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PLATES I TO VIII.

THE MOLLUSCA OF THE RANIKOT SERIES.

PART I. *Cephalopoda* and *Gastropoda*.

BY M. COSSMANN AND G. PISSARRO.

Introductory Note on the Stratigraphy of the Ranikot Series.

BY E. W. VREDENBURG.

CALCUTTA:

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TABLE OF GEOLOGICAL FORMATIONS

Formation	Description	Stratigraphic Position	Thickness (feet)	Thickness (metres)	Geographical Location	Geological Age
Deccan and Peshawar	Deccan trap, basalt, and Peshawar	Fluvatile or lacustrine	Variable		Various parts of the Indian desert of Eastern Sind, and northwards to the plain north of Karachi.	Quaternary
9. Mandhar	The lower and upper beds consist of grey sandstone associated with iron concretions; the middle portion of the group consists of shaly beds of brown color, orange or brown associated with sandstone, shaly and abundant; the lowermost conglomerates contain teeth of <i>Mastodons</i> , <i>Palaeotherium indicum</i> , <i>Rhinoceros paludicosus</i> , etc.	Fluvatile or lacustrine	Nearly 10,000 (3,000 to 450)		The low ridges along the eastern foot of the Khirthar range from the northern frontier of Sind up to the neighbourhood of the Mandhar lake; the basin of the Mandhar lake; the valley of the Baran river from near Karhat to near Bhula Khan's Thana; a broad unshifting tract all along the eastern foot of the Laki range.	Upper Miocene and Lower Pliocene.
8. Gaj	Yellow limestone, either massive or rubbly, with intercalations of shaly arenaceous limestones, clays, gypsum, the latter sometimes massive. Amongst the fossils are <i>Ostrea angulata</i> , <i>J. de C. Sow.</i> , <i>Bryozoa</i> , <i>Coriaria</i> , <i>Echinodermata</i> , <i>Lepidocyclus marginatus</i> .	Marine	1,000 to 1,500 (300 to 450)		A discontinuous ridge parallel with the Khirthar range, and extending from east of Kutte-ka Kalar up to the borders of the Mandhar lake depression; the Moland Mahlar plateau east of the Hab valley; and most of the ridges east of the Hab up to Cape Monze; the greater part of the western and southern portions of the Karachi district.	Arquitanian.
7. Upper Nar.	Thick bedded usually grey sandstone with subordinate beds of clay, shale, ironstone and conglomerate containing <i>Ostrea angulata</i> and <i>Lepidocyclus marginatus</i> .	Large marine	4,000 to 6,000 (1,200 to 1,800)		Lower slopes east and west of the Khirthar range; valleys intervening between the Khirthar, Bhit, Rohra and Laki ranges; valleys of the upper Baran, of the Hab and of the Khand rivers; most of the low ground from Bula Khan's Thana to Jungshahi.	Arquitanian.
8. Lower Nar.	Strata with <i>Nannolites tuberosus</i> and <i>Lepidocyclus marginatus</i> consisting mostly of limestones; the lower beds often shaly and very massive; the upper bed usually brown and yellow interbedded with thick bands of shale and numerous layers of sandstone.	Marine	100 to 1,500 (30 to 450)		Many localities along the higher slopes of the Khirthar range; northern portion of the Laki range.	Stampian.
6. Khirthar	Massive white limestone with <i>Nannolites tuberosus</i> .	Marine	2,000 (600)		Main axis of the Khirthar range.	Upper Lutetian probably reaching into Bartonian.
	Massive white or pale colored nodular limestone occasionally some shaly intercalations towards the base, constituting the middle Khirthar (the Lower Khirthar being absent from Sind). These beds are crowded with numerous fossils including <i>N. perforatus</i> , <i>N. longipes</i> , <i>N. griseus</i> , <i>N. stuebeli</i> , <i>Aspidina cephalus</i> , <i>A. spira</i> .	Marine	500 to 1,000 (150 to 300)		Hills of Sakkar and Rohri; Bhit and Bhadra range; northern portion of Laki range; western slopes of Daphru range; western slopes of Surjano range (east of Bula Khan's Thana); Kanba and Kava ranges; southern termination of Khirthar range; Bolar and Dombur ranges between the Hab and Upper Baran valleys. The shaly beds are locally seen in the hills south of Rohri and at the northern extremity of the Laki range, particularly at Dharan Lak.	Lutetian.
4. Laki	Alveolina limestone, massive white or pale colored nodular rock with shaly at its base, 30 to 50 feet of shaly limestones, constituting the Motung shales. The leading fossils are <i>Nannolites tuberosus</i> and <i>Lepidocyclus marginatus</i> .	Marine	500 to 800 (150 to 240)		The greater portion of the Laki range; the eastern slope of the Daphru and Surjano ranges; the hills along the railway line from Manghad to Jungshahi; the hills south of Hyderabad; the Makhi hills near Tatta. The shaly layers are seen at Motung, between Motung and Jhirak, south of Hyderabad, and near Tatta.	
3. Rankot	Upper: lower limestone interbedded with shaly beds, shales and clays, <i>Nannolites planifolia</i> in the uppermost beds.	Marine	700 (200 feet maximum) 210 to 210		Low ranges east and west of Eden, and east of Band, Veng, neighbourhood of Jhirak.	Lower Eocene.
	Lower: soft sandstone, shaly and clays, often rubbly, colored buff brown and red, often shaly, occasionally some lignite.	Fluvatile	1,000 to 1,200 (1,500 feet maximum) 300 to 450		Eastern scarp of Laki range from Jakkhmati to Rankot; plain of Eden. There is an abundant lignite mine at Rankot.	
2. Deccan Trap.	Basalt	Volcanic	10 to 100 (12 to 27)		Some parts of Laki range.	Mostly Eocene, the upper part not yet reached by the Deccan
	Other beds and trap	Marine	250 to 1,000 (75 to 300)		Some parts of Laki range from Deccan to near Rankot, also west of Rankot.	
1. Mandhar	Upper beds	Marine	1,000 to 1,500		Several exposures along the scarp of the Laki range.	Mostly Eocene, the upper part not yet reached by the Deccan
	Lower beds	Marine	250 to 1,000		Several exposures along the scarp of the Laki range.	

