that the "3 protuberances on the back" signify the anterior ridge and the two posterior knobs that surround the sunken dorsal area; by no possible figure of speech could the two sub-central posterior knobs be described as situated "on the sides" of the shell and it is equally evident that the protuberances "on each side" refer to the bulges of the postero-lateral angles of the margin. The apparently tripartite disposition of the anterior ridge on the type is accidental; all the other specimens from Kachh, Kathiawar, and Sind exhibiting a transverse, hump-shaped ridge of invariable shape. The Sind form does not differ even varietally from the Kachh type.

*Comparison with other species.*—Noetling has referred to *Cypræa humerosa* a Burmese fossil, which, although closely related to the above-described shell, is nevertheless distinguished by certain

differences which are both definite and constant. Whether the differences are to be regarded as specific or varietal may be perhaps a matter of personal opinion, yet, it is advisable to distinguish the Burmese form by a different name which, for the sake of mere convenience, may best be treated as specific. It has therefore been distinguished as *Cypræa singuënsis* (Rec., Geol. Surv. Ind., Vol. LI, pp. 268, 291) after the name of a locality, Singu, where it occurs in abundance. The main difference between this form and the above-described shell from western India resides in the disposition of the aperture, invariably almost straight in *Cypræa singuënsis*, while it is rather strongly bent in *C. humerosa*. The posterior notch of *Cypræa humerosa* is narrower and deeper and does not lead to a deflected, superficial depression as is so conspicuously noticeable in *C. singuënsis*. The depressed dorsal area of *C. humerosa* is much larger than that of *C. singuënsis* and is centrally situated instead of being posteriorly shifted; consequently the anterior, transverse ridge is situated much further anteriorly in *C. humerosa*.

The bend of the aperture is less pronounced in the Sind specimens than in those from Kachh and Kathiawar. Nevertheless the Sind specimens are similarly distinguished from *Cypræa singuënsis* by the characters of the dorsal surface.

Another closely related form is *Cypræa caput viperæ* Martin, from the lower Miocene of Java (Samml. des geol. Reichs. Mus. in Leiden, new series, Vol. I, p. 169), the apertural characters of which closely recall those of *C. singuënsis*. The Javanese form is distinguished both from *C. humerosa* and from *C. singuënsis* by the disposition of the anterior, dorsal, transverse ridge which is either somewhat weakened across the plane of symmetry, or else more frequently anteriorly deflected or even completely interrupted, just where it is most continuous and most prominent in *C. humerosa* and *C. singuënsis*. Moreover the curious, impressed mark of the columellar lip, invariably present in *Cypræa caput viperæ*, is not observed either in *C. humerosa* or *C. singuënsis*.

CYPRÆA (EROSARIA) SINDIENSIS n. sp.

Pl. VI, fig. 14.

Small, elongately oval, slightly rostrate anteriorly, with dorsal surface more convex than the ventral surface.

The spire is concealed by the callous growths of the body-whorl which constitutes the entire visible shell. The dorsal surface exhibits a continuous, elongate, ovoid convexity, the most elevated part of which is situated very slightly nearer to the posterior than to the anterior termination, at the same level as the greatest width. The junction of the dorsal and ventral surfaces is angulated, and is slightly expanded in such a way as to form, along the lateral margins, a narrow rim surrounding the dorsal convexity and connected at both extremities of the dorsal surface, with a broader, though very feebly raised rim surrounding the apertural outlets. Throughout its entire course, and more especially on the right side of the shell, the marginal rim is delicately crenulated dorsally, the crenulations developing into delicate, elongate, axial folds on the rim surrounding the anterior outlet.

The anterior outlet is truncated and not truly notched, the above-mentioned dorsal rim contributing to the slightly rostrated disposition of the anterior termination. The disposition of the posterior outlet cannot be precisely ascertained as the posterior extremity has been damaged in the only available specimen.

The moderately convex ventral surface is unequally divided by the narrow, feebly and regularly curved aperture, which is slightly expanded on nearing the anterior termination. The terminal edge of the columella and the symmetrically situated, inner, terminal, anterior edge of the outer lip merge anteriorly in the shallow truncated terminal outlet without converging towards one another. Both apertural margins carry about twenty-three or twenty-four close-set, transverse folds which extend outward over the entire ventral surface, reaching, on either side, the angulation that divides it from the dorsal surface.

*Dimensions.*—

Height . . . . .	mm.
Width . . . . .	18
Dorso-ventral diameter . . . . .	10
	7

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparison.*—This fossil is perhaps an ancestral form of the living *C. staphylæa* Linn. of the Indo-Pacific region, which is relatively broader, dorsally more convex, with much shorter terminal apertural dorsal rims, and which is further distinguished by the small granules of the dorsal surface.

## STROMBUS SEDANENSIS Martin.

1850. *Strombus fortisi* Alex. Brongn. sec. d'Archiac.—Hist. des progr. de la Géol., Vol. III, p. 295.
1851. *Strombus fortisi* Alex. Brongn.? sec. d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 316, Pl. XXX, fig. 17.
1899. *Strombus sedanensis* Martin.—Samml. d. Geol. R.-Mus. in Leiden. new series, Vol. I, p. 180, Pl. XXIX, fig. 416.

Fairly large, with broadly conical or slightly extraconic, low spire measuring less than one-fifth of the total height, and with large, elongate body-whorl posteriorly angulated, tapering with a conical outline up to its twisted, rostrate extremity and with feebly expanded wing.

The protoconch, which is missing in the available specimens, is followed by five low spire-whorls, the height of which is equal to one-quarter of their width, the greatest width corresponding with the anterior margin or situated quite close to it. The sutures are linear. The whorls are angulated quite close to their anterior margin, except the final portion of the last spire-whorl where the angulation is overlapped by the rise of the suture preparatory to the expansion of the apertural wing. The short surface between the angulation and the anterior suture is vertical or slightly overhanging. From the angulation to the posterior suture, the whorls exhibit a low, concave slope. The angulation and the short anterior surface carry crowded, narrow, vertical ribs which tend to become thicker and wider-spaced on the last spire-whorl. The posterior concave slope, especially on the part nearest the suture, carries close-set, shallow, spiral grooves the most posterior of which isolates a narrow sutural band.

The large body-whorl, measuring eight-ninths of the total height, carries posteriorly an angulation corresponding with the anterior angulation of the spire-whorls, but carrying eight prominent spires instead of the narrow ribs of the spire-whorls. Anteriorly to the angulation it is very elongate and, in a general way, conical. On the right side of the shell the outline is straight or convex up to the broad, stromboid sinus, anteriorly to which it is convex up to the terminal notch of the rostrum which is strongly twisted dorsally and to the left of the shell. On the left side of the shell the outline is straight or somewhat concave up to the narrow concavity of the neck overhung by the projecting border of the terminal rostrum. Near the anterior termination of the shell, on the posterior side of



the concavity of the neck, there is a low, broad, spiral swelling leading to the strombic sinus. The posterior circumsutural slope carries the same spiral ornamentation as on the spire-whorls. From the spinose angulation to the anterior swelling the surface is practically smooth but for the lines of growth. The anterior swelling and the neck carry very shallow, spiral grooves, clearly visible only with a grazing illumination. The lines of growth form an elongate convexity of feeble curvature from the posterior suture to the terminal notch.

The aperture is tall and narrow, curved. The columella, at first oblique and straight, becomes convex, twisted and deflected at its termination. The columellar lip is transversely wrinkled. The outer lip is posteriorly terminated by a feebly expanded wing, corresponding with the posterior circumsutural slope, and not reaching the spire proper anteriorly to the angulation; the outer lip is oblique, anteriorly retrocurrent, and straight or slightly convex up to the broad strombic sinus, anteriorly to which the convexity increases till it ends practically horizontally at the much deflected terminal notch.

*Dimensions.*—The following are the dimensions of a specimen from Kachh :

	mm.
Height . . . . .	63
Thickness . . . . .	41
Height of spire . . . . .	12
Height of body-whorl . . . . .	56

*Occurrence.*—This rare species is at present known from the following localities.

Lower Miocene, Gáj beds, neighbourhood of Karachi: the specimen figured by d'Archiac from the Blgrave collection of the Geological Society of London, in yellow limestone, now in the British Museum; also a very incomplete specimen, mostly in the condition of an internal cast, in yellow limestone crowded with sand-grains, from the Balgrave collection of the Asiatic Society of Bengal (now in the Indian Museum).

Lower Miocene, Gáj beds, to the south and south-west of Kotree or Kutaree ( $23^{\circ} 3'$ ,  $69^{\circ} 14'$ ; see Wynne: Mem., Geol. Surv. Ind., Vol. IX, p. 281) in the river and on the hills (Fedden collection C. 143): one nearly complete specimen, of which the ventral surface of the body-whorl is embedded in rock.

Lower Miocene, Rembang series, Sedan, Java, Verbeek collection: two nearly complete specimens; Geological Museum of Leiden.

*Remarks.*—d'Archiac assimilated this shell with *Strombus fortisi* Brongn. from the Eocene of Ronea, which distinguished from the Indian fossil by the relatively greater height, more extraconic slope and more distinctly terraced disposition of its spire which, moreover, does not seem to carry the spiral threads or grooves that ornament the spire-whorls of the Indian form. The enormously expanded wing of the type of *Strombus fortisi* is, according to Brongniart, an adult characteristic. So far as can be judged from the somewhat scanty material at present accessible, this character is never developed in the eastern Miocene form. The aperture is not complete in the specimen figured by d'Archiac, but is sufficiently preserved to indicate that there existed no such expansion. A specimen from Kachh has the aperture complete with the exception of the termination of the posterior apophyses, and we observe that, in this specimen, the outer lip is scarcely expanded. The same absence of pronounced expansion is observed in the Java specimen figured by Martin. Moreover, in the presence of a particularly well developed anterior notch, the eastern fossil agrees with *Strombus s. str.*, while *Strombus fortisi*, type of the sub-genus *Dilatilabrum* Cossm., is characterised by the almost complete obliteration of the sinus.

STROMBUS MEKRANIOUS n. sp.

Pl. III, figs. 13, 14; Pl. IV, fig. 1.

Medium-size with extraconic spire equal to one-quarter of the total height, and corrugate-conical body-whorl with widely expanded outer lip.

The protoconch, which is missing, is followed by six spire-whorls. The earlier spire-whorls are divided into two sections by a very pronounced angulation. Posteriorly to the angulation there is a broad, feebly sloping, flat or slightly excavate surface, carrying, at rather wide intervals, some very fine, raised, spiral threads. The anterior section of the whorls is vertical or even anteriorly sloping inward and is decorated with numerous, sharp, vertical costæ or flutings, with somewhat spinose posterior terminations. They are crossed at intervals by a few inconspicuous, spiral threads. The number of costæ on each of the whorls is from eighteen to twenty. This

anterior, vertical division of the whorls becomes shorter in each succeeding spire-whorl as, with increasing growth, the suture creeps nearer to the angulation and finally corresponds with it. Consequently the two last spire-whorls and the posterior part of the body-whorl constitute an uninterrupted, gently sloping surface in which there is nothing to indicate the existence of costæ save the waviness of the sutures. When the costæ finally re-appear on the body-whorl they have assumed the appearance of short, broad spines, much fewer in number than on the spire-whorls. This disposition gives a curiously heteromorphous appearance to the spire which thus consists of a broad, very flatly conical, surface encircled by the few spines of the body-whorl, in the middle of which rises the steep, scalariform and fluted, steeple-like protrusion constituted by the earlier whorls.

The large body-whorl, equal to nearly five-sixths of the total height, has a gibbous, elongate-conical base anteriorly terminated by a somewhat twisted rostration. On the body-whorl the posterior angulation becomes deflected outward and backward to form the expanded angle of the wing-like outer lip. Anteriorly to the angulation and its coarse spines, the base contracts conically, but with a very irregular corrugated outline due to the presence of two swellings with obscure, blunt, broad, boss-like knobs. Feebly raised, wide-spaced, thin, spiral threads cover the base wherever not obscured by the great, callous spread from the columellar lip.

The aperture is tall, elongate. The columella is smooth, oblique, feebly convex, anteriorly deflected near its extremity in accordance with the trend of the anterior rostration. The columellar lip is thin, widely spreading, with indistinct border. The incompletely preserved outer lip, carrying posteriorly a wing-shaped expansion, is oblique and probably convex.

*Dimensions.*—The following are the approximate dimensions :

	mm.
Height . . . . .	47
Thickness . . . . .	30
Height of spire . . . . .	12
Height of body-whorl . . . . .	39

*Occurrence.*—Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains.

*Comparison.*—The shell above described is not very closely related to any living or fossil species, though it belongs to the same group that includes such forms as the recent *Strombus bubonius* Lamk. and *Str. tricornis* Lamk.

STROMBUS (GALLINULA) COLUMBA Lamarck.

1822. *Strombus columba* Lamarck.—An. sans. Vertèbres, Vol. VII, p. 208.  
 1830. *Strombus deperditus* J. de C. Sowerby.—Trans. Geol. Soc. Lond., 2nd series, Vol. V, Pl. XXVI, fig. 19.  
 1839. *Strombus nodosus* J. de C. Sowerby.—Trans. Geol. Soc. Lond., 2nd series, Vol. V, Pl. XXVI, fig. 20.  
 1850. *Strombus deperditus* J. de C. Sow.—d'Archiac, Hist. progr. Géol., III, p. 295.  
 1850. *Strombus tunkervilli* Swains.—Reeve, Icon., fig. 26.  
 1854. *Strombus deperditus* J. de C. Sow.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 316, Pl. XXX, fig. 19.  
 1854. *Strombus nodosus* J. de C. Sow.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 316, Pl. XXX, figs. 18, 20, 21.  
 1893. *Strombus exnodosus* Sacco.—Moll. terr. terz. Piem. e Lig., parte XIV, p. 5.  
 1904. *Strombus sowerbyi* Cossmann.—Essais pal. comp. fasc. VI, p. 7.

Rather large, almost symmetrically biconical, with a fairly tall, conical, somewhat stepped spire, equal to one-third of the total height, and with a large, inversely conical body-whorl, with a large, wing-shaped expansion of the outer lip. The degree of elongation of the spire varies considerably.

The small, trochoid protoconch of about three smooth whorls is followed by seven spire-whorls which are decorated with prominent costæ crossed by numerous, spiral threads. The whorls are posteriorly constricted quite close to the posterior suture; the narrow, furrow-like constriction isolates a thin band which forms a short collar enveloping the posterior suture. Anteriorly to the constriction the whorls are strongly convex, with more or less of an angulation mid-way through the convexity, the degree of convexity increasing with the size of the whorls. The prominent costæ are more numerous on the earlier whorls, where their number is 18 to 20, than on the later whorls, where their number dwindles to 15 or 14, sometimes to as few as 11 on the last spire-whorl. Varices occur at irregular intervals. The whole surface of the whorls is decorated with fine, spiral threads. In some specimens they are all equal, but separated by intervals which, towards the sutures, are wider than the threads, or narrower. Lastly there are specimens where the threads regularly alternate in size.

The large body-whorl measures from three-fourths to four-fifths of the total height. Close to the suture it exhibits the same angulation as the spire-whorls. Anteriorly to this angulation its shape, for the greater part, is almost that of a rather steep cone, the surface being but feebly convex. Anteriorly, this conical portion is separated by a rather shallow concavity from the somewhat rostrated, anterior termination of the shell constituted by a rather steeply winding bulge formed by the accretions to the anterior termination of the aperture which is not notched. The angulation of the later spire-whorls becomes sharper on the body-whorl, the posterior portion of which tends to become flat or even excavate, and as the costæ on the body-whorl, contrary to what is observed on the spire-whorls, scarcely extend posteriorly beyond the angulation, there is a tendency for the formation, on the body-whorl, of a broad, shallow excavation between the angulation and the sutural constriction and collar. The costæ on the body-whorl become very short and rather assume the appearance of short spines, as they scarcely extend anteriorly or posteriorly beyond the angulation; they are never continued on to the base. The number of spines or costæ is sometimes the same on the body-whorl and on the last spire-whorl. In some full-grown specimens there only remain four or five very prominent spines on the body-whorl, in others the spines or nodes on the body-whorl disappear almost completely. On approaching the aperture the angulation turns obliquely outward and posteriorly so as to form the protruding portion of the expanded aperture. The suture also takes an oblique posteriorly-directed turn so that the outer lip reaches the penultimate spire-whorl (the antepenultimate whorl of the shell). In some specimens, generally immature, the whole of the body-whorl is covered with spiral threads similar to those of the spire-whorls, though wider-spaced. In full-grown specimens they tend to become effaced and the greater part of the body-whorl, anteriorly to the angulation, is nearly smooth, the spiral threads re-appearing only near the anterior extremity.

The aperture is tall, rather narrow. The columella is steeply oblique, nearly straight. Near its posterior termination it bears some crowded, narrow, elongate, transverse folds. The columellar lip is thin, though well demarcated, spreading somewhat considerably beyond the aperture. The outer lip, anteriorly to the angulation, is oblique, and broadly convex, with a pronounced stromboid sinus near its anterior termination. The internal characters of the

outer lip cannot be observed on account of the rocky incrustation that fills the aperture of all the specimens.

*Dimensions.*—The following measurements were taken from an almost complete specimen :

	mm.
Height . . . . .	61
Thickness . . . . .	36
Height of spire . . . . .	20
Height of body-whorl . . . . .	48

Sowerby's original type measures 57 mm. by 34 mm.

*Occurrence.*—Gáj of Kachh : Soomrow (Grant collection); south bank of river from Teyra ( $23^{\circ} 17'$ ,  $68^{\circ} 58'$ ); Vinjan ( $23^{\circ} 6'$ ,  $69^{\circ} 4'$ ).

Gáj of Sind : near Karachi (Blagrave collection).

*Remarks.*—Shells of *Strombus* are very abundant in the collections from the Miocene of Kachh, but, with the exception of a single specimen of the rare *Strombus sedanensis*, they invariably belong to the above-described species. Sowerby's *Strombus nodosus* is evidently an incomplete specimen of the same form which appears to be identical in every detail with the living *Strombus columba* of the Indo-Pacific region. The same species occurs in the Gáj of Sind amongst the collections from which region most of the specimens were identified by d'Archiac and Haime as *Strombus nodosus*. The shell figured by these authors as *Strombus deperditus* is a specimen with exceptionally low spire, similar to some of the specimens from Kachh, the Sind specimens exhibiting the same variations in the length of the spire as those from Kachh.

#### ROSTELLARIA CURTA Sow.

Pl. IV, fig. 2 a, b.

1842. *Rostellaria curta* Sow.—Sowerby, Proc. Zool. Soc.

Large, extraconic. The earlier spire-whorls up to a diameter of about 6 millimetres are rather tall, their breadth only slightly exceeding their width, convex in outline with the maximum curvature close to the anterior suture. They are decorated with numerous delicate slightly curvilinear costæ equal in width to the intervening spaces. Beyond this stage the other spire-whorls and the corresponding portion of the body-whorl are broadly conical, short : either feebly convex, or with a perfectly flat outline devoid of any bulge or convexity. The sutures form linear grooves ; near the aperture they show just the slightest tendency

to a step-like disposition. These later spire-whorls are either perfectly smooth or else their only decoration consists of delicate, slightly curvilinear lines of growth. The base is decorated with rather flat spiral threads of two sizes which alternate somewhat irregularly and are broader than the intervening spaces. The inner lip shows the characteristic tooth-like projection next to the posterior channel.

*Occurrence.*—This species occurs in the Mekran beds, both at the base of the Talar section, as well as from a higher horizon on the coast.

*Comparisons.*—This shell, especially the specimens from the higher horizon, agrees with the common living species of the neighbouring sea coasts so closely as to leave no doubt as to its identity.

#### ROSTELLARIA (?) SINDIENSIS n. sp.

Pl. VII, fig. 9.

Small, rather broadly conical. Spire-whorls convex, low, their height scarcely exceeding half their width ornamented with very crowded narrow ribs and equally crowded spiral striae. There are a few thin varices on the earliest whorls up to a diameter of about 2 millimeters. The axial ornaments are not continued on the base which carries spiral sulci, wider and wider-spaced than on the spire.

In the absence of the aperture, the genus of this remarkable fossil is doubtful.

*Occurrence.*—The solitary specimen figured is from the Nari of Bhagothoro Hill in Sind.

#### RIMELLA SUBRIMOSA d'Orb.

Pl. VI, figs. 7-10.

1840. *Rostellaria rimosa* Sow.—J. de C. Sowerby, Trans. Geol. Soc. Lond., (2) V, Pl. XXVI, fig. 17.

Non *Rostellaria rimosa* Sol. in Sowerby, Min. Conch, Pl. XCI, figs. 4, 5, 6.

1847. *Rostellaria subrimosa* d'Orbigny.

1852. *Rostellaria subrimosa* d'Orbigny.—Proc. Pal. Strat. Univ., III, p. 59, No. 1023.

Non *Rostellaria rimosa* J. Sow. var. ? d'Archiac and Haime.—Description des animaux fossiles du groupe nummulitiq de l'Indo, Pl. XXX, fig. 9.

Small to medium, slender, with tall spire slightly exceeding half the total height. Elongate tapering body-whorl. Smooth protoconch of several whorls followed by seven closely costate and spirally striate spire-whorls with frequent varices. The height of the spire-whorls is not much more than half their width. They are rather strongly convex. They bear numerous very fine though sharply pronounced axial costae,

narrower than the intervening spaces in addition to which each whorl carries two or three irregularly distributed varices. Spiral striations cover the whole surface of the whorls being equally well-developed across the ribs, the interspaces, and the varices. The body-whorl is elongate terminating anteriorly in a deflected rostrum. The ribs and spiral striations continue all over the base up to the extremity of the rostrum. Both margins of the aperture are bordered by a lamellar callosity, the two callosities uniting backward to form a narrow channelled prolongation which curves dorsally (towards the side away from the aperture) and ends in a narrow hook-like termination, plastered on to the last spire-whorl or on to the preceding one. Anteriorly the callosity of the outer lip bears a stromboid sinus close to the anterior rostrum. The sinus affects only the callous growth and is not developed in the spirally-growing portion of the shell proper.

The short space intervening between the stromboid sinus and the terminal sinus is itself bent into a short sinus, so that the anterior portion of the aperture includes three notches, the intermediate one being however very small. Internally the margin of the outer lip is broad thick, and smooth. Whether any denticulations occur further within the mouth is uncertain, the interior of the aperture being concealed by the calcareous matrix.

Occasionally specimens are observed with the costæ on the body-whorl wider apart than usual. These specimens do not represent a distinct variety or race, but are only individual variations.

J. de C. Sowerby referred this fossil to the European Eocene form *Rimella rimosa* from which it is distinguished owing to the presence of the stromboid sinus and by the shape of the posterior prolongation of the aperture which is prolonged only to a short distance in the shape of a curved hook at the back of the spire, while in *Rimella rimosa* it extends up to the apex. It resembles the recent *Rimella cancellata* in shape, but is distinguished by the absence of crenulations on the outermost margin of the aperture. Moreover the hook-shaped prolongation of the aperture reaches nearer to the apex in the living form than in the fossil.

*Occurrence.*—Gáj of Kachh.

RIMELLA SUBRIMOSA d' Orb. var. NARICA n. var.

Pl. III, figs. 15, 16.

In this Nari fossil, the spire-whorls have a tendency to be taller than in the Gáj form, the entire spire being proportionately a little



taller than in the type: even in such exceptional specimens that have unusually short spire-whorls, the proportionate difference is still maintained: thus if the body-whorl of a Nari specimen has the same proportions as are usual in the Gáj specimens, the spire is proportionately longer: in those rare instances when the spire of the Nari form resembles that of the Gáj specimens, the body-whorl is shorter. The oligocene specimens are apt to be slightly longer than those from the Gáj. The presence of the stromboid sinus has been observed in the oligocene form, though none of the specimens are sufficiently complete for the existence of the subsidiary notch to be ascertained. In every other character the Nari form agrees exactly with the Gáj form. In addition to specimens with the ribs slightly wider-spaced, as observed in the Gáj form, the Nari form also includes one specimen with the ribs much more crowded. It probably represents a local race.

*Occurrence.*—Nari of the Quetta-Pishin region.

**TEREBELLUM SUBULATUM Lamk., var. OBTUSUM J. de C. Sow.**

*Terebellum subulatum* Lamk.—Lamarck, an. sans. Vert. (2nd ed.), X, p. 584.

1840. *Terebellum obtusum* J. de C. Sow.—J. de C. Sowerby, Trans. G. S. L., (2), V, Pl. XXVJ, fig. 31.

1854. *Terebellum obtusum* J. de C. Sow.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 333, Pl. XXXII, fig. 21 (non fig. 20).

1890 *Terebellum punctatum* Chemn. Martin, Samml. geol. Reichanus. Leid., p. 105, Pl. XXXI, fig. 452.

As represented by specimens both from Kachh and from Sind, this species is only doubtfully distinguished from the living *Terebellum subulatum* Lamk. by the relative preponderance of the last spire-whorl as compared with the remainder of the spire. There are, however, certain recent varieties which seem identical in this respect. This same peculiarity is noticed in the Javanese fossil referred by Martin to the recent *Terebellum punctatum* Chemn. (= *Terebellum subulatum* Lamk.)

Of the illustrations published by d'Archiac and Haime, only the second one belongs to the present form. Fig. 20 is probably a specimen of the eocene species *Terebellum subbelemninoideum* d'Archiac and Haime, in which the spire is relatively shorter, the body-whorl more elongate and more contracted anteriorly.

*Occurrence.*—Gáj of Kachh and Sind.

## TEREBELLUM (R. SERAPHS) NARICUM n. sp.

Pl. XIII, fig. 4.

Medium-size, very slender, fusoid, with pointed apex, shape cylindrical, scarcely excavated at the neck. The open part of the aperture terminates at about one fourth the length of the shell from the summit. Posteriorly to its termination the whorls are apparently in contact. A narrow channel between the margins of the outer lip and the columellar lip can be followed almost to the apex. There is no spire, the outer lip being continued exactly to the apex. The columellar lip has a distinct linear edge throughout the entire height of the shell. The outer lip is strongly retrocurrent towards the apex, acquiring thereby a winding disposition in its posterior portion. Throughout the open portion of the tall narrow aperture its course is practically straight, the gradual anterior expansion of the aperture being due, not to any expansion of the outer lip, but to the gradual contraction in an anterior direction of the portion of the shell enclosed within the columellar lip.

*Dimensions.*—

	mm.
Length (restored) . . . . .	48
Thickness . . . . .	10

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

*Comparisons.*—The nearest related form is the genotype.

*Terebellum convolutum* Lamarck, from the Eocene of Europe.

The Indian species has a more slender shape and more pointed apex. The course of the outer lip towards the summit is more retrocurrent in the Indian species.

This is up to the present, the only true *Seraphs* described from India<sup>1</sup> and indeed from Asia. The various forms of *Terebellum*, described by D'Archiac and Haime, all belong to *Terebellum*, *sensu stricto*, with the exception of *T. plicatum*, which is a *Mawryna* (De Gregorie). The fossil from the Ranikot of Sind, referred to *Seraphs*, under the name *Terebellum (Seraphs) lanceolatum* Cossmann and Pissarro, has been found on re-examination to belong not to *Terebellum* but to the section *Semiterebellum* (Cossmann) of *Calyptrophorus*.

<sup>1</sup> A second species, as yet undescribed, occurs in the Meting beds, the lowest subdivision of the Laki stage (Lybian). It is larger and more massive than the Nari species and is inflated posteriorly, the shell acquiring thereby a club-shaped outline.

CERITHIUM (VERTAGUS<sup>1</sup>) KACHHENSE n. sp.

Pl. VII, figs. 11, 12.

Small, pupoid; eight or nine spire-whorls which are not convex, ornamented with three pronounced spiral threads gemmated at the crossing points of axial ribs, and a fourth anterior, non-gemmated very narrow thread quite close to the suture; the three gemmated threads are slightly narrower than the intervening spaces, the two outer threads somewhat broader than the intermediate one.

On the body-whorl the gemmæ disappear from all the threads excepting the posterior one; the fourth thread assumes more importance and is followed on the base by 2 to 4 more spiral threads of alternating sizes; there is a well-marked anti-labral varix; the posterior channel of the aperture is sharp and pointed; the anterior canal exhibits the typical shape of the genus.

The shell appears to resemble *Cerithium turratum* Sowerby, in which, however, judging by Tryon's figures, the costules do not disappear so completely on the body-whorl. The living shell is also slightly more elongate.

*Occurrence.*—Gáj of Kachh.

## CERITHIUM (BELLARDIA) NARICUM n. sp.

Pl. IV, figs. 7-9.

Large, conical with dilated penultimate whorl; earlier spire-whorls almost flat, their width amounting to about twice their height, decorated with about eighteen costæ which fade away into more or less indistinct folds on the penultimate whorl. A narrow and shallow furrow crosses them near the posterior margin of the whorls, but without breaking them into two series of nodosities as in the related species *Cerithium vellicatum* Bellardi. The penultimate whorl carries 5 to 8 pronounced spines situated anteriorly to the furrow just mentioned. As is usual in this genus, these spines are traversed by a linear fasciole resembling the scar of a narrow fissure, which can be followed on to the body-whorl where it no

<sup>1</sup> This name was originally, it seems, applied generically to a species of *Terebra*, by Link in 1807, the name *Terebra* being, however, 50 years older (Adamson, 1757). In 1817, Schumacher promoted to generic distinction Linnaeus' "*Murex vertagus*" the actual name *Vertagus* having been applied to this shell as early as 1753 by Klein. The convenient name selected by Schumacher has been tabooed on the pretext of being "pre-occupied" even though this "pre-occupation" be a faulty one, and therefore, another newer name *Rhinoelasis* (Swanson, 1840) has been substituted. As however there is not the remotest chance of confusion between a *Cerithium* and a *Terebra* we may just as well keep to the time-honoured *Vertagus*.

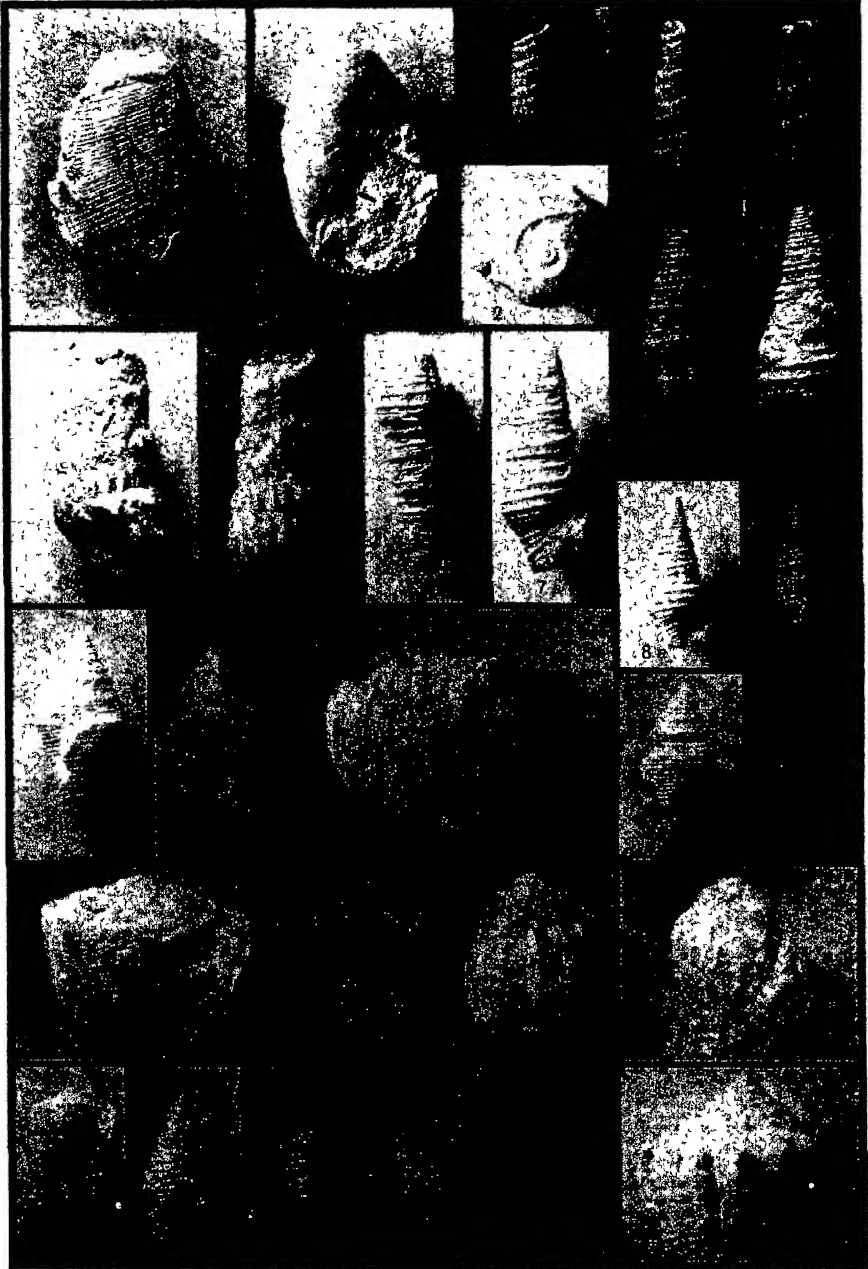
longer traverses spines, but either remains perfectly even or only carries some faintly indicated nodes. The spire-whorls carry some irregularly interspersed varices, about one in each whorl. The body-whorl carries a prominent swelling at 180° from the outer lip. Some obscure striæ decorate the neck.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

*Comparisons*.—This genus has, so far, been described only from the Eocene. The form most closely related to the present one is *Cerithium vellicatum* Bellardi from the neighbourhood of Nice and from Herzegovina (*Mem. Soc. geol. Fr.* [II], IV, Pl. XV, fig. 23; *Palæont. Oest. Ung.* XIII, Pl. XIX, figs. 10, 11) in which however the ribs are represented by a double series of nodosities on the spire-whorls, while the body-whorl carries, along the fasciole, a number of small spines which are only obscurely developed, or absent, in the oligocene species. It should be mentioned that the type of the genus, *Bellardia palæochroma* Bayan occurs in the Lutetian (Khirthar) of Baluchistan.

## PLATE I.

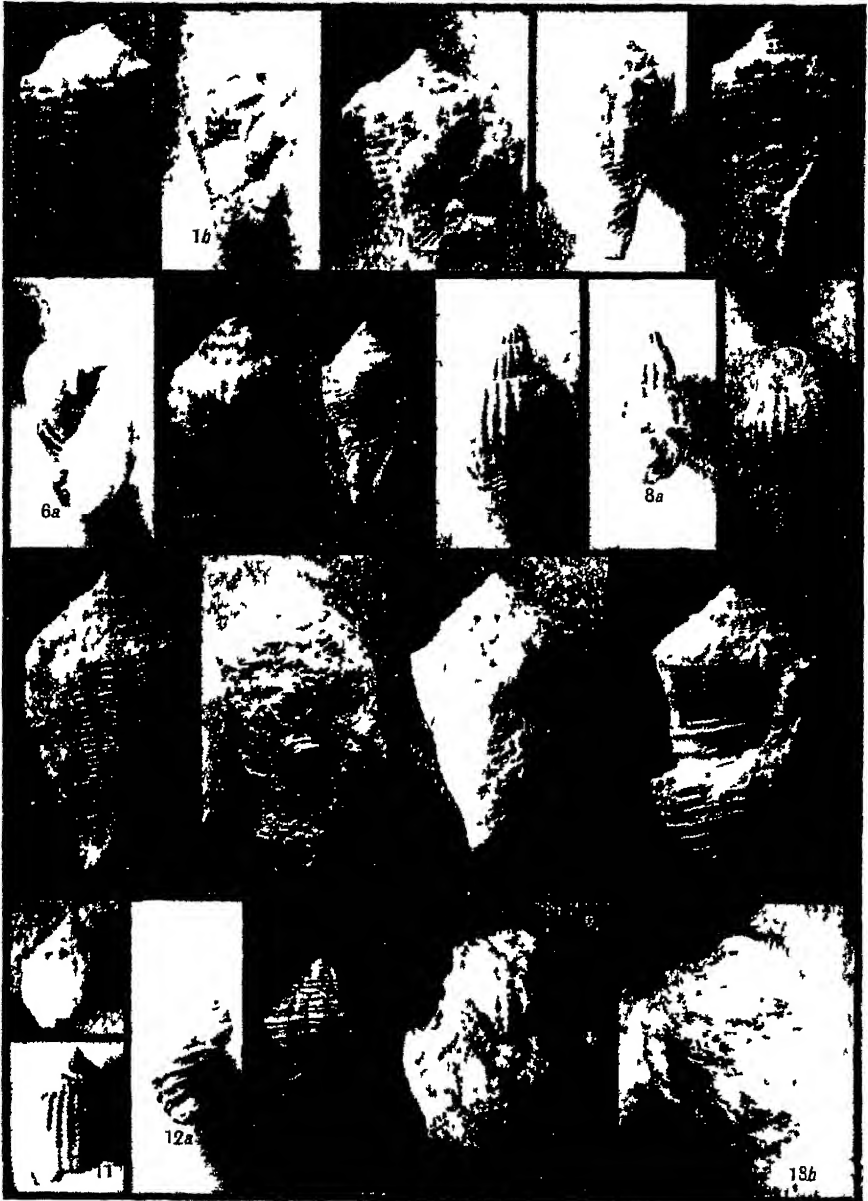
- FIG. 1.—*ACERA NARICA* n. sp., Bhagothoro Hill, Sind. (12,483).  
FIG. 2.—*ACERA NARICA* n. sp., Bhagothoro Hill, Sind. (See also Pl. IV, fig. 3.) (12,484).  
FIGS. 3, 4.—*TEREBRA SUBTESSELLATA* d'Orbigny, var. *OLIGOCENIOA* n. var. Bhagothoro Hill, Sind. (12,487-488).  
FIG. 5.—*TEREBRA QUETTENSIS* n. sp. Nari of Baluchistan. (12,489).  
FIG. 6. *TEEBBRA NABICA* n. sp. Nari of Baluchistan. (12,490).  
FIG. 7.—*PLEUROTOMA YENANENSIS* Noetling, var. *NARICA* n. var. Bhagothoro Hill, Sind. (12,499).  
FIGS. 8, 9.—*PLEUROTOMA ICKEI* Martin, Gaj of Kachh. (12,500-501).  
FIG. 10.—*CONORBIS DORMITOR* Solander var. *SINDIENSIS* n. var. Bhagothoro Hill, Sind. (12,518).  
FIG. 11.—*CONORBIS DORMITOR* Solander var. *BHAGOTHORENSIS* n. var. Bhagothoro Hill, Sind. (12,519).  
FIGS. 12-14.—*CONUS (LITROCONUS) INEDITUS* Michelotti. Bhagothoro Hill, Sind. (12,520-522).  
FIG. 15.—*MITRA INQUINATA* Reeve. Base of Talar section, Mekran. (12,546).  
FIG. 16.—*HARPA (EOCITHARA) NARICA* n. sp. Bhagothoro Hill, Sind. (12,532).  
FIG. 17.—*ATHLETA (VOLUTOSPINA) MEKRANICA* n. sp. Base of Talar section, Mekran. (12,535).  
All the specimens are represented natural size. (12,535).  
The numbers in brackets in this and the following plates are those under which the specimens are registered in the Geological Survey of India collections, Calcutta.



## PLATE II.

- FIG 1 —*ATHELETA (VOLUTOSPINA) MEKLANICA* n sp Base of Talar section, Mekran (12,536).
- FIG 2 —*ATHELETA (VOLUTOSPINA) MEKLANICA* n. sp Base of Talar section, Mekran (See also Pl IV, fig 4) (12,537).
- FIGS 3-5 —*ATHELETA (VOLUTOSPINA) MEKLANICA* n sp Base of Talar section, Mekran (12,538-540).
- FIG. 6 —*HARPA (EUCITHARA) NARICA* n. sp Bhagothoro Hill, Sind (12,533).
- FIG 7 —*LYRIA ANCEPS* Michelotti Non varicose specimen from the Nari of Baluchistan. (12,544).
- FIG. 8.—*LYRIA ANCEPS* Michelotti Bhagothoro Hill, Sind (12,545).
- FIGS. 9-11 —*ATHELETA (VOLUTOSPINA) SINDIENSIS* n sp Bhagothoro Hill, Sind (12 541-543).
- FIG. 12 —*PURPURA (STRAMONITA) ANGULATA* Dujardin Bass of Talar section, Mekran (12,572)
- FIG. 13 —*RANELIA (BIPLEX) PULCHRA* Grey Gál of Kaohh, (12,574).

All the specimens are represented natural size.



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*G S I Calcutta*

TERTIARY FOSSILS FROM NORTH-WESTERN INDIA



### PLATE III.

- FIGS. 1, 2—*TRITONIDEA* (*CANTHARUS*) *ERYTHROSTOMA* [Reeve] Base of Talar section, Mekran. (12,564-565).
- FIGS. 3-5—*CASSIDEA* (*SEMICASSIS*) *OLIGOCALANTICA* n. sp. Bhagothoro Hill, Sind. (12,584-586)
- FIG. 6.—*SCONZIA* *BEYRICHII* [Michelotti]. Bhagothoro Hill, Sind (12,592).
- FIGS. 7-9—*CASSIDEA* (*SEMICASSIS*) *MEKRANICA* n. sp. Base of Talar section, Mekran. (12,588-590).
- FIG. 10—*CYPRÆA* (*BERNAYIA*) *SUBEXCISA* Braun Bhagothoro Hill, Sind (12,599).
- FIG. 11—*CYPRÆA* (*BERNAYIA*) *SUBEXCISA* Braun Bhagothoro Hill, Sind (See also Pl IV, fig. 6) (12,600).
- FIG. 12.—*CYPRÆA* (*BERNAYIA*) *SUBEXCISA* Braun Nari of Baluchistan. (12,601).
- FIGS. 13, 14—*STROMBUS* *MEKRANICUS* n. sp. Mekran beds, base of Talar section. (12,603-604)
- FIGS. 15, 16—*RIMELLA* *SUBRIMOSA* d'Orbigny, var *NARICA* n. var (12,612-613).

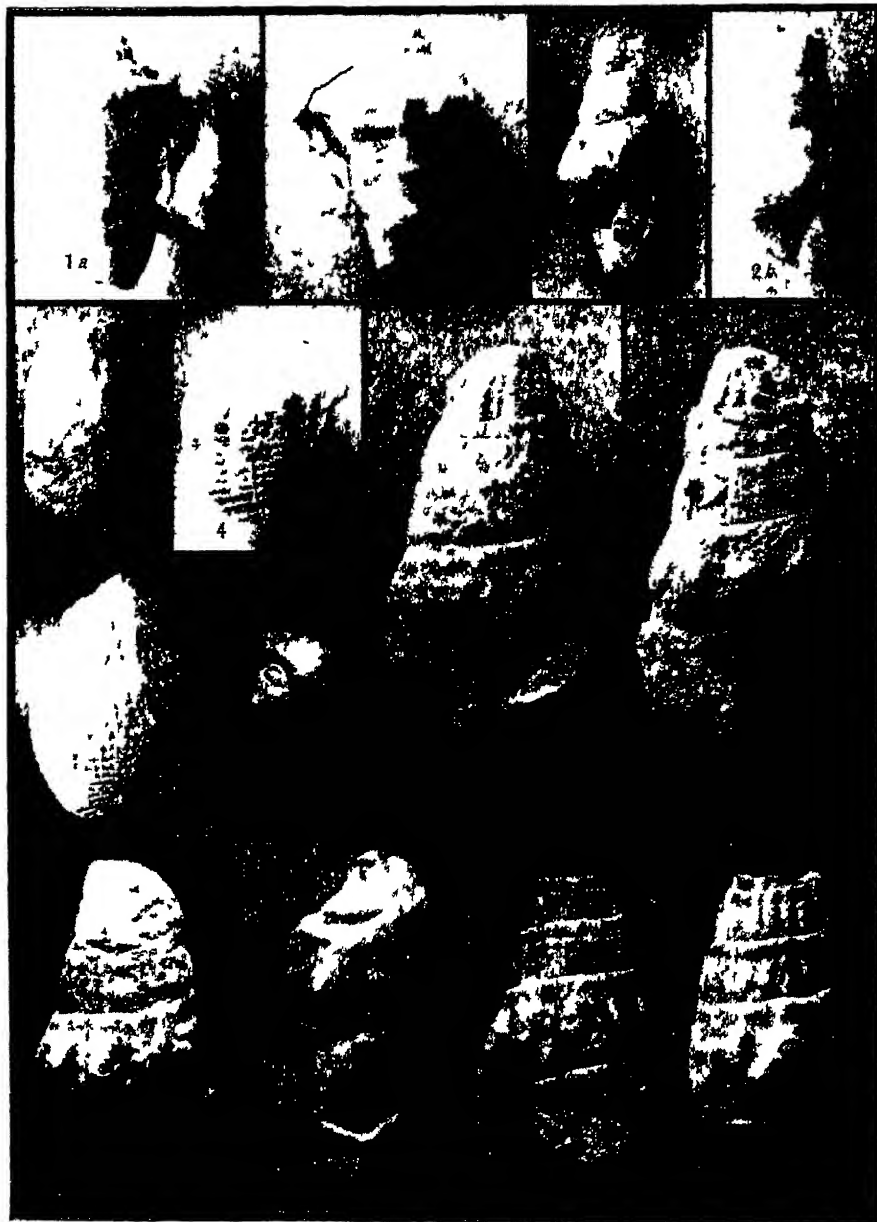
All the specimens are represented natural size.



## PLATE IV.

- FIG 1.—*STROMBUS MEKLANICUS* n sp Mekran beds, base of Talar section (12,605)
- FIG 2.—*ROSTELLARIA CURTA* Sowerby Mekran beds, base of Talar section (12,606).
- FIG 3.—*ACERA NABICA* n sp Bhagothoro Hill Sind (See also Pl I, fig. 2) (12 484).
- FIG 4.—*ATHELETA (VOLUTOSPINA) MEKLANICA* n sp Base of Talar section, Mekran. (See also Pl II, fig 2) (12,537)
- FIG 5.—*CASSIDEA (SEMICASSIS) OLIGOCALANTICA* n. sp Bhagothoro Hill, Sind. (12,587).
- FIG 6.—*CYPRÆA (BERNAYIA) SUBEXCISA* Braud Bhagothoro Hill, Sind (See also Pl III, fig 11) (12,600)
- FIGS 7-9.—*CERITHIUM (BELLARDIA) NARICUM* n sp Bhagothoro Hill, Sind (12,615-617).

