THE MOLLUSCA OF THE INLAND WATERS OF BALUCHISTAN AND OF SEISTAN.

(With Plates III—VIII).

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In studying the aquatic Mollusca of Seistan we have found it necessary to study also those of Baluchistan, from certain parts of which abundant material was available. These parts are the hill-country of the Quetta and Pishin districts in Northern Baluchistan, in which one of us collected the material himself, the great Baluch-Afghan desert, in which a collection was made by Dr. N. Annandale and Mr. S. W. Kemp, and Persian Baluchistan, in which, many years ago, the late Dr. W. T. Blanford[1] obtained many specimens now in the Indian Museum. We have seen no shells from the British district of Mekran, which, however, marches with Persian Baluchistan on the west, from Las Bela and the neighbouring states, or from the Indus plain south of Sibi, in which the fauna is probably quite Indian.

The following is a list of the species and varieties now known, arranged according to the classification set forth by Pelseneer in Lankester's *Treatise on Zoology*, Vol. V (1906).

List of Freshwater Molluscs of Baluchistan and Seistan.

Gastropoda.

PECTINIBRANCHIA.

Fam. Hydrobiidae.	
Amnicola (*Alocinma*) *sistanica*, sp. nov.	Seistan.
? *Amnicola parvula* (Hutton).	N. Baluchistan.
Fam. Viviparidae.	
Vivipara hilmandensis, Kobelt.	Seistan; Afghan desert.
Fam. Melaniidae.	
Melanoides pyramis (Hutton).	N. Baluchistan.
M. pyramis var. *flavida* (Nevill).	W. Baluchistan.
M. pyramis var. *luteomarginata* (Nevill).	Persian Baluchistan; S. Persia.

[1] All the zoological collections made by Dr. Blanford and labelled "Baluchistan" are from this district, in which there happens to be a place called Pishin.

M tigrina (Hutton).	N. Baluchistan.
M scabra var. *elegans* (Hutton).	N. Baluchistan.
Melanopsis deserticola, sp. nov.	Persian Baluchistan.

PULMONATA.

Fam. Limnaeidae.	
Limnaea persica, Issel.	Baluchistan desert; S. Persia.
Limnaea iranica, sp. nov.	Persian Baluchistan.
Limnaea bactriana, Hutton.	N. Baluchistan; Seistan.
Limnaea gedrosiana, sp. nov.	Do. do.
L. gedrosiana var. *rectilabrum*, nov.	Do. do.
Limnaea truncatula, Gray.	N. Baluchistan.
Limnaea hordeum, Mousson.	Seistan.
Fam. Planorbidae.	
Gyraulus convexiusculus (Hutton).	N. Baluchistan; Seistan.
Gyraulus euphraticus, Mousson.	Do. do.
Segmentina calathus (Benson).	Seistan.

Lamellibranchia.

Fam. Unionidae.	
Lamellidens marginalis, subsp. *rhadinaeus*, subsp. nov.	Seistan; Afghan desert.
Fam. Cyrenidae.	
Corbicula fluminalis (Müller).	Baluchistan; Seistan.
? *Pisidium paludosum*, Hutton.	N. Baluchistan.

GEOGRAPHICAL DISTRIBUTION.

The molluscs to be considered in this paper come mainly from three districts, (1) the hill-country of Baluchistan watered (so far as it is watered at all) by the Lora or Pishin river, which has more or less saline water and makes its way down to the desert, where it disappears in the Zanginawar lakes; (2) Seistan, the delta and basin of the Helmand river, which rises in the Hindu Kush a considerable distance to the north of Baluchistan and passes a great body of fresh water, and (3) Persian Baluchistan, a mountainous district lying some considerable distance south of Seistan and reaching to the Arabian Sea. These three districts are separated by the great Afghan-Baluch desert, through which the Helmand flows. As even the desert is not devoid of aquatic molluscs, we have actually four districts to consider.

MOLLUSCA OF THE HILL-COUNTRY OF BALUCHISTAN. The molluscs of this district were described seventy years ago by Hutton, and we have no species to add to his list, though we do not accept all his identifications. The forms known from this district are:—

Melanoides pyramis.	*Melanoides scabra* var. *elegans.*
Melanoides tigrina.	? *Amnicola parvula.*

Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea truncatula.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Corbicula fluminalis.
? *Pisidium paludosum.*

MOLLUSCA OF THE AFGHAN-BALUCH DESERT. The following forms have been found in this desert:—

Melanoides pyramis var. *flavida.*
Vivipara hilmandensis.
Limnaea persica.
Gyraulus euphraticus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF SEISTAN. In the alluvial plain of Seistan the following forms occur:—

Amnicola (*Alocinma*) *sistanica.*
Vivipara hilmandensis.
Limnaea bactriana.
Limnaea gedrosiana.
Limnaea gedrosiana var. *rectilabrum.*
Limnaea hordeum.
Gyraulus convexiusculus.
Gyraulus euphraticus.
Segmentina calathus.
Corbicula fluminalis.
Lamellidens marginalis subsp. *rhadinaeus.*

MOLLUSCA OF PERSIAN BALUCHISTAN. Most of the molluscs known from this district were obtained by the late Dr. W. T. Blanford, but Mr. W. J Good has recently added an interesting species. The following is a list of the known forms:—

Melanoides pyramis var. *flavida.*
Melanoides pyramis var. *luteomarginata.*
Melanoides scabra.
Melanopsis deserticola.
Limnaea iranica.

Of the lists, those of the species of the hill-country of Baluchistan and of Seistan are probably the most complete. Moreover, these two are very similar and the discrepancies between them are probably more apparent than real. In the Seistan list five (out of eleven) specific names are, indeed, present that are absent from the other, viz. *Amnicola sistanica*, *Vivipara hilmandensis*, *Limnaea hordeum*, *Segmentina calathus* and *Lamellidens marginalis*. The *Vivipara*, however, seems to be essentially a fluviatile species, probably unable to live in any but pure fresh water, and rivers with pure fresh water (or water of any kind) are proverbially scarce in Baluchistan; the *Limnaea*, which is also known from Mesopotamia, is exceedingly rare; *Segmentina calathus*, which is not uncommon at some places in the plains of North-western India, is local in its distribution, and the bivalve, though not yet found in Baluchistan, is common (in a distinct racial form) in the neighbouring country of Afghanistan. Of the species probably common to the two countries this bivalve is the only one in which even subspecific distinction is possible, but several others (e.g. *Limnaea gedrosiana*) exhibit slight local dfferences. *Amnicola sistanica* is the only species probably peculiar to Seistan, and

Limnaea hordeum (otherwise known only from lower Mesopotamia) the only true western form.

The Helmand, which, so far as the aquatic fauna is concerned, is the connecting link and the only highway for aquatic animals between the mountains of Baluchistan and eastern Afghanistan and the Seistan basin (or, indeed, between Seistan and all other countries), has naturally a molluscan fauna identical with that of the basin into which it flows. In the small springs of the desert, the water of most of which is more or less saline, only a few very tolerant species (e.g. *Gyraulus euphraticus* and *Corbicula fluminalis*, both of great geographical range) can live, and we found but one form (*Melanoides pyramis* var. *flavida*) probably peculiar to situations of the kind. It occurs in Persian Baluchistan as well as the Afghan-Baluch desert. *Limnaea persica* has only been found as yet in the southern part of the Persian plateau and in the basin of the Lora river in the eastern part of the desert.

The molluscan fauna of Persian Baluchistan is still imperfectly known, but the inclusion of a species of *Melanopsis* indicates the presence of a true western Asiatic element absent from other parts of the area under consideration.

The general absence of this western Asiatic element is perhaps the most striking feature of the fauna considered as a whole. Another point to be noted is the absence of certain large and conspicuous Palaearctic forms (e.g. *Limnaea stagnalis*) common in Kashmir at altitudes no higher than those of the Quetta district. This, however, does not imply that the fauna is essentially Oriental in the strict zoogeographical sense, for conditions of life are clearly inimical to large forms. The fauna is a starved one in which only species of great adaptability can survive. Such molluscs as *Vivipara hilmandensis* and *Lamellidens marginalis*, though evidently of Oriental origin, have spread into Palaearctic districts on the limits of their range, while the species of *Limnaea*, though here described as distinct, have a clear Palaearctic facies and most of them are probably descended from Palaearctic rather than true Indian forms, from which they differ considerably in all but one instance. The species of *Gyraulus* and *Segmentina*, though they occur in Oriental districts, are closely related to and probably derived from European forms.

The molluscan fauna of Seistan and Baluchistan, therefore, has little true geographical significance.

BIONOMICS.

The bionomics of the molluscan fauna of the inland waters of Baluchistan and Seistan are perhaps more interesting than its geographical distribution, but here again characters are negative. The fauna is one that lives habitually in water of abnormal chemical composition, for even potable water in these countries contains far more than its usual allowance of mineral salts (see p. 15, *antea*). The molluscs have not, however, responded to the

chemical stimulus with the facility sometimes associated with this factor in their environment, and are not particularly plastic or variable or at all exuberant in shell-sculpture. This is probably because other conditions are unfavourable—extremes of temperature, drought and lack of food—and the struggle for existence is too keen. The composition of the water has, indeed, had one effect, physical rather than biological, in preserving such sculpture as the shells possess intact from erosion. Probably it has acted indirectly, by discouraging the growth of corroding algae. But, even so, the *Limnaeae* do not develop the strong longitudinal ribs formed on the shells of those that live in saline waters in North America.[1]

The shells of all the species of Gastropods are small and in most cases very thin. They are of perfect form, neither distorted nor abnormal in other respects. Their colours, both of shell and soft parts, are pale. They constitute, in fact, a limited but very normal paludine fauna such as might be found in any temperate region.

No peculiar lacustrine species or even well-marked phases have as yet been evolved in the Hamun-i-Helmand.

In Seistan the recent geological history of the country has been of such a nature that subfossil shells are extremely abundant nearly everywhere except in the central parts of old lake-basins, while owing to the annual floods enormous numbers of quite recent shells are scattered over the country. In the deposits, both recent and historically ancient, examined both in the northern and the southern districts only two species were found (*Limnaea hordeum*, evidently a scarce form, and *Segmentina calathus*, a widely distributed but somewhat sporadic one) which were not found living in the country. The absence of Melaniidae from these deposits was a noteworthy feature. The commonest species in them at most places were *Amnicola sistanica*, *Limnaea gedrosiana*, *Gyraulus convexiusculus*, *G. euphraticus* and *Corbicula fluminalis*. At some spots, evidently those reached with fair regularity by recent floods, *Lamellidens marginalis* was also present in large numbers, and at one place *Vivipara hilmandensis* was common.

An interesting question in the bionomics of freshwater molluscs in a country like those under consideration is that of hibernation and aestivation and their effect on sexual activity. We give evidence below that certain species (mainly those of the genera *Melanoides*, *Corbicula* and *Lamellidens*) burrow into mud or sand either at the approach of winter or on the sinking of the annual floods. Perhaps this is also true of *Amnicola sistanica*. The Limnaeidae and Planorbidae, however, remain active throughout the winter. In Seistan and northern Baluchistan, and also at certain places in the North West Frontier Province, the eggs of

[1] See Baker, *Chicago Academy of Sciences*, special publication 3, p. 30 (1911).