Occurrence.—Lower beds of zone 2. Three miles east of the old coal-pit near Leilan (Fedden, ^{G. 280}_{126^a}).

Comparison with other species.—This species is very closely related to *Drillia jhirakensis*, and as the type is not in a perfect state of preservation, we should have hesitated to separate it, were it not for its more obtuse shape, and its wider-spaced ribs interrupted posteriorly by a much more obsolete depression; the absence of spiral striations may result merely from the weathering of the surface. The canal is broken just as in the case of the previous species; yet the portion preserved indicates that it must have been short as in the genus *Drillia*; moreover, the ornamentation being of the same type as that of other species of this genus, we think it safe enough to include it amongst them.

Family: *CONIDÆ* Adams.

Genus. *GENOTIA*, H. and A., Adams, 1853.

GENOTIA MURICIFORMIS, sp. nov., Pl. II, fig. 1.

Description.—Large, biconical; spire long, regularly conical in outline; seven spire whorls, angular, depressed, their height being equal to one-third of their width, imbricated and separated by deep sutures. Towards the anterior third and upon the angular portion, the ornamentation consists of a ring of prominent tubercles which are widely-spaced and do not correspond from one whorl to the next one. They are followed by a thick median cord behind which there is a broad excavated band, bounded by a small sutural swelling. Body-whorl large, its vertical dimension being equal to two-thirds of the total height; it is ventricose, slightly excavated at its base which is ornamented with a series of thick concentric threads, persisting up to the anterior portion where a keeled swelling is rolled round the neck. Aperture narrow, anteriorly terminated by a long narrow canal, slightly inflected towards the right; columella smooth, feebly sinuous posteriorly, inflected together with the canal at its anterior extremity; the striæ of growth indicate that the outer lip must have been notched in front of the suture, on the posterior depressed band of the body-whorl, by a broad "pleurotomic" sinuosity.