All the specimens are represented natural size



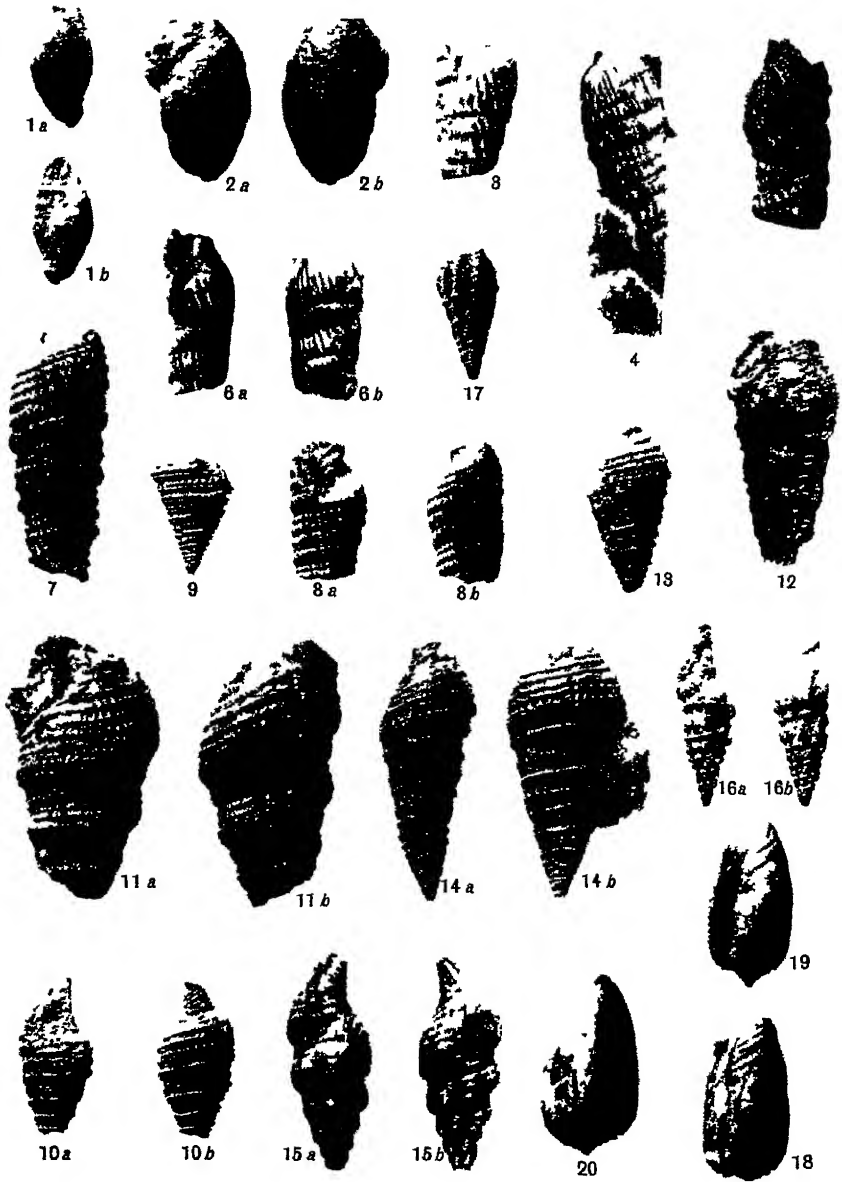
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*G. S. I. Calcutta*

TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

## PLATE V.

- FIGS 1, 2—*ATYS PROTOCYLINDRICA* n. sp. Gáj of Kachh. Enlarged 3/1. (12,485-486).
- FIGS. 3-5.—*TEREBRA MEKRANICA* n. sp. Base of Talar section, Mekran. Enlarged 2/1. (12,491-493).
- FIG. 6.—*TEREBRA GEDROSIANA* n. sp. Base of Talar section, Mekran. Enlarged 2/1. (12,494).
- FIGS 7, 8.—*TEREBRA ASPERA* Hinds. Base of Talar section, Mekran. Enlarged 2/1. (12,495-496).
- FIGS. 9, 10.—*PLEUROTOMA CONGENERA* E. A. Smith var. *MEKRANICA* n. var. Gáj of Kachh. Enlarged 3/1. (12,502-503).
- FIG 11.—*BATHYTOMA CATAPHRACTA* Biocchi var. *GEDROSIANA* n. var. Base of Talar section, Mekran. Enlarged 2/1. (12,510).
- FIG 12.—*DRILLIA (CRASSISPIRA?) MEKRANICA* n. sp. Base of Talar section, Mekran. Enlarged 3/2 (12,512)
- FIGS. 13, 14.—*PLEUROTOMA (GEMMULA) SINDIENSIS* n. sp. Bhagothoro Hill, Sind. Enlarged 5/2. (12,504-505).
- FIG 15—*LATHYRUS DUPLICATUS* n. sp. Base of Talar section, Mekran. Enlarged 2/1. (12,547).
- FIGS 16-17.—*DRILLIA (CRASSISPIRA) KACHHENSIS* n. sp. Kachh, near Warsar. Enlarged 5/2. (12,514-515).
- FIGS 18-20.—*OLIVA (NEOCYLINDRUS) MUSTELINA* Lamarck. Base of Talar section, Mekran. Enlarged 3/2. (12,525-527).



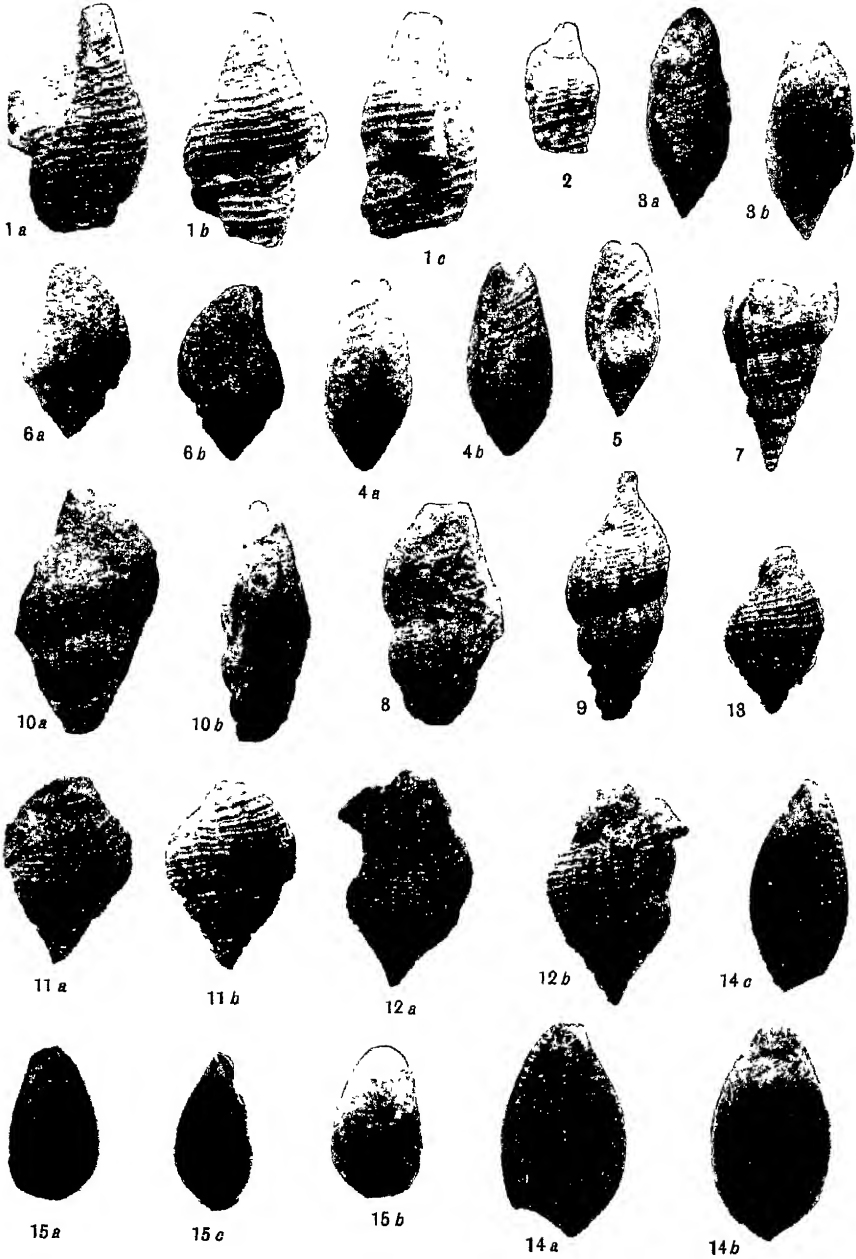
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## PLATE VI.

- FIGS. 1, 2.—*DRILLIA* (*CRASSISPIRA*) *MEKBANICA* n. sp. Base of Talar section Mekran. (12,513, 12,516).
- FIGS. 3—5.—*OLIVA* (*STREPHONA*) *AUSTRALIS* Duclou var. *INDICA* n. var. Near Warsar, Kachh. (12,528-530).
- FIG. 6.—*CAMINELLA* *ANNANDALEI* n. sp. Bhagothoro Hill, Sind. (12,566).
- FIGS. 7—8.—*RIMELLA* *SUBRIMOSA* d'Orbigny. Near Warsar, Kachh. (12,608-609).
- FIGS. 9—10.—*RIMELLA* *SUBRIMOSA* d'Orbigny. Teyra River near Rampur, Kachh. (12,610-611).
- FIGS. 11—13.—*HINDSIA* *NIVEA* [Gmelin] var. *NARICA* n. var. Bhagothoro Hill, Sind. (12,575-577).
- FIG. 14.—*CYPRÆA* (*EROSARIA*) *SINDIENSIS* n. sp. Bhagothoro Hill, Sind. (12,602).
- FIG. 15.—*MARGINELLA* (*GLABELLA*) *NARICA* n. sp. Bhagothoro Hill, Sind. (12,534).

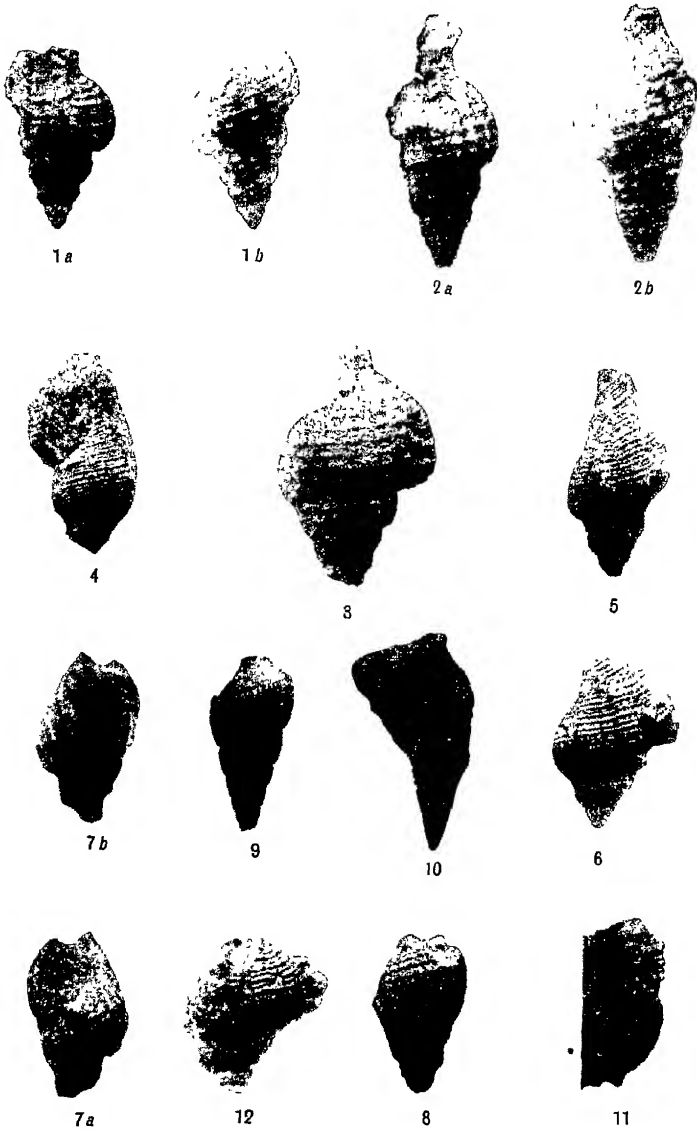
All the figures are enlarged 2/1.





## PLATE VII.

- FIGS. 1-3.—*HINDSIA MEKLANICA* n. sp. Base of Talar section, Mekran.  
Enlarged 3/2. (12,578-580).
- FIGS. 4-6.—*EUTERIOFUSUS SUBREGULARIS* [d'Archiac and Haime] var.  
*NARICA* n. var. Bhagothoro Hill, Sind. Enlarged 3/2. (12,548-550).
- FIG. 7.—*UXIA NARICA* n. sp. Bhagothoro Hill, Sind. Enlarged 3/2.  
(12,523).
- FIG. 8.—*NASSA (HEBRA) BONNETI* Cossmann var. *KACHEENSIS* n. var.  
Near Warsaw, Kachh. Enlarged 3/1. (12,568).
- FIG. 9.—*ROSTELLARIA* (?) *SINDIENSIS* n. sp. Bhagothoro Hill, Sind.  
Enlarged 2/1. (12,607).
- FIGS. 10-11.—*CERITHIUM (VERTAGUS) KACHENSE* n. sp. Near Warsaw,  
Kachh. Enlarged 2/1. (12,618-619).
- FIG. 12.—*MUREX (HAUSTELLUM) NARICUS* n. sp. Bhagothoro Hill, Sind.  
Enlarged 3/2. (12,571).



*E. Vredenburg, Photos.*

*G. S. I. Calcutta.*

PLATE VIII.

- FIG. 1 — *ATURIA NARICA* n. sp. Near Radak, 10 miles S.S.E. of Jhángara,  
Sind. (12,481).  
FIG. 2.— *ATURIA NARICA* n. sp. Bhagothoro Hill Sind. (12,482).

The figures natural size.



1 a



1 b



2 a



1 c



2 b

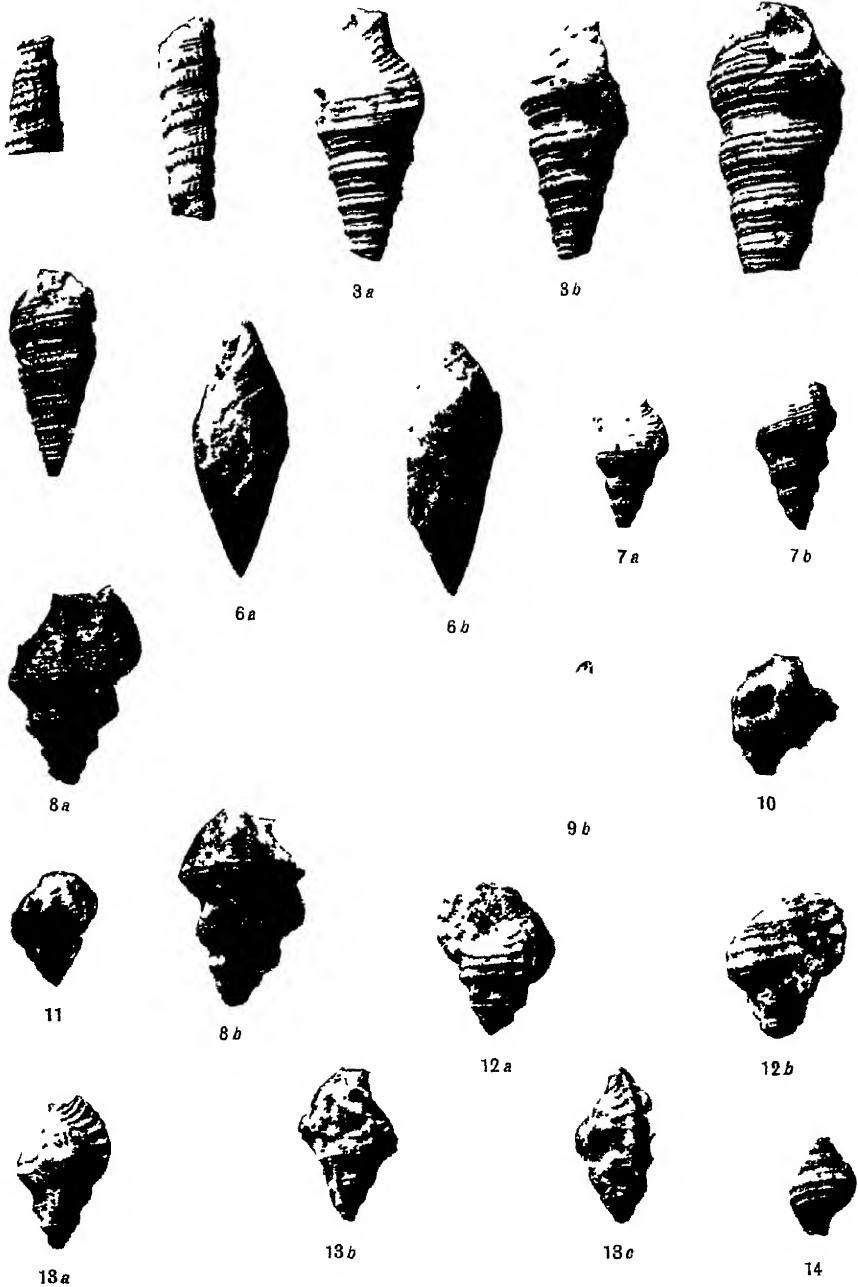
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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

## PLATE IX.

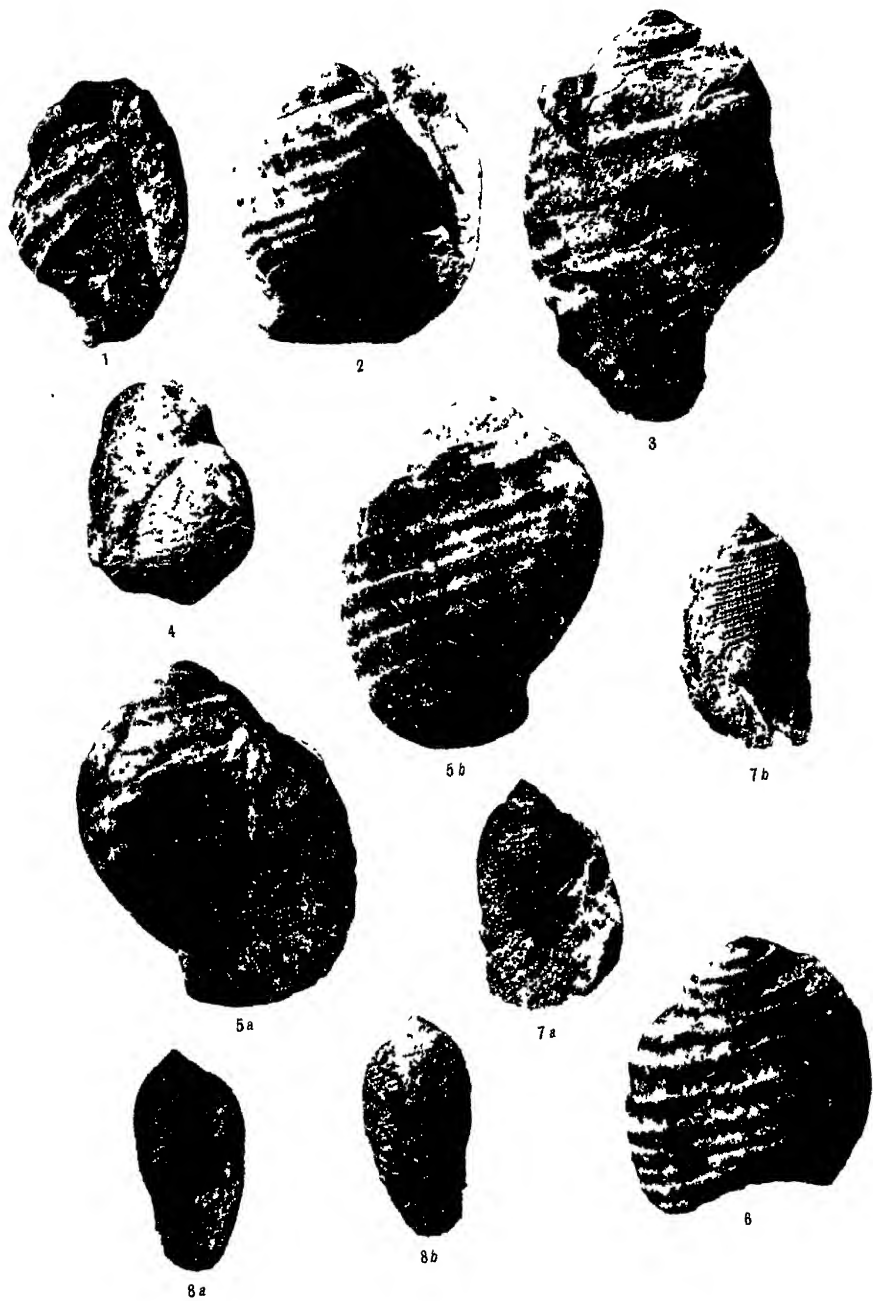
- FIG. 1.—*TEREBRA (MYURELLA) TRIZONATA* n. sp. 7 miles N. W. of Dram in the Mekran. Enlarged 3/2. (12,497).
- FIG. 2.—*TEREBRA (MYURELLA) KACHHENSIS* n. sp. Gáj beds of Kachh. Enlarged 3/2. (12,498).
- FIGS. 3-5.—*PLEUROTOMA HAYDENI* n. sp. West of Gharh Hill in the Mekran. Natural size. (12,506-508).
- FIG. 6.—*ANCILLA INDICA* n. sp. Bhagothoro Hill, Sind. Natural size. (12,531).
- FIG. 7.—*FUSUS (APTYXIS) RETICULATUS* n. sp. Bhagothoro Hill, Sind. Enlarged 3/2. (12,562).
- FIG. 8.—*SIPHONALIA (KELLETTIA) MEKRANICA* n. sp. Base of Talar section, Mekran. Natural size. (12,563).
- FIG. 9.—*METULA MARTINI* n. sp. Karachi, Blagnave collection. Enlarged 2/1. (12,567).
- FIG. 10.—*NASSA (TELASCO) MEKRANICA* n. sp. Kandelak-Garuki, Mekran. Enlarged 3/2. (12,569).
- FIG. 11.—*NASSA (TELASCO) MEKRANICA* n. sp. 8½ miles S. of Bán, Mekran. Enlarged 3/2. (12,570).
- FIGS. 12-14.—*TRITONIUM (NASSIA) INDICUM* n. sp. Bhagothoro Hill, Sind. Enlarged 3/2. (12,581-583).



## PLATE X.

- FIG. 1.—*PURPURA (THALASSA) MEKRANICA* n. sp. Oimara. (12,573).  
FIG. 2, 3—*DOLIUM ORMARENSE* n. sp. ORMARA. (12,593-594).  
FIG. 4.—*CASSIDEA (SEMICASSIS) ORMARENسيس* n. sp. ORMARA. (12,591).  
FIG. 5, 6—*DULIUM (EUDOLIUM) ARABICUM* n. sp. Koh-i-Dumak. (12,595-596).  
FIG. 7.—*PIRULA PAMOTANENSIS* MARTIN, var. *KACHHENSIS* n. var. (12,597).  
FIG. 8.—*PIRULA PAMOTANENSIS* MARTIN, var. *KACHHENSIS* n. var. (12,598).

The specimens are represented natural size.





## PLATE XI.

- FIG. 1.—*TURBINELLA PREMEKRANICA* n. sp. South side of Eri Hill, Sind. (12,551).
- FIG. 2.—*TURBINELLA PREMEKRANICA* n. sp. Fractured specimen showing internal folds. Entering the hills on the road from Jangri to Bula Khan's Thana. Sind. (12,552).
- FIG. 3.—*TURBINELLA PREMEKRANICA* n. sp. Specimen showing the ornamentation of the spire. Same locality as fig. 2. (12,553).
- FIG. 4.—*TURBINELLA PREMEKRANICA* n. sp. Specimen showing the ornamentation of the base. South side of Eri Hill, Sind. (12,554).
- FIG. 5.—*TURBINELLA PREMEKRANICA* n. sp. Nearly complete immature specimen showing the general outline of the shell. West of Bhagothoro Hill, Sind. (12,555).
- FIG. 6.—*TURBINELLA MEKRANICA* n. sp. Fractured specimen showing internal folds. Base of Talai section, Mekran. 12,556.
- All the specimens are represented natural size.



1

2

3

6

4

5

## PLATE XII.

- FIG. 1.—*TURBINELLA MEKLANICA* n. sp. Elongate race Base of Talar section, Mekran. Natural size. (12,557)
- FIG. 2.—*TUBBINELLA MEKLANICA* n. sp. Venticose race Base of Talar section. Natural size. (12,558).
- FIG. 3.—*CLAVATULA (CLIONELLA) SINUATA*. Boon, var. *ARABICA* n. var. West of Gharh Hill. Mekran beds Enlarged 3/2. (12,517.)
- FIG. 4.—*TRIGONOSTOMA INDICUM* n. sp. Bhagothoro Hill Enlarged 3/2. (12,524.)
- FIG. 5.—*PLEUROTOMA (HEMIFLEUROTOMA) BONNETI* var. *bhagothorensis* n. var. Bhagothoro Hill Enlarged 3/1



*E. edentulus*, Photos

## PLATE XIII.

FIG. 1.—*TURBINELLA MEKLANICA* n. sp. Base of Talar section, Mekran. (12,559).

FIG. 2.—*TURBINELLA MEKLANICA* n. sp. Right side of a specimen distinctly showing the corrugations of the early spire-whorls. Base of Talar section, Mekran. (12,560).

FIG. 3.—*MELONGENA GALBOIDES* Lam., var. *SINDIENSIS* n. var. Four miles west of Trak Hill, Sind. (12,561).

FIG. 4.—*TEREBELLUM (SERAPHS) NARICUM* n. sp. *a*, ventral side, *b*, right side, *c*, dorsal side. Bhagothoro Hill, Sind. (12,614).

All the specimens are represented natural size.



*E. Vredenburg, Photos*

TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

*G. S. I., Calcutta.*



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MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.





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VOLUME I, PART 2.

DESCRIPTIONS OF MOLLUSCA FROM THE POST-EOCENE  
TERTIARY FORMATION OF NORTH-WESTERN INDIA :  
GASTROPODA (IN PART) AND LAMELLIBRANCHIATA. BY  
THE LATE E. VREDENBURG, A.R.S.M., B.Sc., *Superin-  
tendent, Geological Survey of India.* (With Plates 14 to 33.)

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## PREFACE.

THE second part of Mr. E. Vredenburg's memoir on the Post-Eocene Mollusca of North-Western India, now published which concludes the work, has, owing to the lamented death of the author, been considerably delayed. This delay was caused not only by the necessity of re-photographing several of the specimens and of reproducing the additional 22 plates, but still more by the preparation of the manuscript for the press, which was undertaken by Sub-Assistant Mr. H. M. Lahiri; this preparation owing to other work both in the field and in Calcutta, could not be carried on continuously.

Mr. Lahiri has not indeed altered Mr. Vredenburg's actual descriptions or determinations, and the extent to which the author himself, had he lived, would have revised them must remain a matter for conjecture. Otherwise, however, the additions to the original manuscript are considerable: specimens which were in some cases found without labels had to be identified with the figures, and contrariwise the explanation of many of the figures had to be ascertained by a study of labelled specimens. The types of four new species here figured still unfortunately remain missing; the localities of all the species have been ascertained by reference to the registers and their geological horizons inserted in accordance with Mr. Vredenburg's latest views and nomenclature. The correction of errors in the synonymies and in typography and the compilation of an index and table of contents complete the list of points to which especial care has been devoted. For all this Mr. Lahiri is in the main responsible, though he has throughout availed himself of Dr. G. E. Pilgrim's help in settling the general arrangement of the material and in decisions upon doubtful points of identity.

E. H. PASCOE,

*Director, Geological Survey of India,*



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MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.

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DESCRIPTIONS OF MOLLUSCA FROM THE POST-EOCENE  
TERTIARY FORMATION OF NORTH-WESTERN INDIA :  
GASTROPODA (IN PART) AND LAMELLIBRANCHIATA. BY  
THE LATE E. VREDENBURG, A.R.S.M., B.Sc.,  
*Superintendent, Geological Survey of India.* (With  
Plates 14 to 33.)

CLASS : GASTROPODA—*contd.*

Family : CERITHIIDÆ—(*contd.*)

CERITHIUM (VERTAGUS) ERECTUM Martin.

1884. *Cerithium (Vertagus) erectum* Martin.—Martin, *Palaeontologische Ergebnisse von Tiefbohrungen auf Java, Samml. geol. Reichsmuseum Leid.*, 1st series III, p. 149, Pl. VIII, fig. 147.

The specimens correspond exactly with the figure and description given by Martin.

*Occurrence.*—Gáj of Sind : about 5 miles south-south-east of Tong, Kohistan.

G. S. I. Type No. 13,540.

CERITHIUM (VERTAGUS) BONNETI Cossmann.

1910. *Rhinoclavis Bonneti* Cossm.—Cossmann, *Journ. de Conch.*, LVIII, p. 34, Pl. II, figs. 1-3.

This beautiful Karikal shell is very closely related to two Javanese forms, *Vertagus gendinganense* Mart. and *V. jampangtengahense* Mart.

Amongst recent species, *V. attenuatus* Phil., *V. recurvus* Sow., *V. Kochi* Phil. and *V. articulatus* D. and R., are somewhat related.

*Occurrence.*—Mekran series (Gwadar Stage): Gwadar, Mekran Coast.

G. S. I. Type No. 13,541.

*CERITHIUM* (GOURMYA) BALUCHISTANENSE n. sp.<sup>1</sup>

Pl. XIV, figs. 1, 2.

The size is large, the shape is pupoid-obtuse; the spirally striated whorls are few, sometimes connected with one another by a continuous even surface, with perfectly level sutures, or else scalariform either anteriorly or posteriorly, while at other times they are slightly carinated both anteriorly and posteriorly so that the sutures become sunken. Moreover the shape of the shell is apt to vary with age, assuming one or other of the above dispositions at varying stages. There is sometimes a slight tendency to develop nodosities. The body-whorl is apt to become somewhat detached or distorted. There are sometimes obscure varices and there appears to be a well-marked one at about 60° from the aperture and a swelling close to the aperture which, however, is badly preserved. The only constant ornament consists of 9 to 11 conspicuous spiral threads on the spire-whorls; the base is similarly ornamented.

*Comparison with other species.*—Very similar to this shell is *Cerithium klipsteini* Micht. from the Helvetian of Turin, especially the var. *pseudolævigata* Sacco the size, however, being smaller. *Cer. romeo* Bayan from the (?) Eocene of the Vicentino<sup>2</sup> is also very similar but smoother. The almost complete absence of nodosities closely recalls the modern *Cerithium gourmyi* and the Javanese fossils *Cer. paungpongtenense* Martin, in both of which the spiral threads are much more delicate and inconspicuous.

*Occurrence.*—Nari of Baluchistan: north of Kudin, east of Kos Kats, Zhob district.

*CERITHIUM* (PTYCHOCERITHIUM) IGHINAI Michelotti.

1855. *Chemnitzia costellata* Lamk.—Sismonda, Note terr. numm. sup., p. 4.

1861. *Cerithium ighinai* Micht.—Michelotti, Ét. Mioc. inf., p. 125, Pl. XIII, figs. 3-

4.

<sup>1</sup> The type numbers of this and other species figured in this volume will be found in the Explanation of Plates.

<sup>2</sup> Is not this the same species as *Cerithium Delbosi* Micht. from Castel-Gombarto? The name *Romeo* is perhaps a correction as there was a previous *Cer. Delbosi* of d'Archiac and Haime.—E. V.

1870. *Cerithium yghini* Micht.—Th. Fuchs, Beitr. zur Kennt. der Conchylien fauna des Vicent, Fortf. überg. *Denkschr. kais. Akad. Wiss.*, Vol. XXXVI, 2nd part, p. 156, Pl. VI, figs. 20-23.

1895. *Ptychocerithium yghini* Micht.—Sacco, Moll. terr. del Piem. e dell. Lig., XVII, p. 23, Pl. II, figs. 21-30.

Medium-sized, tall conical, spire-whorls somewhat inflated, decorated with well-marked axial folds numbering 10 or 11 in each whorl, crossed by 4 spiral threads, with intermediate spiral striations. The body-whorl carries a pronounced varix at about 180° from the aperture. Between this varix and the aperture, the costæ disappear and the four principal spiral threads become very prominent, assuming a thickly lamellar disposition; a similar structure is shown by two additional threads that decorate the base.

*Comparison with Cerithium lamellosum* Bruguière.—This fossil is so closely related to the middle and upper Eocene form of the Paris basin, *C. lamellosum*, that it may be considered a mere variety. Sacco regards it as evidently derived from the Eocene form. Past the last varix, the costæ, in the Indian specimens, become completely obliterated by the spiral threads, the posterior ones of which become practically as important as the three anterior ones of the base. This is the main distinction from the Paris form in which, behind the three extremely pronounced lamellar threads of the base, the costæ remain quite well-developed in the portion intervening between the last varix and the aperture. Although this feature is not mentioned in the text of Michelotti or of Sacco, it is shown in the figures of the latter, which, however, are not as distinct as might be desired. The whorls are slightly more inflated than is usual in the Paris form. They increase in size somewhat more rapidly. The body-whorl is relatively large so that the shell does not show any tendency towards a pupoid or conoidal shape as in the case of the Paris form. The spire-whorls are ornamented with 4 scalariform threads disposed exactly as in the Paris form only not showing any tendency to an increased number as sometimes occurs with the Paris specimens. The intermediate threads are somewhat more pronounced than in the Paris form.

The shape is not unlike that of *Cerithium inabsolutum*, but the spiral threads of the latter are less pronounced than those of *C. lamellosum*, while the opposite is the case with the Indian form.

*Occurrence*.—Lower Nari of Bhagothoro Hill in Sind. Oligocene of Deogo, Carcare, etc.; also in the Oligocene of the Vicentino and of Lesbarritz.

G. S. I. Type No. 13,443



## CERITHIUM (PTYCHOCERITHIUM) PERLAMELLOSUM n. sp.

Pl. XIV, figs. 3-7, 9-12.

Large, slender, conoidal, the spire angle being rather wide in the earliest whorls, then narrower, and the body-whorl contracted; sutures slightly impressed with the exception of that of the body-whorl which is much more deeply impressed owing to the narrowing of the shell in that portion; spire-whorls feebly convex, numbering 9 or 10, with numerous axial folds, numbering about 20 in each whorl, interspersed with rather conspicuous varices (about one per whorl), crossed by seven or eight very prominent broad flat threads, broader than the sometimes feebly striated intervals, which completely obliterate the costæ on the body-whorl and the greater portion of the penultimate whorl, though, in some specimens, the costæ are apt to reappear somewhat after the manner of crenulations along the posterior margin of some portions of the body-whorl. The body-whorl is contracted and carries two additional broad threads on its base. All the threads are apt to become delicately decussated and granulated in the neighbourhood of the aperture. On the east, the position of the varices is marked by a row of impressed dots corresponding to internal denticulations.

This species exhibits to a most emphatic degree the characteristic features of the sub-genus *Ptychocerithium*.

*Occurrence*.—Nari of Balūchistān, north of Kudin, east of Kos Kats, Zhob district; Nari of Sind; Bhagothoro Hill.

## CERITHIUM (PTYCHOCERITHIUM) SINDIENSE n. sp.

Pl. XIV, figs. 8 and 13.

Larger probably slender and conoidal, sutures only slightly impressed, spire-whorls only slightly convex, swelling, quite close to the posterior edge, into a gentle, slightly nodular carina which becomes obsolete on the body-whorl, each whorl bearing 15 to 17 axial ribs, slightly spinose where they cross the posterior carina and generally better pronounced posteriorly than anteriorly, crossed by 20 to 22 very delicate impressed lines. There is a distinct swelling at about 180° from the outer lip, the axial ornamentation being obliterated in the interval. The base carries the three broad threads that characterise many species of *Ptychocerithium*.

This species reaches about the same dimensions as the Baluchistan form *Pt. perlamellosum* which it replaces in Sind, where, however, it is uncommon.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

**CERTHIUM (PSYCHOCERTHIUM) PSEUDOCORRUGATUM d'Orbigny.**

1840. *Cerithium corrugatum* Sow. [non. Bronn.].—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, 2nd. ser., Vol. V, Pl. XXVI, fig. 11.

1852. *Cerithium pseudocorrugatum* d'Orbigny.—Alcide d'Orbigny, *Prodrome de Paléontologie*, Vol. III, p. 83.

*Non Cerithium pseudocorrugatum* d'Orbigny. —D'Archiac and Haime, *Deser. des animaux du groupe numulitique de l'Inde*, p. 299 (1854).

Medium-sized, slender, conical, about ten spire-whorls moderately convex with a slight tendency to the development of a carina near their posterior edge, due to the prominence of one of the spiral threads ornamented with distinct slightly arched axial folds numbering about 13 in each whorl and interspersed at rather irregular intervals with distinct varices, crossed by about 15 delicate spiral threads usually alternating in size, especially towards the posterior portion of the whorls, showing a slight tendency to the development of spires at the points of crossing, especially along the thread whose prominence gives rise to the tendency to a posterior carination. In the body-whorls the axial folds almost entirely disappear, and some of the more prominent spiral threads, especially those situated anteriorly show a tendency to become granular. On the base they are followed by similar non-granulated spiral threads, three of which are especially prominent after the manner characteristic of the subgenus.

*Remarks*.—The above description is based upon the only specimen<sup>1</sup> available in the Calcutta collection, a form from the Gáj of Kachh. Sowerby's original type agrees in every detail except that it does not show the characters of the body-whorl which is entirely missing although the total dimensions of the fragment are the same. It must belong to a larger variety.

The form doubtfully referred to this species by d'Archiac and Haime is totally different.

*Occurrence*.—Gáj of Kachh.

<sup>1</sup> The specimen is unfortunately missing.—H. M. L.

## CERITHIUM (PTYCHOCERITHIUM) ARCHIACI n. sp.

1854. *Cerithium pseudocorrugatum* d'Orb ?—D'Archiac and Haime, Descr. groupe numm. de l'Inde, p. 299, Pl. XXVIII, figs. 5-8 (fig. 6 doubtful, perhaps (*C. rude*).

Large, conical, spire-whorls rugose, ornamented with prominent slightly oblique folds numbering about 13 in each whorl, irregularly interspersed with varices, crossed by 5 or 6 prominent spiral threads forming pronounced nodes at the points of crossing, the three anterior threads being generally more pronounced and wider apart than the posterior ones, the intervals, about equal in width to the threads, being obscurely striated. The foremost thread becomes very prominent on the body-whorl where it is associated with two more prominent threads on the base, thus giving rise to the usual arrangement of three prominent threads frequently observed in this situation amongst the members of the sub-genus *Ptychocerithium*. The axial folds become indistinct on the body-whorl which carries a narrow very prominent varix at about 200° from the aperture. Aperture oblique, somewhat oval, rounded in the middle. "Columellar margin constituting a wing-like expansion; outer lip flexuous, forming together with the columellar margin a narrow angular posterior prolongation which extends backwards upon the penultimate whorl, and an anterior narrow oblique canal deflected backwards." (D'Archiac and Haime).

*Remarks.*—Certain specimens from Sind were doubtfully referred by D'Archiac and Haime to Sowerby's *Cerithium corrugatum* from Kachh (*Cer. pseudocorrugatum* d'Orb). The above description is founded solely upon the same material which had already been studied by d'Archiac and Haime. The species is not represented in the collections of the Geological Survey of India. The exact characters are somewhat difficult to decipher owing to the poor state of preservation of the specimens. The figures in d'Archiac and Haime's monograph are restored to a deceptive degree. Nevertheless enough can be made out to ascertain the distinctness from *Cerithium pseudocorrugatum*. The ornamentation is much coarser and entirely different, especially with regard to the disposition of the spiral threads. The varix on the body-whorl of the Sind species is very prominent and extends further on the base than is the case with the Kachh form.

One of the type-specimens has been erroneously associated on the same slab with a specimen of the typical Gaj fossil *Cer. rude* J. de

C. Sow. The very badly preserved specimen represented in fig. 6 also bears a suspicious resemblance to *Cer. rude*. The mode of fossilisation of both species in the British Museum collection is exactly similar and there seems little doubt that *Ptychocerithium archiaci* is a Gij fossil.

CERITHIUM (PTYCHOCERITHIUM) HAIMEL n. sp.

Pl. XV, figs. 3, 4, 12, 13.

Medium-sized conical, about 11 spire-whorls of which the two embryonic ones are smooth, the remainder nodose, ornamented with prominent nodose slightly oblique folds numbering 10 or 11 in each whorl, interspersed with varices (about one per whorl), crossed by delicate spiral threads of which two are particularly prominent and tend to rise into spines where they cross the axial folds, while a third one also tends to produce spines although not particularly prominent in itself. The two most conspicuous threads are situated approximately at the anterior and posterior thirds of the spire-whorls, the one more posteriorly situated producing the most pronounced nodosities; the third series of nodosities is quite close to the posterior suture in the sunken portion of the whorl that intervenes between the suture and the more prominent series of spines. In addition to the three threads thus described there are numerous intercalary ones which increase in number with the size of the whorls; thus, at a diameter of about 10 mm. there are three or four threads of various sizes between the two principal ones in the middle of the whorls, about 2 on the anterior slope and 5 on the posterior one, making a total of some 12 or 13 for each spire-whorl; at about 15 mm. diameter, in the penultimate whorl, the three or four intercalary threads of the middle part of the whorl are each separated by one to three still finer threads, the anterior slope carries 3 or 4 fine threads, the posterior slope 8 or 10; the total number of threads thus becoming about 22 to 24.

On the body-whorl which is somewhat contracted the three spine bearing threads become ribbon-like, lamellar and very prominent, and are followed on the base by two more equally prominent threads at about equal intervals, the interspaces between these 5 principal threads being occupied by numerous very delicate threads (5 or 6 in each interspace, sometimes equal in size, sometimes of two alternating sizes). The axial folds become somewhat feeble and irre-

gular on the body-whorl where, in the immediate neighbourhood of the aperture, a fresh element of decoration appears in the shape of numerous minute furrows corresponding with the lines of growth and granulating all the spiral threads. The aperture is incomplete, only the angular posterior prolongation being preserved: the outer lip is accompanied by a swelling while there is a pronounced varix at about  $180^\circ$  from the aperture.

*Comparison with other species.*—In the general disposition of its ornamentation this *Cerithium* is not unlike *Ptychocerithium archiaci* for though the spiral ornamentation is much more delicate, the disposition of the nodosities is very similar. The ribs are fewer and their slight obliquity is in the inverse direction: in *Ptychocerithium haimeii*, the anterior end of the ribs is in advance of the posterior end, the opposite being the case with *Ptychocerithium archiaci*.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### CERITHIUM (PTYCHOCERITHIUM) RUDE J. de C. Sow.

1840. *Cerithium rude* J. de C. Sow.—J. de C. Sowerby, *Trans. Geol. Soc. of London*, 2nd ser., Vol. V, Pl. XXVI, fig. 10.

1854. *Cerithium rude* J. de C. Sow. ?—D'Archiac and Haime, *Descr. groupe numm. de l'Inde*, p. 299, Pl. XXVIII, figs. 9-12.

“Subulate, with curved sides, ribbed and furrowed; ribs numerous, cut across by about 5 square furrows, of which the uppermost is distant from the suture; whorls 10 or 12, nearly flat, with an obtuse varix between each—the last varix very prominent; aperture nearly round, with a canal at the upper angle; inner lip thick, with a callus at the top; beak broken.” [J. de C. Sowerby].

This description answers to the specimen figured by Sowerby in which the furrows are much narrower than the intervening flat raised spaces. But in Captain Grant's and in the Geological Survey collections, there are other specimens in which the reverse is the case the sunken portions being much broader than the intervening raised portions, which thus assume the character of narrow linear threads. The appearance thus produced is rather different, the spiral whorls being ornamented with eight narrow spiral threads of alternating prominence. The furrow bounding the most posteriorly situated of these threads usually isolates a band which does not bear any more threads or furrows or only very feeble and tenuous ones: this answers to the portion of the whorl isolated by the “up-

permost furrow distant from the suture" mentioned in Sowerby's description. In certain specimens the axial ribs in the later whorls become very much attenuated or completely obsolete in the anterior portion of the whorls, and then this posterior band assumes some what of the aspect of a row of crenulations, as is rather well shown in d'Archiac and Haime's figures of certain Sind specimens, the illustrations of which are, however, very greatly restored. In the earlier whorls this posterior band is not distinctly individualised and the ornamentation consists essentially of the 12-15 axial ribs crossed by four prominent spiral threads. There occur, however, specimens in which the posterior band does not become individualised at any stage and the spire-whorls carry 12 spiral threads of alternating size.

Somewhat intermediate between the specimens with furrowed spiral ornamentation and those with distinct spiral threads, there exist others in which the spiral elements cannot be described exactly either as furrows or as threads, but rather as steps with a longer, gentle anterior slope and a shorter, steeper posterior slope. Where these steps cross the ribs there is a slight tendency to the development of spines.

Thus there are three principal variations in the spiral decoration: the spiral ornaments may assume the form of furrows, of threads or of steps. There are, however, numerous gradations between these three types.

The costæ remain sometimes very distinct up to the end of the penultimate whorl. At other times they become almost obsolete long before reaching the body-whorl, in which case their anterior portion becomes especially attenuated, the posterior terminations remaining as above described, in the shape of a row of crenulations. These posterior crenulations, sometimes greatly enfeebled, are generally all that subsists of them on the body-whorl.

The appearance of the base is somewhat different in the specimens with spiral furrows and in those with spiral threads. In those with spiral furrows, the foremost furrow is followed on the base by three more furrows isolating three broad conspicuous ribbon-like bands similar to those decorating the remainder of the whorl. On the specimens with spiral threads, the foremost thread is followed, on the base, by twelve more threads alternating in size, so that in this case also the decoration of the base harmonises with that of the remainder of the whorl. The six more prominent

threads correspond to the anterior and posterior edges of the three broad bands of the furrowed specimens, the intermediate more delicate threads decorating the interspaces. In the specimens with step-like spiral ornamentation the general appearance of the base recalls that of the threaded specimens, only that the elements appear somewhat less numerous.

The flatness of the whorls and evenness of outline constitute the most characteristically distinctive feature of this species as compared with those above described.

*Remarks.*—The Geological Survey collections contain specimens of this species from the Gáj of Kachh. In the Sind collections described by d'Archiac and Haime this species is very abundant, but the specimens are badly preserved. They belong principally, so far as can be made out, to the furrowed variety. The species is not represented in the Geological Survey collections from Sind.

D'Archiac and Haime's *Cerithium Kayei* is not unlike the earlier whorls of this species, but it is impossible to form any decided opinion on this attribution without further material.

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49'), north of Jakao (23° 13', 68° 45'); Teyra River valley near Rampur.

G. S. I. Type No. 13,444.

CERITHIUM (PTYCHOCERITHIUM?) TRICINGULATUM n. sp.

Pl. XV., figs. 5, 7-11, 14.

Medium-sized, somewhat pupoid, whorls few, moderately convex, ornamented with three very prominent thick rounded spiral threads, equidistant from one another and from the sunken sutures, the intervals covered with delicate spiral threads. On the earliest whorls there are faint indications of axial ribs causing indistinct nodosities upon the principal threads whose course is otherwise perfectly smooth. The outer lip is accompanied by a prominent swelling, the body-whorl bearing a prominent varix at 200° from the outer lip, two other varices following at intervals of about 300° on full-grown specimens. The earlier whorls are not varicose. The rounded base carries three more prominent principal threads similar to those decorating the whorls.

*Remarks.*—This singular species recalls, by its ornamentation, a *Diastoma* or a *Fastigiella*. Nevertheless, all that can be seen of

the aperture agrees with the characters of a *Ptychocerithium*. It probably represents a species of this sub-genus in which the axial ribs have become obsolete, or perhaps it might be taken as a sub-generic type, the exact characters of which are, at present, too incomplete for diagnosis.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

CERITHIUM (? CHONDROCERITHIUM) BHAGOTHORENSE n. sp.

Pl. XV, figs. 1, 2.

Medium-sized, pupoid, moderately slender. Probably about ten spire-whorls when complete; spire whorls rugose though flat in general outline, with very pronounced spiral threads crossed by axial folds producing pronounced nodular swellings at the points of interference with the spiral threads. The nodosities are relatively more prominent on the thicker spiral threads than on the thinner ones. The anterior half of each whorl carries two conspicuous nodular spiral threads between which are two more intercalary threads of which the anterior one is more isolated and better pronounced. The posterior portion of the whorls carries three spiral threads about equal in importance to the more important of the two anterior intercalary threads. The sunken portion intervening between these principal posterior threads and the main anterior threads bears two very delicate threads. In each of the spaces between the intercalary threads of the anterior part of the penultimate whorl there is one still smaller subsidiary thread visible only with a lens. Both in the penultimate and ante-penultimate whorls, the narrow declivous foremost portion of the whorl in front of the more anterior thread also carries some very delicate threads. The axial folds number some twelve or thirteen per whorl. The varices are somewhat irregularly distributed, about one per whorl.

On the body whorl, the axial elements are relatively more delicate than on the spire, and almost twice as numerous. Beyond the striated sunken portion in front of the more anterior of the two principal threads, the base carries two very prominent smooth threads; the broad space between each of them carries five delicate threads, of which the fourth (counting in a backward direction) is especially conspicuous. The neck also carries spiral threads of various sizes. The last varix is about 120° from the outer lip, prominent and continued on to the neck. Of the aperture, only the posterior channel remains.