Limnaea were observed in great abundance in November, December and January, and in females killed at this time of the year the female part of the reproductive organs was found to be in a state of activity. No individuals were, however, observed paired, and the male part of the hermaphrodite gland seems to be aborted. It is probable, therefore, that *Limnaea* is protandric in the peculiar conditions which exist in Seistan and Baluchistan, that pairing takes place in summer, and that the spermatozoa are stored up for considerable periods.

PARASITES AND INCOLAE.

The main object of the tour on the collections of which this paper is mainly based was to discover what could be discovered about the distribution of the aquatic molluscs and their trematode parasites in reference to the etiology of the disease Bilharziasis or Schistosomiasis. Living molluscs were examined in the field by Mr. S. W Kemp, who has been kind enough to supply us with the following information. His examinations were made in November and December.

The only molluscs in which trematodes were found in water brackish to the taste was *Melanoides pyramis* var. *flavida*. Of twenty-five individuals of this form from a small water-course at Saindak in the western part of the Baluchistan desert one was infected by the young rediae (indeterminate) probably of a *Xiphidocercaria*. The water was potable but tasted salt and bitter.

Sixty specimens of *Limnaea gedrosiana* from the reed-beds of the Hamun near Lab-i-Baring were examined and none found infected. Of another sixty of the var. *rectilabrum* of the same species from a small pool in the desert near Nasratabad only one was parasitized, its parasite being a small cercaria of the family Schistosomatidae. One hundred specimens of *L. bactriana* (fifty of the long-spired and fifty of the short-spired form) were examined at Nasratabad, from an irrigation channel. Ten contained trematode cercariae; in eight of these the parasite was a large monostome, while in one it was a Schistosomatid (apparently the same species found in *L. gedrosiana*) and in one the infection was a mixed infection of these two parasites.

Seventy-four specimens of *Gyraulus convexiusculus* from the reed-beds of the Hamun were examined and seven were found infected by Trematodes, two by indeterminate elongate sporocysts, three by Schistosomatid cercariae without eyespots and two by similar fork-tailed cercariae with eyespots. Only two specimens of *Gyraulus euphraticus* were examined, from the same locality; one was uninfected, while the other contained Schistosomatid cercariae without eyespots, apparently of the same species as was found in *G. convexiusculus*.

The Schistosomatid cercaria found in aquatic Pulmonate molluscs in Seistan does not appear to belong to any of the species known to parasitize man. A liver-fluke of the genus *Fasciola* (*s.s.*) is common in that country, but its cercariae were

not found, probably because their incidence is seasonal. Mr. Kemp has given us a note on this species (*F. gigantea*) which is appended to our paper. He hopes to describe all other parasites later.

Small red nematodes were common in *Gyraulus convexiusculus* in the Hamun in December.

The Oligochaete worm *Chaetogaster* was found in abundance at the edge of the mantle and in the branchial chamber of *Limnaea gedrosiana* var. *rectilabrum* in a pool in the desert near Nasratabad in the same month. Col. Stephenson has identified the worm as *Ch. bengalensis*, Annandale, a species common in Northern India.

SYSTEMATIC ACCOUNT OF THE FAUNA.

Class **GASTROPODA.**

Fam. HYDROBIIDAE.

1915. Paludestrinidae, Preston, *Faun. Brit. Ind., Freshw Moll.*, p. 67.
1919. Paludestrinidae, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 209.

Genus **Amnicola,** Gould and Haldeman.

1865. *Amnicola*, Stimpson, *Smiths. Misc. Coll.*, 201, p. 12.

The excellent account of this genus given in the work cited enables us to relegate to their proper genus certain Indian, Burmese and Persian species that have usually been placed in *Bithynia*. These species, however, differ in some respects from the American forms—sufficiently in our opinion to be regarded as constituting a new subgenus, for which we propose the name:—

Subgenus **Alocinma,** nov.

The shell agrees precisely with that of the American *Amnicola* and the Palaearctic *Pseudamnicola*, being globose or subglobose or slightly elongate, imperforate or subumbilicate, small, thick and smooth, with swollen whorls and having its mouth oval or ovate with a continuous but not greatly thickened peristome. The animal has a relatively short foot, which projects very little if at all beyond the shell. It is rounded or pointed behind and angulate in front. *The snout is long and narrow.* The tentacles are hardly longer than the shell, thin and filiform, and bear the eyes, which are small, at their base externally. The edge of the mantle is simple. The penis is large, flattened, lunate in outline and provided with a long and stout lateral process, which projects on the left side from its concave margin almost at right angles. It is situated almost in the middle of the "neck." *The operculum is of large size, and incapable of withdrawal into the shell, thick and calcareous but usually hyaline or subhyaline, distinctly spiral and with a slightly eccentric nucleus, but ornamented round the margin with concentric lines.*

The radula is very like that of *Amnicola*, *s.s.*, its central tooth being produced at either side and bearing a central process on its disk which projects downwards below its lower margin, as well as two or three lateral basal denticulations on each side.

Type-species. *Amnicola sistanica*, sp. nov.

This new subgenus is very closely related to *Amnicola*, *s.s.*, but differs in its long snout, calcareous oval or ovoid operculum and lunate penis. From *Pseudamnicola* it differs in its much larger, spiral operculum and in having more than one basal denticulation on each side of the central tooth of the radula. It is, indeed, a link between the two groups of species, each of which we regard as having subgeneric rank.

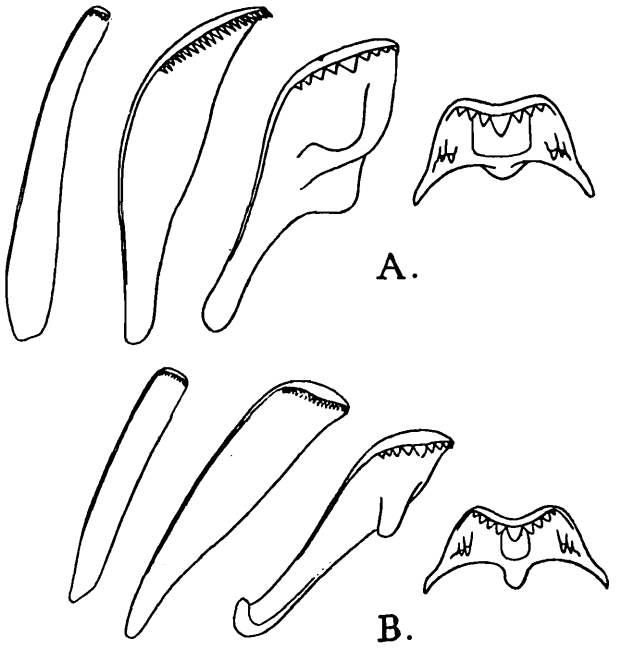

FIG. 1.—Radular teeth of *Amnicola* (× 500).

A. Teeth of *Amnicola* (*Alocinma*) *sistanica*, sp. nov., from the reed-beds of the Hamun-i-Helmand.

B. Teeth of *Amnicola* (*Alocinma*) *alticola* (Annandale), from the Inlé Lake, Southern Shan States.

Among the species that must be placed in the new subgenus are the common "*Bithynia*" *orcula* of Bengal and also *Amnicola alticola* (fig. 1 B) from the Southern Shan States. In the former as well as the latter the operculum is distinctly spiral and both have the other subgeneric characters.

Amnicola (Alocinma) sistanica, sp. nov.

(Pl. iii, figs. 1–5.)

This species is very closely related to *Amnicota orcula*, but the shell is more hyaline and more globose and has the suture more oblique and more impressed. It may be described as follows:—

The shell is small, ovato-conical, short, broad and obese, with five whorls, fairly thick but naturally quite colourless and hyaline, rapidly, however, becoming milky after the death of the animal, polished and ornamented with delicate longitudinal striae on the surface. The suture is impressed and very oblique, so that the spire is much longer in dorsal than in ventral view. The whorls increase rapidly in size and are highly convex; they are flattened outside the suture but rounded externally. The apex is minute but blunt and flattened. The basal whorl in ventral view is at least nearly three times as long as the spire, but these proportions are variable The mouth is large and somewhat expanded, oblique, never much longer than broad, ovate, rounded or bluntly pointed above and broadly rounded below. The peristome is continuous and there is a band-like callus on the inner lip. The outer lip is hardly thickened, but distinctly though slightly flattened and very narrowly retroverted; its inner corner is subangulate. The umbilicus is rimate and the columellar callus is expanded over it. The columella is straight.

Measurements of Shells (in millemetres).

	A	B	C	D	E	F
Length	6·5	8·2	7·8	7·2	5	3·8
Breadth	4·2	5·2	6·1	4·7	4	2·7
Length of mouth	2·5	3·1	3·7	3·2	2·4	1·9
Breadth of mouth	2	2·6	2·6	2·3	2	1·5

The operculum, which cannot be retracted into the shell, is when fresh of glassy transparency. It has three whorls. The nucleus is situated some distance from the antero-internal border. The shape is ovate, broadly rounded anteriorly and bluntly pointed posteriorly.

The radula is of the type normal in *Amnicola, s.s.* The central tooth is small and transverse, produced at each side into a bluntly pointed, narrow process, which points downwards and a little outwards. The disk bears a large quadrate raised area and a series of basal denticulations at each side, remote from both the lateral and the basal margin. In each series there are two distinct denticulations and an obscure, imperfectly developed external one. The upper margin of the tooth is slightly concave. The central cusp is enlarged and there are several smaller denticulations on each side of it; all are triangular, at least as long as broad at the base, and pointed at the tip. The lateral tooth is broad above but slender towards the base. It bears numerous small sharp cusps, the central one of which is slightly enlarged on the inner lateral. This tooth bears a broad blunt process on its disk and has its inner margin broadly and irregularly emarginate below. The outer marginal is very long and narrow, but broadens somewhat at the base. Its cusps are very minute and sharp.

The intromittent organ of the male is of relatively large size and distinctly flattened. Its external (right) margin is semi-circu-

lar and its internal margin concave in the same degree. The tip is pointed. The internal margin bears near its middle a long straight process terminating in a crateriform sucker-like structure, from the centre of which protrudes an elongate muscular papilla. The main body is smooth, the process obscurely annulate. Before entering the penis the vas deferens is highly convoluted and would be of immense length if unravelled. In the penis it pursues a sinuous course near the concave margin and remains distinct nearly to the aperture at the tip of the organ. The outer part of the penis appears to be glandular internally, but is provided with a well-developed layer of transverse muscle fibres externally.

