

INDIAN FOSSIL VIVIPARAE. BY N. ANNANDALE, D.Sc.,
F.A.S.B. *Zoological Survey of India.* (With Plate 11).

IN a recent paper¹ I discussed the fossil Viviparidæ of Upper Burma and compared them with their living representatives from the same country and with similar forms from other regions and epochs. I had not seen Mons. H. Mansuy's² interesting account of fossil species of the family from a lacustrine basin in Yunnan, but Mr. Vredenburg has now been kind enough to call my attention to it and I am glad to find that the French author and I, working independently, have come to very similar conclusions as to the evolution of highly sculptured shells in such genera as *Taia* and *Margarya*. There is, however, one point in my own paper on which additional information, only quite recently available, leads me to think that I expressed too confident an opinion, namely that the nodulose, squamose or even spinose sculpture in the shells of such species was derived from smooth spiral ridges. I was led to this view by the fact that in *Taia theobaldi*, which is in some respects the most primitive form in its genus, the spiral ridges on the shell are nearly smooth; but even in this species they are not absolutely so, and it inhabits an environment (running water in small streams) in which entirely primitive types rarely occur. Moreover, the smooth, hollow ridges on such a shell as that of *Vivipara oxytropis* (Benson) are associated, as I hope to show shortly in a more appropriate place, with an entirely different type of mantle-structure from that correlated with the shell-sculpture of *Taia* and *Margarya*. Indeed, in the Viviparidæ with highly sculptured shells we find three types of sculpture, the nodular, the solid linear, and the hollow linear and they are not homologous, probably not even analogous.

The fossil shells of *Vivipara* from Peninsular India and Baluchistan in the collection of the Geological Survey of India are of late cretaceous, tertiary and quarternary age, but the specimens are few. They have not the superficial interest of the peculiar Burmese forms, but are probably of no less importance, in proving that the

¹ Annandale, *Rec. Geol. Surv. Ind. L.*, p. 209 (1919).

² Mansuy, *Bull. Serv. Geol. de l'Indo-China V*, fasc. 3 (1918).

Indian Viviparidæ have undergone very little outward modification since late cretaceous times and that, so far as the evidence at present available goes, have never developed shells with prominent sculpture.

In describing and discussing these species a question of some little difficulty has first to be answered: Which of the Intertrappean species assigned by Sowerby¹ and Hislop² to the genus *Paludina* really belong to the Viviparidæ? In the collection before me I can find only one that I believe to do so, namely *Vivipara normalis* (Hislop). A few others (e.g., Hislop's *Paludina rawlesi*) may possibly do so, or may even represent connecting links between the Viviparidæ and the Hydrobiidæ; but such questions I must leave to Colonel Godwin-Austen, who tells me that he proposes to re-describe Hislop's species and other molluscs from the Intertrappean beds. If I am right as to the position of *V. normalis*, I have seen only four fossil species from any part of the Indian Empire that can be referred to *Vivipara*. They are:—

- | | |
|---|--|
| <i>Vivipara normalis</i>
(Hislop). | Intertrappean (late cretaceous) beds of
the Central Provinces of India. |
| <i>Vivipara bugtica</i>
(Blanford). | Oligocene or miocene beds of the Gaj
stage in the Bugti Hills, Baluchistan. |
| <i>Vivipara atavia</i> sp.
nov. | Same beds in the Bugti Hills. |
| <i>Vivipara bengalensis</i>
(Lamarck). | Alluvium of the Narbada and the
Ganges; recent all over India east
of the Indus. |

The most interesting of these species is perhaps *V. atavia* as it appears to have given rise with very little modification to a species still living in the inland delta of the Helmand.

VIVIPARA NORMALIS (Hislop).

1860. *Paludina normalis*, Hislop, *Quart. Journ. Geol. Soc., London*, XVI, p. 166, pl. v, figs. 2a, 2b.

I have examined a large number of specimens, including several presented by Hislop himself, but unfortunately they are all casts and none show the true structure of the mouth. So far as can be seen, the shell differed little from species still common in the

¹ Sowerby, *Trans. Geol. Soc. London*, 2nd Ser., V, pl. xlvii (1840).

² Hislop, *Quart. Journ. Geol. Soc. London*, XVI, p. 166 (1860).

same districts and belonging to the group of *Vivipara dissimilis* (Müller).

According to Hislop the fossil is found rarely at Karwad and more abundantly at Takli and Phizdura.

VIVIPARA BUGTICA (BLANFORD).

1883. *Paludina bugtica*, Blanford, *Mem. Geol. Surv. Ind.* XX, p. 131, pl. i, figs. 6, 7.