*Remarks.*—This species is rather more slender than those so far referred to *Chondrocerithium*, but is shorter than the majority of those generally attributed to *Ptychocerithium*. The characters of the aperture are not sufficiently preserved to decide for certain to which of these sub-genera the fossil should be referred.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### CERITHIUM (VULGOCERITHIUM) VULGATUM Bruguière (?)

1789. *Cerithium vulgatum* Bruguière, Dict. No. 13.

Medium-sized, pupoid, somewhat ventricose; spire-whorls somewhat angular, profusely striated, carrying folds which form blunt spines along the median carination of the whorls. The folds number about 11 on each of the 2 or 3 last whorls; on the earlier whorls they are more numerous, about 14 or 15. On the body-whorl the spines become less prominent while some of the spiral threads tend to become granulated, especially, it seems, on the base which, unfortunately, is badly preserved. Sometimes the posterior edge of the body-, and spire-whorls shows an obscure tendency to crenulation. There is a distinct varix situated probably at about 180° from the [missing] outer lip, and other indistinct ones along the spire.

*Remarks.*—This form has been named only provisionally, since its distinctness from *Vulgocerithium vulgatum* is uncertain. It comes very close to the figures of certain recent varieties of that species such as *Cerithium alucaster* Brocchi, (Tryon, Pl. XXI, fig. 40). It is however more ventricose than the forms generally referred to *C. vulgatum*. Compared with certain specimens of *C. europæum*, a form which is itself, doubtfully distinct from *C. vulgatum*, the absence of definite posterior plications or crenulations distinguishes it readily enough from certain specimens such as the one figured under the name of *C. minutum* in fig. 9, Pl. 41, of Hornes' work on the mollusca of Vienna basin, or the numerous specimens figured by Sacco; but when we come to varieties with almost non-plicate posterior margins of the whorls, such as fig. 8 of Hornes, there is no longer any clear distinction other than the very uncertain character of the proportions of the shell. Slight differences in size and in shape are the only insecure differences that can be traced when comparing the Indian shell with *Cer. taurosimpler* Sacco, also a form doubtfully distinguishable from *C. vulgatum*.

More numerous and better specimens will be needed to establish the independence of the Indian form which, in that case, might be called *Cer. indomalghatana*.

*Occurrence.* It is a Gáj fossil, presumably from the Upper Gáj.

TYMPANOTOMUS PSEUDODIABOLI n. sp.

Pl. XIX, fig. 21.

Medium-sized, probably pupoidal, whorls low, concave, ornamented with two pronounced rows of granulations at their anterior and posterior margins, the intermediate concave surface bearing an obscure spiral thread.

*Remarks.*—The specimen is very incomplete but resembles certain varieties of *Cerithium diaboli* Brongn., the main difference being that in the Indian specimen the granulations are further apart. The whorls are also somewhat lower.

*Occurrence.*—Gáj of Sind: south side of Bri Hill (Ram Singh G-<sup>302</sup>/<sub>20</sub>, see Blanford, *Mem. Geol. Surv. Ind.*, Vol. XVII, p. 157).

TYMPANOTOMUS LÆVIS n. sp.

Pl. XV, figs. 6, 15, 16.

Medium-sized, conical, with fairly wide apical angle, very slightly scalariform, whorls very low with a smooth posterior, sometimes slightly raised broad band followed either by three equally spaced threads or by four threads of which the three posterior ones are nearest together. Occasionally these threads become broad and flat and when this is the case, the whorls might better be described as diversified with incised lines rather than with raised threads. The spiral threads and especially the posterior band sometimes bear very faint nodosities particularly visible on the earlier whorls. The base is depressed and bears some spiral ornaments; its margin is rounded.

*Remarks.*—The species illustrates in a most remarkable degree the tendency observed in certain Oligocene Cerithiidae for the axial ornamentation to disappear and to be replaced by spiral ornaments. *Cerithium conjunctum* from the Oligocene of the Paris basin is not unlike in shape, but it has well-marked granulations.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

## TELESCOPIUM CHARPENTIERI de Basterot.

Pl. XV, figs. 17, 18, 20; Pl. XVII, figs. 1-9.

1825. *Cerithium Charpentieri* Bast.—De Basterot, Deser. geol. Bass. tert. S. O' France, p. 56, Pl. III, fig. 3.
1850. *Cerithium Helli* d'Arch.—D'Archiac, Hist. des progrès de la Géol., Vol. III, p. 288.
1854. *Cerithium Helli* d'Arch.—D'Archiac and Haime, Deser. an foss. gr. numm. Inde, p. 300, Pl. XXIX, fig. 1.

There are several varieties of this shell which is very common both in the Nari and Gáj. The Nari specimens from Baluchistan are rather more slender than de Basterot's original type, and correspond both in their shape and in their ornamentation with the Oligocene specimens from the faluns de Gaas and with the Oligocene forms from the north of Italy described by Sacco under the varietal names *appenninensis*, *crassecineta* and *subcylindrica*.

In Kachh there occur certain specimens in which the spiro angle is about the same as in the Bordeaux type or slightly wider, and in which the ornamentation is somewhat subdued. This is perhaps d'Archiac's *Cerithium Helli* though the specimens used for d'Archiac and Haime's description are in such a poor state of preservation that it is not possible to tell for certain whether they represent this form or the Nari variety.

Lastly the collections of the Geological Survey contain numerous large specimens from the Gáj of Sind which are decidedly more obtusely conical than Basterot's type, and in which the tubercles of the posterior margin of the whorls become fewer and more prominent with increasing age, and, on approaching the body-whorl, almost assume the character of veritable spines. In shape these specimens correspond exactly with the Miocene specimens described by Sacco, and the prominence of the posterior tubercles particularly recalls the variety described by him as *tuberculatoconica*; the character is, however, still more exaggerated in the Indian specimens than in the Italian ones, as for example in the specimens figured in Pl. XV, fig. 18, and Pl. XVII, fig. 1.

Shallow spiral sulci decorate the base both in the Nari and Gáj specimens as they do also in the original typical form from the south of France. In the broad base of the large variety from the Gáj of Sind these sulci are particularly numerous and crossed diagonally by impressed lines of growth, producing a very beautiful appearance recalling stamped leather or crocodile-skin.

Both in the Nari and Gáj specimens the columella carries two folds which are smooth and rounded, just as in the original figure and specimens of *Cerithium charpentieri*, and not lamellar as in *Cerithium pseudo-obeliscum* Grateloup, which has sometimes been mistaken for *Cerithium charpentieri*, and in which the roof (posterior inner surface) of the whorls carries a third spiral lamella on the side nearest the columella.

At intervals of about 180°, the floor (anterior inner surface) and internal walls of the whorls carry series of 5 short projecting lamellæ which succeed one another in an axial direction, the direction of each individual lamellæ being at right angles to the axial direction; they do not correspond to external varices. They are beautifully shown in the large specimens from the Gáj of Sind where they are perfectly identical with those of *Cerithium charpentieri* and quite different from the conical internal teeth of *Cerithium pseudo-obeliscum*.

*Remarks.*—Full-grown specimens of the Gáj variety appear at first sight very similar to *Cerithium meneguzzoi* Fuchs, from the Oligocene of the Vicentino, on account of the large wide-spaced spines of the later whorls. In *Cerithium meneguzzoi*, however, the posterior row of granules assumes the character of spines at a much earlier stage. Certain specimens from the Gáj are almost identical with *Cerithium trinittense* Fuchs also from the Vicentino Oligocene. In all probability both the Vicentino species are varieties of *Cerithium charpentieri*.

*Occurrence.*—Nari of Baluchistán: north of Kudin, east of Kos Kats, Zhob district. Gáj of Kachh: north-east of Badro, south of Mhurr. Gáj of Sind: south side of Eri Hill; entering hills on road from Gangri to Bula Khan's Thana.

#### GENUS TEREBRALIA.

With the exception of the imperfectly known *Terebralia mekranica*, the numerous species belonging to this genus in western India may be classified into two groups respectively related to *T. sulcata* and *T. palustris*.

#### GROUP OF TEREBRALIA SULCATA.

To this group *T. sulcata*, *T. semmitrisulcata*, and perhaps *T. vignali* Coss. The shells are ventricose and pupoid, the outer lip

carries anteriorly an extension which does not exist in the *pulstris* group and which sometimes completely shuts off the canal.

*TEREBRALIA MIOSULCATA* n. sp.

Pl. XVI, figs. 1—8; Pl. XVII, figs. 10, 11, 13.

Medium-sized, short, pupoid or barrel-shaped. Spire of about 9 whorls, the six earliest of which are very insignificant. Height of body-whorl about one half the total height of the shell. Ornamentation crowded, consisting of the usual axial and spiral furrows. The spiral furrows are so arranged as to give rise to 4 spiral threads on the earlier whorls while the two last whorls carry 6 spiral threads, or even more, in the neighbourhood of the body-whorl. The mutual distance of successive furrows increases posteriorly so that on the two last whorls the hindmost band appears more important than the others and simulates a row of crenulations. The axial ribs average some 25 to 29 in each whorl but are apt to become much fewer on the last half of both the penultimate and antepenultimate whorls which may carry only 7 or 8 ribs instead of 12 to 14. Some of the ribs are swollen into varices which may be distributed either at intervals of 180°, coinciding from whorl to whorl, or else, are wider-spaced and more irregularly distributed. A pair of prominent teeth corresponds internally to each varix, while the internal axis of the shell carries two spiral folds, one along the middle of the columella, the other at the junction of the roof (posterior inner surface) with the columellar surface. Of the two principal teeth, the more posterior is opposite the interval between the two columellar folds, the anterior one corresponding to the space between the anterior fold and the anterior inner angle of the whorls. (It is probably the presence and disposition of the teeth that affects the development and disposition of the columellar spiral ledges or swellings in many species of *Cerithiidae* and the value of this character, is therefore, perhaps subordinate.)

The base and neck are decorated with numerous spiral threads similar to those ornamenting the spire-whorls.

The aperture is rounded and trumpet-shaped, the outer lip greatly thickened externally. The columellar margin is well developed and semi-detached. The posterior channel is produced and sharply

pointed. The anterior canal is entirely cut off from the aperture by the coalescence of the outer and inner lips just as in the recent species *Terebralia sulcata*.

*Comparison with Terebralia sulcata*.—It is only by the most careful attention that this form can be distinguished from the recent *Terebralia sulcata* Born. The shape of the shell, the variations of the shape, the system of ornamentation, the shape of the aperture correspond exactly. The fossil shell is evidently the ancestral form of the living one and might be classified in the same species as a mutational variety. The slightly more profuse ornamentation of the fossil is the only constant difference: whereas in the living form there are never more than 5 spiral threads except in the immediate neighbourhood of the body-whorl, the two last spire whorls of the fossil carry 6 spiral threads and sometimes more. The axial folds are also generally more numerous though this difference is not so constantly appreciable: the widening of the intervals between the axial folds on the last half of the last spire-whorl is much more frequently observed, however, in the recent form than in the fossil. The varices in the fossil form are slightly more prominent and the posterior channel of the aperture slightly more detached.

*Occurrence*.—Mekran series (Talar Stage): north of Talar gorge on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bán ( $25^{\circ} 30'$ ,  $62^{\circ} 45'$ ).

#### GROUP OF *T. PALUSTRIS*.

Shells turretted, no anterior extension of outer lip.

#### *TEREBRALIA BIDENTATA* Dèfr. var.

Pl. XVI, figs. 9, 10; Pl. XVIII, fig. 1.

The specimens which are of very large dimensions are more obtuse than those from the south-west of France, but not more so than those figured by Hörnes (under the name *T. lignitarum*) from the Vienna basin. The body-whorl shows a slight tendency to dilatation not observed in the available European forms. Otherwise the details of the ornamentation correspond exactly. It might constitute a variety *gajensis* characterised by its large shape, relatively wide angle, and the somewhat more conical outline imparted

by the tendency to expansion of the body-whorl, but the differences are not sufficient for specific distinction.

*Occurrence.*—Gij of Sind: south side of Sri Hill.

TEREBRALIA DIMORPHA n. sp.

Pl. XVI, fig. 11.

Large, turretted, conical, rather slender, with expanded penultimate and body-whorl, probably 10 or 11 spire-whorls rather coarsely decorated with the usual axial and spiral folds. The spiral folds number 4, the penultimate whorl also showing a semi-independent fifth foremost one. The axial ribs number 18 or 19 as far as the penultimate whorl which only has 10 enormously prominent axial folds shaped like varices, giving this part of the shell a remarkably expanded appearance. The body-whorl is expanded so as to fit the outline of the penultimate whorl, but its ribs are not nearly so extravagant, the only feature, comparable in prominence to the ribs of the penultimate whorl being the usual varix at about  $180^{\circ}$  from the outer lip.

On the spire-whorls there are about 2 varices to every three whorls. The neck is elongate, both neck and base bearing the usual spiral folds.

*Remarks.*—This species is closely related to *T. bidentata*. Spire fragments without the penultimate whorl would be undistinguishable.

*Occurrence.*—Mekran Series (Talar Stage): Ban ( $25^{\circ} 30'$ ,  $62^{\circ} 45'$ ); ? Talar gorge.

TEREBRALIA SUBLIGNITARUM n. sp.

Pl. XVIII, figs. 2—5.

Medium-sized, slender, conical; probably about 10 spire-whorls; body-whorl not expanded. Whorls low, their breadth being almost twice their height. Ornamentation consisting of the usual spiral threads, axial ribs and varices. The threads and ribs are narrower than the intervening sulci and are raised into small granules at the points of intersection. There are four spiral threads except on the penultimate whorl where a fifth imperfect foremost thread is occasionally developed. The axial ribs number 23 or 24 on each whorl. On the body-whorl which carries the usual well-marked varix, the axial ribs become even more crowded.

*Comparison with other species.*—The spire-whorls are not unlike the earlier whorls of *T. bidentata* and *T. dimorpha*, but are distin-

guished by their more depressed shape, more crowded ornamentation and much narrower ribs as compared with the breadth of the intervening sulci. *T. lignitarum* closely resembles this species, especially in the disposition of the relatively broad sulci, but it lacks the development of granules at the intersection of the vortical and spiral ribs.

*Occurrence*.—Mekran series (Talar Stage); north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bāñ (25° 30', 62° 45').

TEREBRALIA MEKRANICA n. sp.

? Pl. XVII, fig. 12.

Medium-sized, conical in general outline, with convex spire whorls, the height of which is equal to more than half their width—each whorl bearing eight prominent costæ two of which are swollen into varices, crossed by seven principal ribbon-like threads of which the hindmost one is distinctly granulated, fine subsidiary threads occupying the intervals between the principal ones. The base shows one additional principal thread followed anteriorly by 3 more fine ones.

*Remarks*.—The solitary fragment<sup>1</sup> does not show the characters of the genus, but it has been ascribed to *Terebralia* owing to its close resemblance to the aberrant *Terebralia noetlingi* Martin and *Terebralia bandongensis* Martin, in which Dr. Martin has observed the characteristic internal teeth and columellar folds. The spire angle is narrower than in *Terebralia noetlingi*. *Terebralia bandongensis* has the ribs slightly closer-set and the whorls slightly lower, while the illustrations do not show the tendency to granulation of the posterior thread. The Mekran form is, however, closely related to both species.

*Occurrence*.—Mekran series (Talar Stage).

PYRAZUS PROTEBENINUS n. sp.

Pl. XVIII, figs. 6, 7.

Large, conical, moderately obtuse, with rather low whorls bearing eight very oblique ribs raised into spines where they are crossed by a

<sup>1</sup> The solitary specimen on which the diagnosis of the species is based is, unfortunately, missing. Fig. 12 of Plate XVII, with which the author's description of the species seems to agree, has been provisionally assumed to represent the species.—H. M. L.



shallow carina running about midway through the whorls. The ribs are much more oblique on the later whorls than on the earlier ones. The entire surface of the whorls is decorated with delicate spiral striations. The body-whorl seems to carry a pronounced varix. The aperture is destroyed.

*Comparison with other species.*—The specimens are so badly preserved and overgrown with oysters that it is not possible to determine exactly the characters of this interesting fossil. It is not unlike the Miocene (?) *Cerithium monstrosum* Grateloup and the Oligocene *Cerithium cochlear* Fuchs, but the ribs are much more oblique. This great obliquity of the ribs, especially on the later whorls also distinguishes it from the recent *Cerithium ebeninum* Bruguière which it otherwise closely resembles. The recent species is, however, somewhat variable and it is just possible that with a better series of the fossil form, specific identity might be established. The fossil form seems to attain rather larger dimensions than the living shell.

*Occurrence.*—Gáj of Sind: south side of Eri Hill.

#### POTAMIDES (CERITHIDEA) JENKINSI Martin ?

1879. *Cerithium Jenkinsi* Mart.—Martin, *Tertiärsch. auf Java*, p. 65, Pl. XI, fig. 6.  
 1884. *Potamides (Tympantonotus) Jenkinsi* Mart.—Martin, *Paläont. Ergebn. von Tiefbohr. auf Java, Samml. des Geol. Reichsmus. Leid.*, 1st ser. Vol. III p. 147.  
 1899. *Potamides (Cerithidei) Jenkinsi* Mart.—Martin, *Die Foss. von Java. Samml. Geol. Reichsmus, Leid.*, new series, Vol. I, p. 215, Pl. XXXIII, fig. 199, 500.

The specimen is incomplete as it does not possess the body-whorl, but it agrees perfectly with fig. 499 of Martin.

*Occurrence.*—Mekran series (Talar Stage): north of Talar gorge, on the road from Koj to Gwadar, base of the Sandstones constituting the Talar mountains.

G. S. I. Type No. 13,445.

#### POTAMIDES (CERITHIDEA) FLUVIATILIS Potiez and Michaud or DJADJARIENSIS Martin.

1838. *Cerithium fluviatile* Pot. et Mich.—Potiez et Michaud, *Cat. Moll. de Douai*, p. 303, Pl. XXXI, figs. 19, 20.  
 1887. *Potamides fluviatilis* Potiez et Michaud.—Tryon, *Manual of Conchology*, Vol. IX, p. 159, Pl. XXXI, figs. 38—40; Pl. XXXII, figs. 49, 51, 52.

1899. *Potamides (Cerithidea) djadjariensis* Mart.—Martin, Dic. foss. von Java, *Samml., Geol. Reichsmus. Leid.*, new series, Vol. I, p. 216, Pl. XXXIII, fig. 502.

According to Martin, the only difference between the fossil *Cerithidea djadjariensis* and the recent *Cerithidea ilatu* (regarded by Tryon as a mere synonym of *Cerithidea fluviatilis*) consists in the sharper granulations of the fossil and the greater obliteration of the axial sculpture on the body-whorl of the living shell.

In a solitary incomplete specimen from the Mekran region, the granulations are somewhat prominent, but the axial sculpture, past the last varix, is reduced to the hindmost row of granulations, just as in the case of the living species. Considering the variability of the recent form, it seems scarcely possible to separate the fossil.

*Occurrence.*—Mekran series (Talar Stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

G. S. I. Type No. 13, 446.

POTAMIDES (CERITHIDEA) PREANGERENSIS Martin.

1899. *Potamides (Cerithidea) preangerensis* Mart.—Martin, Dic. Foss. von Java, *Samml. Geol. Reichsmus. Leid.*, new series, Vol. 1, p. 217, Pl. XXIII, figs. 503-506.

There is only one distinct small fragment which agrees, however, with the description and figures published by Martin.

On comparison with actual specimens, the solitary Indian specimen appears very slightly more ventricose and with a very slight tendency to a scalariform disposition of the whorls not observed in the Javanese specimens. Otherwise the identity into every smallest detail is so absolute that I consider these slight differences insufficient for specific separation.

*Occurrence.*—Gáj of Sind: entering hills on the road from Jangri to Bula Khan's Thana.

G. S. I. Type No. 13 447.

POTAMIDES (CERITHIDEA) SINDIENSIS n. sp.

Pl. XV, fig. 19.

Fairly large, pupoid, with moderately tall moderately convex whorls ornamented with nine narrow spiral threads decussated into small squares and rhombs by numerous equidistant slightly

curved close-set ribs. Owing to the imperfect preservation of the specimen, it is not possible to ascertain whether varices may have existed.

*Remarks.*—The ornamentation of this fragment is so characteristic that it is worth describing in spite of the incompleteness of the specimen. The fossil greatly resembles *Cerithidca rhizoporum* Ad., from the Philippines, the exact genus of which needs to be ascertained.

*Occurrence.*—Gáj of Sind: south side of Eri Hill.

#### BATILLARIA MEKRANICA n. sp.

##### Pl. XXIVb, fig. 4.

Medium-sized, conical, slightly conoidal, whorls low, slightly convex, each bearing 11 or 12 ribs which are much better marked at the posterior margin of the whorls than further forward, crossed by 6 narrow sulci dividing the surface of the whorls into bands of equal width though the posterior one is sometimes slightly broader. The ribs disappear on the body-whorl, the base of which bears sulci similar to those of the spire. There is a narrow, not very prominent anti-labral varix. The columellar margin is well developed.

*Remarks.*—The spire bears some feeble indications of varices, but is not well preserved. Nevertheless there seems no doubt as to its generic position and it seems closely related to several living species such as *B. australis* Quoy, *B. zonalis* Bruguière, *B. undulata* Sowerby. The resemblance to *Batillaria australis* is especially close, the antilabral varix, in particular, being absolutely identical. The spiral ornamentation of the living species is somewhat more pronounced, a difference which may be due, however, to the state of wear of the solitary fossil specimen.

*Occurrence.*—Mekran series (Talar Stage): Talar gorge, Baluchistan.

#### Family: STROMBIDÆ<sup>1</sup>.

#### ROSTELLARIA PROTOFUSUS n. sp.

1840. *Rostellaria rectirostris* Lamk.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, (2), V, Pl. XXVI, fig. 18.

<sup>1</sup> Other species of this family have previously been described in *Mem. Geol. Surv. Ind.*, Vol. I, pt I, pp. 313-323.—H. M. L.

Medium-sized, slender. Spire-whorls regularly and rather strongly convex, and rather low, their height scarcely exceeding half their breadth. The earlier whorls up to a diameter of 10 millimetres are decorated with very numerous narrow, sharp, crowded, slightly curvilinear costæ. They become relatively more crowded as the diameter of the whorls increases. Both the costæ and interspaces are delicately decussated by numerous fine spiral striations. On approaching the body-whorl the spiral decoration disappears, the ribs become less prominent and are finally replaced on the body-whorl itself by lines of growth. The base carries numerous, crowded, strongly raised though very fine spiral threads, narrower than the intervening spaces.

Sowerby referred this fossil to *Rostellaria rectirostris* Lamk. (= *Rostellaria fusus* Linn) to which it is very closely related. It is of smaller size than the recent species, and the basal striations are slightly more crowded.

*Occurrence.*—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52') higher than the Pecten-bed of Sookpur; near Warsar (23° 21', 68° 49'), north of Jakao (23° 13', 68° 45').

G. S. I. Type No. 13, 542.

*RIMELLA JAVANA* Martin var. *GEDROSIANA*, n. var.

1880. *Rostellaria javana* Mart.—Martin, *Tertiärschichten auf Java*, p. 50, Pl. IX, fig. 7.

1895. *Rostellaria javana* Mart.—Martin, *Samml. Geol. Reichemus. Leid.*, V, p. 57.

1891-1906. *Rostellaria (Rimella) javana* Mart.—Martin, *Samml. Geol. Reichemus. Leid.*, new series, I, p. 192, Pl. XXX, figs. 445, 446.

Small, relatively ventricose and fusiform. Spire somewhat broadly conical or rather conoidal consisting of very convex whorls whose height is less than their width. Each whorl carries 19 or 23 pronounced costæ, interspersed at irregular intervals with prominent varices, the whole surface cut up into flat spiral bands, by crowded, relatively broad and deep, sulci. On the body-whorl the costæ do not extend on to the base, but the spiral ornaments persist up to the short, slightly deflected anterior rostration, the sulci becoming somewhat broader in an anterior direction. Both lips are thickened with callus, especially the outer one which forms a strongly raised rim. The posterior prolongations unite to form a curved channel terminating in a thin hook plastered on to the back of the last spire-whorl or the previous one. The outer lip

has a strongly marked stromboid sinus. Internally it is strongly crenulated, though the crenulations do not reach the margin.

*Remarks.*—*Rimella javana* is a common fossil in the Miocene of Java and the Philippines. In the Javanese specimens the ribs are slightly less crowded than in the Indian forms, their number being 18 in each whorl. The Javanese specimens are apt to grow slightly larger. Otherwise the Javanese and the Indian forms are identical.

*Occurrence.*—Mekran series (Talar Stage):

Family: *CERITHIOPSIDÆ*.

*CERITHIOPSIS MEKRANICA* n. sp.

Pl. XXI, fig. 4.

Small, very slender, seven whorls preserved; originally there must have been more than ten spire-whorls, very slightly convex, decorated with three rows of granules formed by the intersection of spiral threads and numerous slightly curved costae with their convexity turned backward. The middle row of granules is slightly more prominent than the others, thus contributing to the slightly convex shape of the whorls; the anterior row of granules is the weakest. On the penultimate whorl and still more so on the body-whorl, the granulations of the anterior row tend to become mere asperities along a pronounced spiral thread and there is a tendency to the development of an intercalary thread between the anterior thread and the middle row of granules. A fourth granulated thread very similar to the third one and separated from it by an intermediary thread, appears on the base and is followed by three more delicate spiral threads across which the axial costules still produce slight granulations.

*Comparison with other species.*—The well marked granulated threads of the base, the intercalary threads on the penultimate and body-whorl, and the slight preponderance of the middle row of knobs on the spire-whorls distinguish this species from *Cerithiopsis dactylus* von Koenen (Abh. zur. geol. Specialkarte von Preussen und den Thür. Staat., Vol. X, part 3, Pl. XLIV, figs. 7-10) from the Oligocene of North Germany, which it otherwise closely resembles.

*Occurrence.*—Mekran series (Talar Stage): Bán (25° 30', 62° 45').

Family: *TURRITELLIDÆ*.*TURRITELLA NARICA* n. sp.

Pl. XVIII, figs. 13—17, 21; Pl. XIX, figs. 2, 6.

*TURRITELLA NARICA* n. sp. var. *BALUCHISTANENSIS* n. var.

Pl. XVIII, figs. 10, 20, 22—25; Pl. XXI, fig. 5.

Medium-sized, with a fairly wide apical angle, whorls quite flat in general outline with a pronounced anterior constriction, or else, very feebly convex with a pronounced anterior declivity and feeble posterior one close to the sutures, which, in either case, are greatly constricted. The whorls are ornamented with numerous fine spiral threads. The anterior angulation corresponds with one of these threads and with the greatest width of the whorls. In front of this thread there is another thread of equal size midway towards the suture, the specimens with slightly convex whorls also showing two intercalary threads in the spaces thus delineated. In the specimens with flat whorls, one observes behind the angulation four or five principal threads with more or less pronounced intercalary threads in the interstices. The specimens with slightly convex whorls have the corresponding part ornamented with 10 to 12 threads all of approximately equal size. Two to four threads of gradually decreasing importance decorate the periphery of the rather flat base.

*Remarks and comparison.*—The characters of the form with numerous equal or sub-equal threads are so distinct that, at first, one might feel inclined to look upon it as a separate species. Both forms occur, however, together with intermediate gradations at some of the Baluchistan localities, and it can only be looked upon, therefore, as a variety which may appropriately be termed "*baluchistanensis*", and which is distinguished from the type by its subequal close-set threads and the slight convexity and less pronounced anterior carination of the whorls. The relation to *T. pseudobandongensis* (*vide infra*) is very close, but it is distinguished by its somewhat broader apical angle and more constricted sutures. There seems little doubt that the Oligocene *T. narica*, the Miocene *T. pseudobandongensis* and *T. bandongensis*, and the modern *T. infraconstricta* are genetically related as successive mutations.

*T. narica* seems also very closely related to *T. diversicostata* of the south Bavarian Oligocene (*Palaeontographica*, XLIII, Pl. XXV, fig. 23), the variety *baluchistanensis* exhibiting an equally close resemblance to *T. Sandbergeri* (same plate, fig. 24) which appears to be only a variety of *T. diversicostata* related to the type in the same way as the two Indian forms are related to one other. In both cases the Bavarian forms appear to be more slender and with fewer threads, the latter character distinguishing them from *T. protobandongensis*.

*Occurrence.*—The Sind specimens are from the Nari of Bhagothoro and belong to the type form.

In Balúchistán, the species has been met with at all the explored fossiliferous localities: various spots, sometimes distant only a few yards from one another yield either exclusively the type or exclusively the variety *baluchistanensis*, or else both forms together, the type generally prevailing. In the Nari of Baluchistán, the following localities have been recorded: north of Kudin, east of Kos Kats, Zhob district; Takatu, south of Khanai.

TURRITELLA PSEUDOBANDONGENSIS n. sp.

Pl. XIX, figs. 3—5, 7.

Medium-sized, slender, height of whorls slightly more than half their width, the greater portion of the whorls being almost plane in general outline or very slightly convex, with a pronounced short anterior and posterior slope towards the constricted sutures. The anterior declivity is much more pronounced than the posterior one. The whorls are ornamented with numerous fine threads of alternating sizes. One thread corresponds with the angulation close to the anterior margin and is followed anteriorly by two more principal threads of the same strength, one of which is exactly on the suture, the other situated midway; between these three threads there are, of course, two intervals of which the one further remote from the suture is occupied by a subsidiary thread. Posteriorly to the anterior angulation, there follow about eight threads of alternating sizes, though the last two or three tend sometimes to become subequal. The specimens are not very well preserved and do not show any very distinct ornamentation on the base which is somewhat rounded.

*Comparison with T. bandongensis.*—The species is very closely related to *T. bandongensis* of which it is perhaps a variety. It is smaller and its whorls are comparatively lower so that the subequal threads near the posterior margin of the whorls are less numerous than is often the case with *T. bandongensis*. Otherwise the shape and ornamentation are identical.

*Occurrence.*—Gáj of Sind: about 3 miles south-east of Töng, Kohistan; about 5 miles south-south-east of Töng; south side of Eri Hill.

#### TURRITELLA BANDONGENSIS Martin.

1880. *Turritella bandongensis* Mart.—Martin, Tertiärsch, auf Java, p. 68, Pl. XI, fig. 12.

The nearest living ally is *T. infraconstricta* Smith, from the Andamans, in which the ornamentation is identical and identically distributed, though somewhat more delicate than in the average form of *T. bandongensis*; only the whorls are slightly lower and the anterior constriction more pronounced.

The recent *T. terebra* is also very closely related, only it has lower whorls, a less pronounced tendency towards the development of intercalary threads, a slightly different distribution of the threads in the anterior portion of the whorls, and less profuse threads on the posterior sloping portion.

*T. cerea* has its main threads much wider spaced. *T. columnaris* has shorter and more angular whorls. *T. attenuata* has a pronounced angulation.

*Occurrence.*—Mekran series (Gwadar Stage): Barambab and Ormara, Mekran coast.

G. S. I. Type No. 13, 448.

#### TURRITELLA ASSIMILIS J. de C. Sow.

1840. *Turritella assimilis* J. de C. Sow.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.* (2) V, Pl. XXVI, fig. 8.

1883. *Turritella javana* Mart.—Martin, *Samml. d. Geol. R.-Mus. in Leiden*, Vol. I, p. 233, Pl. XI, fig. 27.

? 1884. *Turritella javana* Mart.—Martin, *Samml. d. Geol. R.-Mus.*, Vol. III, p. 171, Pl. IX, fig. 166.

1905. *Turritella javana* Mart.—Martin, *Samml. d. geol. Reichs.-Mus. in Leiden*, new series, Vol. I, p. 227, Pl. XXXIV, figs. 521-531.



All the Javanese varieties are represented, the commonest form being one more angular than the commonest Javanese form though the latter is also abundant. There is a very common bicarinate form. This fossil is not unlike *Turritella turris* Fuchs from Egypt, but the whorls increase faster, and the angle is somewhat wider than in the Egyptian form.

*Occurrence*.—Gáj of Kachh, Mekran series (Talar Stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bán (25° 30', 62° 45').

G. S. I. Type No. 13, 449.

TURRITELLA ANGULATA J. de C. Sowerby.

1840. *Turritella angulata* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2) Vol. V, Pl. XXVI, fig. 7.
1847. *Turritella acuticarinata* Dunker.—*Palaeontographica*, Vol. 1, p. 132, Pl. XVIII, fig. 10.
1854. *Turritella angulata* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. de l'Inde*, p. 204, Pl. XXVII, figs. 6-9.
1864. *Turritella acuticungulata* Jenkins.—*Javan fossils, Quart. Journ. Geol. Soc.* Vol. XX, p. 58, Pl. VII, fig. 1.
1864. *Turritella simplex* Jenkins.—*Javan fossils, Quart. Journ. Geol. Soc.*, Vol. XX, p. 59, Pl. VII, fig. 2.
1879. *Turritella simplex* Jenk.—Martin, *Tertsch.*, p. 67, Pl. XI, figs. 10, 11.
1879. (?) *Turritella angulata* J. de C. Sow.—Martin, *Tertsch.*, p. 68, Pl. XII, fig. 2.
1879. *Turritella duplicata* Lamk.—Martin, *Tertsch.*, p. 69, Pl. XI, fig. 13.
1879. *Turritella acuticarinata* Dkr.—Martin, *Tertsch.*, p. 69, Pl. XII, figs. 3, 4.
1901. *Turritella angulata* J. de C. Sow.—Noetling, *Miocene beds of Burma*, p. 272, Pl. XVIII, figs. 13-15.
1901. *Turritella simplex* Jenk.—Noetling, *Miocene beds of Burma*, p. 273, Pl. XVIII, figs. 1-4.
1901. *Turritella acuticarinata* Dkr.—Noetling, *Miocene beds of Burma*, p. 274, Pl. XVIII, figs. 5-7.
1904. *Turritella simplex* Jenk.—Martin, *Samml. d. Geol. R.-Mus. in Leid.*, new series, Vol. I, p. 226, Pl. XXXIV, fig. 520.
1905. *Turritella djadjariensis* Mart.—Martin, *Samml. d. Geol. R.-Mus. in Leid.*, new series, Vol. p. 228, Pl. XXXIV, figs. 532-538.

This fossil is extremely abundant in the Miocene beds of Sind Kathiawar, Kachh, Burma, and, locally, of the Mekran region in Baluchistán. In many localities every possible gradation may be observed between the type and the forms *simplex*, *acuticarinata* and *djadjariensis*, so that it is impossible to regard any of these

forms as truly independent species. Noctling had already noticed (Miocene of Burma, p. 272) that the distinction between *T. angulata*, *T. simplex* and *T. acuticarinata* is doubtful.

The specimens from Kachh exactly coincide with Sowerby's original figure and are not variable. Certain specimens obtained near the western extremity of Kathiawar, owing to the exaggeration of the keel and the obliteration of the threads posteriorly to the keel, assume the characters of *T. simplex*, especially when their apical angle is relatively wide, but they are accompanied by elongate specimens indicating that the wide angle cannot be relied on as a specific character.

The Sind specimens from the upper portion of the Gáj beds at the Gáj river section, owing to the equalisation of the threads and lowering of the keel, assume the form of *T. djadjariensis*, though they are accompanied by specimens of the typical form and of the *simplex* form. D'Archiac and Haime came to the conclusion that *T. angulata* and *T. assimilis* represent a single species, and mention the specimen of *T. angulata* illustrated by their fig. 6 as exhibiting the characters of *T. assimilis*. In reality, all the specimens illustrated by them, all of which come from Sind, are genuine examples of *T. angulata* belonging to the *djadjariensis* form. The form *djadjariensis* also occurs in western Kathiawar.

The Mekran form is the typical one with a tendency to assume the extremely carinate shape of *T. simplex*, this being accompanied, however, by a simultaneous exaggeration of all the other threads instead of the production of a smooth surface.

Individual specimens of *T. assimilis* may occur which it is difficult to distinguish from certain specimens of *T. angulata*. Generally, however, there is no ambiguity; whenever the spiral threads are well developed, those of *T. assimilis* are less numerous; when, on the contrary, the shells tend to become smooth, the total absence of threads on the posterior slope of the whorls, such as characterises the "*simplex*" form of *T. angulata* is never observed in *T. assimilis*.

*Occurrence.*— Gáj of Kachh: south and south-west of Kotaroo or Kotree (23° 3', 69° 4'); Teyra River, north of Naliya (23° 15', 68° 52'); near Warsar (23° 21', 68° 49'); Gáj of Kathiawar: 3 miles east by north of Gaga and 4½ miles south-east of Gurgat. Gáj of Sind: Khenji Nai. Mekran series (Talar Stage): Talar gorge, Baluchistán.

G. S. I. Type No. 13,450.

The form *T. djadjariensis* has also been recorded from the Karikal beds which correspond in age with the Gwadar stage of the Mekran series.

TURRITELLA BANTAMENSIS Martin.

1905. *Turritella bantamensis* Mart.—Martin, *Samml. de. Geol R.-Mus. in Leid.*, new series, Vol. I, p. 230, Pl. XXXV, figs. 539-545.

The type and the variety *talahabensis* are both represented. *Occurrence*.—Mekran series (Talar Stage): Bán (25° 30', 62° 45'). ? (Gwadar Stage): about 1 to 1½ mile from Baramhab camp on the way to Bán; south of the Cwad Pass?

G. S. I. Type No. 13,451.

TURRITELLA PSEUDOTETHIS n. sp.

Pl. XXI, figs. 2, 8.

Rather small, conical, fairly slender, height of whorls greater than half their width. The whorls carry two pronounced revolving keels of which the posterior one sometimes shows a tendency to duplication. The two principal keels are close to the suture so that the excavated surface in which are sunk the sutures is often shorter than the excavated interval between the keels. The sutures are accompanied by a delicate thread-like swelling belonging to the anterior margin of the whorls. The excavate surfaces between the keels sometimes carry fine raised threads, at other times very delicate sunken striæ, while they frequently show nothing else but lines of growth. A sharp angular margin limits the flat base.

*Remarks*.—*Turritella tethis* d'Orb (= *T. Archimedis* var. in Grateloup, *Conch. foss. terr. tert. bassin Adour*, Pl. XV, fig. 17) from the Oligocene of south-western France, has a more imbricate disposition of the spire-whorls, its revolving keels are further apart, and the posterior keel is much further away from the posterior suture.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

TURRITELLA BHAGOTHORENSIS n. sp.

Pl. XXI, figs. 1, 3, 6, 7.

Small to medium, extremely elongate, baculiform, whorls rather tall with two angular carinations situated quite close to the sutures

which appear as grooves bisecting the slightly excavated interval between the carinations of successive whorls. This interval is much narrower than the slightly excavated interval between the two carinations of one whorl. The whole surface bears very delicate striations and pronounced, very sinuous lines of growth. An angle limits the flat base.

*Comparison with other species.*—This species is closely related to *T. pseudotethis* from the same beds, of which it may be a variety. I have not, however, observed any passage forms. *T. bhagothorensis* is much more elongate, its carinations are further apart and much less prominent, and it lacks the thread accompanying the suture.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### TURRITELLA HERBERTI d'Archiac and Haime.

1854. *Turritella Herberti* d'A. and H.—D'Archiac and Haime, Desor. an. foss. faune numm. Indc, p. 296, Pl. XXVII, fig. 21.

Small, very slender, whorls bearing two prominent keels each of which is usually duplicated, situated quite close to the sutures which are sunken at the bottom of very deep narrow grooves, the flat, slightly sunken surfaces between the main keels carrying two to four spiral threads either equal or diversified. The main keels usually form such a pronounced rim or ledge near the margins of the whorls that they conceal the re-entering surface adjoining the sutures. In certain specimens, however, the posterior rim is less exaggerated, and the suture is approached by a posterior declivity bearing some very fine spiral threads. A narrow rim surrounds the contracted base.

*Remarks.*—All the specimens in the collection of the Geological Survey of India are from the Gáj of Kachh. D'Archiac and Haime's type is from the Gáj of Sind; it is poorly preserved and half encrusted into a *Cellepora*. Its sutural grooves are less exaggerated, its keels are more angular and the anterior keel is more distinctly duplicated than the posterior one. One of the intermediate spiral threads has a tendency to predominate over its fellows. The Kachh specimens may be regarded as a variety *kachhensis*.

*Comparison.*—Compared with *Turritella Archimedis* which it resembles as regards its ornamentation, *T. herberti* is much smaller, more elongate, and has the two principal keels of each whorl much further apart.

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49'), north of Jakao (23° 13', 68° 45')

G. S. I. Type No. 13,452.

TURRITELLA ASPERULA Brongniart.

1823. *Turritella asperula* Brongn.—Brongniart, *Mém. Terr. sod. Vicentin*, p. 54, Pl. II, fig. 9.

1854. *Turritella affinis*, d'Arch. and Haime (*pars*).—D'Archiac and Haime, *Descr. an. foss. faune numm. Inde*, p. 295, Pl. XXVII, fig. 16 (*non* figs. 17-19).

Most of the specimens have a very prominent anterior spiral thread followed by four more fairly equal and equidistant threads, the interval between the hindmost thread and the posterior suture being bisected by a sixth subsidiary thread. The intervals which are very wide compared with the threads usually bear numerous delicate spiral striations and are sometimes bisected by a subsidiary thread. Sometimes the foremost thread and its next neighbour come very close together, the interval between the two being much narrower than the following intervals; the fossil then assumes the appearance of the specimen figured by d'Archiac and Haime (fig. 16) under the name of *Turritella affinis*.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

This species is very common in the Oligocene of south-western France and northern Italy.

G. S. I. Type No. 13,453.

TURRITELLA CONOFASCIATA Sacco.

1854. *Turritella affinis* d'Arch. and Haime (*pars*).—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 295, Pl. XXVII, figs. 17, 18,? fig. 19 *Protonotus Deshayesi* ?—*non* fig. 16 (*Turritella asperula*).

1861. *Turritella desmarestina* Bast.—Michelotti, *Mém. Mus. nat. hist. Napol.*, p. 85 (*pars*).

1880. *Turritella desmarestina* Bast.—Sacco, *Cat. pal. Bac. terz. Piemonte*, N. 1801 (*pars*).

1895. *Haustator conofasciatus* Sacco.—Sacco, *Moll. terr. terz. Pioni. e Lig.*, XIX, p. 18, Pl. I, fig. 67.

1900. *Turritella (Haustator) conofasciata* Sacco.—Rovereto, *Ill. Moll. foss. longt.*, p. 148, Pl. VIII, fig. 12.

Rather large, apical angle fairly open, spire whorls moderately low, the height being equal to half the width or a little more, with two angular carinations, a feebler posterior one at about the last third or last quarter of the whorls and a much more pronounced anterior one quite close to the anterior suture. A fine thread accompanies

the posterior carination, a very thick torose swollen thread accompanies the anterior one. Between the posterior carination and the posterior suture, the outline is slightly convex; between the two angulations the outline is concave, in front of the swollen anterior thread the surface slopes rapidly towards the suture in the earlier whorls; in the later whorls another swollen thread very similar to the one coinciding with the anterior angulation becomes developed close against the anterior suture, sometimes it projects almost as much and there intervenes a deep sulcus. The posterior convex portion of the whorls carries two fine spiral threads; the median concave portion carries 3 or 4 fine threads. The posterior carination sometimes carries two threads instead of one, in which case the form agrees with the specimen very falsely restored in fig. 17 of d'Archiac and Haime's work. On approaching the body-whorl, all the spiral ornaments become much effaced, the anterior strongly marked cord and the sutural swelling remaining distinct up to the aperture though feebler than on the previous spire-whorls. On approaching the mouth the only important characters are the posterior, anterior and basal angulations together with exceedingly sinuous, strongly marked lines of growth. The nearly flat base bears some obscure spiral striations.

*Remarks.*—The name used by d'Archiac and Haime is pre-empted for a Cretaceous species. Moreover the first figure (fig. 16 of d'Archiac and Haime's work, which, by right, should be the type of their species, represents a specimen of *Turritella asperula* Brongniart. The species, therefore, must take the name given to it by Sacco who re-described it from specimens occurring in the Oligocene of the north of Italy.<sup>1</sup>

<sup>1</sup> Cossmann had noticed the duplication of the specific name *affinis*, and, unaware that Sacco's *Naustator confasciatus* corresponds with the truly distinct portion of d'Archiac and Haime's composite species, proposed the name *halaensis* (1904, *Revue crit. Paléoz.*, Vol. III, p. 197, Rec. Nomencl.). In Cossmann and Pissarro's description of the gastropods of the Indian Lower Eocene fauna published in 1900, the name *halaensis* was given to a species which resembles fig. 16 of d'Archiac and Haime's work. As however it is expressly stated by d'Archiac and Haime that their *Turritella affinis* occurs with Oligocene nummulites, I felt doubtful as to the identity of the Ranikot species, and, as I was unable to consult the original types at the time of my translation of the work of Messrs. Cossmann and Pissarro, I added a query in the synonymy with the consent of the authors. Now that I have had access to the original types it is perfectly evident that the Ranikot form corresponds neither with *Turritella asperula* nor with *T. confasciata*, the two forms included in d'Archiac and Haime's *T. affinis*. Moreover it is also evident that the name *halaensis* as proposed in 1904 refers partly to two species both of which were previously named, but it would be a rather slavish adherence to the "laws" of nomenclature if we were to disregard the name *halaensis* as applied to the perfectly well diagnosed and figured Ranikot species.

*Occurrence*.—Nari of Bhagothoro Hill in Sind,

G. S. I. Type No. 13, 154.

TURRITELLA DESMARESTINA de Basterot.

1825. *Turritella desmarestina* Bast.—De Basterot, Bassin tert. S. O. France, p. 30, Pl. IV, fig. 4.

All the specimens, both from Sind and Balúchistán are remarkably smooth, and may perhaps be regarded as constituting a variety *simplicissima*.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district. Nari of Sind: Bhagothoro Hill. One doubtful fragment from the Gáj of Kachh.

This species is very common in the Oligocene of south-western France and northern Italy.

G. S. I. Type No. 13,455.

TURRITELLA TIPPERI n. sp.

Pl. XIX, fig. 1.

Conical, with very wide apical angle, whorls low, imbricate, flat, with a carination close to the anterior margin, ornamented with seven narrow spiral threads inclusive of the one which accompanies the carination. The threads near the carination and still more so those near the posterior margin are closer-set than the intermediate ones. The suture is accompanied by a raised fillet belonging to the anterior margin of the whorls.

The absence of any differentiated median spiral thread distinguishes this species from all forms of *T. desmarestina*.

*Occurrence*.—Nari of Balúchistán: Takatu, south of Khanai.

TURRITELLA STRANGULATA Grateloup.

1841. *Turritella strangulata* Grateloup.—Atlas Conch. foss. terr. tert. bassin de l'Adour, Pl. XVI, fig. 13.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta.

This species is very common in the Oligocene of south-western France and Northern Italy.

G. S. I. Type No. 13, 456.

*TURRITELLA MAGNASPERULA* Sacco, var. *CRASSOCINGULATA* n. var.

## Pl. XIX, figs. 8—10.

1895. *Haustator magnasperulus* Sacco.—Moll. terr. terz. Piem. e Lig., XIX, p. 18, Pl. I, figs. 65, 66.  
 1895. *Turritella affinis* d'A. and H.—Noetling, *Mem. Geol. Surv. Ind.*, XXVII, Pl. V, fig. 4.  
 1901. *Turritella affinisformis* Noetling.—Miocene beds of Burma, *Pal. Ind.*, new series Vol. I, p. 277, Pl. XVIII, fig. 9.