The living animal was thus described in the field:—"Animal white with black clouding and minute golden yellow specks on the mantle; a suffusion of black pigment on the snout and tentacles. Tentacles slender, when fully expanded no longer than shell. Eyes small, black, prominent, situated near the base of the tentacles

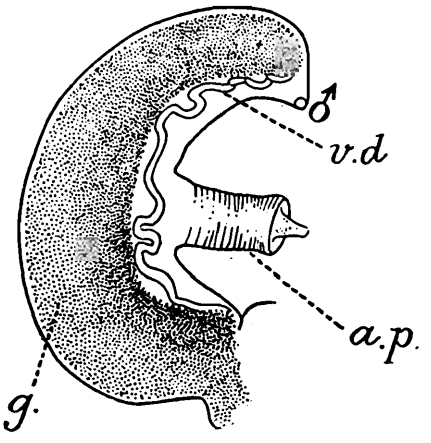

FIG. 2.—Male intromittent organ of *Amnicola* (*Alocinma*) *sistanica*, sp. nov. (×20), seen from below.

a.p.=accessory appendage: *g.*=glandular region: *v.d.*=vas deferens.

externally. Snout rather long and narrow, with parallel sides, slightly notched in front. Foot relatively small, rounded in front and bluntly angulate at the anterior corners, bluntly pointed behind."

Type-specimens. M 11538/2, Zoological Survey of India (Ind. Mus.).

Distribution. All over the dry *Naizar* or reed-country of northern Seistan shells of this species are common in the soil, as they are also in the debris of floods. We found fresh shells in the larger pools in the reed-beds of the Hamun near Lab-i-Baring and a few living individuals among the algae on the roots of *Phragmites* in narrow channels in the same beds.

These living individuals, which were very scarce, were all small and were only found in protected situations. Very large numbers of the mollusc evidently perish annually with the sinking of the floods and the majority of those that survive probably burrow into the mud and hibernate in winter.

The shell of this species bears a close resemblance, perhaps superficial, to that of the Syrian "*Paludina*" *badiella* as figured by Küster,[1] but the mouth is broader, the umbilicus narrower, the whorls less flattened above and pigment entirely absent. There has been much confusion about this Syrian species and we have no means of estimating the true relationship, if any exists, between it and our Seistan mollusc. There is also a resemblance to *Pseudamnicola macrostoma* from Greece, specimens of which we have examined; but the operculum of that species is much thinner, of different structure and of small size as compared with the mouth of the shell, which is much smaller than that of the Persian species.

? **Amnicola parvula** (Hutton).

1850. *Paludina parvula*, Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 655.
1876. *Amnicola parvula*, Hanley and Theobald, *Conch. Ind.*, p. XVII, pl. cli, figs. 8, 9.

We have not seen this species and have no means of ascertaining its true generic and subgeneric position. Hutton says that the operculum is horny, and it would appear, therefore, to belong possibly to *Amnicola*, *s.s.* The other known species of this subgenus are, however, American. Nevill's[2] *Bithynia orcula* var. *parvula* is quite distinct and probably a true variety of *Amnicola* (*Alocinma*) *orcula* (Frauenfeld).

Hutton's species was found in a marshy patch of ground in the Kojak Pass at Chaman (Chammun), now on the Afghan frontier of Northern Baluchistan.

Family VIVIPARIDAE.

Genus **Vivipara**, Montfort.

Vivipara hilmendensis, Kobelt.

1909. *Vivipara* (*dissimilis* var.?) *hilmendensis*, Kobelt, *Paludina* in Martini and Chemnitz's *Conch-Cab.* (*ed.* Küster and Kobelt), p. 289, pl. lix, figs. 9–12.

The complete synonymy of the forms included by Kobelt under the name *Vivipara dissimilis* has not yet been worked out, and we leave the Helmand form provisionally as a distinct species. We have very little to add to Kobelt's description except that the natural colour of the shell is dark olivaceous with curious round whitish spots, and that the opercula of the specimens he examined were unnaturally thin owing perhaps to sand erosion.

The species was described from the Afghan desert and is

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[1] Küster, "*Paludina*, *Hydrocena* and *Valvata* in Martini and Chemnitz's *Conch. Cab.* (*ed.* Schubert and Wagner), p. 62, pl. xi, figs. 25–28 (1852).
[2] Nevill, *Hand List Moll. Ind. Mus.* II, p. 37 (1885).

evidently rare in most parts of Seistan. Single fairly fresh but empty shells were collected at the edge of pools near Nasratabad and Jellalabad and at that of the Hamun near Lab-i-Baring, while a considerable number of bleached specimens were also observed in the soil of occasionally flooded country near Chilling towards the south of Seistan. It is not improbable, therefore, that *V hilmendensis* is common on the banks of the lower Helmand and is essentially a fluviatile species.

Type-series. M 5087/1, Zoological Survey of India (Ind. Mus.).

Family MELANIIDAE.

Melanoides, Olivier.

1807. *Melanoides*, Olivier, *Voy. l'Emp. Ottoman* II, p. 40.
1854. *Plotia*, N. and A. Adams, *Gen. Rec. Moll.*, p. 295.
1874. *Plotia+Striatella* (? in part), Brot, *Melaniaceen* in Martini and Chemnitz, *Conch. Cab.* (*ed.* Küster), p. 7.
1897. *Melanoides+Plotia*, v. Martens, "*Suss. und Brackw. Moll.*", pp. 50, 62 in Weber's *Zool. Ergebn. Niederl.-Ost-Indien* IV.
1898. Neomelanien, P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.
1915. *Striatella+Plotia*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, pp. 15, 35.

In discussing the species of *Melania* (*s.l.*) that occur in Baluchistan and Seistan we have had to overcome two difficulties, firstly to settle the somewhat complicated specific synonomy, and secondly, to decide what characters should be regarded as of generic importance. So far as the second of these questions is concerned we have followed in the main the classification adopted by the Sarasins in the work cited above. We have, however, regarded the groups that they include under the name *Melania* as of generic value, believing that by so doing we are following sound lines in estimating such structures as the operculum and radula as of equal value in this family to the sculpture of the shell and the precise form of its mouth. The groups or subgenera *Plotia*, and *Striatella* (= *Melanoides*) as defined by Brot in his monograph and accepted by Preston in the *Fauna of India*, fade imperceptibly one into the other, and Brot's diagnosis of *Plotia* is, as we have pointed out elsewhere,[1] by no means applicable to all shells even of the type-species.

The question of specific identity and nomenclature in the Indian and Persian species of the genus is complicated by imperfect descriptions, particularly on the part of Troschel and Philippi.

In considering the question due but not excessive attention must be given to the locality of specimens and it must be remembered that the names *Melania pyramis* and *M elegans* are due to Hutton, and not to Benson, who merely distinguished certain forms by letters, and that, further, Hutton was dealing very largely

[1] *Rec. Ind. Mus.* XIV p. 147 (1919).

when he first used these names with a collection from what is now British Baluchistan and the Afghan frontier. We have been greatly helped by an examination of specimens named by Hutton himself.

The conclusions to which we have come are these, (1) that three species, one of which has several varieties, have been as yet found in Baluchistan and the extreme south of Persia; (2) that

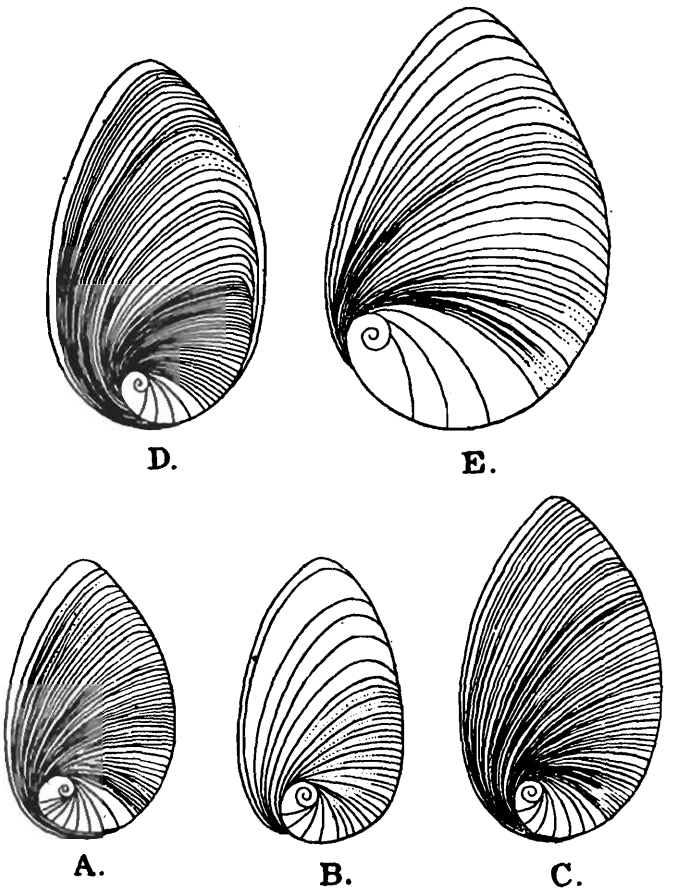

FIG. 3.—Opercula of Melaniidae.

A. *Melanoides tuberculata* (Müller), from large artificial reservoir in Hyderabad State.
B. *M. pyramis* var. *flavida* (Nevill), from spring in the Afghan-Baluch desert.
C. *M. pyramis* var. *luteomarginata* (Nevill), from Persian Baluchistan.
D. *M. tigrina* (Hutton) from Quetta.
E. *Melanopsis deserticola*, sp. nov. from a spring in Persian Baluchistan.

the correct names of these species are *Melanoides scabra* var. *elegans* (Hutton), *M. tigrina* (Hutton) and *M. pyramis* (Hutton); (3) that Hutton has included forms of two distinct species under the name *M. elegans*, and (4) that while one of these forms must be regarded as a variety of *M. scabra*, the other is a variety of *M. pyramis*. In our opinion the last is a transitional form be-

tween the groups *Plotia* and *Melanoides*, but comes in the latter rather than the former.

