

APPENDIX.

DESCRIPTION OF FRESH-WATER SHELLS FROM LOWER SIWALIK BEDS OF THE BUGTI HILLS

The following species were briefly noticed in Part I, Chapter III. They are very curious and interesting forms, and, although I have rarely attempted to describe fossils, I have been induced to undertake the task in the present instance, because I have some acquaintance with the living species of the same genera now inhabiting India and the neighbouring countries, and because of the peculiar interest attaching to fossil land and fresh-water Mollusca in general :—

1. MELANIA PSEUDEPISCOPALIS, sp. nov., Pl. 1, figs. 1, 2.

Testa pro genere magna, solida, breviter turrata, fere pyramidata. Spira imperfecta; anfr. superst. 3½ convexi, sensim accrescentes, costis verticalibus fortibus distantibus, in anfr. ultimo superne juxta suturam atque infra medium evanescentibus ornati, et lineis spiralibus elevatis filiformibus distantibus tuberculoso decussati. Anfr. ultimus basi liris spiralibus confertioribus 4—5 ornatus. Apertura? Long. 1.92; diam. 1.1 poll. angl. Apert. long. circum 1.

Shell large for the genus, thick, moderately turreted, not elongate, but almost pyramidal. Spire imperfect, about 3½ whorls remaining, which are well rounded, and increase in size regularly. They are ornamented with vertical ribs and raised spiral lines; the ribs are far apart from each other, and appear, so far as can be made out, to vanish above near the sutures, and below the middle of the last whorl; they are nodose where crossed by the spiral lines, which are distant from each other, except around the base of the last whorl, where they are rather closer together. So far as can be judged, there must be on the last whorl 5 or 6 distant raised spiral lines round the upper and middle portion, and 4 or 5, closer together, round the base. The form of the aperture cannot be ascertained, but was probably sub-rhomboidal, as in the recent *M. variabilis*.

Melania pseudepiscopal belongs, so far as can be judged from the single specimen procured, in which the aperture is not preserved, to the sub-genus *Melanooides*, Oliv. and is most nearly allied to *M. variabilis*, Bens., *M. episcopal*, Lea, and *M. sumatrensis*, Brot. It is a difficult question how far these species are really separable from each other, and from numerous closely allied forms that have received names from various conchologists. The form that comes nearest to the type now described, of all that I have been able to compare, is one figured in Hanley and Theobald's *Conchologia Indica*, Pl. LXXII, fig. 5, under the name *M. episcopal*, Lea. This specimen, which is from North Cachar, differs considerably from the other

forms referred to the same species in the work mentioned.¹ A specimen from Assam in the British Museum, referred to *M. variabilis*, is also very nearly allied to the fossil.²

Amongst the figures in Brot's admirable monograph of the *Melaniidæ*³ the three forms most nearly allied, so far as sculpture is concerned, are Pl. 11, fig. 2, *M. julieni*, Desh., from Tonquin, Pl. 12, fig. 1a, *M. episcopalis*, Lea, from Malacca, and Pl. 13, fig. 1a, *M. sumatrensis*, Brot, from Sumatra. All of these forms, however, have higher and more turreted spires, and the vertical (transverse) ribs in *M. pseudepiscopalis* are more distant. The spiral lines also are differently arranged. The present form, therefore, may receive nominal distinction.⁴ No known fossil species appears to be very nearly allied.

The similarity between the present form and the species mentioned of the subgeneric section *Melanoïdes* is so well marked that there can be very little doubt as to the affinities of *M. pseudepiscopalis*. The living species of *Melania* belonging to the same section are found along the base of the Himalayas, as far west as the Jumna, and perhaps rather further; they occur throughout a considerable portion of the Gangetic plain, and in Orissa, and they abound in Burmah, the Malay countries, Siam, and the islands of the Malay Archipelago, &c. A species has been found in Malabar, and the type is probably represented in Ceylon, but it is wanting throughout the greater part of the Indian peninsula, and is quite unknown in Sind, the Punjab and all Central India.

Two views of the same specimen are given in figures 1 and 2 of Plate 1.