Dimensions.

Height	. . . . .	60 mm.
Diameter	. . . . .	30 ..

Occurrence.—Uppermost Ranikot, Jhirak (Vredenburg, ^{K. 7}₁₈₉).

Remarks.—The classification of this beautiful shell is particularly puzzling: externally it resembles a *Murex*, or certain kinds of *Melongena*; but it is covered with striæ of growth whose sinuosity indicates that it is certainly a member of the families Pleurotomidæ or Conidæ; moreover, the inflexion of the canal and of the columel

the existence of a swelling on the neck, indicate a real analogy with *Genotia* whose ornamentation somewhat recalls that of the Indian shell. Nevertheless, we are not acquainted with any European shell with which it can be compared. In their memoir on the nummulitic of India, d'Archiac and Haime have figured only one species of Pleurotomidæ which does not at all belong to the same group.

Genus : CRYPTOCONUS von Koenen, 1880.

CRYPTOCONUS SURCULÆFORMIS, sp. nov., Pl. II, figs. 6, 7.

Description.—Fairly large, rather slender, biconical; spire elongated, somewhat conoidal, consisting of eight or nine low whorls, their height being equal to about half their width, with flat or slightly convex surface, overlapping for some distance, bearing posteriorly a narrow non-depressed band, separated from one another by deep sutures, and with a tendency to a step-like disposition in full-grown individuals. Surface ornamented with numerous very close-set striæ of growth, distributed without much regularity, and traversed anteriorly by an extremely curvilinear sinuosity. Body-whorl large, its vertical dimension being more than half the total height, with a rounded base upon which the lines of growth continue up to the neck of the canal; they exhibit a double sinuosity posteriorly excavated. Aperture narrow, oval, posteriorly angular, terminated anteriorly by a canal, which, judging by the inflection of the striæ of growth upon the neck, must have been narrow and short; columella smooth, slightly callous, excavated; outer lip with a very broad crescentic notch in front of the suture which it joins at right angle, very prominent in its anterior portion where it forms another semi-circle before joining the extremity of the columella.

Dimensions.

Probable length	50 mm.
Diameter (the mean of two measurements taken from an individual distorted by pressure).	18 ..

Occurrence.—In the lowermost beds of the Upper Ranikot two miles east of Kandaira, Vera plain east (Fedden ^{G. 280}/₁₃₁), and undercarp of Jakhmari (Noetling, ^{K. 7}/₆₅₈).

Comparison with other species.—By its general outline and its almost smooth spire diversified only by a few obsolete threads, this species somewhat resembles a *Surcula*; but if one considers the vast development of the sinus, its anteriorly prominent outline, and especially (judging from the indications furnished by the striations of growth upon the neck), its sinuous junction indicating a relatively short canal, it becomes evident that this shell is a *Cryptoconus*, distinct, however, from other almost smooth species, or from those with only suprasutural lines such as *C. priscus*, Sol., or *C. clavicularis*, Lamk., from the middle and upper eocene of the Anglo-Parisian region. D'Archiac and Haime have not described any fossil of this group.

CRYPTOCONUS PERLIRATUS, sp. nov., Pl. I, fig. 24, and Pl. VII, figs. 47, 48.

Description.—Small, narrow, biconical; spire rather tall, conical or slightly conoidal; spire whorls depressed, their height being a little more than one-third of their width; they are convex and separated by deep sutures with a tendency to a step-like disposition, ornamented with about ten broad, raised, ribbon-like bands, gradually wider-spaced towards the posterior suture. Body-whorl large, its vertical dimension equalling about three-fifths of the total height of the shell; the flat revolving bands persist up to the anterior extremity, and are crossed by very sinuous lines of growth; base excavated at the neck; outer lip thin, deeply notched in front of the suture, and forming a broadly convex curve in front of the sinus.