The genus *Melanoides* may be defined thus:—Melaniidae in

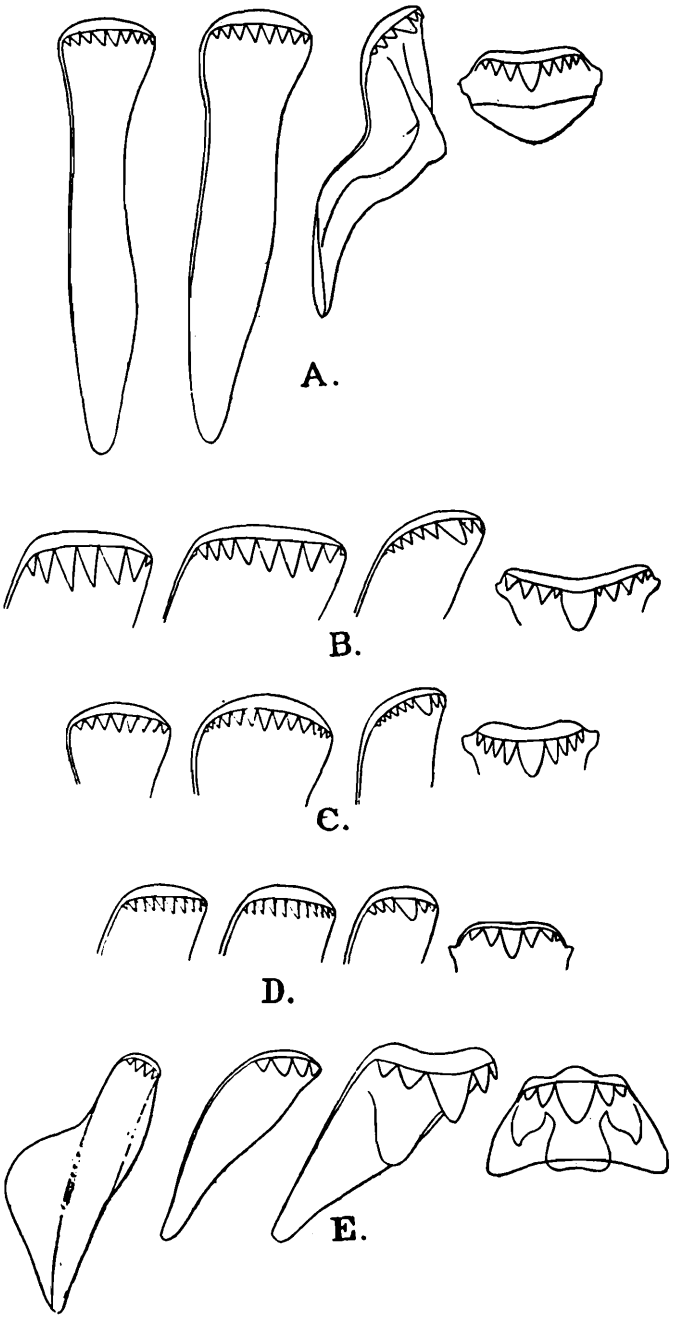

FIG. 4.—Radular teeth of Melaniidae (× 125).

A. Teeth of *Melanoides tigrina* (Hutton) from Quetta.
B. Upper part of teeth of *M. pyramis* var. *luteomarginata* (Nevill) from Persian Baluchistan.
C. Upper part of teeth of *M. pyramis* var. *leopardina*, var. nov. from Poona.
D. Upper part of teeth of *M. pyramis* var. *flavida* (Nevill) from spring in Afghan-Baluch desert.
E. Teeth of *Melanopsis deserticola*, sp. nov. from spring in Persian Baluchistan.

which the *shell* is small or of moderate size, tapering or turreted and never of very great thickness or relative breadth. The mouth is small, ovoid and not greatly produced in front; the columellar

callus moderate; the columella bent but slight and not produced anteriorly; the lip slightly or not at all thickened. The sculpture consists of longitudinal and transverse striae, which produce by their intersection a more or less granular appearance at any rate on the upper whorls. Longitudinal ribs may be present on the lower whorls; their distal extremity is either granular or spinose, as a rule more or less produced. The periostracum is thick and may bear minute hair-like processes.

The *operculum* is ovoid and relatively large, with the posterior extremity pointed. It is distinctly spiral towards the anterior, blunt extremity, but the actual whorls are relatively small and are situated near the inner anterior margin. The remainder of the surface is ornamented with curved parallel lines which radiate outwards from a point situated between the spiral region and the inner margin.

The *radular teeth* are characterized by their sharp and relatively numerous cusps. The lateral tooth is narrow, very oblique in its natural position and as a rule strongly curved or bent longitudinally.

Type-species. *M fasciolata*, Olivier=*M. tuberculata* (Müller), var.

[**Melanoides tuberculata** (Müller).]

(Pl. iv, fig. 1.)

1774. *Nerita tuberculata*, Müller, *Hist. Verm.*, p. 191.
1837. *Melania adspersa*, Troschel, Wiegm. *Arch. f. Naturw.* I, p. 175.
1876. *Melania tuberculata*, Hanley and Theobald, *Conch. Ind.*, pl. lxxiv, figs. 1-4.
1918. *Melania tuberculata*, Annandale, *Rec. Ind. Mus.* XIV, pp. 114, 156, fig. 6, pl. xii, figs. 1, 2.
1919. *Melania tuberculata*, Annandale and Prashad, *Ibid.*, XVI, p. 146, pl. v, fig. 5 (radula).

Although this species is extremely plastic, in some respects it retains its specific characters under all circumstances. These are (1) the very gradual and even increase in size of the whorls from the apex to the mouth, (2) the distinct but not very great convexity of the whorls, (3) the absence of all swelling and comparatively small size of the body-whorl, (4) the small size of the mouth of the shell, the maximum length of which is considerably less than one-third of the total length, (5) the tubercular sculpture, especially of the upper whorls, (6) the smooth spiral ridges at the base of the body-whorl, (7) the more or less distinct longitudinal reddish markings on a background of green or brown. The total length of the shell is from a little less than three to four times the greatest transverse diameter.

We have recently figured the radular teeth (*op. cit.*, 1919, pl. v, fig. 5). The central tooth is broad and rounded at the lateral angles. It is symmetrical or nearly so and has a comparatively small central cusp with four small ones on either side. The other teeth are sub-equal and a little narrower. They have numerous small cusps. In the inner marginal one of the cusps is a little enlarged.

The operculum is regularly ovoid, bluntly pointed posteriorly and broadly rounded anteriorly. It is distinctly spiral, with two and a half whorls in the nucleus, which is situated some distance from the inner margin. The surface is ornamented with numerous lines which curve outwards from near the anterior extremity.

In spite of its extremely wide range, from the Mediterranean to Australia and China, we have no evidence of the occurrence of this species in Baluchistan or Southern Persia.

Melanoides pyramis (Hutton).

(Pl. iv, fig. 3.)

1850. *Melania pyramis* (Benson), Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 658.

This species is distinguished from *M. tuberculata* both by shell-characters and by constant differences in the radula. The shell is considerably shorter and broader, being distinctly less than three times as long as broad. The body-whorl is relatively large and much more swollen. The mouth is more than one-third as long as the shell, which tapers much more abruptly.

The radula of forms we regard as varieties differs considerably from that of *M tuberculata* in the shape of its central tooth, which is produced on either side in an angle, below which it is more or less constricted. It has a relatively large central cusp with the lateral cusps usually more numerous on the right side than the left. The lateral tooth is considerably narrower than the inner marginal.

We have not been able to examine fresh specimens of the typical form of this species, but Hutton states that the form which occurs in marshy land at Quetta is without markings and coarse in sculpture with the apex of the spire and epidermis eroded. A few dead shells of this type were found in a pond in the Residency garden at Quetta in January 1919, but no living individuals could be discovered in spite of a careful search. It is probable that in cold districts the species burrows into mud, as Hutton (*loc. cit.*, p. 657; 1850) states that *M scabra* var. *elegans* does in the same country.

Measurements of Shells (in millimetres).

Length	20·5	24·6
Breadth	7·3	9·1
Length of aperture.	7	8·7
Breadth of aperture	3·8	4·5

The shell we figure is much eroded, though the most complete we have examined in other respects. In a broken specimen of rather smaller size all the whorls but the body-whorl are ornamented with numerous curved longitudinal rows of from four to six tubercles separated by deep longitudinal grooves and divided up by narrow transverse striae.

We are able to recognize no less than four distinct varieties of this species.

[var. **leopardina**, nov.]

(Pl. iv, fig. 4.)

1876. *Melania pyramis* and var. *adspersa*, Hanley and Theobald (*nec* Troschel) *Conch. Ind.*, pl. cx, figs. 1, 2, 4.
1877. *Melania adspersa*, Brot (*nec* Troschel), *op. cit.*, p. 255, pl. xxvi, figs. 4, 4*a*.
1885. *Melania* (*Striatella*) *tuberculata*, Nevill, *Hand List Moll. Ind. Mus.*, II, p. 240 (in part).

This form has almost the same proportions as the *forma typica*, but the body whorl is slightly narrower and the anterior margin of the lip less produced. The surface of the shell is of a pale yellow colour beautifully marked with irregular longitudinal streaks of deep red. The sculpture is similar to that of the typical form but the granules are not so distinct. The shell is considerably thinner.

Measurements of Shells (*in millimetres*).

Length	28·2	28·4	22·3
Breadth	9·7	9.9	8·1
Length of aperture	9·9	10	8·2
Breadth of aperature	5·3	5·3	4·4

Type-series. 1202, Zoological Survey of India (Ind. Mus.) (from Poona).

The denticulations of the teeth of the radula are all rather blunt. The central tooth has four small cusps on each side of the central cusp. Its upper margin is slightly concave. None of the denticulations of the lateral teeth are much enlarged, the inner marginal has about thirteen and the outer about eight denticulations.

We figure the operculum.

This form appears to be the one to which the name *pyramis* has been most commonly applied. The measurements given by Troschel of his type-specimens of *Melania adspersa*, in which the apex was destroyed, preclude their belonging to it. It is not uncommon, though apparently somewhat sporadic, in the Indo-Gangetic plain and Peninsular India, but has often been confused with *M. tuberculata*.

[var. **puteicola**, nov.]

(Pl. iv, figs. 7–8.)

1834. *Melania* (No. 14), Hutton, *Journ. As. Soc. Bengal* III, p. 91.
1885. *Melania* (*Plotia*) *scabra* var. *elegans*, Nevill (specimens from Ferozepore only), *op. cit.*, p. 284.

As we have already pointed out, two quite distinct forms were confused by Nevill, and apparently at one time by Benson and Hutton, under the name *Melania elegans*. The specimens we describe here are those which Hutton found in a well at Ferozepore in the Punjab. They are the only shells we have seen.

Type-series. M 115401/2, Zoological Survey of India (Ind. Mus.).

The shells are similar in shape to *M pyramis*, s.s., but much smaller and thinner and with the lip slightly thickened anteriorly and the suture more impressed. Some of them, but not all, are characterized by the strong longitudinal sculpture of the upper whorls. The ribs, however, are not well defined and barely even distinctly tubercular, never at all produced, at their upper extremity. The surface is of neutral olivaceous buff with red longitudinal markings.

Measurements of Shells (in millimetres).

Length	15·3	15·7	14·8
Breadth	5·7	6	5·9
Length of aperture	6·2	6·3	6
Breadth of aperture	2·9	3	2·8

These shells, though clearly belonging to *M. pyramis*, afford an easy transition to the group *Plotia*, s.s. The fact that Nevill assigned them to *M scabra* is, indeed, strong evidence in favour of the advisability of breaking down the separation between that group and *Striatella*.

var. **flavida** (Nevill).

(Pl. iii, fig. 6; pl. iv, fig. 6.)

1885. *Melania* (*Striatella*) *tuberculata*, subvar. *flavida*, Nevill, *op. cit.*, p. 244.

Nevill gives no description of this variety. Shells exhibit considerable variation in shape, but are usually even broader than the typical form, and have the mouth more expanded and more oblique. The longitudinal ribs are quite obsolete. There is an indistinct smooth ridge running below the suture. The shell is moderately thin and resembles the var. *puteicola*, but is usually paler in colour. Sometimes, however, the colour approaches that of the var. *luteomarginata* and the sutural ridge is often distinctly paler than the remainder of the surface.