2. MELANIA GRADATA, sp. nov., Pl. 1, figs. 3—5.

Testa gradato-turrita, solida, lævigata. Spirâ vix erosa. Anfr. 6. gradatim accrescentes, haud procul a suturâ forte atque prominenter angulati, infra angulum fere cylindracei, lateribus verticalibus planisque, antice concaviusculis; ultimus parum major, infra angulum concavus, subtus convexus. Apertura fere ovata, postice angulata; margine externo postice retro sinuato, antice arcuato. Long. 1.05; diam. 0.5; ap. long. circum. 0.45 poll. angl.

Var. major, minus elata, ovato-turrita. Long. 1.25; diam. circum. 0.75 poll. angl.

Shell turreted, thick, smooth. The spire is high, scarcely eroded at the apex, and composed of six whorls in one or two specimens, five in others, regularly increasing in size by steps, sharply and prominently angulate just below the suture, and nearly cylindrical below the angulation, the sides being flat and vertical in the upper whorls, slightly concave in the lower, especially in the last whorl, which is prominently but bluntly angulate near the suture, then hollow at the side and convex towards the base. Aperture ovate, not preserved entire in any specimen, but raised lines of growth

¹ By Brot (Mart. Chemn. Conch. Cab., Melaniaceen, 1874, p. 89.) these forms are referred to *M. spinata*, Godwin-Austen, but the particular figure 5 of Pl. 72 above noticed is not quoted in Brot's synonymy.

² I am indebted to Mr. E. Smith, the Assistant Keeper, for this comparison. He also pointed out to me the resemblance of the fossil to a form of *M. asperata*, Lamarck, from the Philippine Islands.

³ See preceding note.

⁴ It is rather a question of convenience than fact, whether closely allied forms of fresh-water mollusca shall be classed as "species" or "varieties."

showing the form of the lip when the shell was not quite mature are preserved in a few cases, and show that the posterior or upper part of the outer margin was sinuate or curved back for some distance below the suture, whilst the anterior or lower portion was arcuate or curved forward; the base was probably curved back, perhaps sub-caliculate.

Var. major, Pl. I, fig. 4. Two specimens, rather larger than the rest, differ in having the spire less raised. I think, however, that there is not sufficient evidence to class these specimens in a different species. One of them has spiral sub-distant impressed lines round the base of the last whorl. This may show that it is really a different species, but there are similar lines, though fewer, on one specimen of the smaller form. No such lines, however, occur on those specimens of which the surface is best preserved.

I am unable to find any species of *Melania*, living or fossil, allied to the peculiar type here described. In general form there is some resemblance to the sub-genus *Plotia*,¹ comprising *M. scabra* and its allies, some of which have the whorls angulate below the suture, but the form of the aperture is different. The group *Tiara*, in which the angulation is more marked and the whorls usually smooth, has a much larger last whorl, and a nonsinuate external margin to the peristome. In both these groups the angulation of the whorl is ornamented with spines, and the same may originally have been the case with *M. gradata*. The present species may be allied to the section *Tiaropsis*³ including *M. winteri* of Java and its allies, or to the peculiar form *M. impura*,⁴ Lea, from the Philippines. These have the outer margin of the aperture sinuate and the whorls more or less angulate, but the general form is different, and none have the peculiarly shaped whorls of *M. gradata*.

It is not quite certain, indeed, that the present species was really a *Melania*. The spire resembles that of the curious fresh-water form discovered by Dr. J. Anderson in Yunan, and named *Margarya melanoidea* by Mr. G. Nevill (J.A.S.B., Vol. XLVI, 1877, Pt. 2, p. 30, and Vol. L, 1881, p. 155, Pl. V, fig. 1.—Anderson, An. Zool. Res. Western Yunan, p. 891, Pl. LXXX, fig. 5.), but that has the mouth of a *Paludina* and probably, as suggested by Mr. Nevill, is closely allied to that genus, if it does not belong to it.

The typical form of *M. gradata* is represented on Plate 1, figure 3, the large variety in fig. 4, and in fig. 5 the lines of growth are shown.

3. PALUDINA BUGTICA, sp. nov., Pl. 1, figs. 6, 7.

Testa imperforata, ovato-conoidea, solida, glabra. Spira conoidea, lateribus convexis, apice obtuso, suturâ impressâ. Anfr. 4 parum convexi, subplanulati; ultimus haud descendens, subtus rotundatus. Apertura ovato-rotunda, obliqua; peristomate haud incrassato, recto. Long. 0.6; diam. 0.4; ap. long. 0.27 poll. angl.