Dimensions.

Height	20 m m.
Diameter	8 "

Occurrence.—In the uppermost Ranikot beds. Jhirak (Fedden $\frac{G. 280}{124a}$; Vredenburg, K. 7, 187).

Comparison with other species.—The generic determination of this elegant shell gives rise to no hesitation: it has quite the general appearance of the species of the Paris basin, but is essentially distinguished by its regular and persistent ornamentation. Amongst the species of *Cryptoconus* hitherto described, there are very few in which the whorls do not exhibit anteriorly a smooth zone, in front of the sulcated posterior region. In *C. perliratus*, this smooth zone is not developed, at least not up to the size of the figured type; at any rate, the only Parisian fossil whose ornamentation is comparable with that of *C. perliratus*, is the lutetian species *C. bistriatus*, Desh., whose spiral sulci punctuated and cancellated by the lines of growth do not bear a very close resemblance with the regular ribbons of the Indian species; moreover, the striæ of the last whorl in the lutetian species, are of alternating dimensions—hence the name—while there is nothing of the sort in *C. perliratus*; lastly the height of the aperture relatively to the spire is much less than in *C. bistriatus*.

Amongst completely striated species, one might mention the lutetian species *C. filusus*, Lamk., and *C. calophorus*, Desh., which carry pronounced, wide-spaced, spiral grooves, separated by intervals broader than themselves, and therefore very different from the flat or merely incised grooves of *C. perliratus*; moreover, their general outline is much more inflated, and their body-whorl larger. The same remark applies to an oligocene species described by Mayer-Eymar as *Pleurotoma Duboisi*.

Genus: *CONUS*, Linnæus, 1758.

CONUS BREVIS, J. de C. Sowerby?, Pl. I, figs. 21, 22.

1840. J. de C. Sowerby, *Trans. Geol. Soc.*, V, Pl. XXVI, fig. 33.

1853. D'Archiac and Haime, *loc. cit.*, p. 336, Pl. XXXIV, fig. 6.

Description.—Size moderate, shape conical, rather depressed; spire short, scarcely projecting; protoconch small and button-shaped; four whorls, the last of which

embraces the whole shell whose outline is slightly convex posteriorly, slightly excavated anteriorly.

Dimensions.

Length	25 mm.
Diameter	15 ..

Occurrence.—Uppermost Ranikot, Jhirak (Vredenburg, ^{K. 7}₁₈₃).

Remarks.—The geological horizon of the specimen referred by d'Archiac and Haime to J. de C. Sowerby's species is doubtful. Sowerby's type is from the Gaj beds of Kachh which are not older than uppermost Aquitanian, and which, therefore, differ vastly in age from the Ranikot of Sind. Nevertheless, the Ranikot shell corresponds almost exactly in shape and size with the one figured by d'Archiac and Haime. Our specimen is, however, a mere cast without any trace of external ornaments such as would justify an exact identification. We deem it safest therefore not to attempt any closer determination, especially as d'Archiac and Haime themselves rightly noticed that their specimen might easily be united with the one doubtfully referred by them to *Conus militaris* J. de C. Sow. (another Gaj species), though it appears rather more depressed.

CONUS SUBBREVIS, d'Archiac and Haime?, Pl. I, fig. 23.

1853. D'Archiac and Haime, *loc. cit.*, p. 336. Pl. XXXIV, fig. 8.

D'Archiac and Haime's description reduces itself to the following sentence: "Very much weathered cast strongly recalling a very short undescribed species from the 'faluns' of Touraine, where it is very common." It is of course impossible to identify our fossil from such a short diagnosis; it resembles, however, the figure published in the "Description," showing a spire slightly taller than that of *C. brevis*. The total height must have been about 35 mm. for a diameter of 15 to 17 mm. The spire whorls were probably angular, so far as can be judged from the incomplete cast which we have figured.

Occurrence.—Uppermost Ranikot, Jhirak (Vredenburg, ^{K. 7}₁₈₃).