In addition to two cleaned specimens labelled "type" and evidently those figured by Blanford, there is a large series in the Geological Survey, all collected by the author of the species at Gandoi in the Bugti Hills and some of them still in the original matrix. Blanford believed them to be lower miocene, and Pilgrim¹ has shown that they belong to a fluviatile facies of the Gaj stage, which in the same locality has yielded numerous vertebrate fossils.

The species seems to belong to the same group as *V. normalis*, but the shell is narrower and less acuminate. I have nothing to add to the original description.

VIVIPARA ATAVIA sp. nov.

Pl. XI, figs. 1, 2.

A species closely allied to the living *V. helmandica*, Annandale² from Seistan, Eastern Persia.

The shell is short and broad, about 20-25 mm. high and $1\frac{1}{4}$ times as high as the maximum diameter, acuminate, with $4\frac{1}{2}$ or 5 whorls. The whorls of the spire increase in size gradually and evenly; the body-whorl is a little higher than the spire. None of the whorls are swollen or oblique, but the suture, though linear, is impressed and the surface convexly and narrowly flattened outside it. The aperture seems to have been broadly oval and very little or not at all pointed above, but is incomplete in the specimens examined. The umbilicus was probably closed or rimate. The ventral surface of the body-whorl is more convex than the dorsal and evidently receded abruptly below the umbilicus. There is no trace of angulation or carination on this whorl. The external sculpture has entirely disappeared.

Type-specimen.—K 11—812 G. S. I.

¹ Pilgrim, *Rec. Geol. Surv. Ind.* XXXVII, p. 142 (1908).

² Annandale, *Rec. Ind. Mus.* XIX, p. 114 (1920).

Material.—The species is described from two specimens, both incomplete, collected by Dr. Guy Pilgrim at Kumbhi in the Bugti Hills, Baluchistan. They occurred in the freshwater beds of the Gaj stage, which Pilgrim¹ from determination of their contained vertebrates correlates with the upper Aquitanian stage of the European oligocene.

The two shells, though broken, are well preserved as to the greater part of their structure. The original shell-substance has been replaced by a hard crystalline stone of a creamy tint. In the aperture of one of them there is a plate that at first sight seems to represent a testaceous operculum, but it has no visible structure. In recent shells of *V. helmandica* dug from mud impregnated with salts in the Seistan desert I have observed a hard deposit on the outer surface of the true horny operculum, which is unusually thin, and I have little doubt that the plate in the fossil specimen had a similar origin.

Affinities of the species.—Had the two fossil shells been recent, I would have had no hesitation in referring them to *V. helmandica*, but as there are certain small differential characters it seems best not to assume a specific identity without further evidence. These characters are the less swollen whorls and the smaller relative size of the penultimate whorl. They are to some extent variable in the living species, but in a large series of shells from Seistan I can find none that agree precisely with the fossils. *V. atavia* has been confused in the collection of the Geological Survey of India with *V. bugtica* (Blanford); but the shell is very different in shape, being much broader and in many respects more like the species that are now found living in the extreme north-west of India and in Eastern Persia.

VIVIPARA BENGALENSIS (Lamarck).

Pl. XI, figs. 5-7.

1822. *Paludina bengalensis*, Lamarck, *Anim. sans Vertèbres* VI, (2), p. 174.
 1860. *Paludina bengalensis*, Theobald, *Mem. Geol. Surv. Ind.* II, p. 284.
 1920. *Vivipara bengalensis*, Annandale, *Rec. Ind. Mus.* XIX, p. 112.

This is at present the dominant species in the Ganges valley and has many races and phases in different parts of the plains of the Indian Empire west of the Indus. It belongs to a different group from the other Indian recent and fossil forms and is more closely

¹ Pilgrim, *Rec. Geol. Surv. Ind.* XXXVII, p. 142 (1908) and XLIII, p. 264 (1913).

allied to those found in the Palæarctic Region. Possibly the group has reached India only since the present formation of the country was assumed, and no shells belonging to it have been found except in recent or subrecent deposits.

There are, however, three sets of specimens in the collection of the Geological Survey that have been referred, I think rightly, to *V. bengalensis*. The particulars are as follows:—

The oldest in appearance consists of a single imperfect shell labelled “Kolar Range; recent alluvium. Rev. S. Hislop.” The greater part of the shell-substance has been almost entirely replaced by a hard crystalline deposit, but some of the former apparently persists in the columellar region, which is very imperfect. There are $5\frac{1}{2}$ whorls and the outline, so far as it can be seen, seems to be rather more cylindrical than it is in most living forms of the species. The penultimate whorl is large and swollen as in Kobelt's var. *nepalensis* from the Eastern Himalayas.