Shell imperforate, ovately conoid, solid, smooth. Spire conoid with the side convex, apex blunt, suture impressed. Whorls about 4 in number, slightly convex or flattened, generally the latter; the last whorl not descending, rounded below. Aperture nearly round, oblique; peristome not thickened, all in one plane.

Brot, l. c., p. 263.
Ibid, p. 288.

³ Brot., l. c., p. 299.
Ibid, p. 312.

I am disposed to believe that this species is more probably a *Paludina* than a *Bythinia*, because, had it belonged to the latter genus, I think, in a deposit in which most of the specimens of *Unio* occur with the valves united, that some specimens of the univalve would be found with the shelly opercula in place, just as they commonly are in Indian rivers at the present time.

There is no very closely allied form inhabiting India at the present time (the nearest is perhaps *P. crassa*, Hutton), but *Paludinæ* are not characteristic shells, and a dozen similar species, recent and fossil, might easily be selected for comparison. Two specimens, differing slightly, are represented in figures 6 and 7 of Plate I.

4. UNIO VICARYI, sp. nov. Pl. 2, figs. 1—3.

Testa transversim subtriangulari-ovata, ventricosa, inæquilateralis, concentricè striata, extus atque intus radiatim costata, solida, antice rotundata, postice subangulata; margine dorsali postice primum recto, tunc convexo-declivi, ventrali convexo, postice undulato; umbonibus prominentibus, inflatis; valvulis extus antice glabris, medio ac postice liris sulcisque ornatis, omnibus nisi juxta extremitatem posteriorem subparallelis atque oblique (sc. postice) declinatis, ab margine umbonali ad ventralem decurrentibus; anterioribus minoribus, subdistantibus, mediis 3-4 confertioribus, post medium 3-4 multo majoribus latioribusque, postremis nonnullis brevibus in regione posticâ dorsali, a cæteris divergentibus, atque in marginem posteriorem desinentibus; dentibus cardinalibus magnis. Long. exempli majoris 4; lat. ad 2.25; crass. 2.15 poll. angl.

Shell transversely and subtriangularly ovate, ventricose, especially in the middle, thick, inequilateral, concentrically striated and radiately ribbed both inside and outside, short and rounded anteriorly, subangulate at the posterior end. The dorsal margin is straight for some distance behind the beaks, then rather convex; ventral margin convex, rather prominent in the middle in some specimens, undulating posteriorly opposite the terminations of the ribs on the valves. Umbones prominent and swollen. The valves are nearly smooth near the anterior extremity, but all the rest of the surface is covered with straight ribs and furrows; all the ribs except at the posterior end being subparallel, and sloping obliquely and backwards towards the ventral margin. The first (anterior) ribs are small and subdistant, the next three or four, in the middle of the shell, still small but close together, then a few on the posterior portion of the surface, about 4 in number, are much larger and broader, whilst the dorsal portion of the posterior surface is occupied by a few broad short ribs diverging from the others and running directly towards the posterior end. Cardinal teeth large.

This description is chiefly taken from the only specimen in which the external surface is preserved. The measurements of this specimen are given above. The other examples collected are chiefly casts with the inner portion of the shell remaining. The broad ribs on the posterior surfaces of the valves are preserved in all the casts, and appear as well marked internally as externally, but the finer anterior ribs have disappeared inside the shell. A perfect cast of a shell rather smaller than that of which the dimensions were given above measures—length 3.6, breadth 2.2, thickness 1.9 inches.

I am unacquainted with any species of *Unio*, living or fossil, with which this well marked form can be considered as allied.¹

Only six specimens of this species were collected; in all but one both valves are in position. Many were seen, but the majority were mere casts or too imperfect to be worth bringing away. The species did not appear to be rare. It is named after Captain Vicary, the original discoverer of the deposit containing the curious series of fresh-water shells now described.

In Plate 2, fig. 1, the specimen above mentioned, in which the surface of the shell is fairly preserved, is represented. Figures 2 and 3 are taken from a well-preserved cast with a little of the shell remaining attached.