Remarks.—As in the case of the previous forms, the exact horizon of d'Archiac and Haime's specimen is not known. According to Fedden (*Mem. G. S.*, XVII, p. 210), *C. subbrevis* is also a Gaj species. The authors of the "Description" state that it occurs in a whitish nodular limestone full of quartz grains, a rock quite unlike any of those from the Ranikot, while a material of this description is one of the commonest rocks of the Gaj.

PLATE I.

Fig. 1—4.	NAUTILUS SUBPLEURIAUSIANUS d'Arch	Nat. size.
Fig. 5—10.	STYRACOTHEUTIS ORIENTALIS Crick	"
Fig. 11—13.	BELUSEPIA INCURVATA Cossm. and Piss.	"
Fig. 14—15.	BULLA APICIALIS Cossm. and Piss.	"
Fig. 16—18.	ACERA STREPTA Cosm. and Piss.	2/1
Fig. 19—20.	TORNATELLEA VREDENBURGI Cossm. and Piss.	2/1
Fig. 21—22.	CONUS BREVIS Sow ?	Nat. size.
Fig. 23.	CONUS SUBBREVIS d'Arch. and Haime ?	"
Fig. 24.	CRYPTOCONUS PERFORATUS Cossm. and Piss.	3/2
Fig. 25—28.	SURCULA VOYSEYI d'Arch. and Haime	3/2
Fig. 29—30.	SURCULA (ANGUSTOSYRINX) VREDENBURGI Cossm. and Piss.	3/2
Fig. 31—32.	SURCULA INDICA Cossm. and Piss.	2/1
Fig. 33—35.	PLEUROTOMA (EOPLEUROTOMA) AMBIBOLA Cossm. and Piss.	2/1
Fig. 36.	PLEUROTOMA (HEMIPLEUROTOMA) EUALLISTA Cossm. and Piss.	4/1
Fig. 37.	DRILLIA ADELA Cossm. and Piss.	3/1