Large, slender, whorls fairly flat, usually moderately angulated anteriorly, or else slightly imbricated. The whorls are covered with coarse, close-set, slightly granular spiral threads. Height of whorls slightly more than half their width. At intermediate and adult stages of growth the anterior portion of the whorls which is vertical or slightly sloping anteriorly carries three very thick contiguous threads. The posterior margin generally has a smooth zone showing only lines of growth. This may be followed by, or partly invaded by a zone of about the same width as the anterior three ribbed zone, also carrying three prominent threads which, however, are not adjacent, and are separated by intercalary threads; when the posterior portion of the whorls is thus ornamented, the median part of the whorls, between the posterior and anterior zones is occupied by five close-set, contiguous threads. At other times the ornamentation is less differentiated, and the interval between the smooth posterior zone and the anterior zone carries seven threads all of approximately equal importance, but not contiguous. Sometimes, even when the shell has already attained a large size, the decoration is still more simple, the anterior zone being followed by only four very prominent threads separated by intervals of equal width. The early whorls, previous to a diameter of 10 mm., do not possess the differentiated anterior zone: they only have five granular threads narrower than the intervals, and closely recall the appearance of *Turritella asperula*. Their apical angle is narrower than at subsequent stages of growth.

*Remarks.*—In none of the forms figured by Sacco as *Haustator magnasperulus*, are the spiral threads so coarse as in the Indian fossil. At the same time, the specimens with simplified ornamentation and the early whorls indicate so close a relationship, that the Indian fossil must in all probability be regarded as a variety of that remarkable form. If the study of further material should necessitate



the specific separation of the Italian and western Indian forms, the latter may be specifically named *Turritella crassocingulata*.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district.

TURRITELLA SUBULATA Martin.

1891-1906. *Turritella subulata* Martin.—*Samml. d. Geol. Reichs.-Mus. in Leid.* 1st series, Vol. III, p. 173, Pl. IX, fig. 168.

*Occurrence*.—Mekran series (Talar Stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

G. S. I. Type No. 13,457.

TURRITELLA VITULATA Ad. and Reeve.

1848. *Turritella vitulata* Adam and Reeve.—*Zoology of the Voyage of H. M. S. Samarang*, p. 48, Pl. XII, fig. 5.

*Occurrence*.—Mekran series (Gwadar Stage): south of the Gwad Pass, Balúchistán.

G. S. I. Type No. 13,458.

PROTOMA DESHAYESI d'Archiac.

1850. *Turritella Deshayesi* d'Arch.—*D'Archiac, Hist. des progrès de la Geol.*, Vol. III, p. 285.

1854. *Turritella Deshayesi* d'Arch.—*D'Archiac and Haime, Descr. an. foss. gr. numm. de l'Inde*, p. 205, Pl. XXVII, figs. 16-19.

1895. *Protoma cathedralis* Brongn. var. *serpiculata* Sacco (*an species distinguishenda*).—*Sacco, Moll. terr. terz. Piem. e Lig.*, XIX, p. 33, Pl. III, figs. 22-24.

1897. *Protoma quadricanaliculata* Sand.—*W. Wolff, Die Fauna der Sudbayerischen Oligocænmulasse. Palaeontographica*, Vol. XLIII, p. 268, figs. 25, 26.

1900. *Protoma exocathedralis* Rov.—*Rovereto, Illustrazione die molluschi fossili tongriani, Att. r. un. di Genova*, XV, p. 144.

According to d'Archiac and Haime the species is distinguished from *Turritella cathedralis* Brongn. by its narrower threads, its smaller size, its narrower apical angle and the absence of a swelling at the anterior margin of the whorls.

These distinctions hold good in their entirety only as regards the Sind specimens available to d'Archiac and Haime, constituting the type of their species. When the Balúchistán specimens are considered, two of these distinctions must be left out of ac-

count, that is the narrower apical angle and the absence of anterior swelling. All that remains then to distinguish *Turritella deshayesi* from *Turritella cathedralis* is its smaller size, and its somewhat sharper and narrower threads which, moreover, have less of a tendency to become unequal in relief. With these reduced distinguishing characters, the Indian fossil merges into *Protoma cathedralis* var. *scarplicata* Sacc., which, as Sacco himself suggested, might be regarded as an independent species, essentially Oligocene, with which it would then be necessary to unite his varieties *alternuplicata* and *septemplicata* both of which are also observed in India. In consequence of this identification *scarplicatum* Sacc. cannot be used as the specific name, and the specimens from the Oligocene of Europe must be known as *Turritella Deshayesi* d'Arch., or as *T. cathedralis* Brongu. var. *Deshayesi* d'Arch., according as to whether one chooses to regard them as belonging to an independent species, or merely to a variety of *T. cathedralis*.

Some of the Balúchistán specimens constitute a well-marked variety with only five principal threads instead of six, this being due to the effacement or even complete obliteration of the fourth thread, counting from the anterior margin. This variety then corresponds with *Protoma quadricanaliculatum*<sup>1</sup> Sandb. in which, however, the missing thread is said to be always completely absent, while it is often slightly indicated in the Indian specimens. The form may be named *Protoma deshayesi* var. *quadricanaliculatum* Sandb.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district. Nari of Sind: Bhagothoro Hill.

G. S. I. Type Nos. 13,459—13,460.

PROTOMA SINDIENSE n. sp.

Pl. XIX, figs. 11, 16.

Fairly large, slender, slightly scalariform owing to the posterior margins of the whorls being broader than the anterior margin of the following whorl; whorls ornamented with nine close-set spiral

<sup>1</sup> This name was first published in 1861 with a short description but no figure in Guembel's *Geognostische Beschreibung des bayerischen Alpengebirges*, p. 745. It was once more referred to in 1875, again without a figure in Guembel's "Abriss der geognostischen Verhältnisse der Tertiarsschichten bei Miesbach und des Alpengebiets zwischen Tegernsee und Wendelstein," p. 44—E. V.

threads of which the anterior are slightly farther apart than the posterior, the threads being either all of them approximately of one size or else irregularly alternating.

*Comparison with other species.*—This species is closely related to *Prot. deshayesi* and, of course, to *Prot. cathedrale*. The spiral threads, however, are more abundant and more equal than is usual in the latter, and, in none of the numerous varieties of *Prot. cathedrale* does one observe prominent anterior threads so close-set as in *Prot. sindiense*. It should be remembered, however, that *Prot. cathedrale* is very variable, and it is just possible that with more abundant material from Sind, the two forms might be united. Compared with the recent *Protoma knockeri* Baird, the Indian species is larger, somewhat more tapering and with much more pronounced ornamentation.

*Occurrence.*—Gáj of Sind: about 3 miles south-east of Tong, Kohistan.

PROTOMA RETRODILATATUM n. sp.

Pl. XIX, figs. 13–15, 19 20.

Moderately large; apical angle very open; whorls very depressed, the later whorls deeply concave with a very sharp and greatly expanded posterior keel.

In the earlier part of the spire the main portion of the whorls is approximately flat in general outline and there is a short rapid slope both anteriorly and posteriorly towards the constricted sutures. In these earlier whorls the flat portion is ornamented with six, seven, or eight narrow prominent threads so distributed that the anterior half of the flat portion always carries a group of three prominent threads either all three approximately equal or the two outer ones more prominent than the intermediate one. The posterior portion is sometimes occupied by three more threads which may be either of the same degree of prominence as the middle one of the anterior group, or else all six are of the same importance and equidistant. At other times the anterior group is followed by a deep broad sulcus situated about half-way across the whorl, almost as deep as the sutural depression, followed posteriorly by four fine crowded threads of the second order of magnitude. Sometimes the floor of this sulcus carries a fine thread of a third order of magnitude. In certain specimens the posterior group of threads

is granulated by the interference of the lines of growth, but not the anterior group. All the intervals carry very fine microscopic raised spiral lines of a fourth order of magnitude. Sometimes these very fine striations constitute the only ornamentation of the anterior and posterior slopes towards the depressed sutures. At other times these slopes may carry a few threads of the third magnitude variously distributed.

At a diameter of about 8 mm., the character of the whorls suddenly changes: the posterior carination suddenly develops into a sharp extremely expanded spiral keel; the sutures no longer lie in a depression, but the whorls become thoroughly concave and the sutures are inconspicuously situated on an anterior outward concave declivity which continues the slope of the flange-like expansion of the posterior margin of the following whorl. Instead of the sutures being constricted, it is now the centre of the whorls that represents the most constricted part of the shell. The ornamentation becomes rapidly simplified and soon becomes reduced to two or three principal threads situated midway through the concavity at the most constricted portion of the whorls, and corresponding with the anterior group of the earlier whorls.

The body-whorl bears rather sinuous lines of growth. The base, which is rather convex in general outline, is limited by an angular margin; it has a peripheral sulcus followed by a swelling showing the prominent and deeply sinuous lines of growth characteristic of the genus *Protoma*.

*Remarks.*—In spite of the extraordinary appearance of the full-grown shell, the earlier whorls indicate a distinct relationship to *Protoma deshayesi* and *Protoma cathedrale*. The very wide apical angle and more depressed whorls distinguish early spire fragments from corresponding fragments of *Protoma deshayesi*.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

#### PROTOMA RENEVIERI [d'Archiac and Haime.]

1854. *Turritella Renevieri* d'Archiac and Haime.—D'Archiac and Haime, *Descr. an. foss. gr. numm. de l'Inde*, p. 296, Pl. XXVII, fig. 13.

Several specimens exhibit remnants of the basal fasciole sufficiently well preserved to indicate that this is a *Protoma*. It is closely related to *Prot. deshayesi*, but it is distinguished by its very steep apical angle, and, as already noticed by d'Archiac and Haime,

the great constancy, regularity and regular spacing of its eight threads. The same number of threads is occasionally observed in *Prot. deshayesi*, but they are not so regular in size or in spacing. *Prot. renevieri* does not exhibit the scalariform disposition often seen in *Prot. deshayesi*, as it does not possess the posterior inflation of the whorls which gives rise to this appearance. On the contrary, the anterior part of the whorls is sometimes slightly swollen.

*Occurrence*.—All the specimens in the Geological Survey collection are from the Nari of Bhagothoro Hill in Sind where the species is more abundant than *Prot. deshayesi*, the opposite being the case in the locality from which Blagrave obtained the specimens examined by d'Archiac and Haime.

G. S. I. Type No. 13,461.

PROTOMA SUBRENEVIERI n. sp.

Pl. XIX, figs. 12, 17, 18; Pl. XX, figs. 1, 2.

Medium-size, extremely slender, almost cylindrical, never scalariform; whorls flat or very feebly convex, sutures impressed, ornamentation consisting of 11 or 12 sharp narrow threads, very uniform and regularly distributed, the spacing increasing but very slightly in an anterior direction in each whorl, each interval occupied by a very delicate intercalary thread scarcely appreciable without the aid of a magnifying lens. One rather doubtful specimen would appear to indicate that in the earlier whorls the apical angle is much wider.

*Remarks*.—Although none of the specimens show any remains of the aperture, the resemblance to *Prot. renevieri* is so very close that there seems no doubt that this species belongs to the same genus. The obvious distinction is the difference in the number of spiral threads.

*Occurrence*.—Nari of Balúchistán; north of Kudin, east of Kos Kats, Zhob district; Takatu, south of Khanai.

Family: MATHILDIDÆ.

MATHILDA QUADRICARINATA Brocchi.

1814. *Turbo quadricarinatus* Brocchi.—Conch. foss. subapp., p. 375, Pl. VI, fig. 6.

The solitary specimen<sup>1</sup> seems identical with the recent Mediterranean species which also occurs abundantly in the Miocene of northern Italy.

*Occurrence*.—Gáj of Kachh.

Family: *VERMETIDÆ*.

*SILIQUARIA GRANTI* J. de C. Sowerby.

1840. *Siliquaria Granti* J. de C. Sow.—J. de C. Sowerby. *Trans. Geol. Soc. Lond.*, (2) V, Pl. XXV, fig. 2.

1860. *Tenagodus trochlearis* Mörch.—Mörch, *Proc. Zool. Soc.*, p. 408.

The close-set series of small oval pores, already noticed by Sowerby as distinguishing the Kachh fossil from *Siliquaria anguina* Linn., is absolutely identical with that observed in *Siliquaria trochlearis* Mörch, living at the present day in the Philippine Islands. The fine numerous transverse striations and the absence of longitudinal striations are also in agreement with the same features as observed in the living shell. It seems, therefore, that the name of the fossil, which has priority, should be transferred to the living representative, though it would be advisable to obtain a series of specimens to make certain of this matter.

The only specimen, so far known, is the type described by J. de C. Sowerby which was discovered by Grant in the Gáj beds along the borders of the Rann of Kachh.

Family: *SOLARIIDÆ*.

*SOLARIUM NARICUM* n. sp.

1854. *Solarium affine* J. de C. Sow., var.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 288, Pl. XXVI, fig. 14 (*non-fig.* 13).

Small, conical-depressed, the outline of the spire slightly convex because the earlier whorls are flatter than the later ones: base nearly flat: base and spire entirely decorated with spiral granular ornaments. The small protoconch is followed by six spire-whorls, which, together with the body-whorl, form a very depressed, slightly lenticular cone, whose outline, if one leaves the ornaments out of account, is continuous and even, the sutures being linear, and not impressed. Each spire-whorl bears four pronounced sulci whose

The specimen is missing.—H. M. L.

width and depth increase away from the apex. They limit four bands, wider than the sulci, whose width also slightly increases towards the circumference. The posterior band is in contact with the suture. A very narrow surface raised to the general level of the shell separates the anterior sulcus from the anterior suture. The same four sulci are continued on the aboral surface of the body-whorl, which has also a fifth marginal band: the narrow surface, adjoining the anterior suture of the spire-whorls, represents the edge of this marginal band so far as it escapes concealment by the margin of the following whorl. All the bands are more or less cut up into granules by fine oblique incised lines, the granules being frequently better pronounced on the spire-whorls than on the body-whorl. The base is bordered by two pronounced peripheral raised bands separated by a deep sulcus: the outermost band is the under surface of the marginal band of the aboral surface already described. The peripheral bands are not granular or only slightly so. From the peripheral band to the not-very-wide umbilical cavity, there are distributed five granular bands of which the two nearest the periphery are much less developed than the peripheral bands, appearing almost flat in comparison, while the two nearest the umbilical cavity are extremely prominent, especially the one bordering the cavity, whose granulations resemble the cogs of a wheel. The narrow sulci separating these bands increase in depth on approaching the umbilicus. They are all approximately equidistant amongst themselves, but a flat space approximately equal to the width of a band, separates the outermost of these five bands from the peripheral group. Four of the bands are of equal width, but the one encircling the umbilicus is much broader. As the specimens grow larger, the three outermost of these five bands tend to become obsolete, but the two inner ones always remain very sharp.

*Comparison with other species.*—This species is closely related to the living *Solarium granulatum* Lamk., from the Atlantic and Pacific coasts of Central and North America, but is much smaller. *Solarium javanum* Mart., from the Miocene of Java is also closely related, but is also larger than *Solarium naricum*, and has the base more strongly granulated than in the case of full-grown specimens of the Indian species. The Oligocene forms from northern Italy which Sacco regards as varieties of *Solarium umbrosum* Brogn., are very closely related to *Solarium naricum*. In the Indian fossil,

the sulci of the aboral surface are more pronounced, while, on the base, the second circum-umbilical granulated band is invariably more individualised. The resemblance of this fossil to *Solarium umbrosum* was already noticed by d'Archiac and Haime.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

(†. S. I. Type No. 13,462.

#### SOLARIUM AFFINE J. de C. Sowerby.

1840. *Solarium affine* J. de C. Sow.—J de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXVI, fig. 5.

1854. *Solarium affine* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 288, Pl. XXVI, fig. 13, (*non* fig. 14).

Small, very depressed, aboral surface slightly lenticular or shield-like, entirely decorated with spiral rows of granules, base flat with rather wide umbilicus, two keels round its periphery, and two strongly granulated keels round the umbilicus, the remainder of the surface bearing plications directed along the lines of growth. There are six spire-whorls, each one of which bears four pronounced sulci which increase considerably in width in an outward direction, the outermost being so conspicuous that, at a glance, it marks off the whorls from one another and gives one the impression of a deep suture. This, however, is an illusion: the real suture is not sunken and is situated just in front of the anterior broad sulcus from which it is separated by a narrow rim. This narrow rim, on the body-whorl, is separated from a sharp broad marginal flange, by a fine incised line: but for this marginal flange, the remainder of the aboral surface of the body-whorl is identical with the spire-whorls. All the bands are cut up into innumerable square or circular granules which are just as pronounced on the body-whorl as on the spire-whorls. The base has two conspicuous peripheral bands separated by a deep sulcus. The outer band, corresponding with the marginal flange of the aboral surface is especially broad. Both bands are delicately granulated. Two sulci and two strongly granulated bands surround the rather wide umbilical excavation, the granules of the band bordering the excavation being particularly coarse and resembling the cogs of a wheel. Outside these two granular bands, is again a cycle of somewhat feebler protuberances, not however demarcated by a sulcus, and forming the origin of radial pleats which extend over the broad gently convex expanse



that intervenes between the outer and inner group of bands, and which is devoid of distinct spiral ornaments: the pleats become gradually effaced on approaching the peripheral circular bands which they do not reach. All the whorls are visible internally through the rather broad umbilicus.

*Remarks.*—This species is an ancestral form of *Solarium maximum* Philippi, from the Indian seas. The earlier whorls of *Solarium maximum* are absolutely identical with the fossil which, however, is not known to grow to the large size of the recent form. If the fossil and recent forms should be considered specifically identical, the name of the fossil takes precedence. *Solarium quadriceps* Hind, from the Indian and Pacific oceans is also closely related.

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 45'), north of Jakao (23° 13', 68° 45') (Gáj of Sind).

G. S. I. Type No. 13.463.

#### SOLARIUM PERSPECTIVUM Linn.

1767. *Solarium perspectivum* Linn.—Linnæus, Syst. Nat., Ed. XII, page 1227.

Medium-sized, apical surface lenticular-depressed, base flat. The spire-whorls are slightly convex, the sutures are impressed, and each whorl carries two narrow sulci one of which is close to the anterior suture, the other somewhat more distant from the posterior suture: the intermediate band is much wider than the two marginal bands thus demarcated. Delicate lines of growth cut up all these bands into narrow oblique shallow ribs. On the body-whorl the outline slopes rapidly forward from the outer band, constituting an almost vertical marginal region including a marginal sulcus and marginal rim. On the base there are two narrow peripheral ribs separated by a broad sulcus. Round the rather broad umbilical cavity there are two broad sulci isolating two not very coarsely granular bands. The remainder of the base is occupied by a very broad, flat, slightly concave surface which is smooth except for some very fine crowded radial lines of growth.

The specimen is identical with the recent *Solarium perspectivum* of the Indian ocean, which also occurs as a fossil in the Miocene of Java.

*Occurrence.*—Mekran series (Talar Stage): Bán (25° 30', 62° 45').

G. S. I. Type No. 13.464.

## TORINIA EUOMPHALIDES [ d'Archiac and Haime ].

1854. *Solarium euomphalides* d'A. and H.—D'Archiac and Haime, Descr. an. foss., gr. numm. Ind., p. 289, Pl. XXVI, fig. 15.

Small-medium, very depressed, shaped somewhat like a *Planorbis* with convex whorls and very wide deep umbilicus, the entire shell decorated with fine granulated spiral threads. The protoconch is followed by four broad spire-whorls with convex surface ornamented with six to eight equal, equally spaced, close-set, fine, delicately granulated threads of the same width as the intervening spaces. These are followed on the annular base by 10 more threads which become somewhat coarser-grained on approaching the wide umbilicus. The interspaces on the base, are wider than the threads. The whorls are practically round in section with sometimes just a suspicion of an angulation at the margin of the base, and they are very slightly impressed as seen in section at the junction of the previous whorl. The flattened specimen represented by d'Archiac and Haime is evidently crushed, and the shell, when perfect, never exhibits the double carination at the margin of the base so frequently observed in other species of the genus *Torinia*. All the whorls are visible when looking down the broad funnel-shaped umbilicus.

*Comparison with other species.*—This fossil bears the closest relation to *Torinia infundibuliformis* Gmelin, from the Philippines, which is identical in shape, but does not reach quite the same size as the largest fossil specimens. The spire-whorls in the recent form usually bear only four equal granulated threads: when their number is greater, they become unequal and of more or less alternating size, a disposition which is never observed in the fossil. D'Archiac and Haime compared the Indian fossil with the Eocene *Solarium plicatum* Lamk., which has been regarded by Sacco as the ancestral form of the genus *Torinia*.

*Occurrence.*—Sind, probably from the Gáj.

## Family: CALYPTRÆIDÆ.

## CREPIDULA (SIPHOPATELLA) SUBCENTRALIS Cossmann.

1910. *Crepidula (Siphopatella) subcentralis* Cossmann.—*Jour. Conch.*, Vol. LVIII, p. 53, Pl. III, figs. 16-18.

*Occurrence.*—Mekran series (Gwadar) Stage.

This species occurs also in the Upper Tertiary beds of Karikal.

CALYPTRÆA CHINENSIS [ Linn. ]

1767. *Patella chinensis* Linn.—Linneus, *Syst. Nat.*, Edit. XII, p. 1257.

The solitary specimen is indistinguishable from the recent, almost cosmopolitan species, which is found fossil in the Oligocene and Miocene of Europe, and occurs abundantly in the Indian ocean at the present day.

*Occurrence*.—Gáj of Kaachh: Vinjan (23° 6', 69° 4').

G. S. I. Type No. 13,465.

HIPPONYX CORNUCOPLÆ Lamk., var. NATICA n. var.

Pl. XX, figs. 3—5.

The solitary specimen is very large, but agrees in every essential character with *Hippomyx cornucopia* Lamk. from the middle and upper Eocene of the Paris basin. The anterior slope between the apex and the anterior margin is perhaps slightly shorter, on account of which the Indian form perhaps constitutes a slightly distinct variety, though it would be necessary to obtain more specimens before making quite sure of this point. The anterior margin is by no means so short as in *Hippomyx dilata* Lamk., and the general shape and ornamentation agree with *Hippomyx cornucopia*, not with *Hippomyx dilata*. Fine radial striations are visible on the anterior slope. The remainder of the shell only shows rough concentric distant lines. It is, however, rather worn in places, and, elsewhere, overgrown with attached organisms. The radial ornamentation is often absent from the Paris specimens.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

NATICIDÆ.

NATICA GLOBOSA [ Chemn. ]

? *Nerita globosa* Chemn.—Chemnitz, *Conch. Cab.*, Vol. V, p. 267, figs. 1806, 1807.

1905. *Natica globosa*, Chemn.—Martin, *Samm. Geol. Reichs.-Mus. Leid.*, new series, p. 259, Pl. XXVIII, figs. 618-620.

Medium-sized, globose-elongate, with short spire of four whorls of which the two first are very small and almost flat, the two next rather convex. The whorls are ornamented with oblique lines of

growth. The sutures occupy narrow linear grooves. The portion of the body-whorl situated close to the suture instead of being slightly convex like the spire-whorls, slopes rather steeply towards the apex, the outline being even slightly convex on approaching the suture. The base is globular. The callus of the inner lip is well developed but does not conceal the umbilicus.

This common species of the Indian seas also occurs fossil in the Miocene beds of Java.

*Occurrence*.—Mekran series (Talar Stage): Bán ( $25^{\circ} 30'$ ,  $62^{\circ} 45'$ ).

G. S. I. Type No. 13,466.

NATICA OBSCURA J. de C. Sow.

1840. *Natica obscura* J. de C. Sow.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, (2), V, Pl. XXVI, fig. 2.

As already noticed by J. de C. Sowerby, the greater flattening of the posterior part of the whorls distinguishes this species from the very closely related *Natica epiglottina*, Lamk., of the European Tertiary. A closely related living species also distinguished in the same way is *Natica pellis-tigrina* Chemn., from Australasia.

*Occurrence*.—Gáj of Kachh: near Warsar ( $23^{\circ} 21'$ ,  $68^{\circ} 49'$ ), north of Jakao ( $23^{\circ} 13'$ ,  $68^{\circ} 45'$ ).

G. S. I. Type No. 13,467.

NATICA (NATICINA) sp.

1854. *Natica longispira* Leym.—D'Archiac and Haime, *Desor. an. foss. gr. numm. Inde*, p. 283, Pl. XXV, fig. 24.

The casts are too imperfect for accurate determination. "*Natica longispira*" Leym, seems to attain larger dimensions. The Indian fossils are associated with badly preserved nummulites that appear to be *Nummulites intermedius*. The form would, therefore, be a Nari fossil.

NATICA (POLINICES) POWISIANA Reoluz.

1853. *Natica Powisiana* Reoluz.—Reeve, *Monogr. Natica*, Pl. VI, spec. 22.

1854. *Natica glaucinoides* ?Desh. var.—D'Archiac and Haime, *Desor. an. foss. gr. numm. Inde*, p. 280, Pl. XXV, figs. 10, 11.

1905. *Natica (Polinices) Powisiana* Reoluz.—Martin, *Samml. geol. Reichsmus. Leid.*, new series, I, p. 263, Pl. XXXIX, figs. 633-637.

The solitary available specimen, probably the original of d'Archiac and Haime's fig. 10, comes well within the range of variation attributed to the species by Martin. It is remarkable for its short spire, the considerable development of callus at the posterior angulation of the aperture, the feeble angulation of the circum-umbilical region. The small size of the tuniculum is, to a large extent, a deceptive appearance caused by its fractured condition, though it is certainly smaller than is usually the case in *Natica columnaris* Recluz, regarded by Martin as a variety of *Natica powisiana*. Yet it is quite as large as in some of the specimens illustrated by Martin.

*Occurrence.*—The fossil specimen illustrated by d'Archiac and Haime, is evidently from the Gáj series as indicated by its mode of fossilisation: the only other fossils in Blagrave's collection that resemble the Gáj fossil lithologically are some of the Ranikot forms. The subgenus *Polinices* is unknown, however, in beds older than upper Eocene, and thus the specimens can only belong to the Gáj. The specimens from the Eocene of Subathu labelled *Natica glauvionoides* Desh., by d'Archiac, are completely different. They belong to *Natica* s. str., and are not unlike *Natica Now* d'Orb., from the upper Eocene of Europe, but are too poorly preserved for specific determination.

SIGARETUS AQUENSIS Recluz, var. PRÆCEDENS Sacco.

Pl. XX, figs. 6—7—10—13.

1840. *Sigaretus haliotideus* Lamk.—Gratoloup, Atlas Conch. Bass. Adour, Pl. XLVIII, fig. 19.

1843. *Sigaretus aquensis* Recluz. - Chemn., Ill. Conchyl.

1891. *Sigaretus aquensis*, var. *præcedens* Sacco.—Sacco, Moll. ter. terz. Piem. c. Lig., VIII, p. 98, Pl. I, fig. 59.

The specimens from the Indian Oligocene agree with Sacco's illustration of the form occurring in the Oligocene of northern Italy. *Sigaretus Philippii* Speyr, from the Oligocene of Cassel is perhaps also identical though the type has a slightly more acuminate spire. If this identity were established, the name *Sigaretus Philippii* would be useful to distinguish the Oligocene forms from the Miocene forms which are somewhat flatter and to which the name *aquensis* properly belongs.

*Occurrence.*—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district. Nari of Sind: Bhagothoro Hill.

## SIGARETUS PROTONERITOIDES n. sp.

Pl. XX, figs. 8, 9.

Small, flattened, with elongate aperture, spire depressed, but relatively broad. Inner lip thickened, ending across the umbilicus which it conceals without spreading across it. The shell is thick and the spiral ornaments are coarse and conspicuous.

*Remarks.*—In the proportions of the spire and the character of the ornamentation, this fossil agrees exactly with *Sigaretus neritoides* Linn., of the eastern seas, which, however, grows to a much larger size and has a more rounded aperture.

*Occurrence.* - Mekran series (Talar stage): Ban (25° 30', 62° 45').

Family: *EUSPIRIDÆ*.

## AMPULLONATICA ANGULIFERA J. de C. Sow.

1840. *Globulus ? angulifer* J. de C. Sow.—J. de C. Sowerby, *Trans. Geol. Soc., Lond.*, (2), V, Pl. XXVI, fig. 4.

(*non Natica angulifera*, J. de C. Sow—in d'Archiac and Haime, *Ampullina crassatina*, etc.)

J. de C. Sowerby was perplexed by the generic affinities of this fossil which evidently belongs to Sacco's genus *Ampullonatica*.

It is interesting to find a representative of this extremely rare fossil genus in the Gáj of Kachh. Compared with the rare *Ampullonatica repressa* Rovasenda, from the Miocene of Turin, the Indian form is vertically more depressed and the circumsutural canal does not seem quite so deep. It should be noticed that the suture does not lie on the floor of the channel, which is constituted entirely by a depression at the posterior border of the whorl and is not, therefore, constituted by the neighbouring surfaces of two successive whorls.

*Occurrence.*—Gáj of Kachh.

## AMPULLINA (GLOBULARIA) GIBBEROSA [Grateloup].

1840. *Natica gibberosa* Grateloup.—Atlas Conch. foss. bass. Adour, Pl. IX, figs. 1, 2.

1854. *Natica decipiens* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 282, Pl. XXVI, fig. 4.

The inaccurate proportions of the drawing representing this fossil in d'Archiac and Haime's work convey a very deceptive impression.

*Ampullina gibberosa* is one of the commonest fossils in the Oligocene of Europe and is equally abundant in beds of the same age in India.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13,468.

AMPULLINA (CERNINA) CALLOSA J. de C. Sowerby.

1840. *Natica callosa* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXVI, fig. 3.

The extremely low and small, almost enveloped spire distinguishes this species from the European Miocene *Ampullina compressa* Bast., and from the living *Ampullina fluctuata* Sow. from the Philippines.

*Occurrence*.—Gáj of Kachh.

AMPULLINA (MEGATYLOTUS) CRASSATINA Lamk.

1804. *Ampullina crassatina* Lamk.—Lamarok, Ann. Mus., V, p. 33 and VIII, Pl. LXI, fig. 8.

1922. *Ampullina (Megatylotus) crassatina* Lamk.—Vredenburg, *Rec. Geol. Surv. Ind.*, LIII, p. 361, Pl. XXVIII, fig. 5.

The specimens owing to their low spire, resemble the variety *maxima* Grateloup, which occurs abundantly in the Oligocene of south-western France and northern Italy.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district.

AMPULLOSPIRA (EUSPIROGROMMIUM) OWENI d'Archiac and Haime.

1854. *Phasianella Oweni*, d'Archiac and Haime. D'Archiac and Haime, *Descr. an. foss. gr. numm. Indo*, p. 293, Pl. XXVII, figs. 3, 4, non *Natica Oweni* d'Arch. and H., in Oppenheim, *Palaeontographica*, XLIII, p. 176, Pl. XLII, figs. 6, 7 (1896).

Non *Natica Oweni* d'Arch. and Haime., in Oppenheim, *Palaeontographica*, XLVII, p. 197, Pl. XIV, fig. 3 (1906).

Non *Natica (Euspira) Oweni* d'Arch. and H., in Oppenheim, *Palaeontographica*, XXX, p. 265 (1906).

Non *Ampullospira ? oweni*, d'Arch. and H., in Cossmann and Pissarro's *Palaeont. Ind.*, new series, Vol. III, No. 1, p. 74, Pl. VI, figs. 22, 23.

The various Eocene or lower Oligocene forms which d'Archiac and Haime, Oppenheim, and Cossmann and Pissarro, have, at various times, referred to this species, although very closely related and belonging to the same zoological group for which Sacco has

proposed the name *Euspirocrommium*, nevertheless appear to me to be specifically distinct. The type belongs to a form which is abundantly represented in the Nari of Sind by numerous specimens, both with the shell preserved or as casts, the characters of which are remarkably constant. Their great homogeneity makes it an easy task to detect the divergences exhibited by the older forms. The Ranikot fossil referred to this species by Cossmann and Pissarro has a far more elongate spire. In the case of the Monte-Postale form, (*Palæontographica*, Vol. 43), so far as can be judged by the illustrations, though the elongation of the spire is not so extreme as in the Ranikot form, yet both the spire and the body-whorl are more elongate than in the Nari fossil: there is also a slight shouldering of the whorls not observed in the true *Ampullospira oweni*: moreover the Monte-Postale species reaches larger dimensions than the Indian Nari fossil. The Priabonian form (*Palæontographica*, Vol. XLVII) has the body-whorl larger as compared with the spire than the true Oligocene *Ampullospira oweni*: in shape the Priabonian form is not unlike *Natica (Euspirocrommium) elongata* Miccht., from the Oligocene proper of northern Italy, but it is larger than both the northern Italian and Indian Nari forms. The Eocene form from the Salt-Range referred to this species by d'Archiac and Haime is very similar to the Monte-Postale form, but it represented by fragments too incomplete for ascertaining its characters: the shape is more slender than in the Nari fossil. All these stand in the mutual relation of successive mutations, the tendency, from lower Eocene to Oligocene, being in the direction of a gradual shortening of the proportions.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13,469.

Family: *SCALIDÆ*.

*SCALA (CLATHRUS) GAJENSIS* n. sp.

Pl. XX, fig. 14; Pl. XXI, fig. 9.

Medium-sized, tall, slender, with convex whorls decorated with numerous thin sharp prominent vertical lamellæ deflected towards the direction of the aperture on approaching the posterior sutures, and in the opposite direction on approaching the anterior ones.



*Comparison with other species.*—Amongst recent species, this comes nearest to *Scala indianorum* Upr. of the eastern Pacific, which is more broadly conical, and also resembles *Scala gradata* Hinds., from Amboyna, and *Scala georgina* Kien., from the Atlantic, which are also more broadly conical, and with fewer lamellae.

*Occurrence.*—Gāj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'); near Warsaw (23° 21', 68° 49'), north of Jakao (23° 13', 68° 45').

SCALA (*CIRSOTREMA*) SUBTENUILAMELLA d'Archiac and Haime.

1854. *Scalaria subtenuilamellis* d'A. and H.—D'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 286, Pl. XXVI, fig. 9.

1854. *Scalaria Sedgwicki* d'A. and H.—D'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 286, Pl. XXVI, fig. 10.

Medium-sized, broadly conical, with six sharply angulated spire-whorls, very numerous sharp thin axial lamellae, rather obscure spiral striations in the intervals, occasional narrow varices, an additional angulation round the slightly excavate base, a concave neck, a swollen, neck-like rim round the inner lip formed by the accretions of an ear-like expansion of the inner lip at the termination of the columella. The greater part of the margin of the outer lip is broken.

*Remarks.*—*Scalaria Sedgwicki* is a crushed specimen of the same species as the type of *Scalaria subtenuilamella*. This fossil does not seem very closely related to any species at present living in the Indian Ocean. It is very closely related to *Scala* (*Cirsotrema*) *rustica* from the lower Miocene of Europe.

The Ranikot form compared with this fossil by Gossmann and Pissarro belongs to a different species, and most probably to a different group.

*Occurrence.*—Gāj of Sind.

Family: *TURBINIDÆ*.

TURBO (*OLEARIA*) *PROTOCEPOIDES* n. sp.

Pl. XX, figs. 15, 16, 18, 19, 21.

Medium-size, helicoid. Protoconch followed by three low, very convex spire-whorls. The two earlier spire-whorls are entirely decorated with spiral grooves of which there may be as many as six

or seven on the second whorl. The grooves on the earlier whorl are as broad as the ridges between them: the earliest whorl, when exceptionally well preserved, shows a tendency to be spinose up to a diameter of 2 millimetres. The last spire-whorl (penultimate whorl) generally carries two narrow although deep spiral grooves in the immediate neighbourhood of the posterior suture, isolating two spiral raised bands of which the juxta-sutural one is always crenulated, the following one frequently so. Some specimens have only one pronounced groove isolating the crenulated sutural band. Other specimens again have three grooves crowded close to the suture, the third band thereby isolated being, however, non-crenulate. Lastly, there are a few instances where the number of grooves crowded round the posterior sutures of the last spire-whorl amounts to four, and others again where the last spire-whorl is entirely devoid of spiral ornaments, the juxta-sutural crenulations being still indicated, though not bounded by a groove. In the specimens with three sutural grooves on the last spire-whorl there occur sometimes two more very fine spiral grooves, one of which is situated at some distance from the posterior group, the other at about an equal distance from the anterior suture, a wide space separating them. These additional fine grooves never extend upon the body-whorl where the posterior group nevertheless persists with exactly the same character as on the last spire-whorl, together with the sutural granulations. In those specimens that are entirely devoid of spiral grooves, the sutural granulations on the body-whorl form the starting points of rather conspicuous oblique lines of growth. The base is smooth, or only with lines of growth. The outer lip is oblique, the margin of the rounded aperture slightly expanded. In all the available specimens the columellar margin is rather obscured by the matrix, so that it is difficult to tell whether the shell was completely umbilicated: the umbilical aperture, if free, must have been very narrow: at any rate enough is seen to make sure that it was certainly not concealed beneath an umbilical callosity as in such forms as *Turbo petholutus* Linn., *Turbo variabilis* Reeve, *Turbo caledonicus*, but must have presented essentially the same structure as in *Turbo cepoides* Smith, in which the umbilicus is free from callus.

*Remarks.*—This fossil is closely related to the living *Turbo cepoides* Smith. The living species is of larger size, with taller whorls, more inflated base, its earlier whorls bear spinal sulci analogous

to those of the fossil though not so deep: it has similar rather conspicuous lines of growth and a similarly disposed umbilicus.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district; north-eastern spurs of Takatu range, Nari of Sind: Bhagothoro Hill.

**TURBO (SENECTUS) RADIATUS** Gmelin. var. **NARICUS** nov. var.

Pl. XVIII, figs. 8, 9, 11, 12, 18; Pl. XX, fig. 20.

*Turbo radiatus* Gmel.—Gmelin, Syst. Nat., Ed. XIII, p. 3594.

The specimens vary considerably in the degree of development of the spines and in the number and coarseness of the spiral threads, but agree in all essential characters with the living *Turbo radiatus* of the Indian coasts, from which they are distinguished by their smaller dimensions. The usually spinose thread near the outer margin of the base is perhaps slightly more removed from the vertical portion of the whorls in the living shells than in the fossil ones. The operculum of the fossil agrees with that of the living shell.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

**TURBO (MARMOROSTOMA ?) PSEUDO-UNDULATUS** n. sp.

Pl. XVIII, fig. 19 and Pl. XX, fig. 17.

Medium-sized, conical-depressed, with low spire and flattened base, the whole decorated with spiral grooves. The protoconch is followed by three low, moderately convex spire-whorls. Each whorl is decorated with six equidistant spiral grooves, much narrower than the flat raised bands which they isolate. The raised bands are apt to be rendered rugose by the oblique lines of growth, especially those nearest to the posterior suture. The convexity disappears in the posterior portion of the body-whorl which forms the continuation of the spire-whorls and which is merely conical. A short convexity connects it with the flattened base, both the convex and flat portions being decorated with sub-equidistant grooves, very slightly closer-set than on the posterior part of the body-whorl. The posterior part of the body-whorl is decorated like the spire.

*Remarks and comparison*.—The umbilical portion of the solitary specimen is unfortunately concealed, so that some doubt remains regarding its generic position. It seems however very closely

related to *Turbo (Marmorostoma) undulatus* Martyn, from Australia. The fossil is smaller and has the posterior portion of the body-whorl more regularly conical than the living form where a slightly excavated zone precedes the suture: the spire in the fossil is relatively a little taller, its earlier whorls seem less worn than is usual in the recent form. The ornamentation is similar and similarly disposed, though more pronounced in the fossil than is frequently the case in the recent form.

*Turbo clausus* Fuchs, from the Oligocene of the Vicentino is very nearly related, but has a taller spire, more convex base, and spiral bands of somewhat alternating size.

*Occurrence.* Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta.

Family: *TROCHIDÆ.*

*TROCHUS (TECTUS) LUCASTANUS* Brongn.

1823. *Trochus Lucastanus* Brongn.—Brongniart, Mem. ter. séd. sup. Vicentin, p. 55, Pl. II, fig. 6.  
 1851. *Trochus ? subcognatus* d'Archiac and Haime.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 200, Pl. XXVI, fig. 20.  
 1870. *Trochus Lucastanus* Brongn.—Fuchs, Beitr. zur. Kennt. Conch. Vicent. Tertiargeb, p. 160, Pl. III, figs. 19-21. *Denksch. Ak.-Wiss., M.-n. Cl.*, XXX, part 2.  
 1896. *Trochus Lucastanus* Brongn., var., *plicatoides* Sacco.—Sacco, Moll. terr. terz Piem. e. Lig., XXI, p. 20, Pl. II, fig. 28.

The specimens vary considerably in shape, especially in the amount of elongation and in the disposition and degree of coarseness of the ornamentation. Sometimes the anterior rows of tubercles are replaced by a single system of narrow, delicate, elongated costæ, in which case the specimens recall Sacco's variety *plicatoides*.

*Remarks.* This is one of the commonest fossils in the Oligocene of northern Italy. It is closely related to the living *Trochus triserialis* Lunck. from the eastern seas, but is not so elongate.

*Trochus subcognatus* d'Archiac and Haime is an internal cast of the same species.

*Occurrence.*—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta. Nari of Sind.

TROCHUS (*TECTUS*) *LORVI* D'Archiac and Haime.

1854. *Trochus cognatus* J. de C. Sow. ?.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 290, Pl. XXVI, fig. 18.  
 1854. *Trochus* ? *Lorvi*, d'Arch. and Haime.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 290, Pl. XXVI, fig. 17.  
 1854. *Pleurotomaria* ? *Bianconi* d'Arch. and Haime.—D'Archiac and Haime, Descr. an. foss. numm. Inde, p. 291, Pl. XXVI, fig. 19.

Large-medium, earlier portion of spire very broadly conical, the angle decreasing towards the body-whorl. The spire in full-grown specimens consists of ten or eleven low whorls. The earliest whorls up to a diameter of two centimetres have numerous close-set costæ swollen near the posterior suture and towards the middle of the whorls, and a row of spines adjacent to the anterior suture. Onwards from a diameter of two centimetres, the costæ disappear and there are three rows of rather coarse granules of which the anterior one is vertically more elongate than the others and soon tends to become double, so that the latest whorls usually carry four series of rather coarse granules. The entire base, from its margin to the rather narrow and shallow axial depression is ornamented with conspicuous spiral threads, narrower than the intervening spaces. Upon full-grown specimens their number is twelve. The outer lip, on leaving the margin of the base, first travels horizontally and forms a shallow concavity disposed obliquely to the radius, until it reaches a distance situated at one-third the radius from the axis to the margin of the base. It then joins the columella with a regular S-shaped curve which, at the same time slightly slopes in the direction of the apex: it is the accretions of this S-shaped portion of the aperture that account for the narrow slightly depressed zone in the centre of the base. There is no umbilical perforation. The aperture is damaged, but the prominent columella, the small diameter and shallowness of the central depression agree with the apertural characters of *Tectus*. The inner surfaces of the whorls carry slightly raised spiral keels, so that the casts appear striated.

*Remarks and comparison.*—Full-grown specimens of this fossil were doubtfully referred by d'Archiac and Haime to *Trochus cognatus* J. de C. Sow., from which they differ by their wider conical shape, the coarser and fewer granules, and the raised threads of the base. The type of *Trochus lorvi*, d'Archiac and Haime, represents an immature specimen in which the contraction of the cone and the thickening of the sculpture have not commenced: the fossil is

abundant amongst the duplicates of Blagrave's collection, and the specimens include every intermediate stage between the condition represented by the type of *Trochus loyi*, and that represented by the specimen doubtfully referred to *Trochus cognatus*. In a number of these specimens the shell is partly missing, showing the striated cast, from which it has been ascertained that *Pleurotomaria bianconii* d'A. and H., represents the internal cast of this same form.

Compared with *Trochus lucasianus*, this fossil differs only by its larger size, broader conical shape, more numerous spire-whorls and the tendency to develop four rows of granules instead of three. It is to be regarded as a mutation of the Oligocene species. Specimens of the characteristic Gáj lepidocyclines adhering to the fossil indicate that they were obtained from the horizon of the Lower Gáj.

There is also a specimen of this same fossil erroneously labelled "*Trochus cognatus*," amongst Grant's collections from Kachh. Unfortunately it does not bear any record of the locality from which it was obtained. It is entirely different in its mode of fossilisation from the Soomrow specimens of *Trochus cognatus*, and evidently indicates that Grant's collections were also obtained from two different horizons in the Gáj.

*Occurrence*.—Lower Gáj of Sind and Kachh.

#### TROCHUS (TECTUS) COGNATUS J. de C. Sowerby.

1840. *Trochus cognatus* J. de C. Sowerby.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, (2), V, Pl. XXVI, fig. 6.

1905. *Trochus (Tectus) tji-longanensis* Mart.—Martin, *Samml. geol. Reichsmus. Leid.* new series, I, p. 279, Pl. XLI, fig. 669.

(non *Trochus cognatus* J. de C. Sowerby, in d'Archiac and Haime.)

Fairly large, conical, rather tall, the angle of the spire being somewhat less in the intermediate whorls than in the earliest and latest ones. The tip of the spire is, as usual in this genus, worn off. There are eleven low spire-whorls. The seven first whorls, which, together, constitute about one-third of the height of the spire are decorated with numerous close-set, slightly oblique and slightly granular costæ. On the 8th, 9th and 10th whorls the axial costæ are replaced by four spiral rows of granulations, the spines are replaced by much more numerous oblique nodes, equal in number to the granulations, and forming, as it were, a fifth sutural and more pronounced row of granulations. On the last spire-whorls the

sutural granulations become still more crowded, more numerous than the granules of the four other rows, and rather assume the appearance of a band of crowded short oblique costæ. On the body-whorl the anterior costæ and the adjacent row of granulations tend to coalesce into a confused band, the next row of granulations remains fairly distinct, the following disappears entirely, and the one next the suture becomes much reduced. The flat base has a smooth outer zone followed by a zone of rather feeble spiral sulci followed by a feeble spiral angulation constituting the accretions to the bend of the aperture. The portion of the outer lip coinciding with the flat base is at first very oblique to the radius of the base until it reaches a point situated at one-third the radius as measured from the axis, when it turns suddenly at right angles and joins the axis in a radial direction. This radially directed portion is, itself almost horizontal, only very slightly inclined towards the axis. The margin of the aperture is very slightly raised throughout. There is a small callus swelling at the axis which twists internally to form the columella. Internally the body-whorl has three spiral ridges appearing as sulci on casts: they do not extend, however, to the spire-whorls which are internally smooth. In this respect, the casts of *Trochus cognatus* differ from those of *Trochus lucasianus* the sulci of which extend to the spire.

*Comparison with other species.*—This shell is almost identical with the living *Trochus obeliscus* Linn. of the Indian Ocean from which it is feebly distinguished by its somewhat smaller dimensions and slightly steeper outline. *Trochus tubidus* Reeve, from Australia is of the same size as the fossil, with perfectly identical ornamentation, but more decidedly depressed, and more regularly conical. *Trochus tjilonganesis* Martin, from the Miocone of Java is perhaps an immature specimen belonging to the same species as the Indian fossil.

J. de C. Sowerby compared this species with *Trochus maculatus* Linn. The semblance is superficial, *Trochus maculatus* being the type of the sub-genus *Lamprostoma*, while *Trochus cognatus* is, as above explained, scarcely distinguishable from *Trochus obeliscus*, the type of the sub-genus *Tectus*.

*Occurrence.*—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur.

G. S. I. Type No. 13,471.

## TROCHUS (THALOTIA ?) MARTINSI [ d'Archiac ].

1850. *Monodonta Martinsi* d'Arch.—Hist. prog. Geol., III, p. 285.

1854. *Turbo Martinsi* d'Arch.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 292, Pl. XXVI, fig. 23.

Small, conical-elongate. The earlier whorls are missing: there remain three spire-whorls of which the two earlier are convex and the last angulated; the body-whorl is elongate. The third spire-whorl is comparatively taller than the others and contracted in front of the angulation while the two earlier whorls have no anterior contraction. The convex whorls are decorated with five delicate raised granular spiral threads whose spacing slightly increases in an anterior direction, the first (hindmost) thread coinciding with the posterior suture, while there is a space between the fifth thread and the anterior suture. On the third spire-whorl, the fourth thread corresponds with the angulation, and a sixth thread is locally just visible at the anterior suture. The granulations on the threads are caused by the intersection of oblique costæ forming a remarkably elegant lattice. The sixth threads of the last spire-whorl are continued on the body-whorl: anteriorly to them the base carries six more threads slightly more prominent than those above the angulation, and similarly intersected by the oblique raised lines. There is no umbilicus. The aperture shows indications of the existence of a slightly developed tooth, but it is broken off in such a way that one cannot make certain of this feature.