5. *UNIO CARDIIFORMIS*, sp. nov., Pl. 3, figs. 1—6.

Testa fere orbiculata, rotundato-ovalis, subæquilateralis, valde radiatim costata, crassa, ventricosa, antice atque postice rotundata; margine dorsali ante umbones concavo, post eos primum subrecto, deinde convexo; ventrali rotundato, valde undulatim corrugato; umbonibus prominentibus, inflatis; valvulis liris sulcisque radiantibus rectis fere æqualibus, postice declinatis, obtectis; dentibus cardinalibus magnis. Long. 3; lat. 2·6; crass. ad 2 poll. angl.

Shell almost circular, much resembling a *Cardium* or *Pectunculus* in general form and sculpture, subequilateral and ornamented with strong radiating ribs, thick, ventricose, the anterior and posterior ends rounded; the dorsal margin concave in front of the umbones, straight for a short distance behind them, then convex, ventral margin evenly rounded, and deeply corrugated, the corrugations corresponding to the termination of the ribs on the valves. These ribs are straight, nearly equal in size and equidistant; all have a considerable inclination backwards as they pass from the dorsal to the ventral margin. The number appears to vary. In the best preserved example (that figured) there are 14, on another only 11 or 12, the posterior extremity of the shell being in this case smooth, though it is ribbed on the other. Cardinal teeth very large.

The measurements of a large specimen are given above. A smaller and less perfect pair measurements—length 2·4, breadth 2·2, thickness 1·6 inches. A cast is 2·5 × 2·25 × 1·5.

This and the next species are two of the most remarkable forms of *Unio* ever discovered, and they would probably be made a separate genus by many palæontologists and by some malacologists. There is a slight resemblance between them and certain living American forms, such as *U. plicatus*, Say, and *U. laticostatus*, Lea, but no near connexion. The prominent sculpture formed by the alternating ridges and furrows and the remarkable corrugated ventral margin are exaggerations of the features found in the genus *Cardium*, and rather resemble the peculiar characters of some mesozoic species of *Ostrea*. Some approach to this character is, however, seen in certain intertrappean forms of *Unio* of upper cretaceous age, occurring near Nagpúr.

¹ At first sight it appeared to me that there was a resemblance between both this form and *U. cardiiformis*, and some of the species of *Unio* obtained from the intertrappean (upper cretaceous) beds of Nagpúr and other places in Central India. The same idea occurred independently to Dr. Feistmantel. I was unable to compare the specimens now described with the collection of intertrappean fossils in Calcutta, but although there is a slight similarity between *U. vicaryi* and the intertrappean *U. hunteri*, Hisl, the two do not seem very closely connected.

The cast is almost smooth, the external ribs not being repeated on the inside of the shell except close to the ventral margin.

U. cardiiformis was common at both the places (near Gandoi and near Kumbi) in the Bugti hills, where I found the bed with fresh-water shells, and it was doubtless the species seen by Vicary¹ and taken by him for a *Cardium*. I found either the same or a closely allied form, but poorly preserved, in a bed at nearly the same horizon, close to the base of the Siwalik system, in the Sulemán hills, on the Siri stream, west of Sakhi Sarwar and again in the Vadúr Pass further north. It is possible that the same form was noticed by Mr. Wynne² at precisely the same geological horizon in the Kohát district of the Punjab.

As with the other species of *Unio*, the two valves generally occurred together.

Three views of this shell are given on Plate 3, figures 1, 2, 3. Figures 2 and 3 are to some extent restorations, and are intended to show the dorsal and ventral aspects.

5a. *UNIO CARDIIFORMIS* var. (vel species distincta). Pl. 3, fig. 4.

Testa trigono-globosa, crassa, ventricosa, costis validis paucis radiatim ornata, antice rotundata, postice subangulata; margine dorsali post umbones declivi, recto; ventrali rotundato, valde undulato, cæterum similis U. cardiiformi typo. Long. 2.2; lat. 2.15; crass. 1.9 poll. angl.