GEOLOGICAL SURVEY OF INDIA

M. Cossmann et G. Pissarro.

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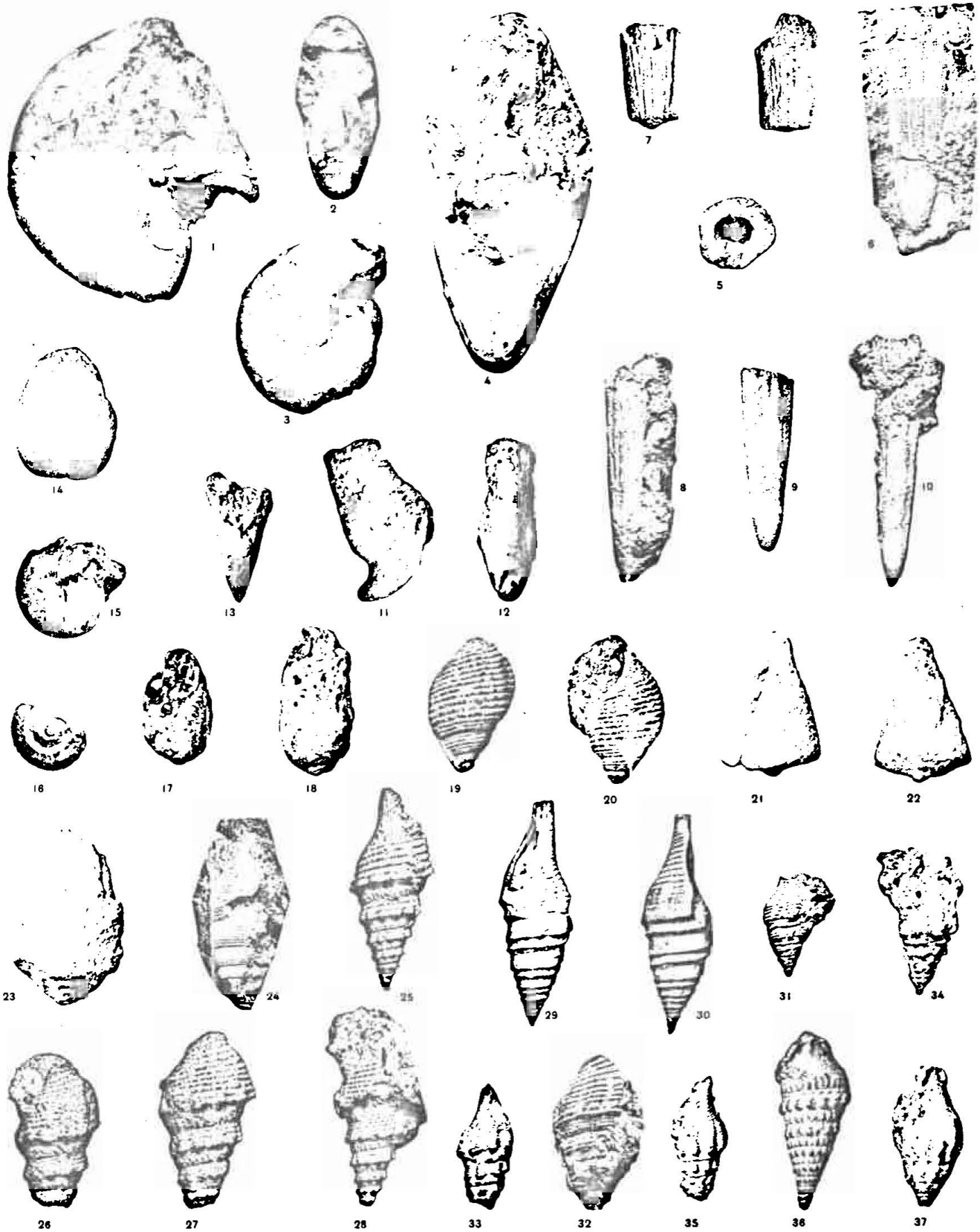


PLATE II.

Fig. 1—2.	GENOTIA MURICIFORMIS	Cossm. and Piss.	Nat. size.
Fig. 3—5.	PLEUROCERA VARIANS	Cossm. and Piss.	"
Fig. 6—7.	CRYPTOCONUS SURCULIFORMIS	Cossm. and Piss.	. . . . .	"
Fig. 8—9.	DRILLIA JHIRAKENSIS	Cossm. and Piss.	. . . . .	2/1
Fig. 10.	.. .. .	<i>varietas</i>	. . . . .	3/1
Fig. 11—13.	SURCULA (APIOTOMA) HYPERMECES	Cossm. and Piss.	. . . . .	2/1
Fig. 14—15.	PLEUROTOMA (EOPLEUROTOMA) JHIRAKENSIS	Cossm. and Piss.	. . . . .	2/1
Fig. 16—17.	ANCILLA (ALOCOSPIRA) INOPINATA	Cossm. and Piss.	. . . . .	3/2
Fig. 18.	VOLUTOSPINA INTERCRENATA	Cossm. and Piss.	. . . . .	Nat. size.
Fig. 19—20.	.. .. .	<i>varietas</i>	. . . . .	"
Fig. 21—22.	OLIVELLA HOLLANDI	Cossm. and Piss.	. . . . .	3/2
Fig. 23—24.	VOLUTOSPINA NOETLINGI	Cossm. and Piss.	. . . . .	Nat. size.
Fig. 25.	HARPA MORGANI	Cossm. and Piss.	. . . . .	2/1
Fig. 26—31.	LYRIA SHURIENSIS	d'Arch. and Haime	. . . . .	Nat. size.
Fig. 27—30.	AULICINA HAIMEI	d'Arch.	. . . . .	"
Fig. 32—33.	VOLUTOSPINA SYKESI	d'Arch. and Haime	3/2
Fig. 34.	AULICINA PUSIOLA	Cossm. and Piss.	2/1

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