*Remarks.*—When first dealing with this species, d'Archiac referred it to the *Trochidæ*, but subsequently, in the "Description" it was classified as a *Turbo*. Nevertheless, the European species with which d'Archiac and Haime compared the Indian fossil are, themselves, not *Turbinidæ* but *Trochidæ*. I have failed to trace any *Turbinidæ* whose shape resembles this fossil, while it is not unlike several kinds of living *Trochidæ* such as *Thalotia lehmanni* Menke, from Australia, *Thalotia strigata* Ad., from Australia and Ceylon, *Thalotia zebrides* Ad.

*Occurrence.*—Sind, probably from the Gáj.

## Family: XENOPHORIDÆ.

## TUGURIUM MEKRANENSE Newton.

1905. *Tugurium mekranense* Newton.—R. B. Newton, *Geol. Mag.*, (5) II, p. 301, Pl. XVII, figs. 8-10.



The nearest living ally is *Tugurium calculiferum* Reeve, of the eastern seas. The fossil form is taller and with coarser ornamentation.

*Occurrence*.—Mekran series (Gwadar Stage): Ormara, Mekran Coast.

G. S. I. Type No. 13, 472.

#### TUGURIUM SUBEXTENSUM d'Orbigny.

1852. *Phorus subextensus*. —D'Orbigny, Prodr. Pal. str., III, p. 7.

1853. *Trochus agglutinans* Lam.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 355.

From the manner in which the specimens of *Nummulites* "*gauransensis*" (*N. intermedia megaspherica*) are attached to the suture of this species, it is evidently a Nari fossil.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13, 473.

### LAMELLIBRANCHIATA.

#### Family: ARCIDÆ.

#### ARCA INFLATA Reeve.

1844. *Arca inflata* Reeve. d'Orb.—Monograph of the genus *Arca*, species 30.

1905. *Arca blanfordi* Newton.—*Geol. Mag.*, (6) II, p. 301, Pl. XVI, fig. 5.

The fossil specimens agree in every particular with those found living along the coasts of the Arabian Sea. The number of ribs is 35 or 36, and in some very large specimens reaches 40. The shape varies in the degree of elongation but is invariably distinguished by the strongly oblique slope of the superior posterior margin. Specimens of *Arca inaequivalvis* Bruguière from the Arabian Sea are generally thinner-shelled, with the superior posterior margin sloping far less obliquely.

The type of *Arca blanfordi* Newton is shorter than the average of *Arca inflata*, but the numerous series of specimens in the collection of the Geological Survey show every gradation between the short and elongated varieties: as already noticed, the length varies greatly both in the living and in the fossil specimens.

This is the commonest species of *Arca* throughout the upper Mekran beds, especially in their upper horizons.

*Occurrence.*—Mekran series: Gwadar, Mekran Coast; Barambab near Mekran Coast; Hara (Hala) range; Talar gorge; south of Talar range; from the raised beach at Kan Berar Thana.

G. S. I. Type No. 13,474.

ARCA OLATHRATA Reeve var. BURNESI d'Archiac.

1844. *Arca clathrata* Reeve.—Monograph of the genus *Arca*, species 48.

1850. *Arca Burnesi* d'Archiac.—Hist. des. progrès de la Géol., Vol. III, p. 265.

1854. *Arca Burnesi* d'Arch.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 264, Pl. XXII, fig. 5.

*Arca burnesi* and the Burmese fossil specimens that have been described and figured under that same name (Noetling, Miocene of Burma, *Pal. Ind.*, new series, pt. 3, p. 131, figs. 6-10), can only be regarded as varieties of *A. clathrata* Reeve: apart from slight differences of shape, they agree in every detail. In *Arca burnesi* the proportions are the same as in the living specimens of *A. clathrata* but the inferior posterior margin is less angular. The Burmese specimens are slightly narrower, with the anterior side a little shorter, the posterior side more elongate, narrower and less angular. The Gáj and Mekran forms can be regarded as a variety for which the name *burnesi* may be retained. In that case the same name cannot be applied to the Burmese specimens which may be considered to constitute a variety *birmanica*. Some of the Mekran specimens attain rather large dimensions which, however, are very closely approached by certain recent specimens from the Andaman Islands.

*Occurrence.*—Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bán (25° 30', 62° 45'). Also from the Gáj beds.

G. S. I. Type Nos. 13,475-13,476.

ARCA TAMBACANA Martin.

1885. *Arca tambacana* Martin.—*Samml. geol. Reichs.-Mus., Leid.* III, p. 244, Pl. XII, fig. 249.

*Occurrence.*—Mekran series (Gwadar Stage); ? south of Talar range, Balúchistán.

G. S. I. Type No. 13,477.

## ARCA RHOMBEA Born.

1780. *Arca rhombica* Born.—Test. Mus. Cæs., p. 90.1843. *Arca rhombica* Born.—Reeve, Monograph of the genus *Arca*, species 12.

*Occurrence*.—Mekran series (Talar Stage): ? Talar gorge, Balú-chistán.

G. S. I. Type No. 13,478.

## ARCA SUBMULTIFORMIS n. sp.

Pl. XXII, figs. 1-4, 7, 9, 10.

Medium-size, thick-shelled, trigonal, strongly inequilateral, umbo large and projecting, area rather short and wide. The proportion of length to height varies a great deal, but when they approach nearest the length exceeds the height, while in most instances the disproportion is very great. The shape is very oblique, the posterior inferior portion of the shell being situated at a much lower level than the anterior region. The anterior margin and the anterior part of the inferior margin together constitute a continuous circular curvature. The posterior continuation of the inferior margin is almost straight, sometimes very feebly concave and follows an obliquely downward course till it passes with a rather broad bend into the posterior margin which eventually becomes rectilinear and oblique up to its junction with the hinge margin at an angle of about  $110^{\circ}$ . The anterior and middle portions of the surface are continuously convex, the convexity slightly decreasing downward and backward. A fairly sharp, though not exactly angular bend extending from the umbo to the postero-inferior marginal bend isolates the posterior flattened portion. The umbo is very prominent and strongly coiled so that in a lateral view of the shell it appears broad and rounded, the rounded shape being due to the fact that the posterior bend above described is not very sharp. The valves are decorated with 25 coarse flat ribs of the same width as the intervening flat spaces: seven of these ribs belong to the posterior flattened portion. The first twelve to fourteen ribs counted from the anterior side carry rounded nodes distributed at very wide intervals. The flat spaces between the ribs bear close-set transverse striæ. The rather short and broad area is decorated with a combination of rhombic and horizontal markings. The rhombic markings are much more pronounced than the horizontal ones, but much

less regular, being wavy and sometimes interrupted. The hinge plate is broad and carries seventeen posterior and fifteen anterior teeth. The interior surface of the shell is rather uneven; the pallial line and muscular scars are coarse. The internal margins are very coarsely ribbed.

*Comparison with other species.*—This shell is very closely related to the Javanese Miocene fossil *Arca multiformis* Mart., but it is more elongate and much more oblique. In some of Martin's illustrations the nodosities decorating the ribs appear just as wide-spaced as in the Indian form, but the specimens that I have been able to study have them close-set. It may be mentioned that they appear to be set even closer in *Arca pilula* Reeve, which is very closely related to the Javanese fossil.

Another closely related form is *Arca rhombea* Born. which is distinguished by its more angular posterior carina. The nodosities of the ribs are also much more distant in the case of *Arca submultiformis* than in that of *Arca rhombea*. The teeth in *Arca submultiformis* seem usually more crowded than in *Arca rhombea*.

A solitary recent specimen from Perak, in the collections of the Indian museum, which has been referred to *Arca rhombea* seems identical with the fossil form above described.

*Occurrence.*—Upper Gáj, west of Bhagothoro in Sind. This species is very abundant in the Miocene beds of Burma. The specimens shown in the illustrations were collected in the uppermost Pegu beds by S. Sethu Rama Rao north of Gwegyo in Myingyan district, Burma. The Bhagothoro specimens are identical in every character, but less suitable for illustration owing to their inferior state of preservation.

#### ARCA LARKHANAENSIS d'Archiac.

1850. *Arca larkhanaensis* d'Archiac.—Hist. des progrès de la Géol., Vol. III, p. 265.

1854. *Arca larkhanaensis* d'Archiac.—D'Archiac and Hame, Descr. an. foss. géol. numm. Inde, p. 264, Pl. XXII, figs. 7-11.

*Occurrence.*—Upper Gáj of Sind: entering hills on the road from Jaugri to Bula Khan's Thana; near Larkanda-Nai, Mebur district; from beds higher than those overlying the variegated shales, west of Bhagothoro.

G. S. I. Type No. 13,479.

## ARCA RADIATA J. de C. Sowerby.

1840. *Arca radiata* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.* [3] V, Pl. XXV, fig. 12.  
 1853. *Arca hybrida* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Indo*, p. 262, Pl. XXII, fig. 1.  
 1901. *Arca Oldhamiana* Noebling.—Miocene beds of Burma, *Pal. Ind.*, new series, Vol. I, pl. 3, p. 142, Pl. VI, fig. 3.

The poor state of preservation of the original type of *Arca radiata* from Kachh accounts for d'Archiac and Haime's erroneous reference of the Sind representatives of this species to the Eocene *Arca hybrida*. Apart from this erroneous attribution, d'Archiac and Haime's description is quite correct.

*Occurrence*.—Upper Gáj of Kachh: south of Looria, Upper Gáj of Sind. Also in the Miocene of Burma.

G. S. I. Type No. 13,480.

## ARCA PEETHENSIS d'Archiac.

1850. *Arca peethensis* d'Archiac.—*Hist. des progrès de la Géol.*, Vol. III, p. 285.  
 1854. *Arca peethensis* d'Archiac.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Indo*, p. 263, Pl. XXII, figs. 2, 3.

*Occurrence*.—Upper Gáj of Kachh and Sind. Also in the Miocene of Burma.

## ARCA NANNODES Martin.

1885. *Arca nanodes* Martin.—*Samml. des. geol. Reichsmus. in Leid.*, III, p. 255, Pl. XIII, fig. 259.

*Occurrence*.—Mekran series (Talar stage): north of Talar gorge on the road from Kej Gwadar, base of sandstones constituting the Talar mountains. Also in the Miocene of Burma.

G. S. I. Type No. 13,481.

## ARCA BATAVIANA Martin.

1885. *Arca bataviana* Martin.—*Samml. des. geol. Reichsmus. in Leid.*, III, p. 253, Pl. XIII, figs. 256, 257.

*Occurrence*.—Mekran series (Talar Stage): Talar gorge, Balúchis tán. Also in the Miocene of Burma.

G. S. I. Type No. 13,482.

## ARCA SQUAMOSA Lamarck.

*Occurrence*.—Mekran beds (Gwadar stage).

## ARCA DIVARICATA Sowerby.

1833. *Byssarca divaricata* Sow.—*Proc. Zool. Soc.*, p. 18.1844. *Arca divaricata* Sow.—Reeve, *Conch. Icon.*, *Arca*, sp. 108.

*Occurrence.*—Mekran series (Gwadar stage): Pohr Sunt, Chandra-kup, near Mekran Coast.

G. S. I. Type No. 13,483.

## ARCA FEDDENI n. sp.

Pl. XXXIII, figs. 1-3.

1880. *Arca trapeziformis* Mart.—Martin, *Tertiarsch, auf Java*, p. 116, Pl. XVIII, fig. 8.

Rather small, generally triangular, umbo sub-central, moderately prominent, much incurved, the umbones of opposite valves approaching each other very closely, hinge moderately long, ligamental area moderately broad. Omitting the umbo, the outline of the valve is generally trapezoidal and consists of the following elements:— firstly, the moderately long straight hinge; secondly, the anterior margin which joins the hinge at an angle of  $100^{\circ}$  and is continued as a circular arc till it passes into, thirdly, the lower margin which is straight or very slightly concave and which finally passes with a sharp more or less acute bend into, fourthly, the nearly straight often very oblique posterior margin joining on to the hinge-line at an angle of  $120^{\circ}$ . The foremost and hindmost portions of the valve include a region separated from the rest of the surface by an angulation: the anterior angulation is moderately pronounced and extends from the apex of the umbo to a point situated high up the anterior margin. The posterior angulation is extremely sharp and runs from the apex to the posterior inferior sharp bend. As a result of the acuteness of the posterior angulation combined with the great obliquity of the posterior margin, the posterior portion of the shell of some specimens is almost entirely out of sight when the shell is viewed laterally. In addition to some very pronounced concentric interruptions of growth, the shell carries numerous very fine radiating ribs which alternate regularly in thickness, and which are delicately granulated at their intersection with numerous delicate concentric ridges.

The area carries only one distinct rhomb. There are about 14 anterior teeth and 19 posterior ones. The internal margin is indistinctly crenulated.

*Remarks.*—The extreme sharpness of the posterior angulation is the most characteristic feature of this shell, which may be identical with *Arca trapeziformis* Mart., the figures and description of which agree exactly with *Arca feddeni*, with the only difference that no mention is made of the alternation in size of the ribs. Owing to the consequent uncertainty as to the identity of the north-western Indian and Javanese forms, I have provisionally distinguished the Indian fossil by a separate name.

*Occurrence.*—Gáj of Kachh.

#### ARCA SUBFILIGRANA d'Archiac and Haimo.

1853. *Arca subfiligrana* d'Archiac and Haimo.—DESCR. AN. FOSS. GR. NUMM. INDO p. 264, Pl. XXII, fig. 12.

*Occurrence.*—Gáj of Sind.

#### ARCA DECUSSATA Sowerby.

1833. *Byssarca decussata* Sowerby.—*Proc. Zool. Soc.*, p. 22.

1844. *Arca decussata* Sow.—REEVE, CONCH. ICON, *Arca*, sp. 81.

*Occurrence.*—Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

G. S. I. Type No. 13,484.

#### ARCA NEWTONI n. sp.

Pl. XXXIII, figs. 5, 6.

Small, inflated, sub-equilateral, relatively tall, hinge-line short, area moderately broad, umbones moderately prominent, subcentral, their points in opposite valves relatively far apart. Anterior margin rounded, inferior margin flat, posterior margin oblique. A distinct angulation extends from the apex to the not very sharp bend connecting the inferior and posterior margins. Valves ornamented with numerous fine inconspicuous radiating ribs, clearly visible only with a lens, and narrower than the intervening spaces: with a good magnification they are seen to be decussated by an extremely delicate system of concentric markings in addition to which there are a few somewhat conspicuous swellings corresponding with interruptions of growth and best seen in the right valve. The ligamental area carries two rhombs. The margins of the valves are internally smooth. The hinge is not accessible.

*Remarks.*—This species is not unlike *Arca tenebrica*, from Bombay, but it is shorter and its umbo is much narrower.

*Occurrence.*—Mekran series (Talar stage): Bán (25° 30', 62° 45').

ARCA MEKRANICA n. sp.

Pl. XXXIII, fig. 9.

Rather small, thin-shelled, sub-equilateral, oblong; hinge-line very long, umbo not prominent, convexity slight, anterior and posterior margin moderately symmetrically oblique, the posterior bend of the inferior margin scarcely more pronounced than the anterior one, the anterior part of the shell slightly taller than the posterior part. Numerous fine, radiating flat ribs, with intermediate ribs dimly perceptible in the intervals. There are also concentric ornaments but they are less clearly developed. Owing to the crushing of the specimen the characters of the umbo and the area cannot be made out. Internal characters unknown.

*Comparison with other species.*—Outwardly the species resembles *Arca compressa* Martin, and *Arca axinæa*, Boettg., (Tertiari. v. Sumatra, Th. II, p. 73, pl. 5, fig. 4, in *Palæontographica* Suppl. III), but is more elongate. The ornamentation resembles that of *Arca tenebrica*, from Bombay, but the outline at both extremities of the inferior margin is much more rounded.

*Occurrence.*—Mekran series (Talar stage): Balúchistán.

ARCA SEMITORTA Lamarck.

1819. *Arca semitorta* Lamarck.—An. sans. vert., Vol. 6, 1st part, p. 57.

1810. *Arca tortuosa* L.?—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, 2d ser., V, Pl. XXV, fig. 13.

1850. *Arca kurracheensis* d'Archiac.—Hist. progr. (60l., III, p. 265.

1853. *Arca kurracheensis* d'Archiac.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Indo*, Pl. XX, fig. 4.

*Occurrence.*—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district. Gáj of Kachh. Teyra river Valley near Rampur (23° 20', 68° 51'), Gáj of Sind: south west of Kuba Jagu Jumali, west-north-west of Schwan: from beds situated higher than those immediately overlying the variegated shales west of Bhagothoro. ? Nari of Sind: Bhagothoro Hill.

G. S. I. Type No. 13, 485.

° Amongst the collections studied by Mr. Vredenburg are some specimens labelled *Arca semitorta* from the Nari of Bhagothoro Hill, a locality not mentioned in the text:—H. M. L.



## ARCA TORTUOSA Linnæus.

*Occurrence*.—Mekran series (Gwadar stage).

## PECTUNCULUS GWADARENSIS n. sp.

Pl. XXII, figs. 5, 6, 8, 11-17.

Medium-sized, thick-shelled, orbicular, moderately and regularly convex, nearly equilateral with a narrow hinge-line which contributes by its shortness, to the generally circular outline of the shell. The anterior margin in front of the hinge-line is slightly more oblique and slightly more angular than the posterior one, the angularity in either case being very slight. There are 19 to 23 ribs which are prominent, broad and flat. Over the greater portion of the shell they are of the same width as the flat intervening spaces or a little wider. Near the hinge-line on the posterior side the intervals become relatively wider. In some specimens the broad flat surface of the ribs shows a tendency to cave in, especially in the case of the six or eight anterior ones where this character sometimes amounts to the development of a dividing furrow, or even, occasionally, a duplication of the ribs: it is principally this peculiarity that causes the variations in the number of ribs. The ribs and interspaces are intersected by coarse lines of growth. The hinge-plate is broad and thick, with rather voluminous teeth which number 9 to 12 on each side and in both valves. The ligament area though small is conspicuously developed, the distance between its apex and the hinge-line being about equal, in full grown specimens, to the breadth of the hinge-plate. The outside of the shell in its fossilised condition is white. Internally to the pallial line the inner surface is of a pale-buff colour with the exception of the muscle scars which are of a deep yellowish-buff similar to the colour observed in the case of many specimens of *Pectunculus pectiniformis* Linn., though the colour does not spread beyond the scars as in the case of recent species: there is only one small stain at the anterior termination of the hinge-plate.

*Comparison with other species*.—This shell is closely related to *Pectunculus maskatensis* Melville, of the Arabian Sea and Persian Gulf, but it is more orbicular and shows less tendency towards the development of a median furrow along the ribs. The outline of *Pectunculus maskatensis* is decidedly different: there is a posterior

inferior angular extension of which no indication exists in *Pectunculus gwadarensis*. The muscular scars of *Pectunculus maskatensis* are not coloured. *Pectunculus pectiniformis* of the Red Sea is also related and is internally coloured very much in the same manner, but it is larger and decidedly less orbicular. It has a longer hinge-line and smaller ligamental area: the shell, instead of being regularly convex, sinks on either side of the umbo, a disposition, which, combined with the breadth of the hinge-line tends to give the upper part of the shell somewhat of a winged appearance which is not observed in the fossil. The ribs of the recent form are also more rounded.

*Occurrence.*—Mekran series (Gwadar stage): Gwadar, Mekran Coast.

#### PECTUNCULUS SINDIENSIS n. sp.

1853. *Pectunculus pecten* J. de C. Sow.—D'Archiac and Haimo, Deser. an. foss. gr. numm. Indo, p. 206, Pl. XXII, fig. 13,

1840. *Non Pectunculus pecten*, J. de C. Sow. *Trans. Geol. Soc. Lond.*, (2) V, Pl. XXIV, fig. 4.

1885. *Pectunculus pectiniformis* Lam., var.—Martin, *Samml. geol. Reichemus. Leis.*, III, p. 237, Pl. XII, fig. 241.

D'Archiac and Haimo have given an excellent description of this fossil which, however, is quite distinct from the Eocene form from Kachh described by J. de C. Sowerby under the name of *Pectunculus pecten*. D'Archiac and Haimo give the number of ribs as 24. In some specimens this number reaches 27; this is the number observed in the Javanese fossil described by Martin as a variety of *Pectunculus pectiniformis*, but which, judging from the illustration is identical with the Indian fossil here alluded to, though, according to Martin the Indian form is flatter. In the case of *Pectunculus pectiniformis* the ribs are never distributed so regularly as in the Javanese and Indian fossils, neither is the shape so orbicular.

*Pectunculus sindiensis* is not unlike *Pectunculus gwadarensis*, but its ribs are more numerous and distributed more regularly specially as regards the anterior ones, so that they are generally narrower. The lines of growth are more delicate. The shell is less convex. The ligament area is smaller, the teeth more delicate and more numerous.

*Occurrence.*—Lower Gáj of Sind.

## PECTUNCULUS LIMA d'Archiac and Haime.

1853. *Pectunculus lima* d'Archiac and Haime.—Descr. an. foss. pt. mum. Inde, p. 20, Pl. XXXI, fig. 14.

*Occurrence*.—Sind, probably from the Gij.

Family: *NUCULIDÆ*.

*NUCULA NARICA* n. sp.

Pl. XXXIII, fig. 7.

Small, flat, very elongate, oval, umbo completely anterior. Outline everywhere regularly curved except at the end of the inferior margin where the termination of the edge bounding the area renders it angular though not re-entering. The area is not sunken and is marked off by a mere angulation. The whole surface is decorated with excessively fine radial striations intersected at wide intervals by a few concentric zones of growth. The species is represented by a solitary right valve not showing the internal characters.

*Comparison with other species*.—The smoothness of outline of this shell constitutes its main distinguishing feature. *Nucula greggini* Desh., from the Oligocene of France and Germany is not unlike but has a more angular outline and the area is demarcated by a groove. *Nucula archiaciana* Nyst, from the Oligocene of Belgium is also related in general shape and ornamentation, but is also more angular in outline.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

*NUCULA CANCELLATA* n. sp.

Pl. XXXIII, figs. 4, 8, 10-13.

Small triangular, umbo posteriorly displaced to about two-thirds the total length from the anterior margin, convexity moderate. Surface ornamented with concentric ridges of about the same width as, or a little narrower than the intermediate furrows which are decussated by numerous radially disposed small ridges and furrows communicating a remarkably beautiful cancellated appearance to the whole surface of the valves. The area is heart-shaped, rather short, deeply sunk, with somewhat channelled border further differentiated by the transverse disposition of the ridges.

The lunula is very long, lanceolate, almost reaching the anterior extremity of the shell: it is concave near the umbo, convex elsewhere, with channelled border and transverse ridges. The hinge carries about 23 anterior and 10 posterior teeth. Internally the margins are delicately crenulated.

*Comparison with other species.*—Compared with *Nucula studeri* d'Archiac, this form is not unlike in marginal outline, but it is less convex and is distinguished by its ornamentation. The ornamentation slightly recalls that of the recent *Nucula rugulosa* Sow., but the fossil is more elongate with a much more sunken area, both the area and lunule being more deeply circumscribed.

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49'); ? Teyra River valley near Rampur (23° 20", 68° 51').

#### NUCULA STUDERI d'Archiac.

1850. *Nucula Studeri* d'Archiac.—Hist. progr. Geol., III, p. 267.

1853. *Nucula Studeri* d'Arch.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 200, Pl. XXII, figs. 13, 17.

This fossil does not appreciably differ from *Nucula convexa* Sow. from the eastern seas. Some of the recent specimens have the umbo shifted a little further back, but this character is inconstant.

*Occurrence.*—Upper Gáj of Sind.

#### LEDA sp.

A solitary specimen from the Gáj of Kachh too incomplete for accurate determination resembles *Leda nasuta* Sow., living in the eastern seas.

#### Family: MYTILIDÆ.

##### LITHODOMUS SUBLITHOPHAGUS d'Orbigny.

1850. *Lithodomus sublithophagus* d'Orb.—D'Orbigny, Prodr. pal. Vol. II, p. 391.

1850. *Mytilus lithophagus* Linn.—D'Archiac, Hist. progr. geol., III, p. 268.

1853. *Mytilus lithophagus* Linn.?—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 268.

1900. *Lithodomus Deshayesi* J. de C. Sow.—Rovereto, Ill. Moll. tongr., p. 74, Pl. IV, fig. 7 (*Atti della r. Univ. di Genova.*)

The specimens are undistinguishable from the Eocene species of the Paris basin which has also been observed by Rovereto in the Oligocene of northern Italy.

D'Archiac and Haime have noticed the perfect identity of this fossil with the form from the Eocene of the Paris basin.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta; small syncline, little over 1 mile north of Kudin, Zhob district. Nari of Sind.

G. S. I. Type No. 13,486.

Family: *ANOMIIDÆ*.

*PLACUNA (INDOPLACUNA) SINDIENSIS* Vredenburg.

1923. *Placuna (Indoplacuna) sindiensis* Vred.—Vredenburg, *Rec. Geol. Surv. Ind.*, Vol. LV, pt. 2, p. 114, Pl. 16; Pl. 17, figs. 4, 5.

The species has already been described in the work quoted above.  
*Occurrence*.—Upper Gáj of Sind: west of Bhagothoro Hill.

*PLACUNA (INDOPLACUNA) IRANICA* Vredenburg.

1923. *Placuna (Indoplacuna) iranica* Vred.—Vredenburg, *Rec. Geol. Surv. Ind.*, Vol. LV, pt. 2, p. 116, Pl. 17, fig. 6a; Pl. 18, figs. 6b, 6c.

The species has already been described in the work quoted above.  
*Occurrence*.—Mekran series East of Mairmani, Biyaban district, Jashk.

Family: *OSTREIDÆ*.

*OSTREA ANGULATA* J. de C. Sowerby.

Pl. XXIV, fig. 3; Pl. XXIV-b, figs. 2, 3.

1840. *Ostrea angulata* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, [2], Vol. V, Pl. XXV, fig. 17.

1853. *Ostrea multicosata* Desh. var.—D'Archiac and Haime, *Desor. an. foss. gr. numm. Inde*, p. 273, Pl. XXIV, fig. 14.

1908. *Ostrea angulata* J. de C. Sowerby.—Vredenburg, *Rec. Geol. Surv. Ind.*, Vol. XXXVI, p. 316.

*Occurrence*.—Nari of Kachh. Nari of Sind: northern end of Watwaro Range, between Trak and Damach; hills south of Kot Baruch near Sehwan. Gáj of Kachh: west-south-west of Mhurr; stream under Koba near Peepur. Gáj of Sind: about 4 miles south-south-west of Beynir hill and 12 miles west of Ahmed Khan's Thana; from beds immediately overlying the variegated shales, west of Bhagothoro; in the gorge nearing Panigumbrok from west; Ran Pethani.

## OSTREA LATIMARGINATA Vredenburg.

Pl. XXIV, fig. 2; Pl. XXIVa., fig. 1.

1810. *Ostrea flabellula* Lamarck.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, [2], Vol. V, Pl. XXV, fig. 18.1908. *Ostrea latimarginata* Vredenburg.—*Rec. Geol. Surv. Ind.*, Vol. XXXVI, p. 317.

*Occurrence*.—Upper Gáj of Kachh: Teyra River, north of Naliya ( $23^{\circ} 15'$ ,  $68^{\circ} 52'$ ); 3 miles south-by-west of Bayr.

Upper Gáj of Kathiawar: 2 miles east of Lowarali, Okha Mandal, from the bank of a creek bordering the Rann. Upper Gáj of Sind:  $\frac{1}{2}$  mile from Dumblandi Schwan road, Karachi taluq; entering hills on the road from Jangri to Bula Khan's Thana; 2 miles north of Kadeji gorge, 33 miles from Karachi. Also in Burma.

## OSTREA CUBITUS Deshayes.

1824. *Ostrea cubitus* Deshayes.—*Descr. des coqu. foss. des environs de Paris*, p. 305, Pl. XLVII, figs. 1, 2, 13-15.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13,487.

## OSTREA FRAASI Mayer-Eymar.

1807. *Ostrea suessoniensis* Deshayes.—*Fraas, Geologisches aus dem Orient*, I, p. 137.1888. *Ostrea Fraasi* Mayer-Eymar.—*Journal de Conchyliologie*, pp. 325-327.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district. Nari of Kachh and Sind.

G. S. I. Type No. 13,488.

## OSTREA GAJENSIS n. sp.

Pl. XXIV, fig. 1.

Large, oval or crescentic oyster of the group of *O. elegans*, with thick, extremely foliaceous deep lower valve, radially ribbed, with exogyroid umbo, rather small exogyroid hinge, distinct pallial line pitted with numerous punctuations which disappear towards the inferior margin; flat opercular valve with ridge-shaped crenulations all round the inner margin, the external surface decorated with fine concentric lamellæ and radial incisions.

The points of distinction from *Ostrea fraasi* are: the larger size of *O. gajensis*, its more massive and more foliaceous lower valve, its thinner upper valve and the rather closer-set crenulations.

*Occurrence.*—Upper Gáj of Kathiawar. Upper Gáj of Sind: Naigh-Nai valley, 12 miles south of Shah Rbui, 10 miles south-west of Manchhar lake; south-west of Kuba Jagu Jumali, west north west of Sehwan; west of Bhagothoro Hill, south of Sehwan. Pokhan, Kohistan. Also in Burma.

OSTREA PSEUDORISSENSIS n. sp.

Pl. XXIII, figs. 1, 2.

Medium-size, flat, hatchet-shaped, height and width equal. Ligament pit small, shallow, strongly deflected backward in an exogyroid fashion, bordered in the left valve (the only one preserved) by small crowded punctuations. Muscle-scar fairly large, semi-circular, occupying an inferior and posterior position. Left valve externally decorated with crowded radial flutings.

*Remarks and Comparison.*—This species evidently belongs to the group of *O. elegans* as is shown by its small exogyroid hinge, the accompanying pallial pits, and the position and shape of the scar. The specimen is unfortunately rather worn. The ornamentation of narrow, close-set, not prominent ribs is exactly that of *O. orissensis* which this fossil also recalls from the relative thinness of the shell. The dimensions, however, are much smaller, and the pits do not indicate any tendency to spread apart on receding from this hinge as in *O. orissensis*. The shell is much thinner than that of *O. fraasi* which it otherwise resembles. Amongst recent species, *O. inaequivalvis* Sowerby seems very similar.

*Occurrence.*—Mekran series (Gwadar Stage): Sangul, Baluchistan.

OSTREA DIGITALINA (DIGTATA) Eichwald, var. RHOLFII Fuchs.

1870. *Ostrea Rholfsii* Fuchs.—*Denkschr. d. k. Akad. d. W. m.-n. Cl.*, XLI, part 2, p. 106, Pl. VI, figs. 5-8.

1883. *Ostrea digitalina* Eichw., var. *Rholfsii* Fuchs.—*Palaontographica* XXX, p. 44, Pl. XII, figs. 3-6, p. 61, Pl. XXII, figs. 1-3.

1901. *Ostrea promensis* Noctling.—Miocene beds of Burma, *Tal. Ind.*, new series, Vol. 1, pt. 3, p. 109, Pl. II, fig. 3, Pl. III, figs. 1, 2.

1912. *Ostrea digitalina* Eichw., var. *Rholfsii* Fuchs.—Vredenburg, *Rec. Geol. Surv., Ind.*, XLI, p. 38, Pl. VI, figs. 1-4.

*Occurrence.*—Mekran series (Talar stage); north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; ? south of Talar range. Also in Burma.

G. S. I. Type No. 13, 489.

## OSTREA PSEUDODIGITALINA Fuchs.

Pl. XXIVa, fig. 2; Pl. XXIVb, fig. 1.

1879. *Ostrea pseudodigitalina* Fuchs.—*Dunk. sch. d. k. Akad. d. W. m.-n. Cl.*, XLI, part 2, p. 107, Pl. III, figs. 4-6.

This probably is only another variety of the above, distinguished by its vertically elongated instead of orbicular outline, its extremely flattened lower valve, and the tendency for the ribs to disappear towards the periphery. In the Balúchistán specimens, this tendency is less pronounced than in those from Persia figured by Fuchs with which they nevertheless agree in every other particular. There are distinct pits on either side of the ligament on a level with it. The pallial line is well marked. The accompanying upper valves are much thicker and much more convex than the fragile lower ones.

*Occurrence*.—Mekran series: (Talar stage): Talar gorge, Balúchistán.

## OSTREA PROTOIMBRICATA n. sp.

Pl. XXIII, figs. 3-7.

Size medium to fairly large, shell rather thin, shape variable, frequently labelliform and posteriorly deflected, at other times orbicular; left valve usually deeply excavate, at other times nearly flat; right valve feebly convex; ligament area small, triangular, posteriorly deflected with a deep groove nearly twice the width of the bordering swellings in the left valve, a shallow broad groove and flat broad marginal swellings in the right valve. There is a broad more or less flattened margin outside the pallial line, which is transversely rugose in the neighbourhood of the ligament. The muscular scar is very large, round, occupying a posterior situation quite close to the pallial line and at about half the height of the shell. Externally there is a variable, but never great, number of broad angular folds sometimes produced here and there into tubular expansions. In the left valve they usually commence immediately beyond the surface of attachment. The primitive portion of the right valve is never plicate, but delicately rugose both radially and concentrically. At a variable distance from the umbo, folds set in, which are not so sharp as in the left valve.

*Remarks and Comparison*.—This fossil belongs to the same group as the more ponderous forms *Ostrea plicatula* Gmelin and *Ostrea*



*virleti* Desh. *Ostrea proplicatula* Sacco, from the Oligocene of Liguria is also related, but appears coarser and more ponderous. The nearest ally is the living *Ostrea imbricata* Lamk, occurring fossil in the Gáj (*Ostrea tubifera* J. de C. Sow.), from which the only distinction of *Ostrea protoimbricata* appears to be a thinner shell apt also to become much more convex, though the latter feature is very inconstant. The Eocene and Priabonian *Ostrea orbicularis* J. de C. Sow. (= *Ostrea martinsi* d'Archiac) is also closely related, but it has much more numerous and sharper folds.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

#### OSTREA IMBRICATA Lamarck.

1819. *Ostrea imbricata* Lamarck.—An. sans vert. Vol. VI, 1st part, p. 213. *Ostrea* No. 46.

1840. *Ostrea tubifera* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 19.

This species is closely related to *Ostrea hyotis* Linn. The muscular scar in *O. imbricata* is situated higher than in *O. hyotis*. The shell is usually broader and smaller.

*Occurrence*.—Upper Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur; east-south-east, of Mhurr; Sookpur; 3 miles south by west of Bayr; near Warsar (23° 21', 68° 49'). Gáj of Sind: 2 miles north of the Baran river and south of Band Vero; south side of Eri Hill; entering the hills on the road from Jangri to Bula Khan's Thana.

G. S. I. Type No. 13,490.

#### OSTREA VIRLETI Deshayes.

1832. *Ostrea Virleti* Deshayes.—Exp. scient. Mor., III, part I, p. 123, 2d. ser. Geol., Pl. V, figs. 1, 2.

1870. *Ostrea Virleti* Desh.—Fuchs, *Denkschr. d. k. Akad. d. W., math. nat. Cl.*, Vol. XLI, part 2, p. 106, Pl. IV, figs. 1-9.

1879. *Ostrea hyotis* Linn.—Martin, *Tertiärsch. Java*, p. 125, Pl. XXI, figs. 1, 2.

1883. *Ostrea Virleti* Deshayes.—Fuchs, *Palaeontographica* XXX, p. 43, Pl. IX, figs. 1-6, Pl. X, figs. 1-4; p. 61.

1901. *Ostrea peguensis* Nootling.—Miocene beds of Burma, XLIII Pal. Ind., new series, Vol. I, pt. 3, p. 107, Pl. II, figs. 1, 2.

This species only differs from *Ostrea imbricata* by its more ponderous shell and more deeply impressed scar. It is also closely related to *O. plicatula* Gmelin.

*Occurrence*.—Mekran Series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bán (25° 30', 62° 45'). Mekran series (Gwadar stage): Barambal near Mekran coast.

G. S. I. Type No. 13,491.

*OSTREA PETROSA* Fuchs.

1879. *Ostrea petrosa* Fuchs. *Denkschr. d. k. Akad. d. W., math. nat. Cl.*, Vol. XLI, part 2, p. 107, Pl. V, figs. 1-4.

*Occurrence*.—Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

G. S. I. Type No. 13,492.

*OSTREA FRONDOSA* de Serres.

1820. *Ostrea frondosa* de Serres.—*Géogn. terr. tert.*, p. 137, Pl. V, figs 5, 6.

*Occurrence*.—Mekran beds (Gwadar stage).

*OSTREA LONGIROSTRIS* Lamarck.

1810. *Ostrea longirostris* Lamarck.—*An. sans vert.* Vol. VI, 1st part, p. 217, n. 17.

*Occurrence*.—Nari of Balúchistán.

*OSTREA GINGENSIS* [Schlotheim].

1813. *Ostracites gingensis* Schlotheim.—Leonhard's Taschenbuch, VII, p. 72.

*Occurrence*.—Gáj of Kachh: Doomra. Gáj of Sind: Naigh-Nai valley, 12 miles south of Shah Rhui, 10 miles south-west of the Manchhar lake; hill scarp 5 miles north of Shah Rhui on the Naigh-Nai. Mekran series. (Talar stage): ? Jhan Chauki.

G. S. I. Type No. 13,493.

*OSTREA PSEUDOCRASSISSIMA* Fuchs.

1878. *Ostrea pseudo-crassissima* Fuchs.—*Denkschr. k. Ak. W. m.-n. Cl.*, Vol. XXXVIII, 2nd part, p. 41, Pl. I, fig. 2.

*Occurrence*.—Mekran series (Gwadar stage): Gwadar, Mekran Coast; Hingol; Sangal, Balúchistán; from raised beach at Kan Bera Thana; Pohar Sunt, Chandra Kup, Mekran Coast; Malan, Mekran Coast, between Karachi and Gwadar.

G. S. I. Type No. 13,494.

## OSTREA BICOLOR Hanley.

1854. *Ostrea bicolor* Hanley.—Conch. Misc., *Ostrea*, fig. 2.

Occurrence.—Mekran series (Gwadar stage): Gwadar, Mekran Coast.

G. S. I. Type No. 13,195.

## OSTREA CRENULIFERA Sowerby.

1873. *Ostrea crenulifera* Sowerby.—Reeve's conch. Icon., *Ostrea*, sp. 67.

Occurrence.—Mekran series (Gwadar stage): Gwadar, Mekran Coast.

G. S. I. Type No. 13,496.

## OSTREA LINGUA J. de C. Sowerby.

1810. *Ostrea lingua* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 20.

The typical form has an elongate shape, occasionally curved. The lower valve is very foliaceous, the foliæ often bearing delicate close-set ribs which are apt to be lost amidst the protruding foliæ. At other times the folds are only locally developed, further apart, and prolonged into tubes. The upper valve is less foliaceous, flat, and without distinct ribs.

Comparison.—This species is very closely related to the living *O. talienvahnensis* Crosse (*Journ. Conch.*, X, 1861, p. 149, Pl. VI, fig. 6) and also to *O. rostralis* Lamarck of the European Atlantic estuaries.

Occurrence.—Gâj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur; near Warsar (23° 21', 68° 49'), north of Jakao (23° 13', 68° 45'). Gâj of Sind: west flank of limestone ridge, 3 miles south of Bandh Vero; entering the hills on the road from Jangri to Buda Khan's Thana; from oyster-bed at the base of the Manchhar group, west of Bhagothoro; south side of Eri Hill; Naigh-Nai valley, 12 miles south of Shah Rhui, 10 miles south-west of the Manchhar lake.

G. S. I. Type No. 13,497.

## OSTREA VESTITA Fuchs.

1883. *Ostrea vestita* Fuchs.—*Palæontographica* XXX, p. 44, Pl. XI, figs. 1-5, Pl. XII, figs. 1, 2.

This is probably a variety of *O. lingua*. The general characters of the ornamentation are similar, but the shell is much more pon-

derous, much larger, and has a tendency to assume a triangular shape, the hinge nevertheless remaining small in comparison with the body. Well-preserved upper valves carry extremely delicate close-set radial ribs, with a slight tendency to become spinose, extending over the concentric folia in such a manner as to communicate a smooth appearance to the surface. This ornamentation is not indicated in the upper valves illustrated by Fuchs which are too much exfoliated for its preservation. This peculiar ornamentation is observed in some upper valves of *O. cucullata*.

*Occurrence*.—Upper Gáj of Kachh. Sabrye River. Gáj of Sind: Hill scarp 5 miles north of Shah Rhui on the Naigh-Nai; west of Bhagothoro, south of Sehwan; Mol plateau, 10 miles north of Shah Beg; hills south of Kot Baruch near Sehwan; west of Ranikot, base of Manchhars resting unconformably on the Alveolma limestone; about  $1\frac{1}{2}$  miles north-east of Shah-Beg.

G. S. I. Type No. 13,498.

#### OSTREA CUCULLATA Born.

1780. *Ostrea cucullata* Born.—Mus. Ind. Ces., Pl. VI, figs. 11, 12.

*Occurrence*.—Mekran series (Gwadar Stage): Sangal, Balúchistán; about 7 miles west of Karachi, Sind.

G. S. I. Type No. 13,537.

#### OSTREA PARASITICA Gmelin.

*Ostrea parasitica* Gmelin.—Systema Naturæ, p. 205.

*Occurrence*.—Mekran series (Gwadar Stage): Sangal, Balúchistán.

G. S. I. Type No. 13,538.

#### OSTREA FOLIUM Gmelin.

*Ostrea folium* Gmelin.—Syst. Nat.

The specimen shows very clearly the peculiar manner in which the indentation of the lower valve, caused by the shell being moulded on to a twig, is answered by a symmetrically corresponding protrusion in the upper valve.

*Occurrence.*—Gáj of Sind: south side of Eri Hill.

G. S. I. Type No. 13,539.

GYPHŒA BRONGNIARTI, Bronn.

1831. *Gryphæa Brongniarti* Bronn.—Bronn., Ital. tert. Gebild., p. 122.

1840. *Gryphæa globosa* Sow.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 16.

The coarser hinge teeth distinguish this form from English specimens of the Cretaceous *Gryphæa vesicularis* with which J. de C. Sowerby had identified the Kachh fossil under the name of *Gryphæa globosa*. In the Eocene or Oligocene form from Kachh illustrated by J. de C. Sowerby as *Ostrea callifera* Desh.? (see Deshayes, 1st. ed., I, p. 339, Pl. L, fig. 1, Pl. LI, figs. 1, 2), the ridge of the hinge bears no teeth, but the form is represented by a single imperfect left valve. Deshayes' illustration also shows a form devoid of teeth. In his monograph on the Priabonian, Oppenheim mentions that *Gryphæa brongniarti* is also found in the greensand of Crespano near Bassano in the upper horizons of the Schio beds.

The forms designated *Ostrea vesicularis* by d'Archiac and Haimc (Descr. an. foss. gr. numm. Inde., p. 274), are shapeless fragments from the Eocene.

*Occurrence.*—Gáj of Kachh.

Family: PECTINIDÆ.

PECTEN (AMUSSIOPECTEN) LABADYEI d'Archiac and Haimc.

1853. *Pecten Labadyei* d'Archiac and Haimc.—Descr. an. foss. gr. numm. Inde, p. 271, Pl. XXIV, fig. 2.

1853. *Pecten Hopkinsi* d'Archiac and Haimc.—Descr. an. foss. gr. numm. Inde, p. 271, pl. XXIV, fig. 3 (non fig. 4=? *Pecten articulatus* J. de C. Sow.)

1857. *Pecten Pasinii* Meneghini.—De la Marmorata, Voy. en Sardaigne, II, p. 511, Pl. II, fig. 13.

1865. *Pecten Bouéiformis* von Schauroth.—Verzeichn. der Versteinerungen in herzogl. Mineralienkab. zu Cobourg, pp. 200-1, Pl. XVII, fig. 1.

1903. *Pecten Pasinii* Meneghini.—Oppenheim, *Zeitschr. d. deutsch. geol. Gesellschaft*, Vol. LV, p. 162, Pl. IX, figs. 2, 3.

There are about 18 ribs succeeded by a smooth band near the anterior side, while a similar band near the posterior border bears delicate radial striations. On the left valve the ribs are somewhat broader than the intervals, while on the right valve both the ribs and intervals are about equal. They show a tendency to fade away

towards the margin, sometimes to the extent of closely simulating the appearance of *Pecten burdigaliensis*, except that *P. labadyei* always remains of smaller size. Both valves are nearly alike and very flat, even at the umbo, so that the shape is quite similar to that of *P. burdigaliensis*. The internal ribs are very pronounced.

This is the commonest *Pecten* in the Nari and Gáj. The Nari forms have perhaps the ribs stronger, with less of a tendency to fade away at the margins, and are perhaps generally of a somewhat smaller size, but there is no precise characteristic by means of which the Nari and Gáj specimens can be separated. The Nari specimens usually have one more rib than those from the Gáj. Since the Nari specimens represent the type of the species, the Gáj specimens may be distinguished as *Amusiopecten labadyei* var. *pasinii*.

Concentrically coloured zones are frequent, a reddish tinge prevailing at the umbo, the succeeding zones alternating white and bluish-grey.

D'Archiac and Haime's original figure is restored and represents an uncharacteristic specimen which is immature and does not show the effacement of the ribs towards the margin. One of the types of *Pecten hopkinsi* (fig. 3) belongs to this species and is associated with nummulites. The other appears to be a specimen of *Pecten articulatus* J. de C. Sow.

The species is closely related to *Pecten burdigaliensis* but is smaller and thicker and does not show so pronounced a tendency to the effacement of the ribs as is frequent in *P. burdigaliensis*. It may be mentioned that some forms occurring in the Schio beds have been referred to *P. burdigaliensis* by Oppenheim.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta; Takatu, south of Khanai. Nari of Kachh. Nari of Sind: Bhagothoro Hill; Hindi Hill north of Trak (from Nari beds flanking the hills); near the base of the Nari beds, near Radak, seven miles south-south-west of Bhagothoro and ten miles south-south-east of Jhangara, close to the eastern side of the Dharan Pass near Laki. Gáj of Kachh. Gáj of Sind: Naigh-Nai valley, 12 miles south of Shah Rhui, 10 miles south-west of Manchhar lake; hills south of Kot Baruch near Sehwan; flanks of Kotar Range west of Damach; scarp about 6 miles south-east of Shah Bog.

PECTEN (*AMUSSIOPECTEN*) PLACENTA Fuchs.

1879. *Pecten placenta* Fuchs.—*Denksch. Akad. Wiss. m.-n., Cl.*, 2d. part, XLI, p. 103, Pl. II, figs. 3, 4.

Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52')  
Gáj of Sind: also in Burma.

G. S. I. Type No. 13,500.

PECTEN (*AMUSSIUM*) SUBCORNEUS d'Archiac and Haime.

1853. *Pecten subcorneus* d'Archiac and Haime—*Bescri. en. foss. gr. numm.* Inde, p. 269, Pl. XXIII, figs. 10, 11.

This fossil is not related to *Pecten corneus* which belongs to another genus. It closely resembles *P. cristatus* from the Pliocene of Europe, and still more so the type of the sub-genus *Amussium*, *A. pleuronectes* L.

*Occurrence.*—Gáj of Kachh: Teyra River valley near Rampur (23° 20', 68° 51'); north of Nunjal, south of the Chitrani (trap) hills; Ukree or Akri (23° 23', 68° 36'); Junagia (23° 28', 68° 50'). Gáj of Sind;  $\frac{1}{2}$  mile from Dumblandi Sehwan road, Karachi Taluq.

G. S. I. Type No. 13,501.

PECTEN (*ÆQUIPECTEN*) SCABRELLUS Lamarck.

1819. *Pecten scabrellus* Lamarck.—*Hist. nat. an. sans vert.* V, première partie, p. 183.