Measurements of Shells (in millimetres).

	Hurmuk			Persian Baluchistan.		
Length	19·6	15·5	17·2	30·7	27·4	25·2
Breadth	6·2	5	7	10·3	9·9	7·7
Length of aperture	6·4	4·9	6·7	10·9	9·7	7·2
Breadth of aperture	3·8	2·7	4	6·2	5·8	4·9

The central tooth of the radula is produced at either side into a distinct angle and is asymmetrical. It has three cusps on the left side of the middle enlarged, one and two on the right. The lateral tooth is considerably narrower but has very similar cusps. The marginal teeth are subequal, both broader than the lateral, and have a large number (at least ten) of sharp cusps on each.

The operculum has a distinct notch at the lower margin but is otherwise very like that of *M. tuberculata*, except that it bears fewer curved transverse striae.

Nevill named this variety from specimens from Pishin (not to be confused with the Pishin north of Quetta) and other localities in Persian Baluchistan and from Kalagan and Kerman in the south-east of Persia proper, and we have seen a rather dark shell from lower Mesopotamia.

Type-series. The specimens from the first of those districts may be regarded as the type-series, No. M. 11541/2, Zoological Survey of India (Ind. Mus.).

This form is not uncommon in small springs in the desert of Baluchistan and the Persian frontier. We collected specimens at Saindak and Robat in water distinctly salt to the taste, and at Hurmuk in fresh water. The following description of the animal is copied from the station book of the expedition:—

"Foot hardly longer than broad, subquadrate, with both extremities subtruncate; the antero-lateral angles acute and slightly produced. The snout long, flattened, rather narrow. The tentacles very slender, as a rule hardly longer than the snout. Processes at margin of mantle elongate, pointed, 7 or 8 in number. Sole of foot greyish white, with a faint tinge of pink and an indistinct grey border, spotted with microscopic yellow specks. Dorsal surface of foot, whole of snout, tentacles and edge of mantle black, the snout clouded with white, especially towards the base, the tentacles minutely speckled with dull yellow, the mantle processes edged and tipped with black. The animal moves with the ordinary jerky gait and holds its shell parallel to the surface when moving. When at rest the apex is often held sloping upwards."

var. **luteomarginata** (Nevill).

(Pl. iv, fig. 5.)

1885. *Melania tuberculata* subvar. *luteomarginata*, Nevill, *op. cit.*, p. 244.

This is a very beautiful and distinct variety distinguished by its regularity of form, colouration and sculpture. It is, however, linked by intermediate individuals with the var. *flavida*. The form is narrower than that of *M. pyramis* (*s.s.*), but the difference is not great. The colour is a deep chocolate-brown without reddish markings but rendered distinctive by the narrow paler spiral band that runs down the shell just outside the suture. The lower part of the inner margin of the mouth of the shell is also of the same colour. The sculpture, except at the base of the body-whorl, has a regular granulose appearance due to the fact that the longitudinal striae are numerous and not much deeper or broader than the transverse ones, and there is a narrow flattened ridge outside the suture. At the base of the shell only the transverse, spiral striae are developed. The shell is moderately thick.

Measurements of the Shells (in millimetres).

	Persian, Baluchistan (*Blanford*).		
Length . .	37·2	29.1	29·4
Breadth	13	9·9	10·8
Length of aperture .	11·1	10·2	10·3
Breadth of aperture .	6·4	5·5	6·3

Type-series. 1205, Zoological Survey of India (Ind. Mus.).

We have extracted the operculum and radula from one of Blanford's specimens. The former does not differ much from that of *M tuberculata* but is rather larger and more pointed posteriorly.

The radula, while of the same type as that of the vars. *leopardina* and *flavida*, differs slightly in the proportions and denticulation of teeth (see fig. 4), all of which are larger and broader than those of var. *flavida*. The central tooth has two extra cusps on either side and the cusps of the other teeth are much larger. Those on the outer marginal are fewer, not more than seven.

The variety is represented in the collection of the Zoological Survey of India by specimens collected by the late Dr. W T. Blanford in Persian Baluchistan and at Kalagan in the south of Persia proper.

Melanoides tigrina (Hutton).

(Pl. iv, fig. 2.)

1850. *Melania tigrina*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 658.

This species is, as Hutton pointed out in his original description, distinguished from all varieties of *M pyramis* by the much greater smoothness of the shell, in which both the longitudinal and the transverse striae become almost obsolete towards the base. The shell resembles that of *M. pyramis* var. *leopardina* in shape, texture and colouration, but exhibits some variation in the extent to which the longitudinal reddish markings are developed. The specimens collected by Hutton and still in the Indian Museum are, as he stated, much eroded on the surface and have lost the apical whorls. We have examined, however, other examples from Quetta which are almost perfect. The shell only differs in form from that of *M. pyramis* var. *leopardina* in being still more acutely pointed, in having the whorls a little less convex and the suture slightly impressed owing mainly to a narrow flattening of the upper margin of each whorl. The sculpture on the upper whorls, in unworn shells, is distinctly though minutely granular, but it becomes gradually less distinct towards the body-whorl, on which only a comparatively small number of lightly impressed spiral striae and very indistinct longitudinal striae can be distinguished.

Measurements of Shells (in millimetres).

	Quetta.		
Length	34·6	33·2	32
Breadth	10·8	11·3	11·2
Length of aperture	10·6	10·5	11·1
Breadth of aperture	6·1	6·2	6

The radula is very like that of the varieties of *M. pyramis.*

The operculum is very similar to that of the varieties of *M. pyramis.*

The geographical range of this species is obscure and there has evidently been much confusion with *M. pyramis* and *M. tuberculata.* The only specimens we have examined are from Quetta and the Kangra Valley. They include Hutton's type-series (No. 1208 M, *Z.S.I.*).

Melanoides scabra (Müller) var. **elegans** (Hutton).

1850. *Melania elegans*, Hutton, *op. cit.*, p. 657.
1885. *Melania scabra* var. *elegans*, Nevill, *op. cit.*, p. 284 (in part).

To judge from Hutton's description, this is a large, thick, strongly sculptured and brilliantly coloured form of Müller's *Buccinum scabrum*, the specific name of which must be applied in a restricted sense to the smaller, thinner-shelled form with definite spines at the upper end of the longitudinal ribs on the body-whorl, common in South India.

We can find in the collection no specimens either from the Bolan Pass, which lies between Quetta and the plains, or from Sibb in Persian Baluchistan, from which place Nevill records specimens of the typical form. There is, however, a series stated, perhaps incorrectly, to be from the Sunderbans in the Gangetic Delta which agrees well with Hutton's description and with the remarks made by Nevill in his "Hand-List." We figure one of these shells.

The complete synonymy of *M. scabra* and its allies has still to be worked out. So far as we can say at present, the form *elegans* should not be regarded as having specific value.

Genus **Melanopsis**, Férussac.

1877. *Melanopsis*, Brot., *op. cit.*, p. 416.

This genus is represented in the southern part of the Persian Plateau[1] by several species. We have recently obtained from Persian Baluchistan a good series of specimens of a very distinct new form, for which we propose the name:—

Melanopsis deserticola, sp. nov.

(Pl. iii, fig. 8.)

The shell is smooth as a whole, tapering regularly, acuminate, fusiform, a little more than twice as long as broad. The whorls,

[1] See Nevill, *Hand List Moll. Ind. Mus.* II, pp. 206–209.

of which there are at least eight in complete shells, increase very gradually and regularly and are not at all swollen. The suture is not impressed but is, at any rate above the body-whorl, slightly undercut downwards. It is a little oblique. The spire is relatively long, nearly as long as the body-whorl in ventral and longer than that whorl in dorsal view. It is sharply pointed in the complete shell. The body-whorl is relatively narrow, much longer than broad and almost oblong in ventral view. In dorsal view the outer profile is in a straight line with that of the spire for about a third of its length and then curves abruptly inwards. The outer anterior angle is pointed and slightly produced. The mouth is rather small and relatively broad, slightly oblique and distinctly constricted posteriorly. The outer lip, which is not thickened, is sinuate and convex in its anterior part. The columella projects slightly; it is bent and its callus is moderate. The posterior canal of the mouth is short, narrow and straight. The surface of the shell is sculptured with coarse longitudinal striae, some of which on the body-whorl are irregularly thickened. In very old individuals these may have the appearance of obsolete ribs. The colour is normally a dull purplish black with the upper part of each whorl and the base of the body-whorl slightly paler; but some shells are bleached.

Measurements of Shells (in millimetres).

			Type-sp.
Length	14·4	13·6	13·3
Breadth	6·3	6·1	6·2
Length of aperture	6	5·8	6·1
Breadth of aperture	3·2	3·1	3·3
Length of spire (dorsal)	7·3	6·9	6·4

The operculum is thick and has the nuclear region small and obscurely spiral.

The animal is much shrunk in the specimens examined, but some interesting features of its external anatomy are apparent. The snout is relatively short and broad and slightly notched in front. The foot is much longer that broad. The tentacles, in a contracted condition, are very short, tapering and not very thick. They bear a relatively large oculiferous lobe at their outer base. The eye is also large. The upper surface of the exposed parts is blackish with white transverse lines, the sole white.

The radular teeth are large and rather stout. The central tooth is much broader than high. It is produced into blunt angles at the base on either side. Its upper margin bears three low prominences, while the lower margin is concave. There are five cusps, of which the central cusp is more than twice as long as the others; all are bluntly pointed and directed downwards. The disk bears a very large trilobed process with the central lobe broad and truncate, the lateral lobes pointed and with sinuate inner margins. The

lateral tooth is oblique but not bent. It has five cusps resembling those of the central tooth and bears a broad blunt process on its disk. The inner marginal has four or five subequal cusps and is much narrower than the outer. The outer marginal is relatively long and narrow as a whole, with four small cusps; but its outer margin is produced some distance below its upper edge into a broad, blunt lobe. On the upper part of the inner margin there is a similar but much less prominent projection.

Type-specimens. No. M 11535/2 *Zool. Surv. Ind.* (*Ind. Mus.*).

The type-series was found by Mr. (temporary Major) W. J Good, at the time Administrative Commandant, South Central District, Eastern Persian Cordon, at Kaindak (long. 60° 48′ E., lat. 29° 48′N.), Persian Baluchistan. The molluscs were collected on damp alga at the edge of a small spring of slightly brackish water. The water comes out of a patch of earth 20 to 30 feet square and forms a mere trickle.

At first sight the shell of this species is very like that of the dwarfed Persian form of *M. praerosa* (Linn.) called by Nevill var. *nana*. It is, however, considerably narrower and more acuminate and has the spire very much longer.

Family LIMNAEIDAE.

