MEMOIRS

OF

THE GEOLOGICAL SURVEY OF INDIA,

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DESCRIPTIONS OF MOLLUSCA FROM THE POST-EOCENE TERTIARY FORMATION OF NORTH-WESTERN INDIA: CEPHALOPODA, OPISTHOBRANCHIATA, SIPHONOSTOMATA. 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 studie 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 Sind, 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 Fedden 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 Mekran. 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 Odeng 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 lithoiogically 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 Hingiáj (*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. Annandale 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 14 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

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

Pl. I, fig. 10.

1766. *Conus dormitor* Solander.—Brand., Foss. Hanton., p. 16, Pl. I, fig. 24.
1821. *Conus dormitor* Sol.—Sowerby, Min. Conch., Vol. III, p. 179, Pl. CCCI.
1850. *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-looking 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.—

	mm.
Height	23
Thickness	10·3
Height of spire	8·8
Height of body-whorl	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-

erved 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 vimineous* 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.

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 yamatanensis* 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 thalassiarchus* 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 umbo-like 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 ickei* 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 thalassiarchus* 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 blagravei*.

Conus (Dendroconus) loroisii Kiener.

1847. *Conus loroisii* Kiener.—Iconographie des coquilles vivantes, p. 91, Pl. LXV fig. 1.

? 1847. *Conus berghausi* Michelotti.—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* Kiener.—R. Hoernes and Auinger, Gaster. I u. II Mioc. Med. Stufe, p. 21, Pl. III, fig. 5.

1882. *Conus loroisii* Kiener.—Martin, Samml. des geol. Reichs-Museums in Leiden, series 1, Vol. I, p. 100.

1883. *Conus loroisii* Kiener.—Martin, Samml. des geol. Reichs-Museums in Leiden, series 1, Vol. I. p. 223.

? 1893. *Conus (Dendroconus) exloroisii* Sacco.—Moll. terr. terz. Piem. e Lig., part XIII, p. 8.

1895. *Conus loroisii* Kiener.—Martin, Samml. des geol. Reichs-Museums 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° in the case of very immature specimens, of from 38° to 44° at average stages of growth, and of 48° 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 loroisii* 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 loroisii*, 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. loroisii*. It should be noticed, however, that Sowerby's illustration of *C. loroisii* 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 loroisii* 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 loroisii*, an identification regarded as incorrect by Sacco who, without stating the reasons for this opinion, has substituted, for this fossil, the name *exloroisii*, 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. loroisii*.

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 INDICUM 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 feebly 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 last

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 VENANENSIS Noetling, var. NARICA n. var. Bhagothoro Hill, Sind. (12,499).

FIGS. 8, 9.—PLEUROTOMA ICKEI Martin, Gàj 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).

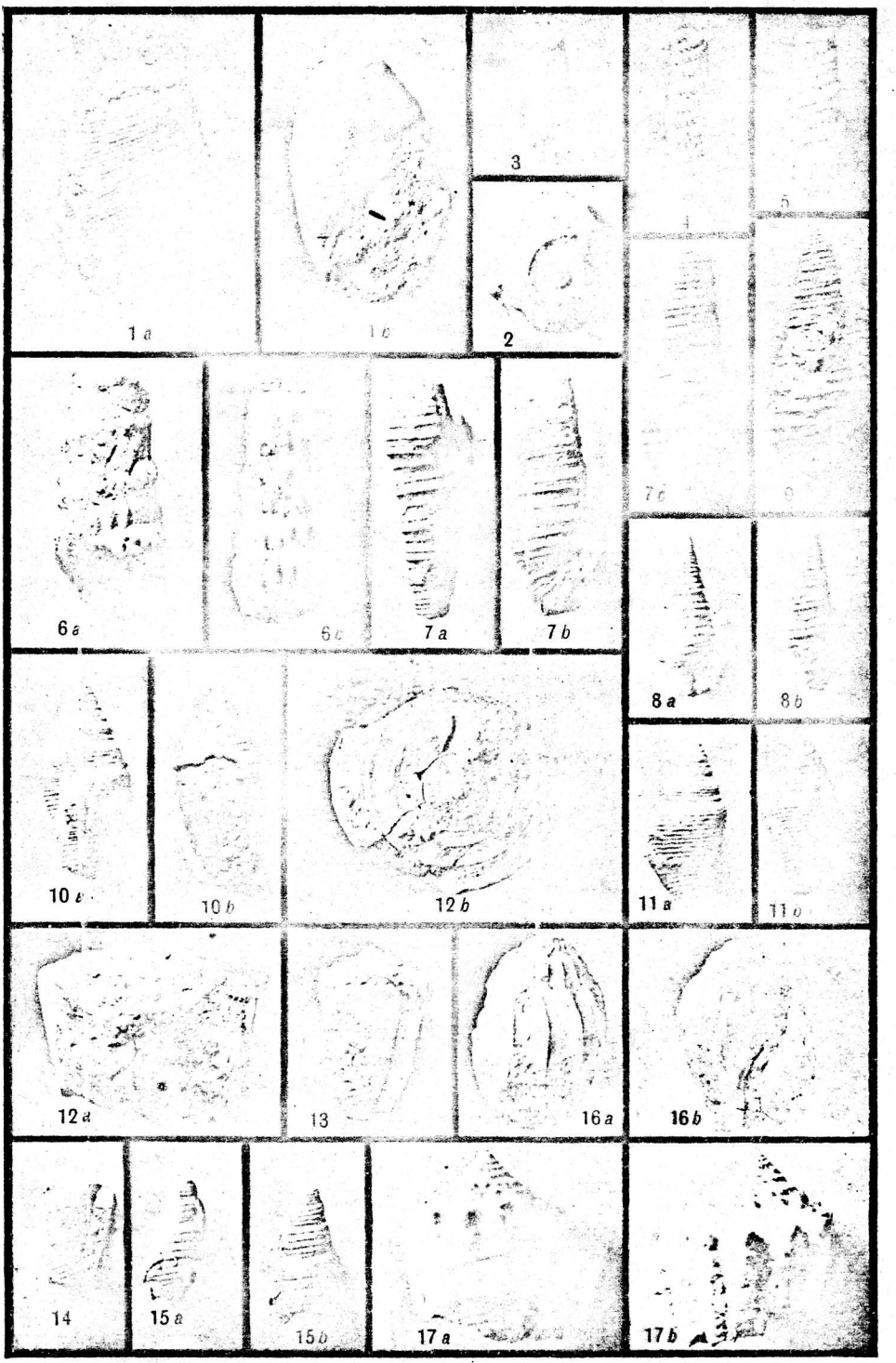
FIG. 15.—MITRA INQUINATA Reeve. Base of Talar section, Mekran. (12,546).

FIG. 16.—HARPA (EOCITHARA) NARICA n. sp. Bhagothoro Hill, Sind. (12,532).

FIG. 17.—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.



E. Vredenburg, Photos. *G. S. I. Calcutta.*

TERTIARY FOSSILS FROM WESTERN INDIA.