The second series includes five shells in excellent preservation and is labelled “Pleistocene. Narbudda. Hackett.” Theobald has recorded the existence of two forms of the species in alluvial deposits on the Narbada and it is probable that these shells belong to the larger form to which he refers. The specimens differ considerably from most recent shells in their thickness, strong vertical sculpture, elongate shape and wide umbilicus. They agree, however, very closely in these and other respects with two shells I once found on the sea-shore at Puri. The latter were evidently from a series of pools in the bed of a small stream of fresh water the mouth of which was temporarily blocked by sand. Their surface was fairly fresh and there was no reason to regard them as anything but quite recent. Had these two shells and those from the Narbada deposits stood alone, I would have been prepared to regard them as representing a species distinct from *V. bengalensis*, but there are in the Indian Museum two large series of recent shells from widely separated parts of Peninsular India that render this course impossible. All these specimens agree with those from Puri in the thickness of the shell, but they vary widely both in general outlines and in the form of the umbilicus, providing a complete transition to the typical *bengalensis* in every character except that of thickness of shell. These specimens are from Poona and from the Karnul district of Madras.

I propose for the large elongate phase from Puri and the Narbada the new name "phase *pachydolicha*."

The third series of shells of *V. bengalensis* in the collection of the Geological Survey was dug up under Clive Street in Calcutta and is probably not at all ancient. The shells are thin and small and represent a type by no means uncommon in ponds of very slightly brackish water in the delta of the Ganges. These specimens are certainly recent. They are from the deposit in which the large oyster called *Ostræa gryphoides* by Newton and Smith¹ also occurred.

¹ Newton & Smith, *Rec. Geol. Surv. Ind.* XLII, p. 1 (1912). See also Vredenburg, *ibid.*, Vol. XXXI, p. 174 (1904) and Annandale, Vol. XXXVII, p. 221 (1908).

EXPLANATION OF PLATE XI.

(All the figures are from direct photographs of natural size.)

Vivipara atavia sp. nov.

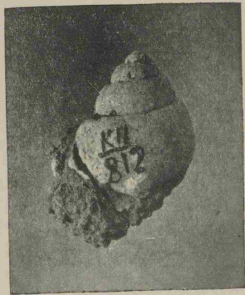
- FIG. 1.—Type specimen from the miocene beds of the Bugti Hills, Baluchistan.
 FIG. 2.—Another specimen from the same locality and horizon, showing the apparent presence of a testaceous operculum.

Vivipara helmandica Annandale.

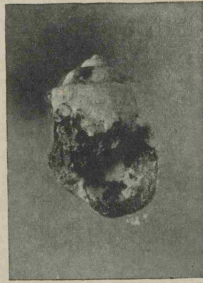
- FIG. 3.—Small shell from the recent alluvium of the Helmand, Seistan, Eastern Persia, showing the thin horny operculum covered with a deposit of caked mud and salt.
 FIG. 4.—Larger shell (co-type) from the same locality.

Vivipara bengalensis phase *pachydolicha*, nov.

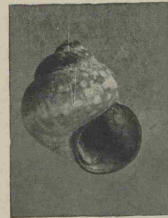
- FIGS. 5, 6.—Shells from the alluvium of the Narbada.
 FIG. 7.—Fresh shell from Puri, Orissa.



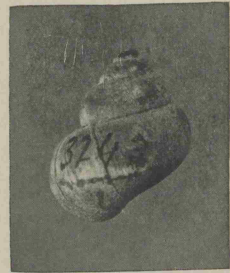
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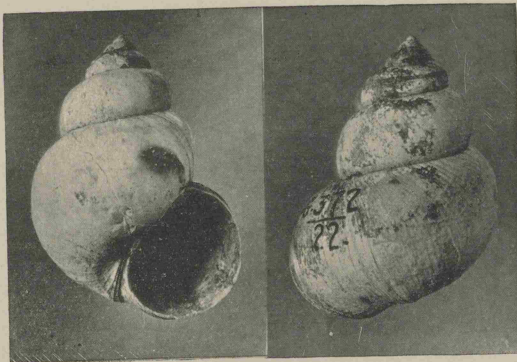
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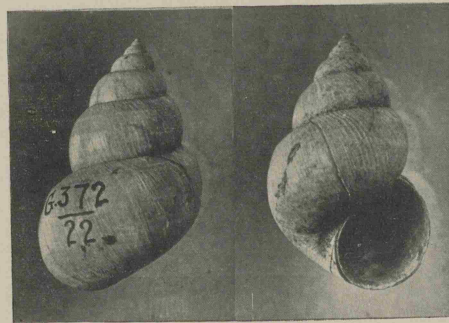
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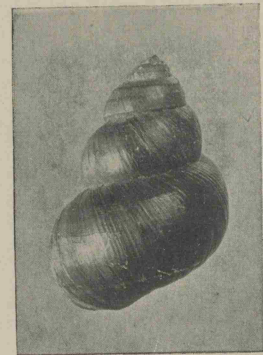
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G. S. I. Calcutta.

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