In shape the specimens somewhat resemble certain specimens of the Oligocene *Pecten miocenicus* Micht., on account of the posterior superior margin behind the umbo being rather straighter than is often the case in the European specimens of *Pecten scabrellus*. The ribs, however, are not smooth as in *Pecten miocenicus*, but are ornamented exactly as in *Pecten scabrellus*.

*Occurrence.*—Gáj of Kachh. Gáj of Sind:  $\frac{1}{2}$  mile from Dumblandi Sehwan hill road, Karachi taluq; road from Bula Khan to Darwat gorge, Baran river; about 3 miles South-east of Tong, Kohistan; west side of Lal Bukkur range, about 12 miles west-north-west of Karachi.

G. S. I. Type Nos. 13,502—13,503.

## PECTEN (CHLAMYS) FEDDENI n. sp.

Pl. XXV, figs. 1-4, 6.

Medium-sized, equivalve, with the right valve very slightly more convex than the left valve, equilateral, orbicular-expanded, flattened, ears large and symmetrical, byssal notch scarcely apparent. Twenty-three prominent, broad, rather coarse ribs, as wide as the intervals on the right valve, scarcely narrower on the left valve, carrying thick rectangular knobs, becoming squamose towards the margin in full-grown specimens; the intervals bear delicate transverse striations. On either side of the ligament pit, the portion of the hinge-surface decorated with delicate transverse rugose plications is flat and very broad. The surface of the shell is variously coloured in concentric zones.

*Occurrence.*—Lower Gáj of Sind: a few miles south of Pir Mangal north of Karachi; shortly beyond ( $\frac{1}{4}$  mile) the 8th milestone on the Las Bela road from Karachi; between 8th and 9th milestones on the same road. Gáj of Kachh.

## PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp.

Pl. XXV, figs. 7-12.

## PECTEN (CHLAMYS) PROTOTRANQUEBARICUS var. PAUCICOSTATUS n. var.

Pl. XV, fig. 14.

Medium-small, equilateral, equivalve, flat, orbicular, height equal to, or slightly exceeding the length. Ears well developed and ornamented with squamose ribs. Byssal notch deep. Valves decorated with 18 to 20 (12 only in the variety *paucicostatus*) simple, very prominent semi-cylindrical ribs, equal to or narrower than the flat intervals. The variety *paucicostatus* above alluded to has fewer ribs, the width of the ribs remaining the same as in the type while the intervals become broader.

*Comparisons.*—The ribs as compared with the interspaces are somewhat narrower and somewhat more raised and more sharply marked off than in *Pecten tranquebaricus*. The ribs decorating the ears are also more pronounced. The radial striations that subdivide the interspaces between the ribs of *Pecten tranquebaricus* are indistinct or absent in the fossil in which, moreover, these intervals bear a delicate reticulated pattern not observed in the living form, a similar pattern being observed in *Pecten articulatus*.



In all other characters of shape and ornamentation, number of ribs, etc., the fossil and recent forms agree exactly. Nevertheless, the differences, slight though they are, remain constant even when large series of both the fossil and living species are compared. It seems, therefore, advisable to name the fossil separately, though the forms bear the closest relationship.

The same characters that distinguish the fossil from *P. tranquebaricus* also distinguish it in a slightly more pronounced degree from *P. singaporinus* which, moreover, seems to attain a larger size.

*Occurrence*.—Mekran series (Gwadar Stage): Gwadar, Mekran coast; Karbat, west of Ras Malan, Mekran coast.

PECTEN (CHLAMYS) ARTICULATUS J. de C. Sowerby.

1840. *Pecten articulatus* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 15.  
 1850. *Pecten Bouei* d'Archiac.—*Hist. progr. Géol.*, III, p. 260.  
 1853. *Pecten Bouei* d'Archiac.—D'Archiac and Haime, *Descr. an. foss. gr. numm.* Indo, p. 269, Pl. XXIV, fig. 1.  
 1853. *Pecten Hopkinsi* d'Archiac and Haime.—*Descr. an. foss. gr. numm.* Indo, p. 271, Pl. XXIV, fig. 4 (*non* fig. 3=*Pecten Labadyei* d'A. and H.)  
 1901. *Pecten Kokenianus* Noetling.—*Miocene beds of Burma, Pal. ind.*, new series, Vol. I, p. 117, Pl. IV, figs. 2-6.

The nearest ally is *Pecten varius* Linn., of the European seas, fossil in the Miocene and Pliocene of Europe, of which *Pecten articulatus* may be only a variety. The Indian fossil has the ribs relatively a little broader as compared with the intervals; the anterior ear of the right valve is slightly longer and narrower. The intervals between the ribs bear a delicate diagonally reticulate pattern.

*Occurrence*.—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'), higher than the *Pecten*-bed of Sookpur; stream under Koba near Peepar; Warsar (23° 21', 68° 49'); Vinjan (23° 6', 69° 4'); Sookpur. Gáj of Sind: ½ mile from Dumblandi Sehwan) Hill road, Karachi taluq; about 1½ mile, north-east of Shah Beg.

PECTEN (CHLAMYS) SENATORIUS Gmelin, var. SOOMROWENSIS J. de C. Sowerby.

1840. *Pecten soomrowensis* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 14.  
 1850. *Pecten Faurei* d'Archiac.—*Hist. progr. Géol.* III, p. 260.

1853. *Pecten Favrei* d'Arch.—D'Archiac and Haime, Desor. an. foss. gr. numm. Inde, p. 270, Pl. XXIV, fig. 5.

1879. *Pecten senatorius* Gmelin.—Martin, Tertiärschichten auf Java, p. 124, Pl. XX, fig. 11.

Compared with the recent representatives of *Pecten senatorius*, the Indian fossil has a tendency to be taller, with deeper furrows, and sometimes more convex. These characters are, however, so variable in the recent shell, and so frequently overlap the characters exhibited by the fossil that they cannot be regarded as specific; it is sufficient therefore to look upon the fossil as a variety of *Pecten senatorius*.

*Occurrence*.—Gáj of Kachh Teyra River, north of Naluja (23° 15', 68° 52'), higher than the *Pecten*-bed of Sookpur; south and south-west of Kootaree or Kotree (23° 3', 69° 14') Sookpur; Ukree (23° 23', 38° 36'). Gáj of Sind;  $\frac{1}{2}$  mile from Dumblandi Schwan road, Karachi taluq.

G. S. I. Type No. 13,506.

*PECTEN (CHLAMYS) ALEXANDRI* n. sp.

Pl. XXVI; Pl. XXVIII, figs. 1, 3.

Vertically elongate (with the general outline of *Pecten gloriamaris*, etc.), equivalve, thin as compared with its size, of very shallow convexity, ornamented with about 30 close-set ribs, broader than the interstices, and usually accompanied on each side by one, or sometimes two very narrow subsidiary ribs equal in width to about one-third the total width of the narrow interspaces, so that only a very narrow groove subsists between them. The main ribs are decorated with tenuous raised squamæ very similar to those of *Chlamys varia*, but closer-set. The subsidiary ribs are decorated with much more numerous extremely sharp squamæ, giving the shell a very richly decorated appearance. A similar decoration is observed on many specimens of *Pecten senatorius*, though less conspicuous. When the specimens are ever so little weathered, this beautiful decoration disappears entirely. The ears carry numerous squamæ ribs (10 to 13) which, together with the intervals between them are beautifully cancellated by lines of growth.

The shell grows to a very large size, about 15 cm. in height.

*Comparison with other species*.—The nearest fossil ally is the Miocene species *Chlamys gloriamaris* (lower and middle Miocene), but its ornamentation is less rich and more confused, the tendency

being rather towards the development of intercalary ribs instead of symmetrical bordering subsidiary ones. Moreover it never reaches the dimensions of the form here referred to.

The nearest living allies are *Pecten asperrimus* Lamarck, from Australasia, and *Pecten ruschenbergieri* Tryon from Maskat. Compared with *Pecten asperrimus*, the Indian fossil is constantly taller and narrower, the byssal notch and the corresponding sinusity in the left valve are shallower, the principal ribs on the valves and ears are coarser and do not tend so much to become lost amongst the subsidiary ones towards the anterior and posterior margins of the shell. The fossil grows to larger dimensions than the recent species.

Compared with *Pecten alexandri*, *Pecten ruschenbergieri* Tryon (*Am. Journ. Conch.*, V, p. 171, Pl. XIV, fig. 1) from Maskat, has the same shape, the same number of ribs similarly disposed and with similar squamæ. In each interspace there is, however, one smooth rib, so that the middle of the interspaces is occupied by a ridge instead of a deep furrow. The interspaces are also broader, compared with the ribs, than in the fossil form. It is also not certain whether this shell grows to so large a size as the fossil.

*Occurrence*.—Mekran beds, especially in the upper division: Gwadar, Mekran Coast; Sangal, Balúchistán; Hara (Hala) range; Pohr Sunt, Chandrakup, Mekran Coast; Karbat, west of Ras Malan Mekran Coast.

PECTEN (CHLAMYS) TAUROPERSTRIATUS Sacco, var. PERSIMPLICULA Sacco.

1897. *Chlamys tauroperstriata* Sacco, var. *persimplicula* Sacco.—Moll. terr. terz. Piem. e. Lig., XXIV, p. 8, Pl. I, figs. 27, 28.

*Occurrence*.—Nari of Balúchistán: north of Kudin east of Kos Kets, Zhob district.

G. S. I. Type No. 13,507.

PECTEN VASSELLI Fuchs.

1878. *Pecten Vasselli* Fuchs.—*Denkschr. k. Ak. W.*, 2d part, p. 40, Pl. II, fig. 3.

This beautiful fossil, the leading species in the upper Tertiary of the Suez canal, has been completely described by Fuchs. It is only necessary to add that, in well-preserved specimens, finely squamous lines of growth traverse profusely both the ribs and interstices of both valves.

. The shell is easily recognised owing to the repeatedly dichotomous ribs of the rather convex right valve, and the ribs of alternating size of the flat left valve. It should be noticed that the ornamentation of the left valve which, at first sight, seems as if it were disposed differently from that of the right one, naturally originates as a necessary consequence: the dichotomy of the ribs on the right valve causes the intervening grooves to alternate in size. The natural consequence is the alternation in size of the corresponding ribs on the left valve. The occasional bifurcation of ribs sometimes seen on the left valve corresponds with the occasional development of intercalary ribs sometimes seen on the right valve.

*Occurrence.*—Mekran series especially in the upper division Gwadar, Mekran Coast.

G. S. I. Type No. 13, 508.

PECTEN NEARCHI n. sp.

Pl. XXV, figs. 5, 13.

Large, equilateral, right valve moderately convex, length equal to or exceeding the height. Ears equal, byssal notch scarcely noticeable. Umbo rather deeply incurved. Near the apex, the right valve is almost smooth except for five wide-spaced deep grooves (of which sometimes only four actually reach the apex). These grooves maintain their importance up to the margin, but, as the shell grows larger, the intervals between them become diversified by numerous close-set shallower grooves cutting up the whole surface into a number of close-set, rather irregular, and rather irregularly dichotomous ribs. The ears are decorated with numerous ribs. Submicroscopic frills of close-set small squamæ in concentric series striate the entire shell.

*Comparison with Pecten vasseli.*—This remarkable shell is closely allied to *Pecten vasseli*. In *Pecten vasseli* the dichotomous ribs of the right valve originate near the apex from six main bundles separated by five main grooves whose preponderance remains appreciable in many instances even in the full-grown shell. In *Pecten nearchi*, the five main grooves acquire extreme conspicuousness from the fact that the intervening spaces remain smooth up to a considerable distance from the umbo when they break up into ribs which dichotomise very much in the same manner as in *Pecten vasseli*, though they do not sort themselves so distinctly into pairs.

As in the case of *Pecten vasseli*, intercalary ribs occasionally occur. The left valve, unfortunately, is unknown.

*Occurrence*.—Mekran series (Gwadar Stage); Ormara, Mekran coast.

Family: *CARDITIDÆ*.

*CARDITA MURICATA* Sowerby.

1832. *Cardita muricata* Sowb.—G. B. Sowerby, *Proc. Zool. Soc. Lond.*, 1832, p. 195.  
 1844. *Cardita muricata* Sowerby.—Reeve, *Conch.*, *Icon.*, *Cardita*, sp. 18.  
 1852. *Cardita excavata* Desh.—Deshayes, *Proc. Zool. Soc. Lond.*, 1852, p. 100, Pl. 17, figs. 1-3.  
 1853. *Cardita Keyserlingi* d'Archiac and Haime.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 254, Pl. XXI, figs. 15, 16.

This fossil is identical with the living *Cardita muricata* Sowerby from the Pacific Ocean which is itself only doubtfully distinct from *Cardita excavata* Desh., from Australasia. Compared with the recent *Cardita calyculata* Linn. and the recent and Miocene European fossil *Cardita rufescens* Lamk., it is distinguished by its narrower posterior ribs.

*Occurrence*.—Gáj of Sind and Kachh.

*CARDITA ARDUINI* Brongniart.

1823. *Cardita Arduini* Brongniart.—Vicentin, p. 79, Pl. V, fig. 2.  
 1870. *Cardita Arduini* Brongn.—Fuchs, *Vicent. Tertiärgebirg.*, *Denkschr. k. Ak. Wiss.*, *n. n. Cl.*, Vol. XXX, 2d part, pp. 181, 202, Pl. XI, figs. 16.  
*Occurrence*.—Nari of Bhagothoro Hill in Sind.

*CARDITA (VENERICARDIA) LAURÆ* Brongniart.

1823. *Venericardia Lauræ* Brongniart.—Vicentin, p. 80, pl. V, fig. 3.  
 1860. *Cardita neglecta* Michelotti.—Miocène inférieur, p. 68, Pl. VIII, figs. 3, 4.  
 1870. *Cardita Lauræ* Brongn.—Fuchs., *Vicent. Tertiärgeb.*, *Denkschr. k. Ak. Wiss.*, *m.-n. Cl.*, Vol. XXX, 2d part, pp. 181, 202, Pl. XI, figs. 13-15.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

*CARDITA (VENERICARDIA) PSEUDONODULOSA* n. sp.

1849. *Cardita intermedia*, Brocchi.—J. de C. Sowerby, *Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 10.

Medium-sized, orbicular to oval, convexity moderate, umbones anteriorly deflected, not very prominent. In front of the umbo

the margin of the shell is regularly convex. Behind the umbo the outline is more broken, the margin being at first rectilinear and then, with a sharp bend, sloping rapidly downwards to meet the inferior margin which it joins with another sharp bend so that the general outline of the shell is trapezoidal rather than triangular. There are 18 to 21 ribs much narrower than the intervals. The ribs are undivided and are ornamented with rectangular knobs whose greater dimension is transverse to the ribs. The intervals bear delicate striations. The hinge is incompletely preserved but shows in the right valve two powerful elongate posterior ledges between which is fitted a powerful ridge similarly situated in the left valve.

*Remarks and comparison.*—J. de C. Sowerby referred this fossil to the European Pliocene and recent form *Cardita intermedia* Brocchi, which is distinguished by its relatively thicker ribs, the tripartite disposition of the anterior ones, and the weaker hinge. This fossil closely resembles the recent *Cardita nodulosa* Reeve, from the Atlantic and Mediterranean region, the recent shell being distinguished by its regularly sloping posterior margin which gives it a triangular rather than a trapezoidal shape. *Venericardia squamosa* Lamk., from the Paris Eocene is very similar, but with the umbo less deflected anteriorly.

*Occurrence.*—Gáj of Kachh: Teyra River valley, near Rampur (23° 20', 68° 51'); near Warsar (23° 21', 68° 49').

G. S. I. Type Nos. 13,509—13,510.

#### CARDITA (VENERICARDIA) sp.

For the sake of completeness mention is here made of a very large *Venericardia* which is unfortunately too badly preserved for identification. It has tripartite spinose ribs, and closely resembles many Eocene species such as *Venericardia acuticostata* Lamk., from the middle and upper Eocene of the Paris basin.

*Occurrence.*—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta.

#### CARDITA (GLANS ?) ROVERETI n. sp.

Pl. XXXIII, figs. 14-16, 19.

Shell thin, rather small, moderately elongate, rather convex, umbones sharp, only moderately deflected forward, bounded ante-

riorly by a well-defined small heart-shaped lunula, anterior and inferior margin forming a continuous oval curve, posterior dorsal margin straight, joined rather abruptly to the posterior margin which is obliquely straight, and bends sharply into the inferior margin. The valves carry a multitude of very fine, sharp, delicately gemmulated ribs numbering about 40. Internal characters not visible.

This shell resembles an Oligocene *Cardita* from northern Italy figured by Roverto (Ill. Moll. foss. tongr., p. 84, Pl. V, fig. 7) in which the umbo appears however to be much further deflected forward.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta.

Family: *LUCINIDÆ*.

*LUCINA* (*DENTILUCINA*) *NARICA* n. sp.

Pl. XXXIII, figs. 17, 18, 20, 21.

Small, rather globose, expanded-oval, umbo approximately sub-central or rather displaced posteriorly, the anterior side more extended and taller than the posterior portion of the shell. Upper margin on either side of the umbo almost horizontal. The valves are decorated with prominent concentric ridges slightly deflected along a line extending from the umbo to the posterior-inferior margin. The characters of the lunula and the area cannot be made out, nor the internal characters.

*Remarks*.—All the species of *Dentilucina* to which I have been able to refer differ either in their shape or ornamentation. I have, therefore, considered it worth while naming this shell although its diagnosis cannot be completed from the solitary specimen available.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range north-east of Quetta.

*LUCINA* (*GIBBOLUCINA*) *DEPERDITA* Michelotti.

1861. *Lucina deperdita* Michelotti.—*Et. Micoc. inf.*, p. 70, Pl. VIII, figs. 8, 9.

1861. *Diplodonta ? obliquata* Michelotti.—*Et. Micoc. inf.*, p. 72, Pl. VIII, figs. 12, 13.

1901. *Megaxinus deperditus* Micht.—Sacco, Moll. terr. terz. Piem. e. Lig., XXIX, p. 76, Pl. XVII, figs. 27, 28.

*Occurrence*—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district; north-eastern spurs of the Takatu range, north-east of Quetta.

G. S. I. Type No. 13,511.

LUOINA (LINGA) COLUMBELLA Lamarck.

1818. *Lucina columbella* Lamarck.—Hist. nat. *uzi.* sans. vert., V, p. 543.

This shell, one of the commonest Miocene fossils in Europe, still living in the tropical parts of the Atlantic Ocean occurs both in the Nari of Balúchistán and the Upper Gáj of Sind.

*Occurrence*.—Nari of Balúchistán: north-eastern spurs of the Takatu range, north-east of Quetta. Upper Gáj of Sind.

G. S. I. Type No. 13,512.

DIPLODONTIDÆ.

DIPLODONTA INCERTA d'Archiac.

1850. *Diplodonta incerta* d'Arch.—d'Archiac, Hist. progr. Géol. III, p. 259.

1853. *Lucina inflata* d'Archiac and Haime.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 240, Pl. XVI, figs. 15-16, Pl. XXXVI, figs. 7, 8.

1853. *Lucina incerta* d'Arch.—d'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 355.

This species is probably an ancestral form of *Diplodonta pacifica* Fischer, from the eastern seas, from which it is only doubtfully distinguished by its smaller size. The European Oligocene, Miocene, and living species, *Diplodonta rotundata* Montagu, is closely related, but its umbo is less voluminous.

*Occurrence*.—Sind; probably from the Upper Gáj.

DIPLODONTA INCERTA d'Archiac and Haime, var. *NARICA* n. var.

Pl. XXVII, figs. 1-3.

The specimens show the closest analogy to *Diplodonta incerta* and the two forms may be united as varieties of a single species. Compared with the type, the variety *narica* is vertically less contracted anteriorly, the outline is more regularly rounded and consequently the surface more regularly convex without the suspicio



of an angulation which, in *Diplodonta incerta* extends from the umbo to a posterior inferior marginal bend of which there is no distinct indication in the outline of the specimens of the variety *narica*. The European Oligocene form *Diplodonta esclavigata* Sacco, seems related, but is apparently less globose, with the unbonal part of the shell more triangular. The superior posterior bend of the shell seems more expanded away from the umbo in the case of the European Oligocene to recent *Diplodonta rotundata* than in the Indian fossil which, on an average, is also more oblique than the European form.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

### Family: CRASSATELLIDÆ.

#### CRASSATELLA SULCATA [Solander.].

1776. *Tellina sulcata* Sol.—Brander, Fossil. Hanton., Pl. VII, fig. 69.

The specimens from the Nari and Gáj beds of India correspond with the typical form from the Barton beds of England. The Gáj specimens have the concentric lamellæ slightly more crowded than the Nari ones. It is quite likely that this difference characterises two different races restricted respectively to these two horizons though the material available is insufficient to decide whether they may not be local variations. Both the Gáj and Nari forms come well within the range of variation of the European species and I have, therefore, not named them separately.

*Occurrence*.—Nari of Sind; Bhagothoro Hill. Gáj of Kachh: near Warsar (23° 21', 68° 49').

G. S. I. Type Nos. 13,513—13,514.

#### CRASSATELLA CARCARENSIS Michelotti.

1847. *Crassatella carcarenis* Micht.—Michelotti, Descr. foss. mioc., p. 129.

1899. *Crassatella carcarenis* Micht.—Sacco, Moll. terr. terz. Piem. e Lig., XXVII, p. 23, Pl. VI, figs. 39, 40, Pl. VII, figs. 1, 2.

A solitary specimen of a right valve represents this common European species which occurs abundantly in the Oligocene of Liguria and is also represented by the variety *neglecta* Micht., in the Oligocene of the Vicentino,

The specimen is identical with fig. 1, Pl. VII of Sacco's monograph above referred to. This specimen is either immature or represents a small race.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13,515.

Family: *CARDIIDÆ*.

*CARDIUM* (*DISCORS*) *NARIUM* n. sp.

Pl. XXVII, figs. 4—6, 8, 11—13, 16.

1870. *Cardium anomale* Math.—Fuchs, Beitr. zur Kenntn. der Conch. Faun. des Vicent. Tertiärgeb., p. 166, Pl. VII, figs. 7-10. (*Denkschr. k. Ak. Wiss. m.-n. Cl.*, XXX, 2d part.)

Medium-sized; shape usually fairly equilateral though occasionally quite oblique, in which case the anterior side is vertically much contracted. Ratio of height to length and thickness (valves united), 1: 1: .75. Umbo small, strongly incurved, slightly prosogyrous. Lunula small and heart-shaped; escutcheon small and narrow. Very numerous radial ribs which are more crowded anteriorly and even more so in the middle region than posteriorly; they are traversed anteriorly by rather broad, obliquely transverse markings disposed in such a way as to represent a succession of imbrications with their free edge towards the umbo. In the posterior region where the ribs are less crowded, they are trellised in the interstices by cross-bars. Margins with crenulations corresponding with the ribs.

*Remarks*.—The leading characteristic of this form is the prominence and wide spacing of the posterior radial ribs to which the concentric sculpture is quite subordinate, forming, in the interspaces, cancellations which never cross the radial ornaments, and never give rise to nodosities. The fragment represented by d'Archiac and Haime under the name *Cardium anomale* is excluded from identification with the present form owing to the clearness of the concentric markings throughout the posterior half of the shell. It corresponds with the G&J species, *C. trifforme* Sow. In Schaueroth's illustration of *Cardium pasinii*, the features of the posterior end of the shell are obscured by the shading; in the description, however, special mention is made of the concentric posterior ridges.

while the radial ribs are said gradually to fade away. *C. pasinii* does not correspond, therefore, with the Nari form.

The oblique anterior scalariform folds are more crowded in *Cardium naricum* than in *C. triforme*.

There seems no doubt that this is the form represented as *Cardium anomale* by Fuchs.<sup>1</sup>

Occurrence.—Nari of Bhagothoro Hill in Sind.

#### CARDIUM (DISCORS) TRIFORME J. de C. Sowerby.

1840. *Cardium triforme* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 11.
1842. *Cardium anomale* Matheron.—*Cat. méth. et descr. des corps. org. foss. du dép des Bouches-du-Rhône*, p. 194, Pl. XXXII, figs. 11, 12.
1853. *Cardium anomale* Math.—*D'Arch. and Haime, Descr. an. foss. gr. numm. Inde*, p. 259, Pl. XXIII, fig. 4.
1865. *Cardium Pasinii* von Schauroth.—*Verz. Verst. Cobourg*, p. 210, Pl. XX, figs. 1-3.
1903. *Cardium Pasinii* v. Schaur.—*Oppenheim.—Zeitschr. Deutsch. Geol. Gesellsch.*, LV, p. 181.

In this form which is apt to attain rather large dimensions, the leading feature is the beautiful cancellation produced all over the posterior part of the shell by the intersection of fairly equally developed, close-set, concentric and radial ridges. At the extreme posterior margin, the concentric ridges preponderate greatly over the radial ones. This is the characteristic feature mentioned by Matheron in his description of *Cardium anomale* which evidently corresponds with the Indian fossil. As mentioned above in the description of *Cardium naricum*, the same feature is also mentioned in Schauroth's description of *Cardium pasinii*. It is poorly shown in Matheron's figure and not at all in Schauroth's where the posterior portion of the shell is in deep shadow. The degree of inequilaterality shown in Matheron's figure is probably not typical; it is much less in Schauroth's, while, according to Mayer-Eymar *C. anomale* is less oblique than his *C. aquitanicum*, which must make it practically equilateral. Rovertó (*Moll. tongr.*, p. 92) unites *C. aquitanicum* with *C. pasinii*, which is inexact, for, besides the differ-

<sup>1</sup> In Fuchs' figure the ribs in the centre of the valve seem somewhat further apart than in the Nari specimens, while posteriorly the reverse seems to be the case. Nevertheless the gradation is in the same direction as in the Indian form, that is, the ribs are closest in the middle of the valve and become much wider apart posteriorly.—E. V.

ence in shape just mentioned, *U. aquitanicum* has much feebler ribs and lacks the posterior concentric markings.

Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'); Nariensir or Narayan Sarovar (23° 41', 68° 32'). Gáj of Sind: Hill near Greibbee, Baran River; south side of Eri Hill; Har Pass, near Kandabingo, Vero Plain; Gággar Hill, east side of Surjana range, east of Bula Khan; hill range, 10 miles north west of Karachi. Mekran series (Talar Stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

In Europe this fossil is known from the Aquitanian of Provence and from the Schio beds.

G. S. I. Type No. 13,516.

CARDIUM (NEMOCARDIUM) BHAGOTHORENSE n. sp.

Pl. XXVII, figs. 14, 15.

Large, posterior side rather contracted with a rectilinear truncation, anterior margin with a shorter and much less distinct truncation in its upper portion, all the remaining marginal outline curved and convex. Ratio of height to length and thickness (valves united), 1:1:·7. Umbo rather deeply incurved, prosogyrous. Posterior third ornamented with about 35 crowded fine radial ribs covered with delicate spines, the remainder of the valves smooth or with only some shallow concentric furrows. Margins delicately denticulated throughout.

The presence of spines on every rib distinguishes this species from *Cardium semistriatum* Deshayes.

Occurrence.—Nari of Bhagothoro Hill in Sind.

CARDIUM (TRACHYCARDIUM) VERRUCOSUM LAMARCK.

1824. *Cardium verrucosum* Lamk.—Deshayes, *Env. Paris*, I, p. 173, Pl. XXIX, figs. 7, 8.

1870. *Cardium verrucosum* Lamk.—Fuchs, *Vicent*, Tertiärgeb., p. 106.

1900. *Trachycardium verrucosum*.—Desh., var. *crustellata* Sacco.—Sacco, *Moll. terr. terz. Piem. e Lig.*, XXVII, p. 42, Pl. X, fig. 10.

1900. *Cardium verrucosum* Lamk.—Rovertò, *Ill. moll. foss. tongr.*, p. 90. (*Atti r. Univ. Genova.*)

The ribs are fairly numerous so that the specimen approaches the Italian Oligocene form mentioned by Sacco. This fossil, in Europe, occurs in the middle and upper Eocene of the Paris basin, and in the Oligocene of Liguria and of the Vicentino.

*Occurrence.*—Nari of Balúchistán: north-eastern spurs of the Takatu range, north east of Quetta.

G. S. I. Type No. 13,517.

CARDIUM (TRACHYCARDIUM) SINDIENSE n. sp.

Pl. XXVII, figs. 7, 9, 10.

Medium-sized, tall, inflated, nearly equilateral; umbo prominent, nearly central, very slightly displaced anteriorly, projecting well above the hinge-line, with the points moderately deflected forward in such a manner as to give rise to a rather vaguely defined lunula. The upper margin is joined on to both the anterior and posterior lateral margins by a bend, the anterior bend being slightly sharper than the posterior one which, however, is further removed from the umbo: the remainder of the marginal outline forms an almost continuous curve. The middle and anterior portions of the valves are fairly regularly convex: the posterior region is flatter, tending even to become concave in the neighbourhood of the posterior superior bend. There are about forty narrow prominent simple ribs which are more crowded on the central and anterior portions of the valves than upon the flattened posterior division. All over the central and anterior portions they are rendered slightly spinose by slightly raised lines of growth which form a succession of fine lattice-like ledges in the interstices. This decoration is less pronounced upon the ribs and broader interstices of the flat posterior portion of the valves. The margins are serrated, the ribs and furrows of one valve interlocking with those of the other. The hinge is imperfectly seen in one left valve: its development is moderate.

*Comparison with other species.*—This fossil is not unlike *Cardium porulosum* Solander, of the Eocene and Oligocene of Europe, but its ribs are much more crowded: the shape of the Indian fossil is also taller than is usual with the European form. *Cardium sharpei* d'A. and H. is not unlike in shape, but the type is an undeterminable cast.

*Occurrence.*—Nari of Bhagothoro Hill in Sind.

CARDIUM (TRACHYCARDIUM) GREENOUGHII d'Archiac and Haime.

1853. *Cardium Greenoughi* d'A. and H.—D'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 258, Pl. XXI, fig. 21.

The only specimen with preserved shell is the very incomplete type from Blagrave's collection described by d'Archiac and Haime

who compared it with the Oligocene *Cardium tenuisulcatum* Nyst. and the Miocene and Pliocene *Cardium multicostratum* Brocchi. The Indian fossil is only doubtfully distinct from the living *Cardium setosum*, Redfield of Malaya and Eastern Asia, but it would require better material to make sure of the identity.

*Occurrence*.—Gáj of Sind: Gaggar hill, east side of Surjana range, east of Bula Khan.

G. S. I. Type No. 13,518.

#### CARDIUM (TRACHYCARDIUM) sp.

The Gáj collections from Sind contain another form which is small, narrow, very tall, rounded anteriorly and truncated posteriorly, with about 30 equidistant ribs. Being only in the condition of a cast, it cannot be accurately diagnosed or compared.

#### CARDIUM (LÆVICARDIUM) MELVILLI Newton.

1905. *Lævicardium Melvilli* Newton.—*Geol. Mag.*, (V), II, p. 299, Pl. XVI, figs. 1-4.

*Occurrence*.—Mekran series (Gwadar stage): Ormara, Mekran Coast.  
G. S. I. Type No. 13,519.

#### CARDIUM (LÆVICARDIUM) UNICOLOR Sowerby, var.

1840. *Cardium unicolor* Sowerby.—*Proc. Zool. Soc. Lond.*, p. 107.

The ribs number 46 and appear slightly less crowded than in the type, with a very slight tendency to become granular also not observed in the type.

*Occurrence*.—Mekran series (Talar stage): Bán (25° 30', 62° 45').  
G. S. I. Type No. 13,520.

#### Family: VENERIDÆ.

#### DOSINIA PSEUDOARGUS [d'Archiac and Haime.]

1853. *Lucina pseudourgus* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 239, Pl. XVII, figs. 2-4.

1854. *Venus pseudoargus* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 354.

*Occurrence*.—Gáj of Kachh: Teyra River valley near Rampur (23° 20', 68° 51'); south and south-west of Kutaree or Kotree

(23° 3', 69° 14'); Gáj of Sind; south-west of Kuba Jagu Jumali, west-north-west of Sehwan.

Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains; Bán (25° 30', 62° 45').

G. S. I. Type No. 13,521.

*DOSINIA PSEUDOARGUS* [d'A. and H.]; var. *GEDROSIANA* n. var.

Pl. XXVIII, figs. 2, 4.

Specimens from the Upper Mekran are distinguished by their larger dimensions, and, occasionally, by the sinuosity of the posterior outline which may show a tendency to become concave. The latter character, however, is not constant, and the form may be regarded as a variety of *Dosinia pseudoargus*.

*Occurrence*.—Mekran series (Gwadar stage): Gwadar, Mekran Coast.

*DOSINIA SUBPENICILLATA* n. sp.

Pl. XXIX, figs. 7-9.

Medium-sized, orbicular, expanded in an antero-posterior direction, convexity feeble, posterior side of the shell very tall so that the ligamental margin is practically horizontal, the angle formed by the antero-superior and postero-superior margins on either side of the umbo forming a very wide angle with one another; lunula protruding, small. Ligament pit narrow, bordered by closely approximated nymphæ. Concentric ridges fine, numerous, not raised into follicular expansions at their terminations, or only slightly so. Hinge not accessible.

*Remarks*.—This shell differs only feebly from *Dosinia penicillata* Reeve, from the eastern seas. In the recent species the ascending disposition of the ligamental margin, consequent upon the wide angle between the antero-superior and postero-superior margins does not seem quite so pronounced.

*Occurrence*.—Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of sandstones constituting the Talar mountains; Bán (25° 30', 62° 45').

## DOSINIA PERALTA n. sp.

Pl. XXIX, figs. 1-6.

Medium-sized, height considerable compared with the antero-posterior dimension, convexity slight. Ligamental margin short, anterior upper margin very short, both of them passing with a rather sharp bend respectively into the posterior and anterior margins. Nymphæ moderately wide apart. Lunula extremely small, protruding and convex in its middle portion, deeply sunk in its anterior portion. Concentric ridges extremely numerous and extremely fine, with a tendency to pass into foliaceous expansions at their terminations. Hinge not accessible.

*Remarks.*—Though this species is represented by a small number of imperfect specimens, it is worth naming on account of its extremely pronounced characteristics, especially the remarkable shortness of the shape, the small size of the lunula, and the extreme delicacy of ornamentation which, combined together, distinguish it rapidly from all fossil and living species with which I am acquainted.

*Occurrence.*—Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of sandstones constituting the Talar mountains; Bán (25° 30', 62° 45').

## CYTHEREA (CALLISTA) FLORIDA [Lamarck.]

1818. *Venus florida* Lamarck.—An. sans. vert., Vol V, p. 602.*Occurrence.*—Mekran beds.

## CYTHEREA (CALLISTA) SPLENDIDA Mérian.

1860. *Cytherea splendida* Mérian.—Deshayes, An. s. vert. Bassin Paris. I, p. 440. Pl. XX, figs. 1-4.*Occurrence.*—Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13, 522.

## CYTHEREA (CALLISTA) EXINTERMEDIA Sacco.

1900. *Callista exintermedia* Sacco.—Moll. torr. terz. Piem. e Lig., XXVIII, p. 18, Pl. IV, figs. 17, 18.

*Occurrence.*—Nari of Sind: east side of Rois Hill south-east of Damach. In Europe, this species occurs in the Oligocene of Degò, Carcare, etc., and also in the Schio beds.

G. S. I. Type No. 13, 523.



## CYTHEREA (CALLISTA) PSEUDO-UMBONELLA n. sp.

Pl. XXIX, figs. 10-13; Pl. XXX, figs. 1-3, 5-6.

Medium to large, oval, inflated; the umbo is rather thick, the anterior margin of the shell projects considerably beyond the umbo; the height and length and thickness are about in the relative proportion of 4.75 : 6 : 3.75. The anterior and inferior margins together constitute an unbroken curve the convexity of which gradually decreases inferiorly and posteriorly; the superior-posterior margin is obliquely sloping and consists of two successive very flat curves connected together by a very slight bend and with the posterior inferior margin by a rather sharper bend. The valves are decorated with concentric grooves and ridges which are moderately crowded and always strongly marked on the anterior portion of the valves, usually less prominent on the middle portion, and usually fine and crowded posteriorly. A very fine linear groove borders the heart-shaped lunula. The internal characters are not clearly visible.

*Remarks.*—This fossil resembles the recent *Callista umbonella* Lamk., from the Indian Ocean which is larger, taller and more convex, and has the anterior plications further apart. The fossil has a wide vertical range, extending in age from the Gáj to the Talar stage or Upper Hinglaj. The above description applies to the specimens from the Lower Hinglaj or Gwadar stage. The Gáj specimens have a tendency to be flatter and longer. The solitary specimen G. S. I. Type No. 13, 543 from the beds at Jashk, whose age must be approximately Upper Hinglaj, is larger and thicker. Therefore the Jashk specimen comes slightly nearer to the recent species with which the fossil has been compared, while the Gáj specimens are slightly more distinct. The older form may be regarded as constituting a variety *kachhensis*, the newer one a variety *persica*. Both are however closely connected with the type.

*Occurrence.*—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52'); Teyra River valley near Rampur (23° 20', 68° 51'). Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of sandstones constituting the Talar mountains. Mekran series (Gwadar stage): Jashk, Gulf of Oman.

## CYTHEREA (? CARYATIS) PRATTI [d'Archiac and Haime.]

1853. *Venus Prattii* d'Arch. and H.—D'Archiac and Haime, Deser. an. foss. gr. numm. Inde, p. 248, Pl. XVIII, fig. 4.

This fossil has not reappeared in the collections of the Geological Survey so that there are as yet no available specimens for determining the internal characters. Judging from the external appearance it may be related to *Caryatis virgo* Gray, recent in Java.

*Occurrence*.—Sind; probably from the Gáj.

CYTHEREA (AMLIANTIS) INCRASSATA [Sowerby.]

1817. *Venus incrassata* Sowerby.—*Mineralog. Conch.*, II, p. 126, Pl. 155, figs. 1, 2.

The specimens agree particularly well with those from the Oligocene of Paris.

*Occurrence*.—Gáj of Kuchh: west-south-west of Mhurr; Boota or Buta (23° 23', 68° 50'); Aio-bett hillock, south of Boota.

G. S. I. Type No. 13, 524.

CYTHEREA (PITAR) PORRECTA Koenen.

1894. *Cythera porrecta* Koenen.—*Norddeutsch. Unt. Olig. Moll. Fauna*, VI, p. 1254, Pl. LXXXVII, fig. 8.

1900. *Pitar porrectus* Koen.—*Sacco, Moll. terr. terz. Piem. e Lig.*, XXVIII—p.20, Pl. IV, fig. 30.

The numerous specimens are unfortunately all embedded in the matrix, and none of them show any internal characters. The majority exhibit exactly the shape of the shells illustrated by Koenen and the Sacco. Others are much more orbicular, and may represent individual variations. The concentric ridges are perhaps slightly broader and more prominent than they appear to be in the specimens illustrated by Koenen and by Sacco, which would bring the Indian form closer to the Eocene *Pitar sulcatus* Deshayes, of which *Pitar porrectus*, as suggested by Sacco, may be a mere variety.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob districts. Also some doubtful specimens from the Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13, 525.

VENUS (VENTRICOLA) MULTILAMELLA [Lamarck].

1818. *Cytherea multilamella* Lamarck.—*Hist. nat. an. sans vert.*, V, p. 581.

The specimens are all from the Nari. Those from Bhagothoro Hill in Sind where the species is abundant, vary considerably in

size and in the relative crowding of the lamellæ. The Nari of Balúchistán has yielded two specimens which agree with one another, but which, compared with the Sind form, are flatter, more elongate, with lamellæ more crowded. This form also occurs fossil in the Oligocene of Italy as well as in the Miocene, and is still living in the European seas. The other Oligocene forms, *Venus præcursor* Mayer-Eymar, and *Venus lugensis* Fuchs, have the lamellæ less crowded, as is also perhaps the case with *Venus experplexa* Sacco.

*Occurrence.*—Nari of Balúchistán: north-eastern spurs of the Takatu range, north east of Quetta; Takatu, south of Khanai. Nari of Sind; Bhagothoro Hill.

G. S. I. Type Nos. 13, 526—13, 527.

VENUS (OMPHALOLATHERUM) PUERPERA Linn., var. AGLAURÆ Brongniart.

1823. *Venus Aglauræ* Brongniart.—Mém. sur le Vicentin, p. 80, Pl. V, fig. 5.  
 1870. *Venus Aglauræ* Brongn.—Fuchs, Vicent. Tertiärg., p. 200, Pl. XI, figs. 6, 7.  
 1900. *Omphalolathrum Aglauræ* Brongn.—Sacco, Moll. terr. terz. l'icm. e Lig. XXVIII, p. 26, Pl. VII, fig. 6.  
 1900. *Venus Aglauræ* Brongn.—Rovereto, Ill. moll. foss. tongr. p. 106, Pl. VI, fig. 6.  
 1900. *Venus ambigua* Rovereto.—Ill. moll. foss. tongr., p. 106.  
 1903. *Venus Aglauræ* Brongn.—Oppenheim, Zeitschr. Deutsch. Geol. Gesellsch., LV, p. 182.

The Nari beds of north-western India contain numerous specimens of a fossil which is evidently identical with the common Oligocene and Aquitanian form of northern Italy. At the same time, when compared with certain varieties of *Venus puerpera* of the eastern seas, particularly with var. *crispata* Desh., the relationship is so close that the fossil cannot be regarded as anything but an ancestral variety of the recent form, distinguished by smaller dimensions. The ornamentation is finer and closer than is often the case with the recent shell, but this character is eminently variable, certain forms, such as var. *ægrota* Reeve, exhibiting an ornamentation which is just as fine as in the fossil or even finer. Some of the Indian fossil specimens are elongated like the one represented by Brongniart. Others are orbicular like those represented by Sacco and by Fuchs. There is every gradation in shape between the elongate and the orbicular forms amongst specimens from one bed and one locality. It is not possible, therefore, to regard the two

forms as distinct, as has been done by Rovereto who regards the orbicular form as a separate species under the name of *Venus ambigua*. The concentric lamellæ do not always come so close together as is represented in Brongniart's and Sacco's figures. It is especially at Bhagothoro hill that one observes specimens with this very close-set sculpture. Nevertheless, at this locality and elsewhere, there are many individuals with the concentric lamellæ much further apart, in which case the ornamentation comes to resemble very closely that of *Venus granosa* J. de C. Sow.

A characteristic feature of this shell, both in its elongated and orbicular varieties, is the perfectly continuous curvature of the anterior margin (also observed in its living representatives), while in the case of *Venus granosa* the anterior margin exhibits anteriorly a somewhat angular bend.

The lunula is shorter than in *Venus granosa* and much shorter than in the Mekran form *Venus mekranica*.

The hinge is identical with that of the recent form.

*Occurrence*.—Nari of Sind, Balúchistán and Kachh: north of Kudin, east of Kos Kats, Zhob district; small syncline, a little over 1 mile north of Kudin; north-eastern spurs of the Takatu range, near Quetta. Nari of Kachh. Nari of Sind: Bhagothoro Hill; flank of range south-west of Dharan Lak, south of Sehwan; Lundi hill flank, north of Bandhri, 8 miles south of Jhangara; near the base of the Nari beds, near Radak, seven miles south-south-west of Bhagothoro and ten miles south-south-east of Jhangará, close to the western side of the Dharav Pass near Laki; east side of Rois Hill, south-east of Damach; Seri camp, 8 miles south-east of Jhangara.

G. S. I. Type No. 13, 528.

VENUS (OMPHALOCATHRUM) PUERPORA Linn., var. GRANOSA J. de C. Sowerby.

1840. *Venus granosa* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 7.

1840. *Venus cancellata* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 7a.

1850. *Venus granosa* J. de C. Sow.—D'Archiac, *Hist. progr. Géol.*, III, p. 262.

1850. *Venus cancellata* J. de C. Sow.—D'Archiac, *Hist. progr. Géol.*, III, p. 262.

1853. *Venus granosa* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 245,

1853. *Venus cancellata* J. de C. Sow.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 245.

1853. *Venus subaglauro* d'Archiac and Haime.—Descr. an. foss. gr. numm. Inde, p. 246, Pl. XVIII, fig. 5.

This is another variety of the same form. The shape is less variable, and one never meets with the elongated specimens so frequent in the case of *Venus aglauro*. There is a tendency to an angularity of the anterior inferior margin. The lunule is slightly longer. The concentric ridges are further apart than the average of *Venus aglauro*, and the radiating ones are never so close together as is sometimes observed in some of the Nari specimens.

Compared with the typical form of *Venus puerpera*, the fossil is distinguished by the shape of the inferior margin, the lateral outline of which is less rounded, which partly accounts for the tendency to a break in the continuity of the anterior curvature; the general size is smaller, the shape less inflated.

*Occurrence*.—Gáj of Kachh: Teyra River, north of Nabya (23° 15', 68° 52'), higher than the Pecten-bed of Sookpur; Teyra River valley near Rampur (23° 20', 68° 51'); stream under Koba near Peepur; North of Sujapur (23° 21', 68° 52'). Gáj of Sind: south side of Eri Hill; Har Pass near Kandabingo, Vero plain; Gágar Hill, east side of Surjana range east of Bula Khan; flanks of Kotar range, west of Damach.

G. S. I. Type Nos. 13, 529—13, 530.

VENUS (OMPHALOCATHRUM) MEKRANICA n. sp.

Pl. XXX, figs. 4, 7, 8; Pl. XXXI, fig. 1.

Fairly large, oval, posteriorly expanded. Umbo situated at one-third the total length from the anterior end. The umbo is small, moderately incurved, prosogyrous. Shell rather thin. The anterior and inferior margins constitute a continuous curvature; a somewhat more abrupt bend connects the inferior margin with the posterior margin which is not nearly so convex and passes by a fairly abrupt bend into the superior margin which is almost rectilinear up to the umbo. Lunula rather large, lanceolate, bordered by a rather deeply incised line. The entire surface is cancellated by concentric and radial ribs. Hinge as in *Venus puerpera*.

*Comparison with other species*.—The shape resembles that of the more elongate specimens of *Venus aglauro*, but the ornamenta-

tion is wider-spaced, especially as regards the radial ribs. The most precise specific character is the shape of the lunula which is much more elongate than in *Venus aglauræ* and all other forms of *Venus puerpera*.

The shape of the shell, the character of the ornamentation, and the relative dimensions of the lunula closely correspond with those observed in the European Miocene *Venus haueri* Hoernes which has a tendency, perhaps, to be slightly more orbicular. The Viennese fossil grows, however, to much larger dimensions.

*Occurrence*.—Mekran series (Talar stage): north of Talar gorge, on the road from Káj to Gwadar, base of sandstones constituting the Talar mountains; ? Talar gorge.

VENUS (CLEMENTIA) PAPYRACEA Gray.

Pl. XXXII, fig. 3.

1840. *Venus non-scripta* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, ser. 2, Vol. V, Pl. XXV, fig. 8.

1853. *Astarte hyderabadensis* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 242, Pl. XVI, fig. 17.

1853. *Venus non-scripta* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 246, Pl. XVII, fig. 7.

1853. *Venus hyderabadensis* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 247, Pl. XVII, fig. 8.

1853. *Venus astarteoides* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 247, Pl. XVIII, fig. 1.

1855. *Clementia papyracea* Gray.—Sowerby, *Thes. Conch.*, Vol. II, p. 700, Pl. CLI, fig. 155.

1870. *Clementia papyracea* Gray.—Martin, *Tertiär. Java*, p. 90, Pl. XVII, fig. 6.

*Occurrence*.—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68° 52') higher than the Pecten-bed of Sookpur. Gáj of Sind: Gágar hill, east side of the Surjana range, east of Bula Khan. Mekran series (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains. Mekran series (Gwadar stage): Gwadar, Mekran Coast; Barambab, near Mekran coast.

VENUS (CLEMENTIA) PAPYRACEA Gray, var. GRANDIS n. var.

Pl. XXXII, figs. 1, 2, 4.

A giant race characterising the Upper Mekran (at which horizon the type also occurs) may be regarded as a variety *grandis*; or, if

it be thought entitled to specific distinction as *Clementia grandis*; its large dimensions constitute its only distinctive character.

*Occurrence*.—Mekran series (Gwadar Stage): Gwadar, Mekran Coast; Barambab near Mekran Coast.