The molluscs of this family found in Baluchistan and Seistan all belong to the genus *Limnaea* in a wide sense, but fall into two very distinct groups, which we may call provisionally the group of *L. auricularia* and that of *L. truncatula*. Until the anatomy of the Limnaeidae of India and of Western Asia is better known it would be premature to discuss the nomenclature and status of these groups. To that of *L. auricularia* belong *L. persica*, *L. bactriana*, *L. iranica* and *L. gedrosiana*, while *L. truncatula* and *L. hordeum* represent the group of the former species.

Genus **Limnaea**, Lamarck.

The *Limnaeae* found in the countries under consideration are all of small size and, except those of *L. truncatula* group, have thin, fragile shells, which are unpigmented or of very pale colouration. They are all paludine forms. We have recognized six species. Although some of these resemble Palaearctic or Indian species in shell-characters, we have not felt justified in identifying any but the plastic *L. truncatula* with species known either from Europe, from Central Asia or from India. One peculiar species (*L. hordeum*) we assign, after a comparison of specimens, to a Mesopotamian form. The resemblances in the shell in other instances are no more than resemblances, and in most cases precise information as to anatomical characters is deficient or altogether lacking.

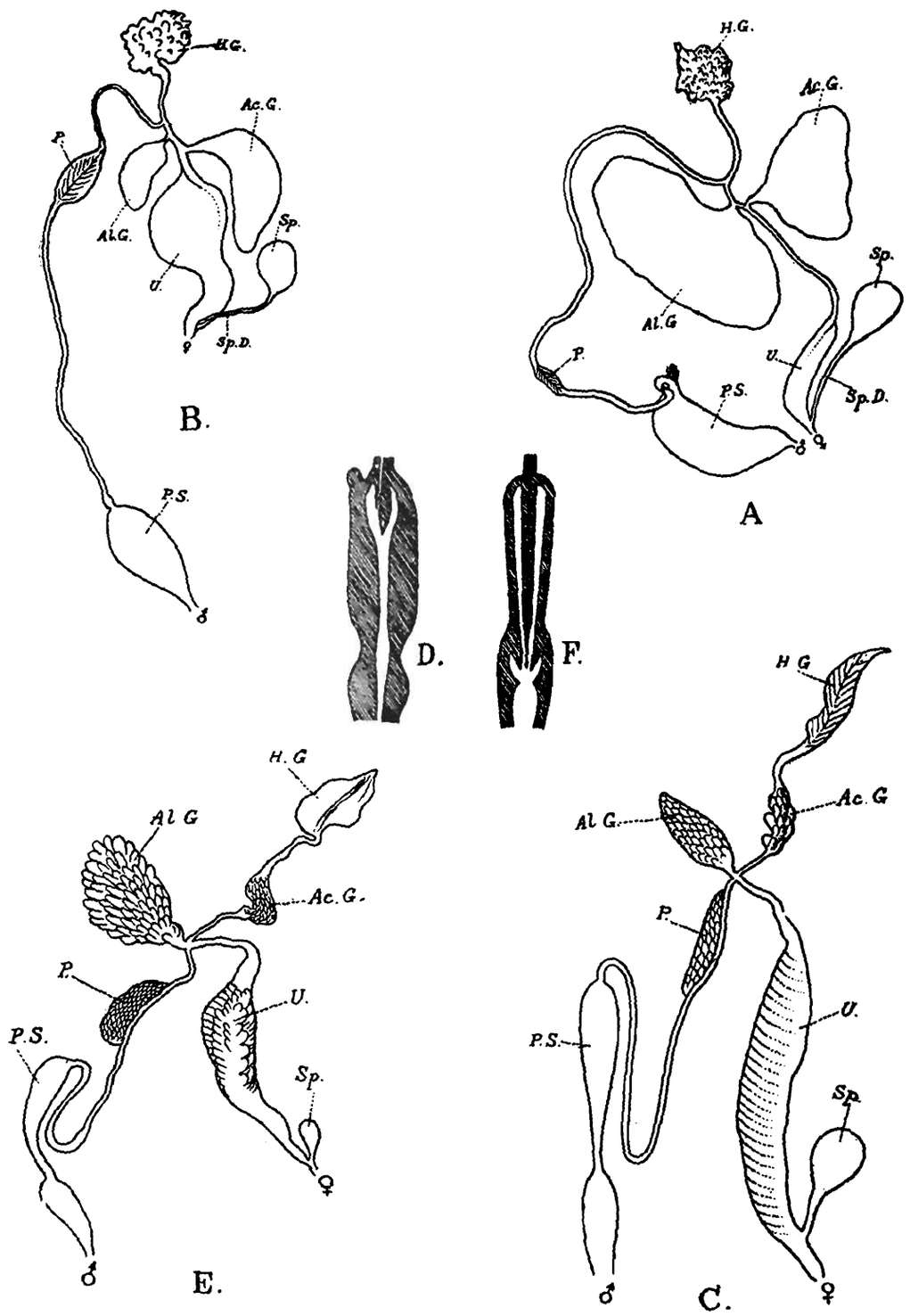

FIG. 5.—Genitalia of Pulmonate Molluscs.

A. Genitalia of *L. bactriana*, Hutton.
B. Genitalia of *Limnaea gedrosiana* var. *rectilabrum*, var. nov.
C. Genitalia of *Gyraulus euphraticus*, Mousson.
D. Penis-sheath of same specimen as seen in optical section (further enlarged).
E. Genitalia of *Gyraulus convexiusculus* (Hutton).
F. Penis-sheath of *Segmentina calathus* (Benson) as seen in optical section (× 35).

Key to the Shells of Limnaea *known from Baluchistan and Seistan.*

1. Shell thin, moderately small; its mouth large and more than half as long as the shell.
   - A. Mouth expanded and projecting posteriorly from shell at a right angle; its outer arc practically a semi-circle ... ... *L. persica.*
   - B. Mouth not or little expanded, usually projecting at an angle much less than a right angle; its outer arc less than a semi-circle.
     - i. Spire exserted, with swollen whorls and impressed suture; main axis of mouth forming an acute angle with that of shell ... *L. bactriana.*
     - ii. Spire much less exserted; its whorls not swollen and its suture not impressed; main axis of mouth parallel to that of shell.
       - a. Outer arc of mouth quite regular; apex sharply pointed ... ... *L. iranica.*
       - b. Outer arc of mouth irregular; apex bluntly pointed.
         1. Curve of outer arc of mouth only slightly flattened ... ... *L. gedrosiana, s.s.*
         2. Curve of outer arc of mouth flattened to a straight line ... ... *L. gedrosiana* var. *rectilabrum.*

2. Shell moderately or very thick, of very small size, elongate, with the length of the mouth much less than half the total length.
   1. Apex pointed; whorls of spire moderate ... *L. truncatula.*
   2. Apex blunt; whorls of spire very large ... *L. hordeum.*

Limnaea persica, Issel.

(Pl. v, figs. 3–6.)

1865. *Limnaea auricularia* var. *persica*, Bourguignat, Issel, *Moll. Miss. Ital. Persia* (*Torino*), p. 47.
1883. *Limnaea persica*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, p. 285.

Issel gave a very brief description of this form, which he did not figure, merely comparing it with *L. auricularia* and stating the length and breadth of the shell. Locard had probably seen specimens, as he compared his *L. subpersica* with it, but gave no further details. It seems to us impossible that the form which Nevill[1] called *Limnaeus lagotis* var. *persica*, Issel (= *L. iranica*, nobis) can be identical, as that form has no particular resemblance to *L. auricularia.*

We have before us a series of shells[2] collected by the late Dr. W. T. Blanford at Saidabad, S.W of Kerman (the type locality). The measurements of one of these agree almost precisely with those given by Issel. We have also a much larger series from the Baluchistan desert clearly belonging to the same species but differing slightly. Fully adult shells from the former locality are somewhat broader than Issel's type, the specimen that agrees with it being not quite full-grown, and we do not know from what kind of

[1] Nevill, *Hand List Moll. Ind. Mus.* I, p. 237 (1879).
[2] Identified by Nevill as *L. auricularia*, var. (*op. cit.*, p. 238).

environment either Philippi's or Blanford's specimens came. It is possible, therefore, either that Issel's type was immature, or that the specimens from the desert are more near the typical form than those which chanced to be collected in the same district as it. We will describe and figure shells from the Kerman district and point out the characters wherein those from the desert (examples of which we also figure) differ from them.

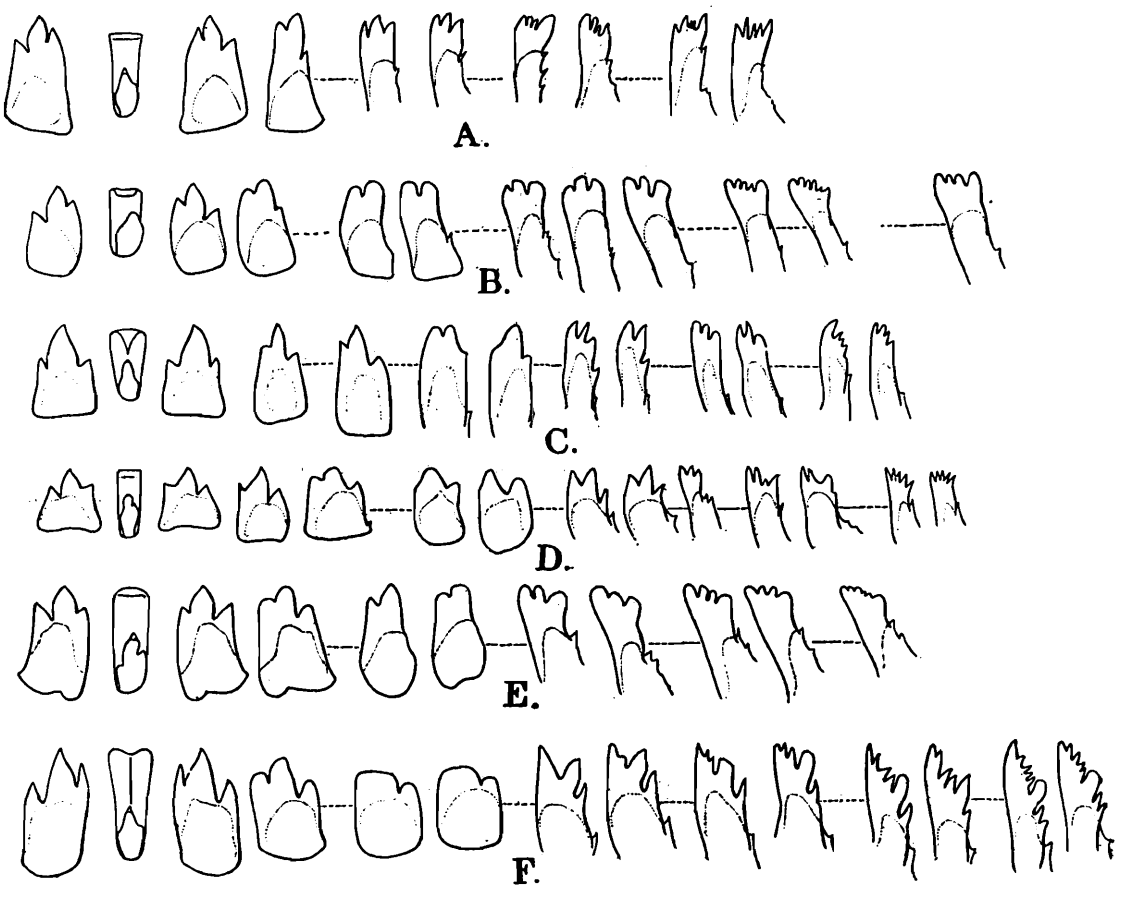

FIG. 6.—Radular teeth of *Limnaea* (× *ca.* 185).