This is probably only a variety of *U. cardiiformis*, with fewer ribs and a more triangular shape. It would doubtless be classed as distinct by many palæontologists and conchologists, but recent forms of *Unio* are excessively variable, and I should not like to propose a name for the present form without more evidence of its distinctness. Only one specimen (a pair of valves as usual) has been brought away. The anterior portion of the shell has perished, and of this part only the cast remains; in the perfect shell there were probably about 8 or 9 radiating ribs on the surface of each valve.

The shell described is represented in figure 4 of Plate 3.

6. *UNIO CARDITA*. sp. nov., Pl. 1, figs. 8, 9.

Testa ovata, inequilateralis, mediocriter ventricosa, crassa, costis validis subconfertis, ab margine dorsali ad ventralem subradiatim decurrentibus oblique atque postice declinatis ornata, antice atque postice rotundata; margine dorsali ante umbones concaviusculo, post eos subrecto; ventrali convexo, valde undulato; umbonibus prominentibus; dentibus cardinalibus magnis. Long. 2.75; lat. 2.1; crass. 1.6 poll. angl.

Shell ovate, resembling a *Cardita* in form and sculpture, inequilateral, moderately ventricose, thick; the surface of the valves covered with strong straight radiating ribs not very close together, running obliquely from the dorsal to the ventral margin and inclined posteriorly in the latter direction. Anterior, posterior, and ventral margins rounded, dorsal margin a little concave in front of the umbones, nearly straight and sloping behind, cardinal teeth large.

The measurements of a large specimen are given above; a small pair measures—length 1.85, breadth 1.45, thickness 1.15.

¹ Q. J. G. S., Vol. II, 1846, p. 264.

² Mem. G. S. I., Vol. XI, pp. 61 (165) and 64 (168).

Although this shell, the specific name of which is given on account of its resemblance to the genus *Cardita*, is well distinguished from *U. cardiiformis* both by form and sculpture, the shape being much more ovate and less ventricose, and the ribbing considerably more distant and more oblique, I am far from certain that the two are not varieties of a single form. Only three specimens, a large and a small pair of shells and one cast, belong to *U. cardita*, and the peculiar variety of *U. cardiiformis* last described shows a tendency to a passage, through having fewer ribs than the type. But so well marked a form as *U. cardita* requires nominal distinction at all events, whether connected with *U. cardiiformis* by intermediate links in the same locality or not.

Like its ally, the present species has not, so far as I am aware, any known ally living or fossil.

Two representations of the specimen described are given in figures 8 and 9 of Plate 1.

7. *UNIO PUGIUNCULUS*, sp. nov., Pl. 1, figs. 10—13.

Testa transversim elongata, pyriformi-ovata, valde inæquilateralis, ventricosa, crassa, antice breviter rotundata, subtruncata, postice attenuata, demum truncatula; margine dorsali postice declivi, fere recto, ventrali convexo, juxta extremitatem posticam concaviusculo, umbonibus prominentibus, inflatis, prope marginem anticum positis, valvula utraque costis duabus, inferiore multo validiore, haud procul a margine dorsali ab umbone ad extremitatem posticam decurrentibus, ornata; dentibus cardinalibus validis. Long. 1.3; lat. 0.8; crass. 0.65 poll. angl.

Shell transversely elongate, pyriformly ovate, very inequilateral, ventricose, thick, short and rounded, almost truncate anteriorly, subconical behind, and gradually diminishing to the end, which is cut off, the dorsal margin sloping, almost in a straight line, from the umbones to the posterior extremity, the ventral margin convex throughout the greater part of its length, but slightly concave close to the posterior termination. Umbones prominent, swollen, situated close to the anterior end of the shell, each valve furnished with two ribs near the dorsal margin running from the umbones to the posterior extremity, the inner of the two (that farthest from the dorsal margin) being much the more prominent, and forming, in fact, a division between the general surface of the valve and the hinge area. Cardinal teeth very large and thick.

There is no very near ally of this form living in the peninsula of India, the nearest being species like *U. cæruleus*, Lea, and *U. gerbidoni*, Eydoux. In this case, as in that of *Melania pseudepiscopalis*, much greater similarity can be traced to types existing at present only east of the Bay of Bengal. The closest ally appears to be a form described from Pegu by Mr. Benson under the name of *U. pugio*,¹ and this, again, is said to resemble the Siamese *U. ingallsianus*,² Lea. In China, the type is well developed, the extreme form, and one of the best known, and being *U. grayanus*, and some species probably belonging to the same group are found in North America, e.g., *U. nasutus*, Say.³

¹ Ann. Mag. Nat. Hist., 3, Vol. X (1862), p. 193. Hanley and Theob. Conch. Ind. Pl. X, fig. 7.