VENUS (CLEMENTIA) PROTOPAPYRACEA n. sp.

Pl. XXX, figs. 9-11.

Small-medium, oval moderately convex umbo rather pointed, valves decorated with concentric waves finely and rugosely striated concentrically. Interior characters not clearly visible. The shell is very thin so that the casts appear similar to the specimens provided with their shell, except that they do not exhibit the subsidiary striations.

This form is clearly the ancestor of the Miocene and recent *Clementia papyracea* of the eastern region, from which it is distinguished by its small size. Also, the concentric waves remain as strongly pronounced along the periphery as near the apex, while in the genuine *Clementia papyracea*, they tend to become irregular with increased growth and to fade away. It is another instance of the presence of the eastern element in India at so early a period as the Oligocene.

*Occurrence*.—Nari of Balúchistán: north of Kudin, east of Kos Kats, Zhob district.

CIRCOR CORRUGATA [Chemnitz].

*Venus corrugata* Chemitz.—Conch. Cab., Vol. VII, p. 25, Pl. XXIX, figs. 410, 411.

*Occurrence*.—Mekran series (Gwadar Stage): Gwadar, Mekran Coast; Near Jashk, Gulf of Oman.

G. S. I. Type No. 13, 531.

TAPES (CALLISTOTAPES) VIRGATUS [J. de C. Sowerby].

1840. *Pullastra virgata* J. de C. Sowerby.—*Trans. Geol. Soc., Lond.*, (2), V, Pl. XXV, fig. 9.

1850. *Pullastra virgata* J. de C. Sow.—D'Archiac, *Hist. progr. Géol.*, III, p. 262.

1852. *Venus subvirgata* d'Orbigny.—*Prodr. pal.*, III, p. 109.

1853. *Venus subvirgata* d'Orb.—D'Archiac and Halme., *Descr. an. foss. gr. numm. Inde*, p. 246, Pl. XVII, fig. 10.

1893. *Tapes virgatus* J. de C. Sow.—Mayer, *Descr. foss. tert. inf. J. G.*, XLJ, p. 58.

1898. *Tapes subvirgatus* d'Orb.—Rovertò, Cenni prev. Pelec. Tongr. Lig., p. 50.

1900. *Callistotapes virgatus* J. de C. Sowerby.—Sacco Moll. Terr. tert. Piem.e Lig., XXVIII, p. 54.

The hinge which is clearly seen in some specimens, is identical with that of the living *Callistotapes liratus* Phil.

This shell which occurs in the Oligocene of Sassello and S. Giustina, characterises, in India, the Gáj.

*Occurrence*.—Gáj of Kachh: Teyra River, north of Naliya (23° 15', 68' 52") higher than the Pecten-bed of Sookpur; Gáj of Sind: south-west of Kuba Jagu Jumali, west-north-west of Sehwan.

G. S. I. Type No. 13, 532.

TAPES (CALLISTOTAPES) PSEUDOLIRATUS n. sp.

Pl. XXXI, figs. 2—5.

Medium-sized, flattened, elongate, rather acute anteriorly, the posterior, and still more the anterior margin reduced to mere bends in the general outline. The length, height, and thickness (of united valves) are about in the proportion of 4·5: 3: 2. Umbo small, prosogyrous. Lunula superficial, elongate, extending almost to the anterior extremity of the shell, bordered by a shallow incision. Ligament narrow. Valves ornamented with rather prominent close-set concentric folds, broader than the intervening furrows.

*Comparison with other species*.—This species is distinguished from *Callistotapes virgatus* by its coarser ornamentation which tends to assume an irregular disposition owing to seasonal variations of growth. The shape is identical.

Compared with the recent *C. liratus* Phil., the anterior inferior margin is less rounded and more oblique, the anterior upper margin less sloping, the ornamentation finer and less even. In coarseness of ornamentation, *C. pseudoliratus* is about intermediate between *C. virgatus* and *C. liratus*; only neither of the two latter species exhibit any seasonal irregularities of growth. The hinge is slightly coarser than in the recent species, but otherwise identical. The shape and disposition of the lunula are identical with the recent species.

*Occurrence*.—Mekran series (Talar stages): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains,



## TAPES (TEXTRIX) MALABARICUS [Chemnitz].

? *Venus malabarica* Chemnitz.—Conch. Cab., Vol. VI, p. 3234, Pl. XXXI, figs. 32, 325.

1864. *Tapes malabarica* Chemn.—Reeve, Conch. Icon., *Tapes*, sp. 27.

*Occurrence*.—Mekran series (Gwadar stage): near Jashk, Gulf of Oman.

G. S. I. Type No. 13, 533.

## Family: SOLENIDÆ.

SOLENOCURTUS SINDIENSIS n. sp.

Pl. XXXI, fig. 6.

Medium-sized, not very elongate for the genus, slightly depressed at about half the total length, with a few distinct rather wide-spaced zones of growth, entirely covered with a close-set rugose decoration anteriorly radiating from the umbo while posteriorly it is disposed in the angular fashion characteristic of other species of the same genus. This ornamentation is very crowded, especially posteriorly and is conspicuous and sharp though extremely fine. In the immediate neighbourhood of the anterior extremity of the shell, it becomes less distinct without, however, entirely disappearing.

*Comparison with other species*.—The crowded ornamentation distinguishes this shell from *Solenocurtus similis* Koenen of the lower Oligocene of Northern Germany which it otherwise resembles. Amongst recent species, *Solenocurtus sulcatus* Dunker from eastern Australia is very similar but grows to a much larger size.

*Occurrence*.—Nari of Bhagothoro Hill in Sind.

## Family: SCROBICULARIIDÆ.

SEMELLE MEKRANICA n. sp.

Pl. XXX, figs. 12, 13.

Rather small, convexity feeble, shape oval and oblique, the major axis of the oval sloping downward and forward. Outline very regularly curvilinear, the small umbo scarcely breaking its continuity but for the very slight sinking in front of its point

where there is a minute lunula level with the rest of the shell, but marked off by a finely engraved line. The anterior portion of the shell is much more expanded than the posterior portion, the umbo being much nearer the posterior end than the anterior one. The ornamentation consists of numerous very fine concentric lamellar ridges, much narrower than the flat intervals which, on examination with a lens are found to be ornamented with innumerable radially disposed striae, reproducing, on a microscopic scale, the style of ornamentation rendered familiar by such shells as *Corbis*. The internal characters are not accessible. I have not come across any living or fossil form resembling this species.

*Occurrence*.—Mekran beds (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

Family : *TELLINIDÆ*.

*TELLINA EXARATA* J. de C. Sowerby.

1840. *Tellina exarata* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.*, (2), V, Pl. XXV, fig. 6.

1853. *Tellina exarata* J. de C. Sow.—D'Archiac and Haime, *Descr. an. foss. gr. numm. Inde*, p. 236.

J. de C. Sowerby compared this fossil with *Tellina virgata* Lamk. It seems more closely related to *Tellina capsoides* Lamk., from Singapore. It also seems related to the European Miocene and living *Tellina serrata* Renieri.

*Occurrence*.—Gáj of Kachh and Sind.

*TELLINA (MOERELLA) SUBDONACIALIS* d'Archiac and Haime.

1853. *Tellina subdonacialis* d'Archiac and Haime.—*Descr. an. foss. gr. numm. Inde*, p. 237, Pl. XVII, fig. 1.

D'Archiac and Haime have enumerated the differences which distinguish this form from the very closely related *Tellina donacialis* Lamk. from the middle and upper Eocene of the Paris basin. *Tellina dubia* Desh., from the eastern seas is also closely related, but is more orbicular.

*Occurrence*.—Sind, probably from the Gáj.

Family : *CORBULIDÆ*.*CORBULA CARINATA* Dujardin, var. *OLIGOLEVVIS* Sacco.

1837. *Corbula carinata* Dujardin.—Couches du sol en Touraine, *Mem. Soc. Geol. Fr.*, II, p. 257.

1901. *Corbula carinata* Duj. var. *oligolevvis* Sacco.—Sacco, *Moll. ter. terz. Piem. e Lig.*, XXIX, p. 37, Pl. IX, figs. 18-20.

A solitary specimen of a right valve appears to agree with the above Oligocene form. It is from the Nari of Bhagothoro Hill in Sind.

G. S. I. Type No. 13, 534.

*CORBULA TUNICOSULCATA* n. sp.

Pl. XXXI, figs. 10-19.

1840. *Corbula rugosa* Lamk.—J. de C. Sowerby. *Trans. Geol. Soc. Lond.*, (2).V. Pl. XXV, fig. 5.

Small to medium, rather elongate, inflated, equivalve, posterior portion of valves elongate and contracted, with a very pronounced curvilinear ridge separating a posterior area which bears an additional less pronounced ridge bounding an escutcheon which, though distinct, is not ornamented differently from the remainder of the shell. The lunula does not possess sharp boundaries. The whole shell is ornamented with broadly spaced angular costæ which are apt to become more crowded where the shell bends inwards towards the margin or towards a region representing an arrest of growth. The ribs have a tendency to be a little more crowded on the left valve than on the right. Umbo broadly triangular, flattened, moderately prominent and moderately incurved.

*Remarks and Comparison.*—This shell was identified by J. de C. Sowerby with *Corbula rugosa* Lamk., in which the costæ are much more delicate, and the umbo much more prominent. It is related to the living species *C. tunicata* Hinds, from the Philippines, and *C. sulcata* Lamk. from Senegal, both of which are larger than the fossil. The fossil is, in some respects, intermediate between the two living forms. The right valve is practically identical with that of *Corbula tunicata*. The isolated posterior division of the left valve is much more developed than in *Corbula tunicata*, even slightly more than in *Corbula sulcata*, the right valve of which, it, nevertheless, closely resembles.

*Occurrence.*—Gáj of Kachh: near Warsar (23° 21', 68° 49') Teyra River; valley near Rampur (23° 20', 68° 51').

*CORBULA TRIGONALIS* J. DE C. SOWERBY.

1840. *Corbula trigonalis* J. de C. Sowerby.—*Trans. Geol. Soc. Lond.* (2), V, Pl. XXV, fig. 4.  
 1853. *Corbula trigonalis* J. de C. Sow.—D'Archiao and Haimo, *Deser. an. foss. gr. numm. Inde*, p. 235, pl. XVI, figs. 6, 7.  
 1879. *Corbula trigonalis* J. de C. Sow.—Martin, *Tertiärschichten auf Java*, p. 93, Pl. XV, figs. 12, 13.

*Occurrence.*—Gáj of Kachh: Teyra River north of Naliya (23° 15', 68° 52'), higher than the Pecten bed of Sookpur. Gáj of Sind.

G. S. I. Type No. 13, 535.

*CORBULA ACUTICOSTA* MARTIN.

1885. *Corbula acuticosta* Martin.—*Samml. geol. Rei hsmus. Leid.* III, p. 197, Pl. X, fig. 200.

*Occurrence.*—Mekran series (Gwadar stage): Gwadar, Mekran Coast.

G. S. I. Type No. 13, 536.

*CORBULA MEKRANICA* n. sp.

Pl. XXXI, figs. 7-9.

Small, inequivalve, not elongate, inflated, roughly trigonal but for the inferior margin which is moderately convex anteriorly with a feeble posterior sinus. The ratio of length to height and thickness (valves united) is about 4:3:2.5. Umbo small, central, moderately incurved at right angles to the plane of junction of the valves. It is more pointed and less curved in the smaller left valve than in the opposite valve. A pronounced angulation, especially sharp near the umbo, separates a posterior area in which there is a bluntly defined escutcheon. Lunula indistinct. Both valves ornamented with crowded well-defined folds.

This species is not unlike *Corbula tunicosulcata*, but is more inequivalve and generally less elongate.

*Occurrence.*—Mekran beds (Talar stage): north of Talar gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar mountains.

Family: *PHOLADOMYIDÆ*.

*PHOLADOMYA PUSCHI* Goldfuss.

1840. *Pholadomya Puschi* Goldfuss.—Petr. Germ., II, p. 273, Pl. CLVIII, fig. 3.

1853. *Pholadomya Puschi* Goldf.—D'Archiac and Haime, Descr. an. foss. gr. numm. Inde, p. 232.

1901. *Pholadomya Puschi* Goldf.—Sacco, Moll. terr. terz. Piem. e Lig. XXIX, p. 141, Pl. XXVIII, figs. 1-8.

1903. *Pholadomya Puschi* Goldf.—Oppenheim, Zeitschr. Deutsch. geol. Gesellsch. LV, p. 187.

Very frequent in Europe in the Oligocene, extending to the base of the Vindobonian; occurs in the Schio beds.

*Occurrence*.—Sind; probably from the Gáj.

## PLATE I.

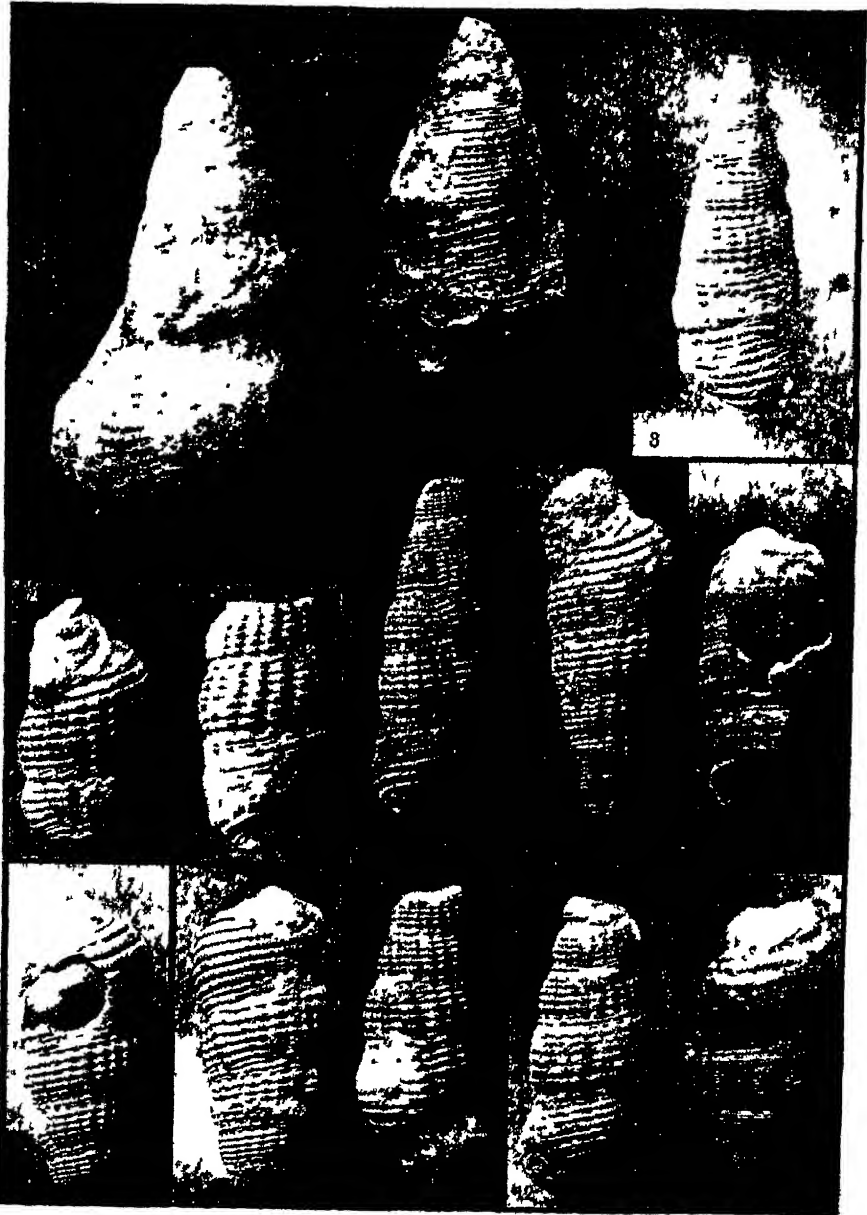
- FIG. 1.—*ACERA NARICA* n. sp., Bhagothoro Hill, Sind. (12,483).  
FIG. 2.—*ACERA NARICA* n. sp., Bhagothoro Hill, Sind. (See also Pl. IV, fig. 3.) (12,484).  
FIGS. 3, 4.—*TEREBRA SUBTESSELLATA* d'Orbigny, var. *OLIGOCENICA* n. var. Bhagothoro Hill, Sind. (12,487-488).  
FIG. 5.—*TEREBRA QUETTENSIS* n. sp. Nari of Baluchistan. (12,489).  
FIG. 6.—*TEREBRA NARICA* n. sp. Nari of Baluchistan. (12,490).  
FIG. 7.—*PLEUROTOMA YENANENSIS* Noetling, var. *NARICA* n. var. Bhagothoro Hill, Sind. (12,499).  
FIGS. 8, 9.—*PLEUROTOMA IOKEI* Martin, Gaj of Kachh. (12,500-501).  
FIG. 10.—*CONORBIS DORMITOR* Solander var. *SINDIENSIS* n. var. Bhagothoro Hill, Sind. (12,518).  
FIG. 11.—*CONORBIS DORMITOR* Solander var. *BHAGOTHORENSIS* n. var. Bhagothoro Hill, Sind. (12,519).  
FIGS. 12-14.—*CONUS (LITHOCONUS) INEDITUS* Michelotti. Bhagothoro Hill, Sind. (12,520-522).  
FIG. 15.—*MITRA INQUINATA* Reeve. Base of Talar section, Mekran. (12,546).  
FIG. 16.—*HARPA (EOCITHARA) NARICA* n. sp., Bhagothoro Hill, Sind. (12,532).  
FIG. 17.—*ATHELETA (VOLUTOSPINA) MEKRANICA* n. sp. Base of Talar section, Mekran. (12,535).  
All the specimens are represented natural size. (12,535).  
The numbers in brackets in this and the following plates are those under which the specimens are registered in the Geological Survey of India collections, Calcutta.

## PLATE XIV.

- FIGS. 1, 2.—*CLPITHIUM* (*GOURMYA*) *BALUCHISTANENSE* n. sp. N. of Kudm, E. of Kos Kats, Baluchistán, Nair. (13,233 234) Page 352.
- FIG. 3.—*CERITHIUM* (*PTYCHOCERITHIUM*) *PERLAMELLOSUM* n. sp. N. of Kudm, E. of Kos Kats, Baluchistán, Nair. (13,235). Page 354.
- FIGS. 4, 5.—*CERITHIUM* (*PTYCHOCERITHIUM*) *PERLAMELLOSUM* n. sp. Same locality as fig. 3. Figs. 4, 5. Two views of the same specimen. (13,236). Page 354.
- FIGS. 6, 7.—*CERITHIUM* (*PTYCHOCERITHIUM*) *PERLAMILLOSUM* n. sp. Same locality as fig. 3. Figs. 6, 7. Two views of the same specimen. (13,237). Page 354.
- FIGS. 8, 13.—*CERITHIUM* (*PTYCHOCERITHIUM*) *SINDIENSE* n. sp. Nair of Bhagothoro Hill in Sind. Figs. 8, 13. Two views of the same specimen. (13,240). Page 354.
- FIGS. 9, 10.—*CERITHIUM* (*PTYCHOCERITHIUM*) *PERLAMELLOSUM* n. sp. Same locality as fig. 3. Figs. 9, 10. Two views of the same specimen. (13,238). Page 354.
- FIGS. 11, 12.—*CERITHIUM* (*PTYCHOCERITHIUM*) *PERLAMILLOSUM* n. sp. Same locality as fig. 3. Figs. 11, 12. Two views of the same specimen. (13,239). Page 354.

All the specimens are represented natural size.

NOTE: The numbers in brackets in this and the following explanations of Plates are those under which the specimens are registered in the Type Fossil Collection of the Geological Survey of India, Calcutta.



*E. Vredenburg, Photos*

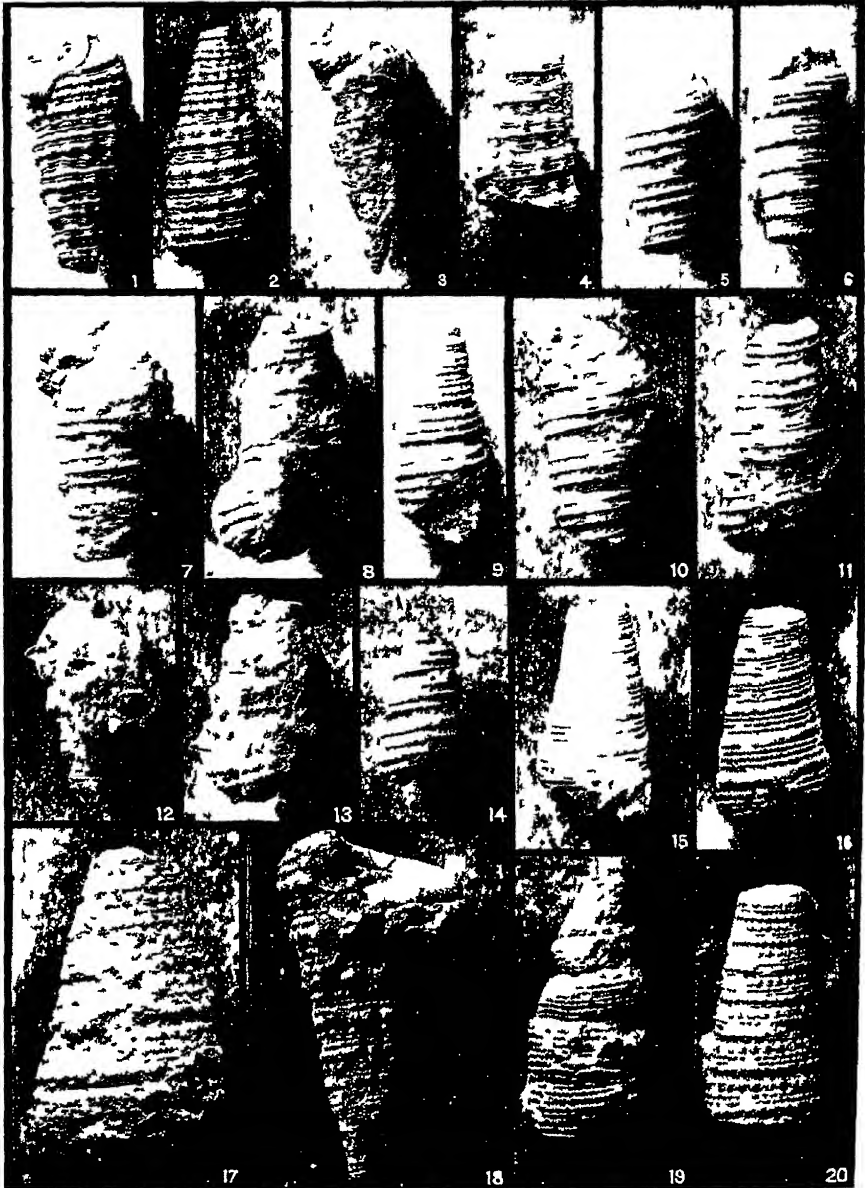
*G. S. I. Calcutta*

TERTIARY FOSSILS FROM NORTH-WESTERN INDIA



## PLATE XV.

- FIGS. 1, 2.—*CERITHIUM* (? *CHONDROCERITHIUM*) *BHAGOTHORENSE* n. sp. Nari of Bhagothoro Hill in Sind. Figs. 1, 2. Two views of the same specimen. (13,249). Page 361.
- FIGS. 3, 4.—*CERITHIUM* (*PTYCHOCERITHIUM*) *HAIMDI* n. sp. Nari of Bhagothoro Hill in Sind. (13,241-242) Page 357.
- FIG. 5.—*CERITHIUM* (*PTYCHOCERITHIUM* ?) *TRICINGULATUM* n. sp. Same locality as fig. 3. (13,244). Page 360.
- FIG. 6.—*TYMPANOTOMUS LEVIS* n. sp. Same locality as fig 3 (13,251) Page 363.
- FIGS. 7, 8.—*CERITHIUM* (*PTYCHOCERITHIUM* ?) *TRICINGULATUM* n. sp. Same locality as fig. 3 Figs. 7, 8. Two views of the same specimen. (13,245). Page 360.
- FIG. 9.—*CERITHIUM* (*PTYCHOCERITHIUM* ?) *TRICINGULATUM* n. sp. Same locality as fig. 3. (13,246). Page 360.
- FIGS. 10, 11.—*CERITHIUM* (*PTYCHOCERITHIUM* ?) *TRICINGULATUM* n. sp. Same locality as fig. 3. Figs. 10, 11, Two views of the same specimen. (13,247). Page 360.
- FIGS. 12, 13.—*CERITHIUM* (*PTYCHOCERITHIUM*) *HAIMDI* n. sp. Same locality as fig 2. Figs. 12, 13. Two views of the same specimen (13,243). Page 357.
- FIG. 14.—*CERITHIUM* (*PTYCHOCERITHIUM* ?) *TRICINGULATUM* n. sp. Same locality as fig. 3. (13,248). Page 360.
- FIGS. 15, 16.—*TYMPANOTOMUS LEVIS* n. sp. Same locality as fig. 3. Figs. 15, 16. Two views of the same specimen (13,252) Page '63.
- FIG. 17.—*TELESCOPIUM CHARPENTIERI* [Bast.], N.E. of Badro, S. of Mhuir, Kachh, Gáj (13,253). Page 364
- FIG 18 —*TELESCOPIUM CHARPENTIERI* [Bast.]. Entering hulls on the road from Jangli to Bula Khan s thana, Sind, Gáj (13,251). Page 364.
- FIG. 19.—*POTAMIDFS* (*CERITHIDEA*) *SINDIPNSIS* n. sp. South side of Eri Hill, Sind, Gáj. (13,283). Page 371.
- FIG 20 —*TELESCOPIUM CHARPENTIERI* [Bast.]. N. of Kudin, E. of Kos Kats, Baluchistán, Nari. (13,255). Page 364.
- All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

## PLATE XVI.

FIGS. 1, 2.—*TEREBRALIA MIOSULCATA* n. sp. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). Figs. 1, 2. Two views of the same specimen. (13,265). Page 366.

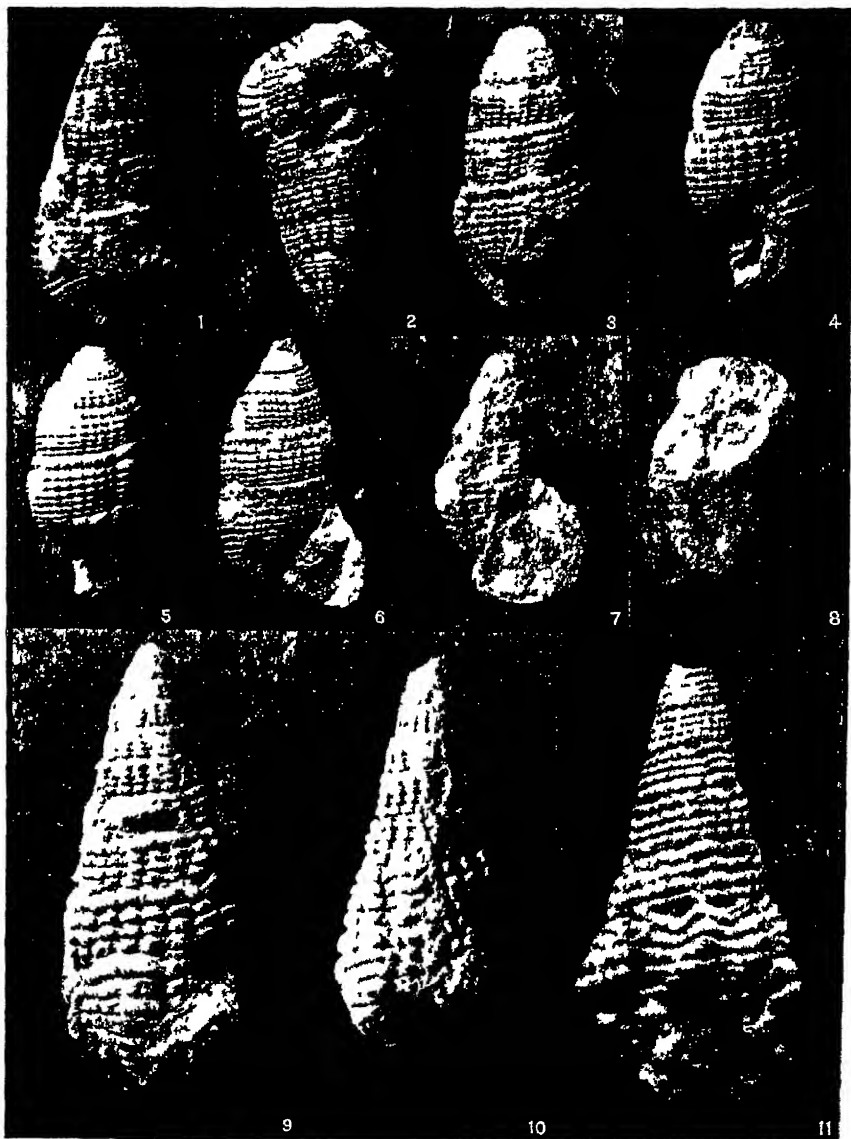
FIGS. 3-6.—*TEREBRALIA MIOSULCATA* n. sp. Same locality as figs. 1 and 2. (13,266-269). Page 366.

FIGS. 7, 8.—*TEREBRALIA MIOSULCATA* n. sp. Same locality as figs. 1 & 2. Figs. 7, 8. Two views of the same specimen. (13,270). Page 366.

FIGS. 9,10.—*TEREBRALIA BIDENTATA* Defr. var. South side of Eri Hill, Sind, Gáj. (13,273-274). Page 367.

FIG. 11.—*TEREBRALIA DIMORPHA* n. sp. Talar gorge, Baluchistán, Mekran series (Talar stage). (13,276). Page 368.

All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.

## PLATE XVII.

- FIGS. 1, 2.—*TELESCOPIUM CHARPENTIERI* [Bast.]. South side of Eri Hill, Sind, Gáj. (13,256-257). Page 364.
- FIG. 3.—*TELESCOPIUM CHARPENTIERI* [Bast.]. N. of Kudin, E. of Kos Kats, Baluchistán, Narl. (13,258) Page 364.
- FIG. 4.—*TELESCOPIUM CHARPENTIERI* [Bast.]. South side of Eri Hill, Sind, Gáj. (13,259). Page 364
- FIG. 5.—*TELESCOPIUM CHARPENTIERI* [Bast.]. Same locality as fig. 3. (13,260). Page 364.
- FIGS. 6-9.—*TELESCOPIUM CHARPENTIERI* [Bast.]. Same locality as fig. 4. (13,261-264). Page 364.
- FIGS. 10, 11.—*TEREBRALIA MIOSULCATA* n. sp. Baluchistán, Mekran series (Talar stage). Figs. 10, 11. Two views of the same specimen. (13,271). Page 366.
- FIG. 12.—? *TEREBRALIA MEKRANICA* n. sp. The specimen is missing. (13,442). Page 369.
- FIG. 13.—*TEREBRALIA MIOSULCATA* n. sp. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). (13,272). Page 366.
- All the specimens are represented natural size.



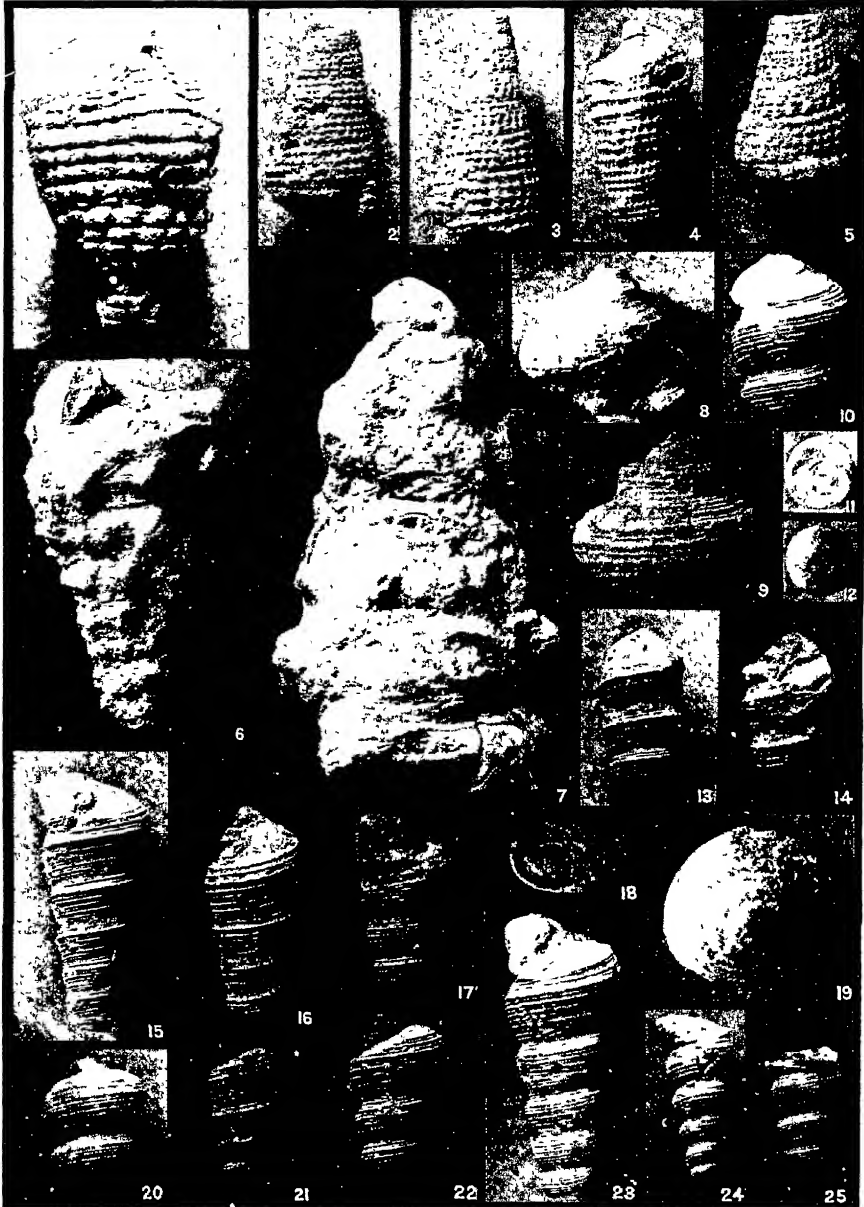
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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

## PLATE XVIII.

- FIG. 1.—*TEREBRALIA BIDENTATA* Defr. var. South side of Eri Hill, Sind, Gáj. (13,275). Page 367.
- FIGS. 2-5.—*TEREBRALIA SUBLIGNITARUM* n. sp. Bán, Baluchistán, Mekran series (Talar stage). (13,277-280). Page 368.
- FIGS. 6, 7.—*PYRAZUS PROTEBENINUS* n. sp. Same locality as fig. 1 (13281-282). Page 369.
- FIGS. 8, 9.—*TURBO (SENECTUS) RADIATUS* Gmelin, var. *NARICA* n. var. Nari of Bhagothoro Hill in Sind. Figs. 8, 9. Two views of the same specimen. (13,338). Page 404.
- FIG. 10.—*TURRITELLA NARICA* n. sp. var. *BALUCHISTÁNENSIS* n. var. N. of Kudin, E. of Kos Kats, Baluchistán, Nari. (13,294). Page 375.
- FIGS. 11, 12.—*TURBO (SENECTUS) RADIATUS* Gmelin, var. *NARICA* n. var. Operculum. Nari of Bhagothoro Hill in Sind. Figs. 11, 12. Two views of the same specimen. (13,339). Page 404.
- FIGS. 13, 14.—*TURRITELLA NARICA* n. sp. Same locality as fig. 10. (13,286-287). Page 375.
- FIGS. 15, 16.—*TURRITELLA NARICA* n. sp. Nari of Bhagothoro Hill in Sind. (13,288-289). Page 375.
- FIG. 17.—*TURRITELLA NARICA* n. sp. The specimen is missing. Page 375.
- FIG. 18.—*TURBO (SENECTUS) RADIATUS* Gmelin, var. *NARICA* n. var. Operculum from the same locality as figs. 11 & 12. (13,340). Page 404.
- FIG. 19.—*TURBO (MARMOROSTOMA ?) PSEUDO UNDULATUS* n. sp. North-eastern spur of the Takatu Range, Baluchistán, Nari. (See also Pl. XX, fig. 17). (13,342). Page 404.
- FIG. 20.—*TURRITELLA NARICA* n. sp. var. *BALUCHISTÁNENSIS* n. var. Baluchistán, Nari. (13,295). Page 375.
- FIG. 21.—*TURRITELLA NARICA* n. sp. Nari. (13,291). Page 375.
- FIG. 22.—*TURRITELLA NARICA* n. sp. var. *BALUCHISTÁNENSIS* n. var. Same locality as fig. 10. (13,296). Page 375.
- FIGS. 23-25.—*TURRITELLA NARICA* n. sp. var. *BALUCHISTÁNENSIS* n. var. Takatu, South of Khanai, Baluchistán, Nari. (13,297-299). Page 375.
- All the specimens are represented natural size.



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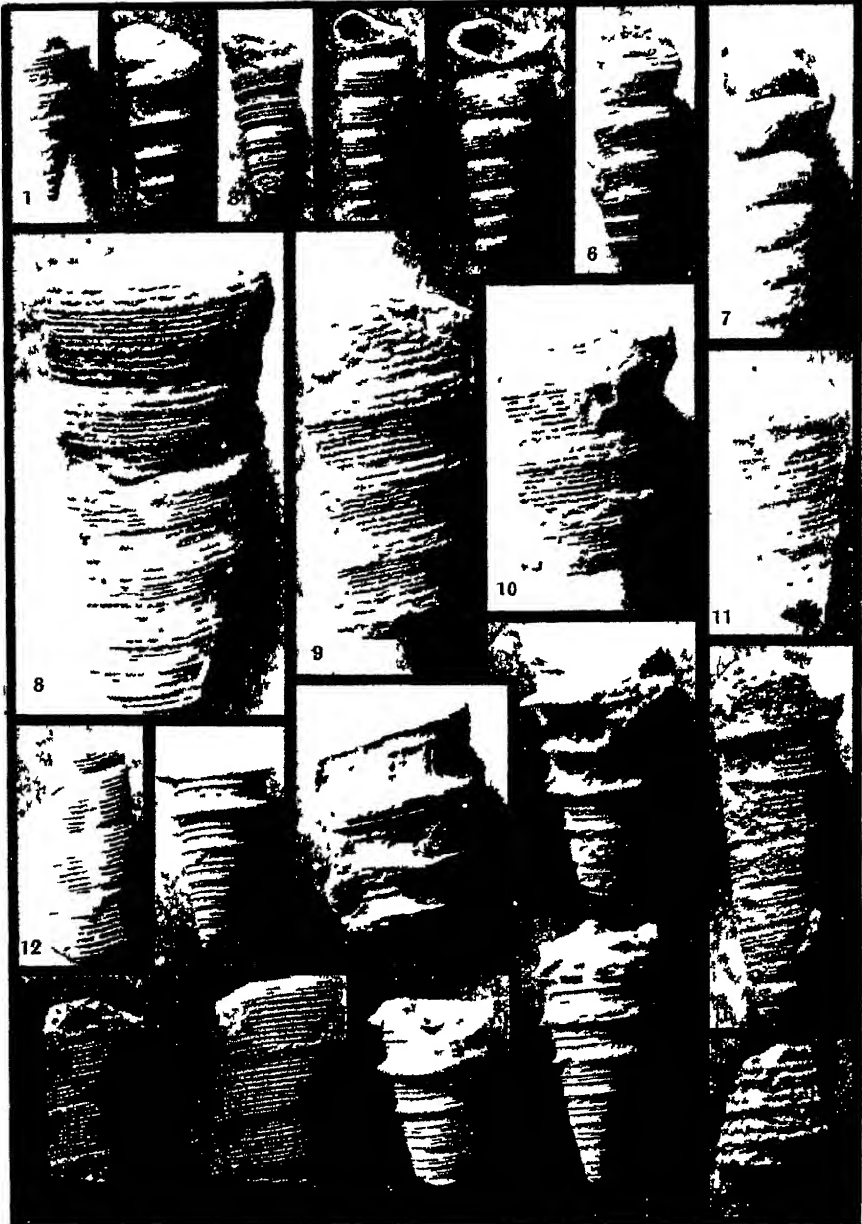
TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.



## PLATE XIX.

- FIG. 1.—*TURRITELLA TIPPLEI* n. sp. Takatu, S. of Khanai, Baluchistan, Nam. (13,311). Page 384.
- FIG. 2.—*TURRITELLA NAMICA* n. sp. N. of Kudin, E. of Kov Kats, Baluchistan, Nam. (13,292). Page 375.
- FIG. 3.—*TURRITELLA PSEUDOBANDONGENSIS* n. sp. Gaj of Sind. (13,301). Page 376.
- FIGS. 4, 5.—*TURRITELLA PSEUDOBANDONGENSIS* n. sp. About 3 miles S. E. of Tong, Sind, Gáj. (13,302-303). Page 376.
- FIG. 6.—*TURRITELLA NARICA*. Same locality as fig. 2. (13,293). Page 375.
- FIG. 7.—*TURRITELLA PSEUDOBANDONGENSIS* n. sp. Same locality as fig. 4. (13,304). Page 376.
- FIGS. 8-10.—*TURRITELLA MAGNASPLEULA* Sacco, var. *CRASSOCINGULATA* n. var. Same locality as fig. 2. (13,312-314). Page 385.
- FIG. 11.—*PROTOMA SINDIENSIS* n. sp. Same locality as fig. 4. (13,315). Page 387.
- FIG. 12.—*PROTOMA SUBRENILVILRI* n. sp. The specimen is missing. (13,322). Page 390.
- FIGS. 13-15.—*PROTOMA ELTRODILATATUM* n. sp. Nam of Bhagothoro Hill in Sind. (13,317-319). Page 388.
- FIG. 16.—*PROTOMA SINDIENSIS* n. sp. Same locality as fig. 11. (13,316). Page 387.
- FIG. 17.—*PROTOMA SUBRENILVILRI* n. sp. Takatu, S. of Khanai, Baluchistan, Nam. (13,323). Page 390.
- FIG. 18.—*PROTOMA SUBRENILVILRI* n. sp. Same locality as fig. 2. (13,324). Page 390.
- FIGS. 19, 20.—*PROTOMA ELTRODILATATUM* n. sp. Same locality as figs. 13-15. (13,320-321). Page 388.
- FIG. 21.—*TYMPANOTOMUS PSEUDODIABOLI* n. sp. South side of Eri Hill in Sind, Gáj. (13,250). Page 363.

All the specimens are represented natural size



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

PLATE XX.

- FIG. 1.—*PROTOMA SUBRENEVIDRI* n. sp. The specimen is missing. (13,325). Page 390.
- FIG. 2.—*PROTOMA SUBRENEVIDRI* n. sp. N. of Kudin, E. of Kos Kuts, Baluchistan, Nar. (13,326). Page 390.
- FIGS. 3 5.—*ΠΡΟΜΥΧΑ ΚΟΛΝΟΥΟΙΤ* Lamk., var. *ΝΑΡΙΣΑ* n. var. Nar of Bhagothoro Hill in Sind. FIGS. 3, 4, 5. Three views of the same specimen. (13,327). Page 396.
- FIGS. 6, 7.—*SIGARITUS AQUINIS* Recluz, var. *ΠΡΑΓΓΙΔΙΣ* Sacco. Nar of Bhagothoro Hill in Sind. FIGS. 6, 7. Two views of the same specimen. (13,329). Page 395.
- FIGS. 8, 9.—*SIGARITUS PROTONITTOIDIS* n. sp. Bal, Baluchistan, McKian series (Talai stage). FIGS. 8, 9. Two views of the same specimen. (13,325). Page 399.
- FIGS. 10-11.—*SIGARITUS AQUINIS* Recluz, var. *ΠΡΑΓΓΙΔΙΣ* Sacco. Same locality as figs. 6 & 7. FIGS. 10, 11. Two views of the same specimen. (13,330). Page 395.
- FIGS. 12, 13.—*SIGARITUS AQUINIS* Recluz, var. *ΠΡΑΓΓΙΔΙΣ* Sacco. ? Nar of Baluchistan. FIGS. 12, 13. Two views of the same specimen. (13,331). Page 395.
- FIG. 14.—*SCALA (CLATHRIS) CAJFENSIS* n. sp. Teyra River, N of Nahya, Kachh, Gaj. (13,332). Page 401.
- FIGS. 15, 16.—*TURBO (OLEARIA) PROTOCLIOIDIS* n. sp. Same locality as fig 2. FIGS. 15, 16. Two views of the same specimen. (13,334). Page 402.
- FIG. 17.—*TURBO (MAKOROSOMA?) PSEUDO UNULATUS* n. sp. Same specimen as Pl. XVIII, fig 19, another view. (13,342). Page 404.
- FIG. 18.—*TURBO (OLEARIA) PROTOCLIOIDIS* n. sp. North-eastern spur of the Takatu Range, Baluchistan, Nar. (13,335). Page 402.
- FIG. 19.—*TURBO (OLEARIA) PROTOCLIOIDIS* n. sp. Same locality as fig. 2. (13,336). Page 402.
- FIG. 20.—*TURBO (SENECTUS) RADLATUS* Gmelin, var. *NARICA* n. var. Nar of Bhagothoro Hill in Sind. (13,341). Page 404.
- FIG. 21.—*TURBO (OLEARIA) PROTOCLIOIDES* n. sp. Same locality as fig. 20. (13,337). Page 402.
- All the specimens are represented natural size.

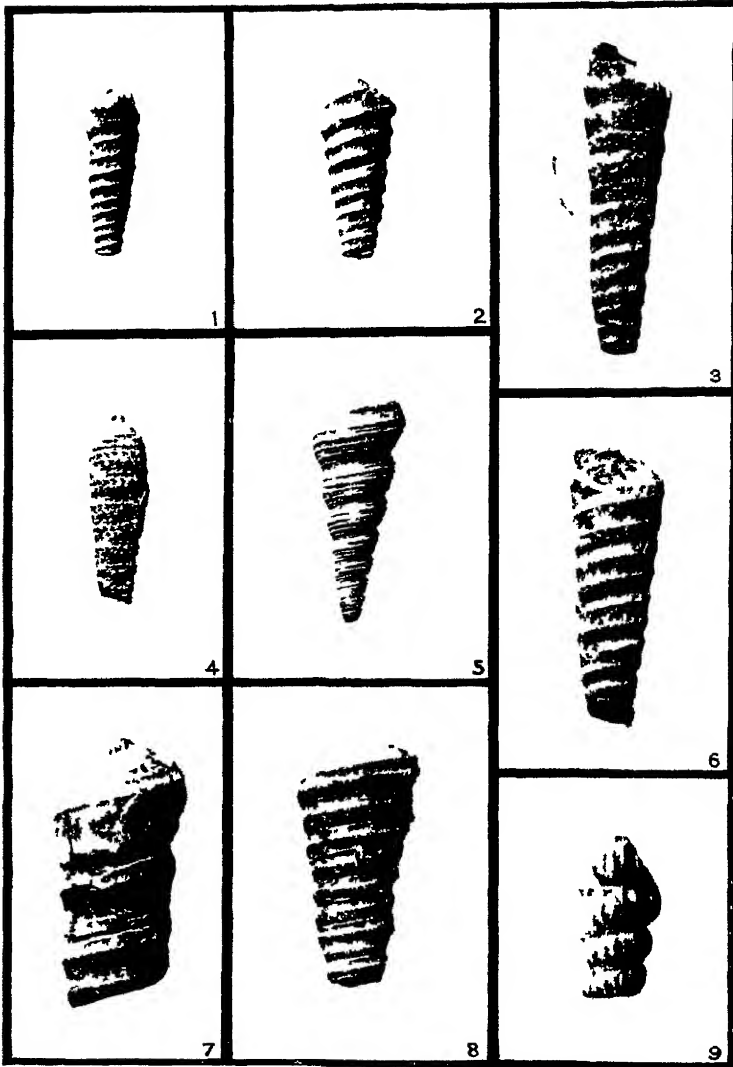


*E. Vredenburg, Photos*

*G. S. I. Calcutta*

## PLATE XXI.

- FIG. 1.—*TURRITELLA BHAGOTHORENSIS* n. sp. Nari of Bhagothoro Hill in Sind. (13,307). Page 380.
- FIG. 2.—*TURRITELLA PSEUDOTETIS* n. sp. Same locality as fig. 1. (13,305). Page 380.
- FIG. 3.—*TURRITELLA BHAGOTHORENSIS* n. sp. Same locality as fig. 1. (13,308). Page 380.
- FIG. 4.—*CERITHIOPSIS MEKBANICA* n. sp. Bán, Baluchistán, Mekran series (Talar stage). (13,285). Page 374.
- FIG. 5.—*TURRITELLA NARICA* n. sp. var. *BALUCHISTÁNENSIS* n. var. Baluchistán, Nari. (13,300). Page 375.
- FIG. 6.—*TURRITELLA BHAGOTHORENSIS* n. sp. Same locality as fig. 1. (13,309). Page 380.
- FIG. 7.—*TURRITELLA BHAGOTHORENSIS* n. sp. Same locality as fig. 1. (13,310). Page 380.
- FIG. 8.—*TURRITELLA PSEUDOTETIS* n. sp. Same locality as fig. 1. (13,306). Page 380.
- FIG. 9.—*SCALA (CLATHRUS) GAJENSIS* n. sp. Gáj of Kachh. (13,333). Page 401.
- All the specimens in this Plate are represented twice the natural size.