A. Teeth of *Limnaea gedrosiana*, sp. nov from pond in garden in Quetta.
B. Teeth of same species from the reed-beds of the Hamun-i-Helmand.
C. Teeth of *L. gedrosiana* var. *rectilabrum*, var. nov from stones at edge of Kushdil Khan reservoir, Northern Baluchistan.
D. Teeth of same variety from small pool in desert near Nasratabad, Seistan.
E. Teeth of *L. bactriana*, Hutton, from irrigation channel, Nasratabad, Seistan.
F. Teeth of *L. iranica* from Persian Baluchistan.

Form from the Kerman district. The shell is small and thin, of a pale horny colour and (perhaps through age) opaque. The spire is short but prominent, acutely pointed and slightly oblique as a whole. It is considerably longer on the dorsal than on the ventral aspect of the shell, occupying about $\frac{1}{5}$ of the total length on the former and on the latter nearly $\frac{1}{8}$. The body-whorl is relatively large but not greatly inflated; its outlines are sinuous and it has considerable obliquity. The mouth of the shell is large

and oval; its main axis lies nearly parallel to but considerably outside that of the shell; it is hardly pointed posteriorly. The outer lip is sharp, broadly and fairly regularly arched; it extends far beyond the body-whorl posteriorly. The antero-internal angle is broadly rounded and a little expanded, the anterior border slightly flattened in its immediate vicinity. The columella is straight, its callus well-developed and broad but not coarse; it is slightly or not at all folded and is extended over the narrowly rimate umbilicus. The sculpture consists of fine, somewhat irregular longitudinal ridges with microscopic striae running parallel to them; the former are often developed only on the body-whorl.

Form from the Baluchistan desert. Our specimens from the Baluchistan desert were collected in December, 1918 by Mr. S. W Kemp at the edge of the Zanginawar lakes, 20 miles east of Nushki. These lakes are a series of small basins which retain the overflow from the Pishin river and contain water that is nearly fresh in winter and supports a luxuriant submerged vegetation. Mr. Kemp found only empty shells. These were abundant on the shore of the lakes one to two feet above the water-level.

The shells from Zanginawar only differ from those from the Kerman district in being rather smoother and distinctly narrower and in having the columellar callus narrower and slightly more folded. As may be seen from the figures on plate V, they vary somewhat in outline, and young shells are narrower and have the mouth less expanded than old ones.

Unfortunately we have no information about the radula or soft parts of either race of this species.

Measurements of Shells (in millimetres).

Specimens A—C are from Saidabad, S.W. of Kerman, S. Persia; specimens D—F from Zanginawar in the Baluchistan desert, 20 miles west of Nushki.

	A	B	C	D	E	F
Length	13·3	11·2	10·8	12·8	12·4	12·3
Breadth	10·0	7·0	7·0	7·7	7·6	7·9
Length of aperture	11·1	7·8	8·0	9·5	9·2	9·4
Breadth of aperture	7·0	5·0	5·0	6·4	6·1	6·5
Length of spire (dorsal)	2·5	2·7	2·0	2·1	2·3	2·4
Breadth of base of spire	2·5	2·5	2·5	2·0	2·4	2·6

It seems better, in the lack of anatomical information, not to dogmatize as to the precise relations of this form. There can, however, be little doubt that it belongs to the same group as *L. auricularia.*

Limnaea iranica, sp. nov.

(Pl. vii, fig. 1.)

1878. *Limnaea lagotis* var. *persica*, Nevill (*nec* Issel), *Hand List Moll. Ind. Mus.*, I, p. 237.

Shell. The shell is of small or moderate size, fairly thin, dull on the external surface, of a pale, dull opaque buff colour, orna-

mented with very fine longitudinal ridges and striae but without transverse striae. The shape is regularly, narrowly ovate, with the apex sharply pointed. The suture is not impressed and slightly oblique. The whorls, of which there are $4\frac{1}{2}$, increase gradually in size. The spire is prominent, but short, slightly oblique as a whole. It occupies a little less than $\frac{1}{4}$ of the total length in dorsal view and is only a little longer in ventral view. The body-whorl is ovate and not at all swollen, almost bilaterally symmetrical. In dorsal view the internal profile forms for the greater part of its length from the base of the spire a regular arc a little less than a semi-circle but is distinctly constricted in front of the internal anterior angle, which is broadly rounded and slightly produced. The mouth of the shell is long and narrowly pear-shaped, pointed and slightly introverted posteriorly. It runs backwards for about the length of the body-whorl. The outer lip is sharp, not at all thickened internally, broadly and regularly arched but not expanded. The columella is straight and slightly folded. Its callus, which is continuous with the outer lip posteriorly, is moderately developed. The anterior margin of the mouth is rounded and projects slightly. The columellar callus completely covers the very narrowly rimate or altogether closed umbilicus.

Measurements of shells (in millimetres).

Specimens A—C are from Persian Baluchistan (*Blanford*), specimens D—F from Magas in S. Persia (also *Blanford*).

	A	B	C	D	E	F
Length	18·3	14·5	15·3	14·4	13·4	10·3
Maximum breadth	11	9·1	9·1	8·4	7·5	6·2
Length of aperture	14·2	11·4	11·8	11·2	9·3	7·3
Breadth of aperture	9·5	8·1	7·3	7·2	6·4	5·1
Length of spire (dorsal)	3 6	2·9	3·3	3·4	2·4	2·6
Breadth of base of spire	4·2	3·5	3·7	3·5	3·5	2·9

Shells from the two localities only differ in size. Our specimens are those examined by Nevill.

Radula. We have extracted the radula from one of Blanford's specimens in which remains of the animal persisted. It is of the same type as that of *L. bactriana* but differs in several particulars. The base of the central tooth is distinctly bilobed. The three cusps of the inner lateral teeth are long and sharp, but those of the intermediate bicuspid teeth are short and blunt, the inner cusp being broadly truncate. The marginal teeth are somewhat remarkable, having the outer margin coarsely denticulate, one of the denticulations being often of a lobular nature. The dental formula is approximately 12.7.1.7.12.

Type-specimen. No. M11545/2, Zoological Survey of India (Ind Mus.) [Persian Baluchistan].

Localities. The only specimens we have seen are those collected by Dr. Blanford in Persian Baluchistan and at Magas in Southern Persia. There is a good series from each locality.

The position of this species is a little doubtful. The shell is in some respects intermediate between that of *L. peregra* (*ovata*) and that of *L. lagotis*. It resembles somewhat that of *L. intermedia* as figured by Kobelt in the new edition of Rossmässler's "Iconographie" (pl. 488, No. 2602), but the whorls increase more gradually in size and the mouth is broader.

Limnaea bactriana, Hutton.

(Pl. v, figs. 1, 2; pl. vii, fig. 6.)

1850. *Limnaea bactriana*, Hutton, *Journ. As. Soc. Bengal* XVIII (2), p. 656.

The shell is moderately small, thin, fragile, of a pale, dull brownish colour, polished when clean but coated with calcareous algae in most of the specimens examined. The surface is often irregularly decussated and always bears, at any rate on the body-whorl, prominent but narrow longitudinal ridges and corresponding striae set close together. No transverse striae can be detected with a lens. The sculpture is often concealed by the calcareous algal coat. The apex is acuminate but not very acute, the spire prominent, but occupying less than $\frac{1}{3}$ of the total length in dorsal view. The suture is impressed and moderately oblique. There are 4 or $4\frac{1}{2}$ whorls, which are neither swollen nor shouldered; those of the spire increase gradually in size and the penultimate whorl is relatively large. The body-whorl is large and of ovoid form; its inner outline is markedly sinuate and somewhat emarginate towards the anterior extremity, but the antero-internal angle is broadly rounded, the outer outline is evenly and not very strongly curved. The mouth is large but not expanded, extending backwards for more than $\frac{4}{5}$ the length of the body-whorl and being less than twice as long as broad; it is of symmetrical ovoid form, pointed posteriorly and with its main axis parallel to that of the shell. The outer lip is sharp and neither introverted nor expanded; it has a regular and considerable outward curvature and extends forwards considerably beyond the limits of the body-whorl. The peristome is continuous, the callus broad but thin, extending over the narrow but profoundly perforate umbilicus; the columella is distinctly folded.

As in many species of *Limnaea* the shell is dimorphic. We shall call the two forms (*a*) and (*b*) and describe the commoner (*a*) first.

(*a*) In this form the shell has a comparatively long spire, occupying nearly $\frac{1}{4}$ of its length in dorsal view. The first $3\frac{1}{2}$ whorls increase in size gradually, but the basal whorl of the spire is enlarged, the spiral is by no means uniform and the body-whorl comparatively narrow.

(*b*) The shell differs from that of (*a*) mainly on account of the fact that there is a distinct change in the direction of the spiral between the ultimate and penultimate whorls. The base of the spire is therefore concealed in the body-whorl so that its visible part

becomes comparativey short (slightly more than $\frac{1}{5}$) of the total length, while the body-whorl being more transverse appears broader and has a more expanded mouth, the posterior extremity of which is situated at a higher level on the shell.

Measurements of Shells (in millimetres).

	Type (*a*).	Type (*b*).	Young.
Length ..	18·0	16·0	7·4
Breadth	11·7	11·3	4·6
Length of aperture	11·0	10·8	4·8
Breadth ot aperture	6·5	6·3	1·7
Length of spire (dorsal view)	5·0	3·4	2·5
Breadth of base of spire (dorsal view)	3·5	3·2	2·0

The soft parts of the living animal have no noteworthy peculiarity. The foot and head are pale greenish yellow with minute whitish specks. The lower part of the mantle is black with large rounded yellowish spots; higher up the yellow predominates and the dark pigmentation is reduced to a delicate network.

The alimentary canal. The jaw is not strongly developed; the central piece is narrow and lunate, only its outer or marginal half is fully cornified and of a brown colour. The side pieces are feeble. The buccal mass is large and powerful, deeply rounded in lateral view. The salivary glands are smaller than in some species; they enter the alimentary canal just behind the buccal mass.

The radula is broad, its dental formula being approximately 18.7.1.7.18. The central tooth, which is comparatively large, has a distinctly tridentate cusp, which is very asymmetrical and is provided at the tip of the central denticulation with a minute thickened spine or tooth. The base of the tooth is elongate and only a little emarginate proximally. The lateral teeth are broad and tridentate; those on either side of the central tooth have the innermost denticulation subequal to the outermost and the central denticulation long and sharp. The outer lateral or intermediate teeth have two rather blunt cusps; the true marginals have from 3 to at least 7 very short and blunt denticulations, the outermost of which is the broadest. These denticulations are arranged in an almost straight transverse line.