² Lea, Trans. Am. Phil. Soc., Vol. X, p. 232, Pl. XXIV, fig. 41. Ry. Conch. Icon., Unio No. 126.

³ The species named are figured in Lea's Observations; in Küster's Monograph of the genus (Martini and Chemnitz, Syst. Conch. Cab.); and in Reeve's Monograph in the Conchologia Iconica.

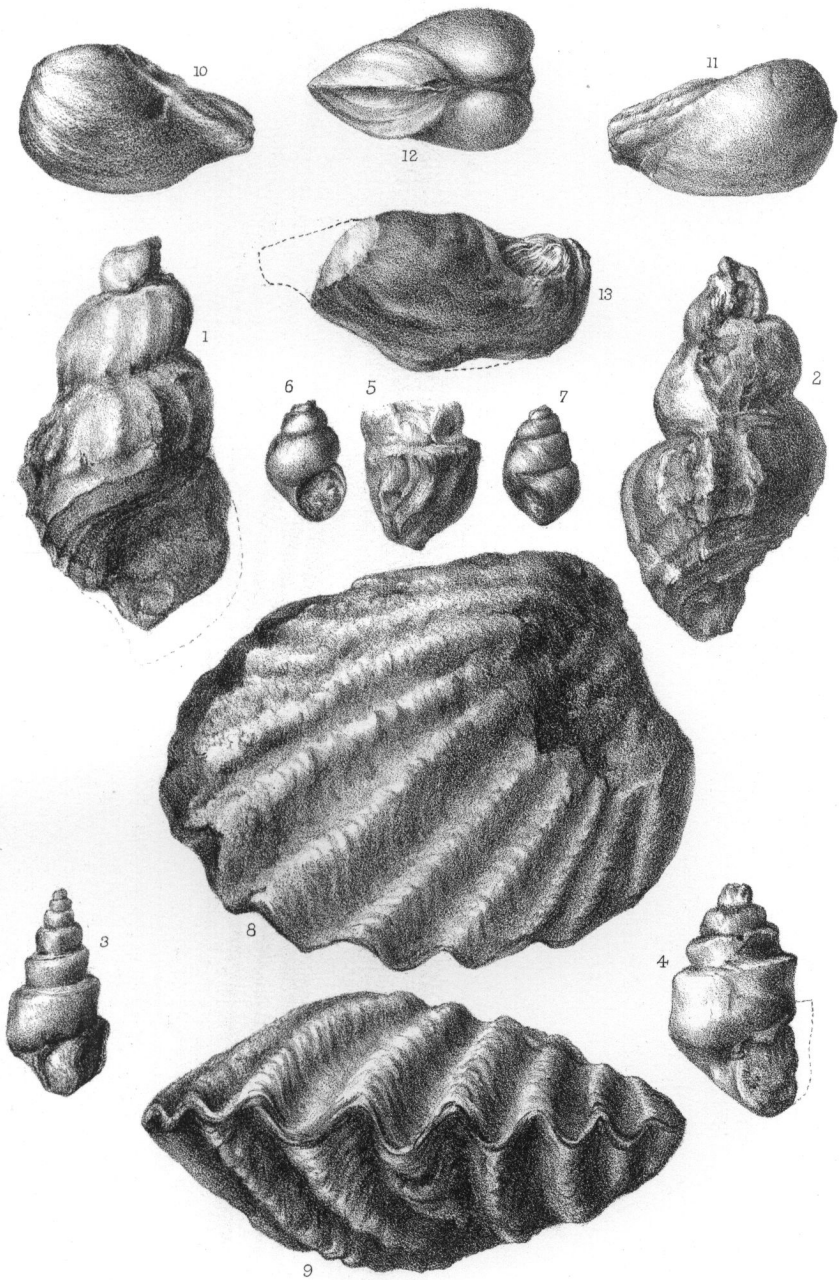
U. pugiunculus occurred commonly with the other species described. Several specimens were obtained in fair condition. Both valves, in this and the other species of *Unio*, were almost always found together, showing that the animals must have lived on, or nearly on the spots where they have been preserved.