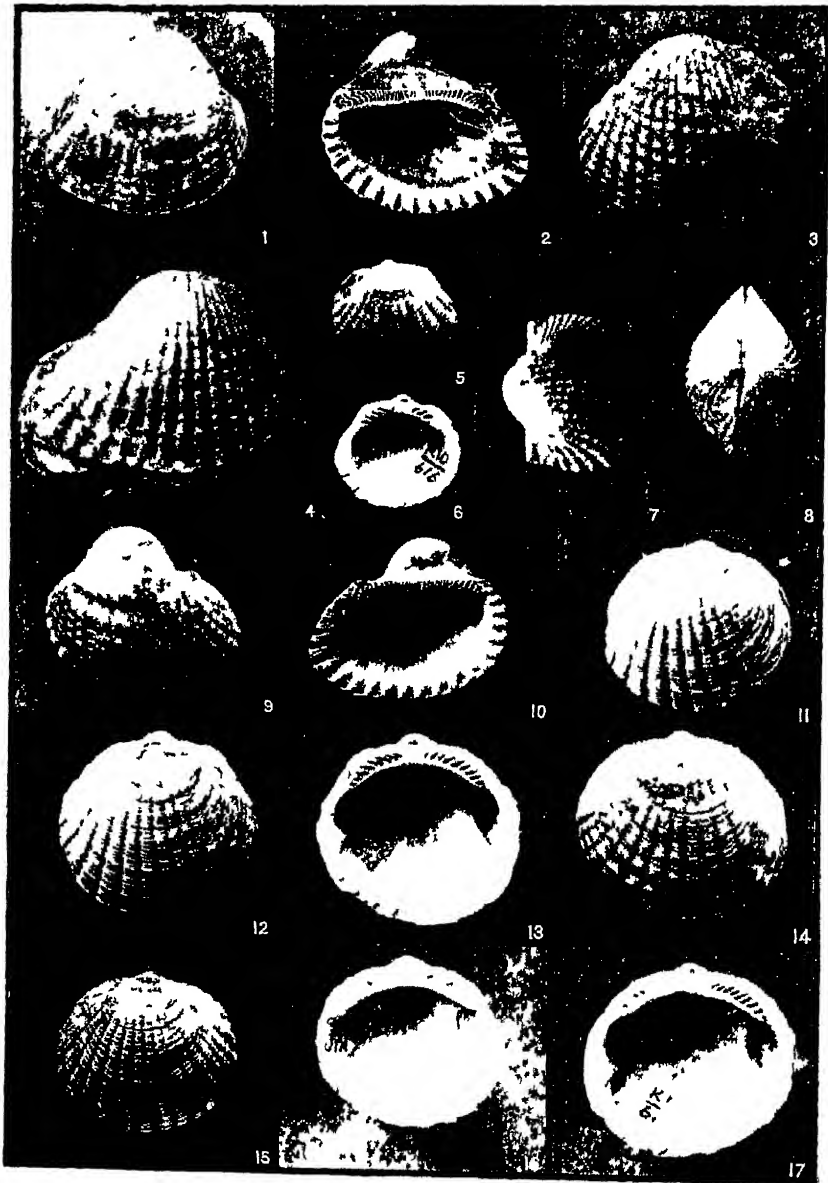
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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.

## PLATE XXII.

- FIGS. 1, 2.—*ARCA SUBMULTIFORMIS* n. sp. Right valve. N. of Gwegyo, Burma, Miochen. Fig. 1, external view; fig. 2, internal view. (13,343). Page 412.
- FIG. 3.—*ARCA SUBMULTIFORMIS* n. sp. Left valve, external view. Same locality as figs. 1 & 2. (13,344). Page 412.
- FIG. 4.—*ARCA SUBMULTIFORMIS* n. sp. Right valve, external view. Same locality as figs. 1 & 2. (13,345). Page 412.
- FIGS. 5, 6.—*PLECTUNCULUS GWADALENSIS* n. sp. Left valve. (Gwadar, Baluchistan, McKean series (Gwadar stage). Fig. 5, external view; fig. 6, internal view. (13,352). Page 418.
- FIG. 7.—*ARCA SUBMULTIFORMIS* n. sp. Fragmentary valve, external view. Same locality as fig. 3. (13,346). Page 418.
- FIG. 8.—*PLECTUNCULUS GWADALENSIS* n. sp. Gwadar, Baluchistan, McKean series (Gwadar stage). Dorsal view of both valves. (13,353). Page 418.
- FIGS. 9, 10.—*ARCA SUBMULTIFORMIS* n. sp. Left valve. Same locality as fig. 3. Fig. 9, external view, fig. 10, internal view. (13,347). Page 412.
- FIG. 11.—*PLECTUNCULUS GWADALENSIS* n. sp. Right valve of same specimen as fig. 8, external view. (13,355). Page 418.
- FIGS. 12-17.—*PLECTUNCULUS GWADALENSIS* n. sp. Same locality as figs. 5 & 6. Figs. 12, 13, right valve, external and internal views; (13,354). Figs. 14, 17, left valve, external and internal views; (13,355). Figs. 15, 16, right valve, external and internal views; (13,356). Page 418.
- All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA



## PLATE XXIII.

- FIGS. 1, 2.—*OSTREA PSEUDORISSENSIS* n. sp. Left valve. Sangal, Baluchistán, Mekran series (Gwadar stage). Fig. 1, external view; fig. 2, internal view. (13,367). Page 424.
- FIGS. 3, 4.—*OSTREA PROTOIMBRICATA* n. sp. ? Right valve. W. of Bhagothoro Range, S. of Sehwan, Sind, Nari. Fig. 3, external view; fig. 4, internal view. (13,370). Page 425.
- FIGS. 5, 7.—*OSTREA PROTOIMBRICATA* n. sp. Left valve. Same locality as figs. 3 & 4. Figs. 5, external view; fig. 7, internal view. (13,371). Page 425.
- FIG. 6.—*OSTREA PROTOIMBRICATA* n. sp. Left valve, external view. Same locality as figs. 3 & 4. (13,372). Page 425.
- All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

## PLATE XXIV.

FIG. 1.—*OSTREA GAJENSIS* n. sp. Left valve. Naigh-Nai valley, S. W. of Manchhar Lake, Sind, Gaj. Fig. 1*a*, internal view; fig. 1*b*., external view. (13,366). Page 423.

FIG. 2.—*OSTREA LATIMARGINATA* Vred. Left valve. Teyra River, Kachh, Gaj. Fig. 2*a*, internal view; fig. 2*b*, external view. (13,364). Page 423.

FIG. 3.—*OSTREA ANGULATA* J. de C. Sowerby.—Left valve. Northern end of Watwero Range, between Trak and Damach, Sind, Nall. Fig. 3*a*, external view; fig. 3*b*, internal view. (13,361). Page 422.

All the figures in this Plate except Fig. 1*b*, are slightly smaller than natural size. Fig. 1*b* is nearly half natural size.



1 a



1 b



2 a



3 a



3 b



2 b

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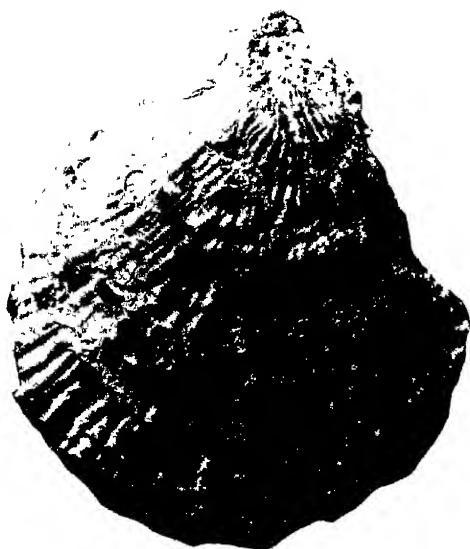
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PLATE XXIVa.

FIG. 1.—*OSTREA LATIMARGINATA* Vred. Left valve. Lowarali Okha Mandal, Kathiwar, Upper Gáj. Fig. 1a, external view; fig. 1b, internal view. (13,365). Page 423.

FIG. 2.—*OSTREA PSEUDODIGITALINA* Fuchs. Left valve. Talar gorge, Baluchistán, Mekran series (Talar stage). Fig. 2a, internal view; fig. 2b, external view. (13,368). Page 425.

The specimens in this Plate are represented slightly smaller than natural size.



1 a



2 a



2 b



1 b

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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.

PLATE XXIVb.

- FIG. 1.—*OSTREA PSEUDODIGITALINA* Fuchs. Left valve. Talar gorge, Baluchistán, Mekran series (Talar stage). Fig 1a, external view, fig 1b, internal view. (13,369) Page 425.
- FIG. 2.—*OSTREA ANGULATA* J. de C. Sowerby W. S. W. of Mhuri, Kachh, Gaj. Fig. 2a, Left valve, external view, fig 2b, Right valve, external view and interior view of the margin of left valve (13,362) Page 422
- FIG. 3.—*OSTREA ANGULATA* J. de C Sowerby Left valve North of Babba band on hillroad from Karachi to Schwam, Sind, Gaj. Fig 3a, internal view: fig. 3b, external view (13,363) Page 422.
- FIG. 4.—*BATILLARIA MEKLANICA* n sp. Talar gorge, Baluchistán, Mekran series (Talar stage) Figs 1a, b, Two views of the same specimen (13,284) Page 372.

All the specimens in this Plate are represented slightly smaller than natural size.



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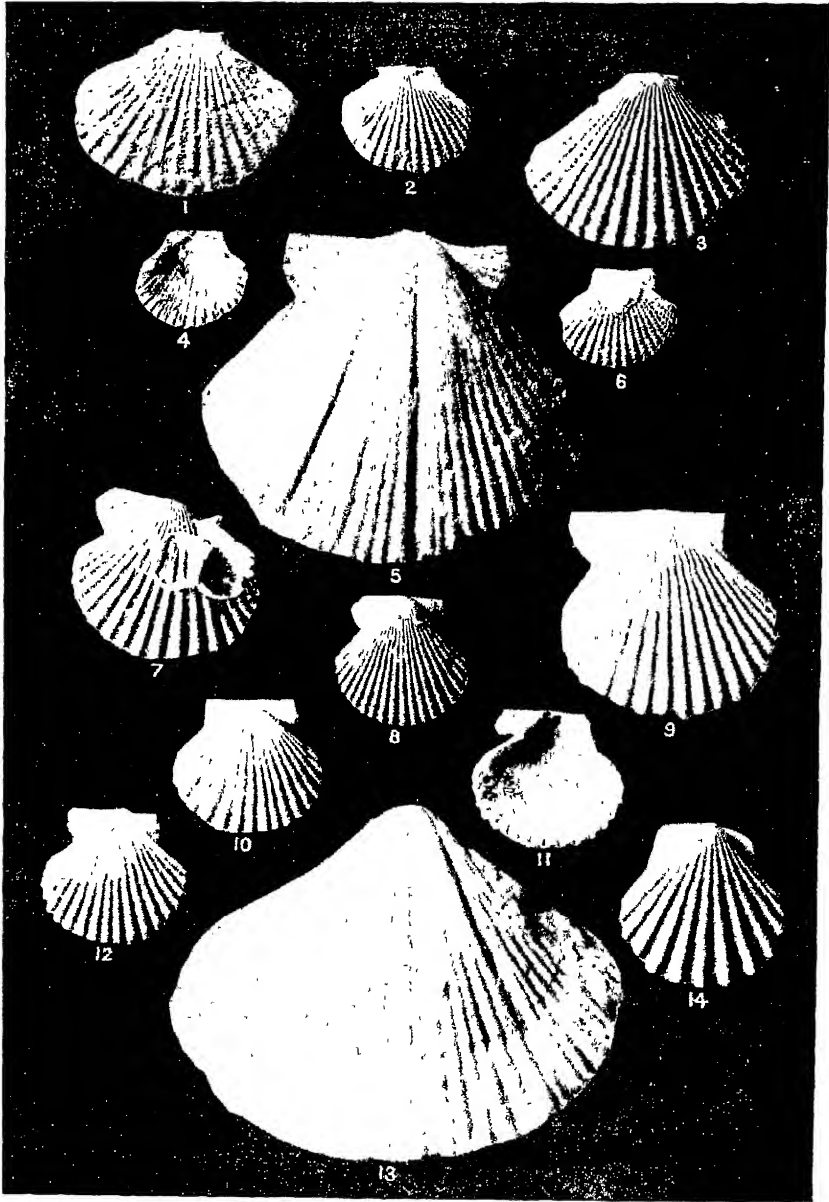
*G S I Calcutta*



## PLATE XXV.

- FIG. 1.—PECTEN (CHLAMYS) FEDDENI n. sp. Right valve, external view. S. of Pirmangal, N. of Karachi on road from Karachi to Las Bela, Sind, Lower Gúj. (13,373). Page 433.
- FIG. 2.—PECTEN (CHLAMYS) FEDDENI n. sp. Left valve, external view. Between 8th and 9th milestones on road from Karachi to Las Bela, Sind, Lower Gúj. (13,374). Page 433.
- FIG. 3.—PECTEN (CHLAMYS) FEDDENI n. sp. Right valve, external view. Same locality as fig. 1. (13,375). Page 433.
- FIG. 4.—PECTEN (CHLAMYS) FEDDENI n. sp. Left valve, internal view. Between 8th and 9th milestones on road from Karachi to Las Bela, Sind, Lower Gúj. (13,376). Page 433.
- FIG. 5.—PECTEN NEARCHI n. sp. Right valve, external view. Ormara, Baluchistán, Mokrán series (Gwadar stage). (13,391). Page 437.
- FIG. 6.—PECTEN (CHLAMYS) FEDDENI n. sp. Right (?) valve external view. Same locality as fig. 4. (13,377). Page 433.
- FIG. 7.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. Left valve, external view. Gwadar, Baluchistán, Mokrán series (Gwadar stage). (13,378). Page 433.
- FIG. 8.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. Left valve, external view. Same locality as fig. 7. (13,379). Page 433.
- FIG. 9.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. Left valve, external view. Baluchistán, Mokrán series (Gwadar stage). (13,380). Page 433.
- FIGS. 10, 11.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. Right valve. Same locality as fig. 7. Fig. 10, external view; fig. 11, internal view. (13,381). Page 433.
- FIG. 12.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. Left valve, external view. Same locality as fig. 7. (13,382). Page 433.
- FIG. 13.—PECTEN NEARCHI n. sp. Right valve, external view. Ormara, Baluchistán, Mokrán series (Gwadar stage). (13,392). Page 437.
- FIG. 14.—PECTEN (CHLAMYS) PROTOTRANQUEBARICUS n. sp. var. PAUCICOSTATA n. var. ? Right valve, external view. Same locality as fig. 7. (13,383). Page 433.

All the specimens in this Plate are represented slightly smaller than natural size.



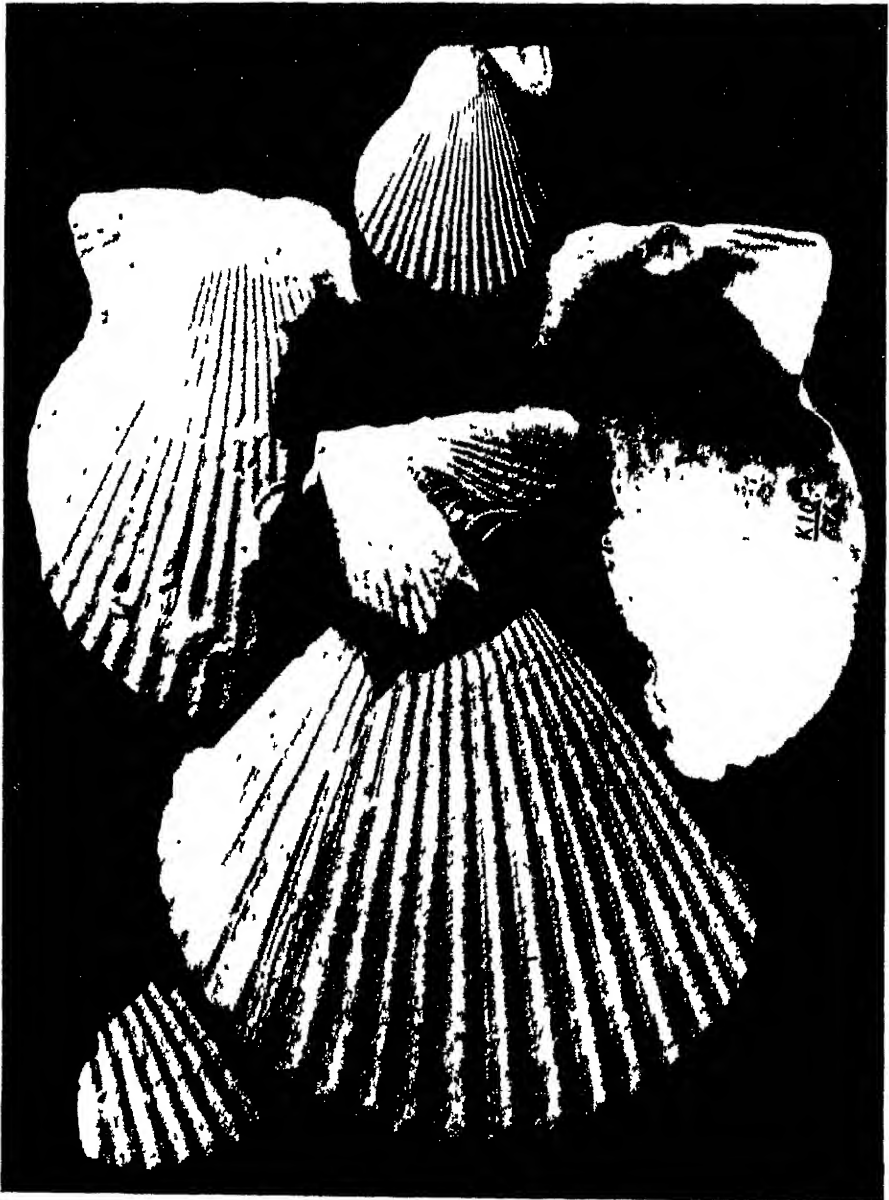
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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.

## PLATE XXVI.

- FIG. 1.—*PECTEN (CHLAMYS) ALEXANDRI* n. sp. Right valve, external view. Polu, Sunt, Chandrakup, Baluchistan, Mekran series (Gwadar stage). (13,384). Page 435.
- FIG. 2.—*Pecten (Chlamys) alexandri* n. sp. Fragmentary left valve, external view. Same locality as fig. 1. (13,385). Page 435.
- FIG. 3.—*Pecten (Chlamys) alexandri* n. sp. Fragment of right valve with anterior ear, external view. Same locality as fig. 1. (13,386). Page 435.
- FIG. 4.—*Pecten (Chlamys) alexandri* n. sp. Same specimen as fig. 2, internal view. (13,385). Page 435.
- FIG. 5.—*Pecten (Chlamys) alexandri* n. sp. Fragmentary valve of a large specimen showing ornamentation of surface. Same locality as fig. 1 (13,387). Page 435.
- FIG. 6.—*Pecten (Chlamys) alexandri* n. sp. Fragment of a valve, external view. Gwadar, Baluchistan, Mekran series (Gwadar stage). (13,388). Page 435.
- All the specimens are represented natural size.



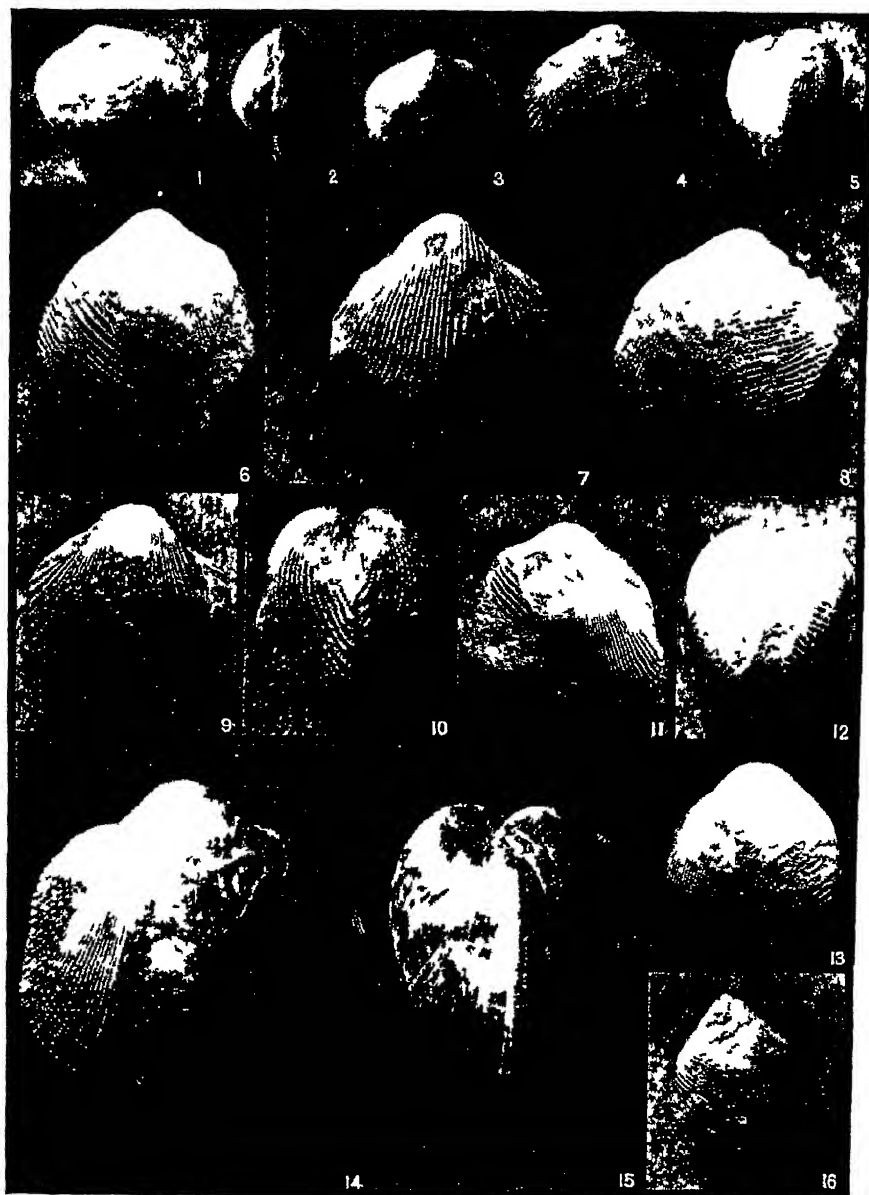
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## PLATE XXVII.

- FIG. 1.—*DIPLODONTA INCERTA* d'Aichiac and Haime, var. *NARICA* n. var. Left valve, external view. Nari of Bhagothoro Hill in Sind. (13,396). Page 441.
- FIG. 2.—*DIPLODONTA INCERTA* d'Aichiac and Haime, var. *NARICA* n. var. Same locality as fig. 1. Dorsal view of both valves. (13,397) Page 441
- FIG. 3.—*DIPLODONTA INCERTA* d'Aichiac and Haime, var. *NARICA* n. var. Right valve, external view. Same locality as fig. 1. (13,398). Page 441.
- FIGS 4, 5.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Same locality as fig. 1. Fig. 4, right valve, external view; fig. 5, both valves, view from posterior. (13,399). Page 443.
- FIG. 6.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Fragmentary left valve, external view. Same locality as fig. 1. (13,400). Page 443.
- FIG. 7.—*CARDIUM* (*TRACHYCARDIUM*) *SINDIENSE* n. sp. Left valve, external view. Same locality as fig. 1. (13,406). Page 446.
- FIG. 8.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Right valve, external view. Same locality as fig. 1. (13,401). Page 443.
- FIGS. 9, 10.—*CARDIUM* (*TRACHYCARDIUM*) *SINDIENSE* n. sp. Same locality as fig. 1. Fig. 9, right valve, external view; fig. 10, both valves, view from posterior. (13,407). Page 446.
- FIG. 11.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Left valve, external view. Same locality as fig. 1. (13,402). Page 443.
- FIGS. 12, 13.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Same locality as fig. 1. Fig. 12, both valves, view from anterior; fig. 13, right valve, external view. (13,403). Page 443.
- FIGS. 14, 15.—*CARDIUM* (*NEPHEMOCARDIUM*) *BHAGOTHORINSE* n. sp. Same locality as fig. 1. Fig. 14, right valve, external view, fig. 15, both valves, view from anterior. (13,405). Page 445.
- FIG. 16.—*CARDIUM* (*DISCORS*) *NARICUM* n. sp. Left valve, external view. Same locality as fig. 1. (13,404). Page 443.
- All the specimens are represented natural size.



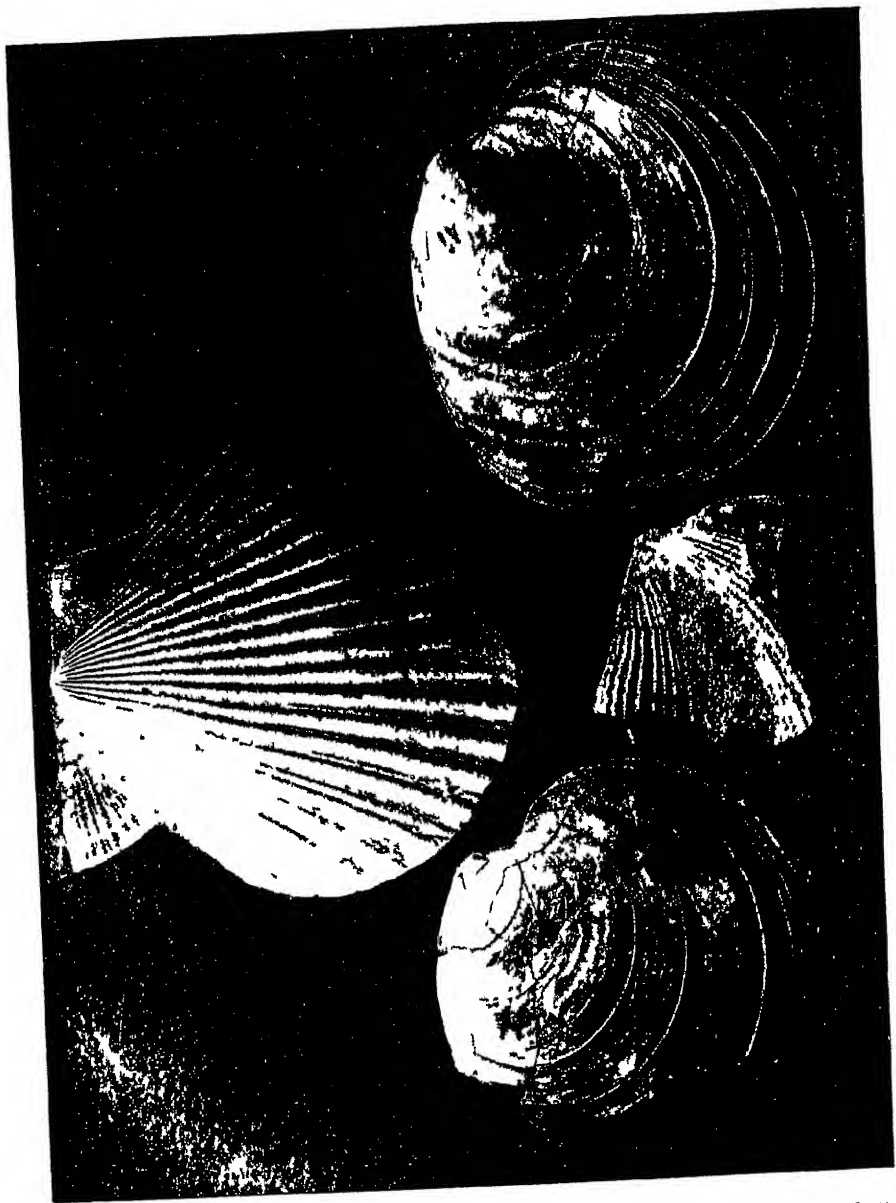
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## PLATE XXVIII.

- FIG. 1.—*PECTEN (CHLAMYS) ALEXANDRI* n. sp. Left valve, external view. Pohn. Sunt, Chandakup, Baluchistan, Mekran series (Gwadar stage). (13,389). Page 435.
- FIG. 2.—*DOSINIA PSEUDOARGUS* d'Archiac and Haine, var. *GEDROSIANA* n. var. Right valve, external view. Gwadar, Baluchistan, Mekran series (Gwadar stage). (13,408). Page 448.
- FIG. 3.—*PECTEN (CHLAMYS) ALEXANDRI* n. sp. Fragmentary left valve with anterior ear. Same locality as fig. 1. (13,390). Page 435.
- FIG. 4.—*DOSINIA PSEUDOARGUS* d'Archiac and Haine, var. *GEDROSIANA* n. var. Right valve, external view. Same locality as fig. 1. (13,409). Page 448.
- All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA.



## PLATE XXIX.

- FIGS. 1, 2.—*DOSINIA PIRALTA* n. sp. N. of Talar gorge, Baluchistan, Mekran series (Talar stage) Fig. 1, left valve, external view, fig. 2, dorsal view of both valves. (13,412). Page 449.
- FIGS. 3, 4.—*DOSINIA PIRALTA* n. sp. Ban, Baluchistan, Mekran series (Talar stage). Fig. 3, left valve, external view; fig. 4, dorsal view of both valves. (13,413). Page 449.
- FIG. 5.—*DOSINIA PIRALTA* n. sp. Left valve, external view. Same locality as figs 1 & 2. (13,414). Page 449.
- FIG. 6.—*DOSINIA PIRALTA* n. sp. Same locality as figs. 1 and 2. Dorsal view of both valves. (13,415). Page 449.
- FIG. 7.—*DOSINIA SUBPINICILLATA* n. sp. Left valve, external view. Same locality as figs. 3, 4. (13,410). Page 448
- FIGS. 8, 9.—*DOSINIA SUBPINICILLATA* n. sp. Same locality as figs 3, 4. Fig. 8, right valve, external view; fig. 9, dorsal view of both valves. (13,411). Page 448.
- FIGS. 10, 12.—*CYTHERRA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Same locality as figs. 1, 2. Fig. 10, left valve, external view, fig. 12, dorsal view of both valves. (13,416). Page 450.
- FIG. 11.—*CYTHERRA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Right valve, external view. Teyra River near Rampur, Kachh, Gáj. (13,417). Page 450.
- FIG. 13.—*CYTHERRA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Left valve, external view. Teyra River, N. of Nahya, Kachh, Gáj. (13,418). Page 450.

All the specimens are represented natural size.



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TERTIARY FOSSILS FROM NORTH-WESTERN INDIA

### PLATE XXX.

- FIGS. 1, 2.—*CYTHERA (CALLISTA) PSEUDO-UMBONELLA* n. sp. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). Fig. 1, right valve, external view; fig. 2, both valves, view from anterior. (13,419). Page 450.
- FIG. 3.—*CYTHERA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Fragmentary specimen, left valve, external view. Same locality as figs. 1, 2. (13,420). Page 450.
- FIG. 4.—*VENUS (OMPHALOCLETHRUM) MEKRANICA* n. sp. Fragmentary right valve, internal view. Same locality as figs. 1, 2. (13,422). Page 454.
- FIG. 5.—*CYTHERA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Right valve, external view. Same locality as figs. 1, 2. (13,421). Page 450.
- FIG. 6.—*CYTHERA (CALLISTA) PSEUDO-UMBONELLA* n. sp. Same specimen as fig. 3, anterior view of both valves. (13,420). Page 450.
- FIGS. 7, 8.—*VENUS (OMPHALOCLETHRUM) MEKRANICA* n. sp. Talar gorge, Baluchistán, Mekran series (Talar stage). Fig. 7, both valves, dorsal view, tilted slightly forward; fig. 8, right valve, external view. (13,423). Page 454.
- FIG. 9.—*CLEMENTIA PROTOPAPYRACIA* n. sp. Left valve, external view. N. of Kudin, E. of Kos Kats, Baluchistán, Nari. (13,428). Page 456.
- FIGS. 10, 11.—*CLEMENTIA PROTOPAPYRACIA* n. sp. Nari of Baluchistán. Fig. 10, right valve, external view; fig. 11, dorsal view of both valves. (13,429). Page 456.
- FIGS. 12, 13.—*SEMELE MEKRANICA* n. sp. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). Fig. 12, ? right valve, external view; fig. 13, dorsal view of both valves. (13,433). Page 458.
- All the specimens are represented natural size.



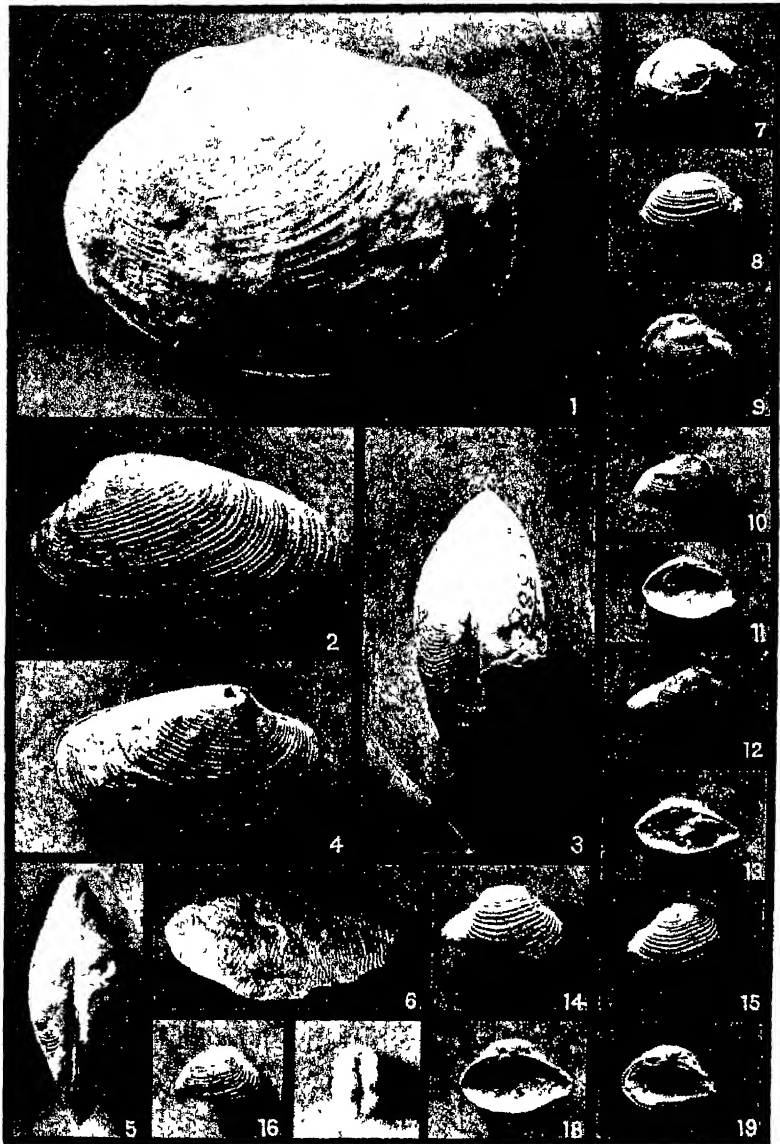
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## PLATE XXXI.

- FIG. 1.—*VENUS (OMPHALOCATHRUM) MEKRANICA* n. sp. Left valve, external view. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). (13,424). Page 454.
- FIGS. 2, 3.—*TAPES (CALLISTOTAPES) PSEUDOLIBATUS* n. sp. Same locality as fig. 1. Fig. 2, left valve, external view; fig. 3, dorsal view of both valves. (13,430). Page 457.
- FIGS. 4, 5.—*TAPES (CALLISTOTAPES) PSEUDOLIBATUS* n. sp. Bán, Baluchistán, Mekran series (Talar stage). Fig. 4, right valve, external view; fig. 5, dorsal view of both valves. (13,431). Page 457.
- FIG. 6.—*SOLENOCURTUS SINDHENSIS* n. sp. Fragmentary valve, external view. Nari of Bhagothoro Hill in Sind. (13,432). Page 458.
- FIG. 7.—*COEBULA MEKRANICA* n. sp. Left valve, external view. Bán, Baluchistán, Mekran series (Talar stage). (13,439). Page 461.
- FIGS. 8, 9.—*COEBULA MEKRANICA* n. sp. N. of Talar gorge, Baluchistán, Mekran series (Talar stage). Fig. 8, left valve, external view; fig. 9, left valve of another specimen, external view. (13,440-441). Page 461.
- FIGS. 10-19. *COEBULA TUNICOSULOATA* n. sp. Warsar, Kachh, Gáj. Figs. 10, 11, right valve, external and internal views; (13,434). Figs. 12, 13, right valve, external and internal views; (13,435). Figs. 14, 18, right valve, external and internal views; (13,436). Figs. 15, 19, right valve, external and internal views; (13,437). Figs. 16, 17, external view of right valve and dorsal view of both valves; (13,438). Page 460.
- All the specimens are represented natural size.



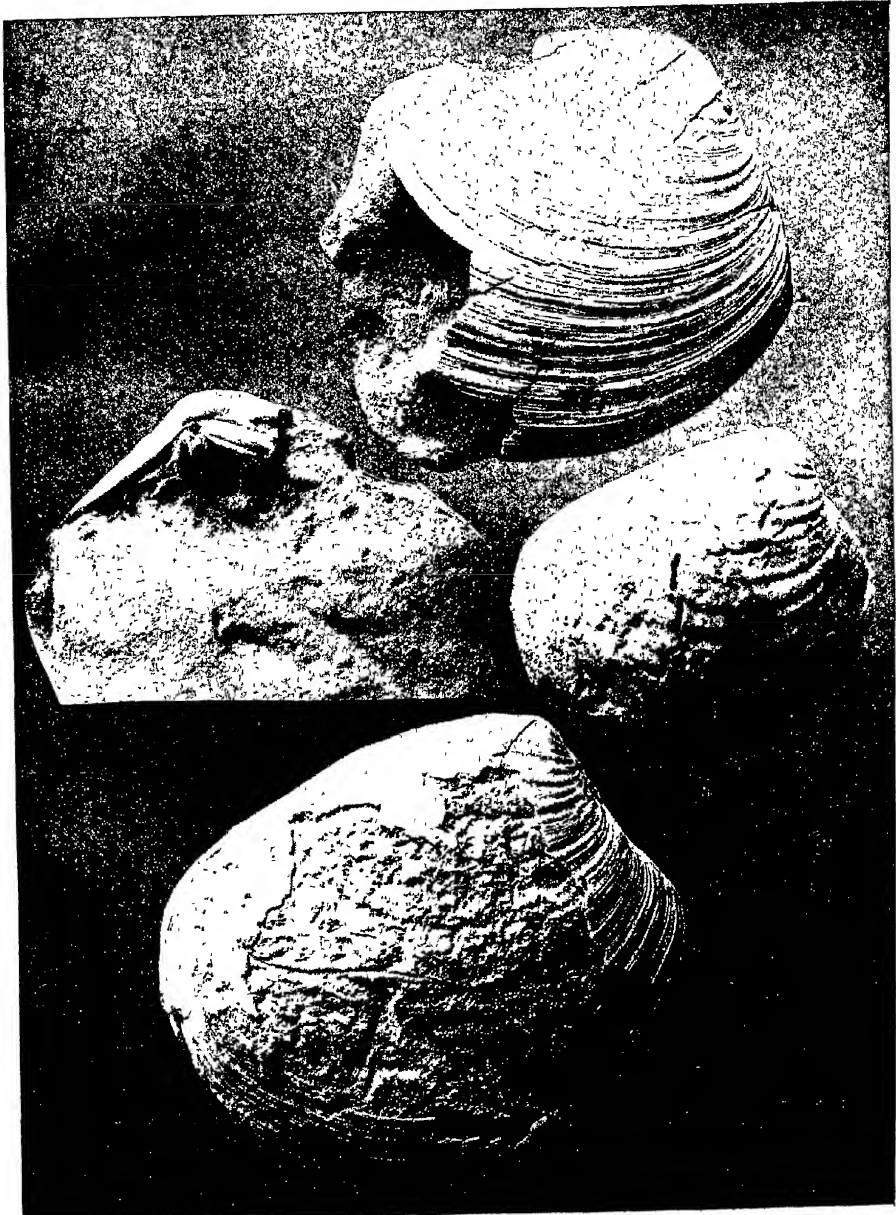
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## PLATE XXXII.

- FIGS. 1, 2.—*CLEMENTIA PAPHYRACEA* Gray, var. *GRANDIS* n. var. Right valve. Gwadar, Baluchistán, Mekran series (Gwadar stage). Fig. 1, external view; fig. 2, internal view. (13,426). Page 455.
- FIG. 3.—*CLEMENTIA PAPHYRACEA* GRAY. Right valve, external view. Same locality as figs. 1, 2. (13,425). Page 455.
- FIG. 4.—*CLEMENTIA PAPHYRACEA* Gray, var. *GRANDIS* n. var. Right valve, external view. Barambab, Baluchistán, Mekran series (Gwadar stage?). (13,427). Page 455.
- All the specimens are represented natural size.



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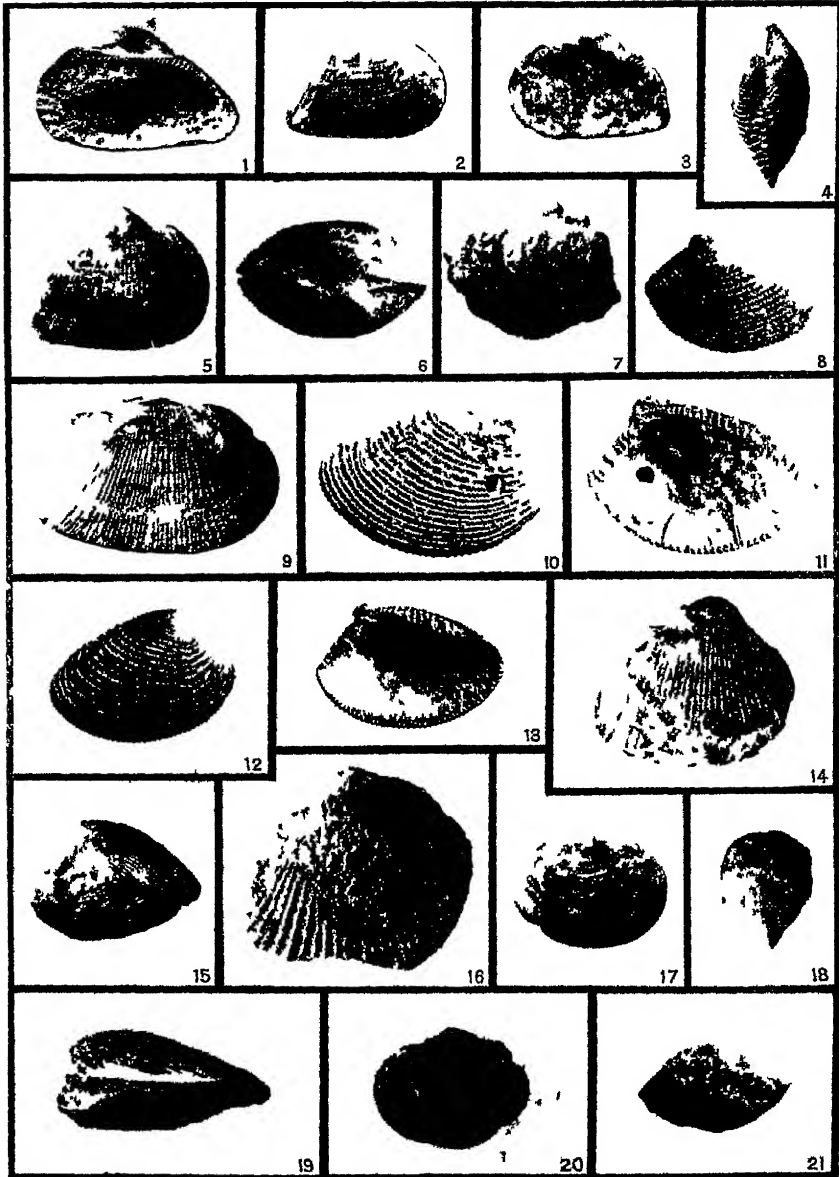
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## PLATE XXXIII.

- FIG. 1.—*ARCA FEDDENTI* n. sp. Right valve, internal view. Gáj of Kachh. mag.  $\times 2$ . (13,348). Page 415.
- FIGS. 2, 3.—? *ARCA FEDDENTI* n. sp. The specimen is missing. Figs. 2 and 3 appear to represent two views of the same specimen. (13,349). Page 415.
- FIGS. 4, 8.—*NUCULA CANCELLATA* n. sp. Gáj of Kachh. Fig. 4, dorsal view of both valves; fig. 8, left valve, external view mag.  $\times 3$ . (13,358). Page 420.
- FIGS. 5, 6.—*ARCA NEWTONI* n. sp. Bán Baluchistán, Mekran series (Talar stage). Fig. 5, right valve, external view; fig. 6, dorsal view of both valves. mag.  $\times 3$ . (13,350). Page 416.
- FIG. 7.—*NUCULA NARICA* n. sp. Right valve, external view. Nari of Bhagothoro Hill in Sind. mag.  $\times 2$ . (13,357). Page 420.
- FIG. 9.—*ARCA MEKLANICA* n. sp. Right valve, external view. Baluchistán, Mekran series (Talar stage). mag.  $\times 3$  (13,351). Page 417
- FIGS. 10, 11.—*NUCULA CANCELLATA* n. sp. Right valve. Gaj of Kachh Fig 10, external view; fig. 11, internal view. mag.  $\times 3$ . (13,359). Page 420.
- FIGS. 12, 13.—*NUCULA CANCELLATA* n. sp. Right valve, Gaj of Kachh. Fig 12, external view; fig. 13, internal view. mag.  $\times 3$ . (13,360). Page 420.
- FIGS. 14, 15.—*CARDITA (GLANS ?) ROVERETTI* n. sp. North eastern spurs of Takatu Range, Baluchistán, Nari. Fig 14, right valve, external view, fig 15, both valves, view from anterior. mag.  $\times 2$ . (13,393). Page 439.
- FIGS. 16, 19.—*CARDITA (GLANS ?) ROVERETTI* n. sp. Same locality as figs. 14 and 15. Fig. 16, right valve, external view; fig. 19, both valves, view from posterior. mag.  $\times 2$ . (13,394). Page 439.
- FIGS. 17, 18, 20, 21.—*LUCINA (DENTILUCINA) NARICA* n. sp. Same locality as figs. 14 and 15. Fig. 17, right valve, external view; fig. 18, both valves, view from anterior; fig. 20, left valves, external view; fig 21, dorsal view of both valves. mag.  $\times 2$ . (13,395). Page 440.
- The magnification of the specimens is in all cases stated in the explanations of the respective figures.



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