Three views of different specimens from different directions are given in Plate 1, figures 10, 11, 12. Figure 13 represents a large cast.

To sum up. Of the seven species above described four have no known living allies; one more is not nearly represented by any Indian species, but may perhaps be related to forms existing elsewhere; it belongs, however, to a genus in which there is no great variety and which is not very characteristic. Of the remaining two species, one, *Melania pseudepiscopalis*, is so closely allied to forms now inhabiting Burma and North-Eastern India as to be scarcely separable, and it may be considered as virtually a living species, whilst the last, *Unio pugiunculus*, although clearly distinct from any known living form, is related to a Burmese species, and more distinctly to other forms now inhabiting China and Siam.

Thus of seven fresh-water shells that inhabited the rivers of the north-western Indian frontier in Lower Siwalik times, none are now represented in the surrounding country, five have completely died out, and two have either migrated eastward or have survived to the east and disappeared to the west of India.

It is interesting to note that none of the species described appears allied to the Miocene or Pliocene fresh-water Mollusca of Europe.

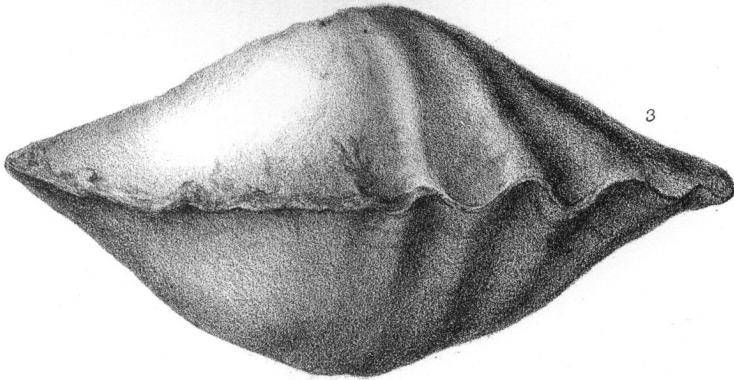
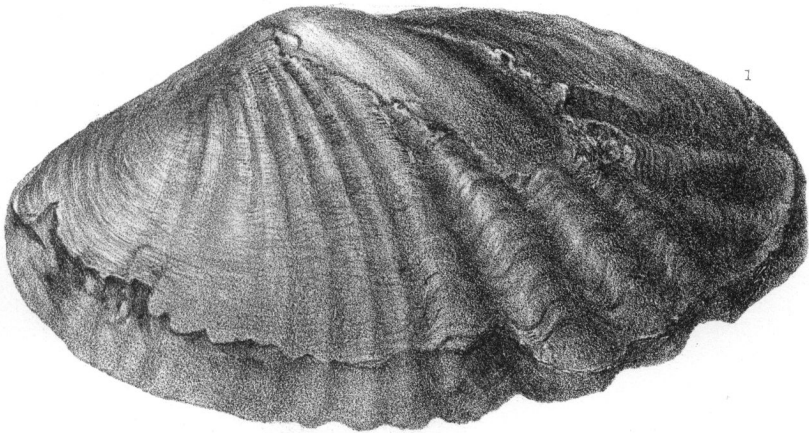


G.M.Herschell ad.nat lith.

Hanhart lith imp.

LOWER STWALIK MOLLUSCA.

1-2 *Melania pseudepiscopalis*, 3-5 *M.gradata*.
 6-7 *Paludina bugtica*, 8-9 *Unio cardita*.
 10-13 *Upugiunculus*.

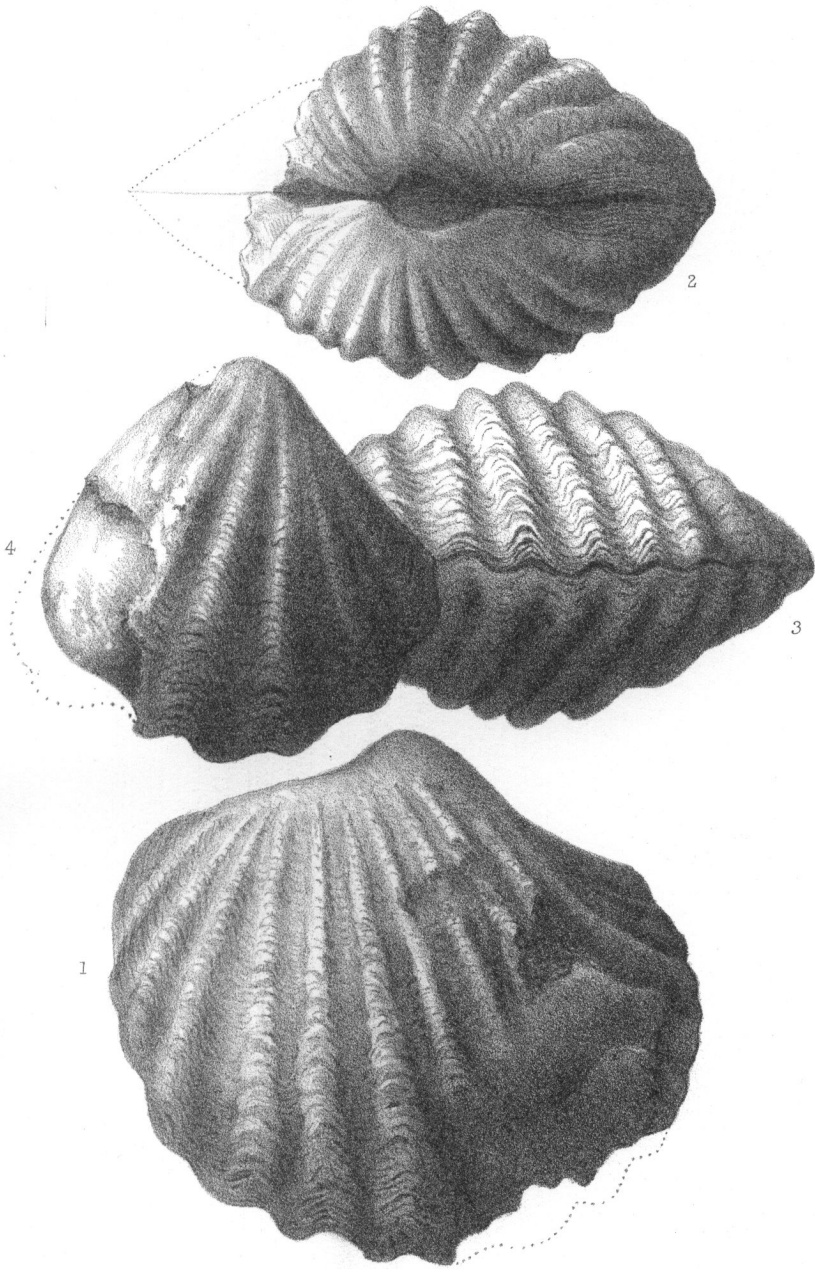


G.M.Herschell ad.nat. lith.

Hanhart lith imp.

LOWER SIWALIK MOLLUSCA.

1-3. *Unio vicaryi*.



M. Suft del. et lith.

Hanhart imp.

LOWER SIWALIK MOLLUSCA.

1-4 *Unio cardiiformis*.

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MEMOIRS
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GEOLOGICAL NOTES ON THE HILLS IN THE NEIGHBOURHOOD
OF THE SIND AND PUNJAB FRONTIER BETWEEN QUETTA
AND DERA GHAZI KHAN, *by* W. T. BLANFORD, F.R.S.,
&c., *Deputy Superintendent, Geological Survey.*

PART I.—GENERAL.

CHAPTER I.

INTRODUCTION.—PREVIOUS OBSERVERS.

The principal object of the field work done by me in the season
1881-82 was to trace northward the well marked
series of tertiary rocks, of which the age has been
determined by the occurrence of marine fossils at several different hori-
zons in Sind, and to ascertain how far the classification established in
that province could be applied to the tertiary beds of the Punjab. As is
well known, in consequence of the absence of marine fossils, or of any
well marked subdivisions, it has hitherto been found impracticable, in
the last named area, to determine the age of the beds above the eocene,