The oesophagus is slender and elongate, marked on the surface with lines of dark pigment; it forms a well-defined double loop at about half its length between the buccal mass and the chyle stomach. This structure is short and by no means clearly differentiated externally. The lateral muscular masses of the gizzard are large but quite distinct in the middle line and slightly unequal in size; they extend very little over the true stomach, which is elongate and merges very gradually into the intestine

near the point at which the liver-duct enters the alimentary canal. The proximal part of the stomach is somewhat sacculated. The liver is large and the intestine rather stouter than in some species.

The *genitalia* are very like those of *L. chlamys*,[1] but the upper part of the male duct above the prostate, the lower part of the same duct and also the spermathecal duct are all considerably longer. Other apparent differences (the larger size of the female accessory glands and the more lobate form of the hermaphrodite gland) are probably due to the state of sexual activity in the specimens examined. The ovarian part of the hermaphrodite gland is particularly well developed. The prostate is spindle-shaped, but very small.

Habitat. This species was described from Quetta and was found in considerable abundance in an irrigation-channel leading to the garden of the British Consulate at Nasratabad (Seistan town) and also in pools on the parade-ground at the same place. In the channel the water was usually still, but it was allowed to flow freely every few days. It was always more or less turbid. The bottom was composed of stiff clay and supported a rather scanty growth of Characeae and of a narrow-leafed *Potamogeton*. In the pools, which had a similar bottom but contained a somewhat more luxuriant vegetation consisting chiefly of *Zannichellia palustris*, the water was extremely foul, being frequented by camels, donkeys and mules. The basins had been excavated in obtaining clay for bricks and the water had probably entered by percolation. Shells were also found subfossil in the banks of old water-channels near Nasratabad.

Habits. It is noteworthy that these molluscs, though living in water the surface of which was frequently frozen at the season at which they were observed, were in a state of sexual activity so far as the female organs were concerned. Egg-masses were abundant on the water-weeds. The adults seemed to feed chiefly on minute algae growing on the mud.

No difference was observed between those individuals from the dirty pools and those from the irrigation channel.

Affinities. Until the anatomy of the Asiatic Limnaeidae is better known some doubt must remain as to the affinities of this species. The shell resembles those of the group *L. lagotis*, but is more distinctly perforate. The structure of the spire somewhat resembles that of *L. lagotis* var. *subdisjuncta*,[2] Nevill, but the penultimate whorl is relatively large and the structure of the mouth is quite different. Hutton in his original description compared the shell to that of the young *L. chlamys*, Benson, and curiously enough, before we recognized the identity of our specimens, we did the same so far as the genitalia were concerned. There can be little doubt, therefore, that a relationship with the Indian

[1] Annandale and Prashad, *Rec. Ind. Mus.*, XVI, p. 143, fig. 4 (1919).

[2] *Sci. Res. Yarkand Miss. Mollusca*, p. 9 (1886). For figures see Weber, *Wiss. Ergeb. Reise. Thian-Schan*, Mollusken, pl. i, figs. *f-h* (*Ab. Bayer. Ak. Wiss. Math.-phys. Klasse*, XXVI, 1913).

species exists, but what precisely that relationship is still remains to be discovered.

We have compared our specimens from Seistan with one named by Hutton from the old collection of the Asiatic Society of Bengal This shell is stated to be from Kandahar, but Hutton records the species only from Quetta, which was in Afghanistan when he wrote. It is very possible that the locality is incorrect. The specimen is not mature and agrees very closely with the young shell figured by us on pl. vii.

Limnaea gedrosiana, sp. nov.

(Pl. vii, figs. 2–4.)

1850. *Limnaea peregra*, Hutton, *Journ As. Soc Bengal* (2) XVIII, p. 655.

This species, so far at any rate as the shell is concerned, closely resembles *L. iranica*, but differs in that the shell is smaller, thinner, paler in colour, smoother, less regular in outline, with a blunter apex, more oblique spiral and slightly more impressed suture. The colour is a faint greenish yellow, the shell is extremely fragile and when fresh quite transparent. There are $3\frac{1}{2}$ or 4 whorls. The spire is twice as long in dorsal as in ventral view, occupying at least $\frac{1}{4}$ of the length of the shell in the former. The curvature of the inner profile of the body-whorl is less convex and not so regular as in *L. iranica*, and this whorl as a whole is much less symmetrical. The mouth of the shell is ovate, pointed but not retroverted posteriorly. It is almost bilaterally symmetrical and narrower than in *L. iranica*; its main axis is parallel to that of the shell. Though relatively as long as in the preceding species, it only extends backwards for about $\frac{7}{9}$ the length of the body-whorl. The curvature of the outer lip is slightly flattened in adult shells. The anterior margin projects considerably beyond the body-whorl.

Measurements of Shells (*in millimetres*).

	Quetta			Lab-i-Baring.		
Length	11	9·1	7·1	7·5	8	7·8
Maximum breadth	6·3	5·6	4·6	4·1	4·1	4·6
Length of aperture	8·2	6·7	5·7	6·0	6	5·4
Breadth of aperture ..	5·4	4·1	3·6	3·8	3·6	3·3
Length of spire (dorsal)	2·3	1·7	1·4	1·3	1·4	1·4
Breadth of base of spire.	3·1	2·3	1·9	2·1	2·3	2·1

The living animal resembles that of *L. bactriana*, but the foot is perhaps rather smaller, the tentacles longer and more pointed and the colour pale.

The alimentary canal also resembles that of *L. bactriana*, but the muscular gizzard is more uniformly developed and more compact. It can be seen in the living animal through the shell as a globular shining mass.

The jaw and radula are of the same type as those of the species already discussed, and closely resemble those of *L. bactriana* in particular. They exhibit, however, great placticity and individual variability (see figures, p. 42). The marginals never have the peculiar form of those of *L. iranica*.

Genitalia. The genitalia are of the same type as those of *L. bactriana*, but have one important difference, viz. that whereas in that species the male and female parts of the system are approximately equal in length, in *L. gedrosiana* the vas deferens is greatly elongated, while the female ducts are short. This difference is not correlated with any difference in the position of the external sexual apertures, which in both species are situated almost on a level, but in *L. gedrosiana* the male duct is strongly convoluted.

Type-specimens. M. 11533/2, Zoological Survey of India (Ind. Mus.).

Localities. This species is common, as Hutton noted, in the Pishin district (Chaman) and at Kandahar. It also occurs in abundance at Quetta and in the Hamun-i-Helmand in Seistan.

Habits. *L. gedrosiana* can apparently live only amidst dense submerged vegetation. Hutton found it in brick tanks at Kandahar and in a small marsh at Chaman. Our specimens from Quetta were taken among weeds in a pool supplied by water from an underground source in the Residency gardens. The submerged vegetation in this pool was dense and the water, in November and January, perceptibly warmer than the air. In the Hamun this *Limnaea* occurs mainly amidst algae growing on the roots of *Phragmites* and also on *Potamogeton pectinatus* in small pools in the reed-beds.

Affinities. *L. gedrosiana* is apparently related to *L. peregra*, but differs in the blunter spire, more oblique spiral and longer mouth of its shell. We do not feel justified in uniting the two forms, and the shell differs considerably from that of any of the "varieties" from Central Asia ascribed to *L. peregra* by former authors.

Variation and plasticity. There is not much individual variation in shells from the same environment, except that correlated with age. Shells from Quetta, however, are larger and a little broader and have distinctly larger mouths than those from the Hamun. Moreover, their spire is distinctly shorter.

var. **rectilabrum**, nov.

(Pl. vi, figs. 1–6.)

This variety or phase differs from the *forma typica* so far as the shell is concerned mainly in having the outer lip distinctly flattened so that it slopes outwards in a straight line. Its margin is sometimes slightly turned inwards towards the aperture. The precise form of the mouth is, however, subject to considerable individual variation (see pl. vi). The radula does not differ more from that of the *forma typica* than that of the latter varies. The genitalia

are practically identical, but the vas deferens differs slightly in proportions.

This variety exhibits both individual variation and plasticity in a higher degree than *L. gedrosiana, s.s.* The shape of the mouth of the shell and of the whole body whorl differs considerably in individuals from the same environment, while individuals from one environment differ in having a narrower shell than those from another. The two localities from which we have examined fresh specimens are the Kushdil Khan reservoir, situated at an altitude of 5000 ft. in the hill-country of Baluchistan north of Quetta, and a small pool in the desert some miles south of Nasratabad in Seistan. The Kushdil Khan reservoir is a large body of clear shallow water artificially confined and liable to dry up in summer. In winter it contains at certain places a fairly dense submerged vegetation consisting of *Potamogeton pectinatus*, *Naias major*, etc. The pool near Nasratabad was quite a small one. At the time of our visit it was completely isolated in the desert, but in flood-time is evidently connected with a large backwater of one of the effluent channels of the Helmand. Its vegetation consisted in December of dead reeds and a scanty growth of broad-leaved *Potamogeton.*

Specimens from Kushdil Khan were much larger and as a rule considerably broader than those from Seistan (*cf.* figs. 1–3, 4–6 on pl. vi). All the shells from each locality belonged, though differing considerably, quite definitely to the variety.

At Kushdil Khan dead shells, some with remains of the animal, were collected in flood-drift on the edge of the reservoir, while a few individuals were found adhering to the lower surface of stones near the margins. The molluscs in the desert near Nasratabad were attached in large numbers to dead reed-stems and to the droppings of goats, flocks of which watered at the pool.

Measurements of Shells (in millimetres).

Specimens from A—C are from Kushdil Khan reservoir (Baluchistan), and specimens D—F from a small pool, some miles south of Nasratabad, Seistan.

	A	B	C	D	E	F
Length	15·1	13·4	14·5	12·2	11·1	9·8
Maximum breadth	9·6	8·1	8·8	7	6·8	5·4
Length of aperture	11·5	10	10·7	9·2	8·9	7·2
Breadth of aperture	8·1	6·4	7·6	5·6	5·5	4·4
Length of spire (dorsal)	3	2·7	3·4	2·8	2·2	1·8
Breadth of base of spire	3·8	3·4	3·5	3·1	2·7	2·8

Type-series. M 11534/2, Zoological Survey of India (Ind. Mus.).

Limnaea truncatula, Gray.

1850. *Limnaea truncatula,* Hutton, *Journ. As. Soc. Bengal* (2) XVIII, p. 656.

We have seen no specimens from Baluchistan or Seistan, but have examined a large series from different parts of the Western

Himalayas. These specimens provide evidence of much local plasticity, some agreeing with European shells, others having the form of the var. *longula* figured by von Martens in the report (in Russian) on the molluscs in Fedtschenko's *Reise in Turkestan* (vol. 1, pl. ii, fig. 26, 1874). Specimens from some Himalayan localities are much larger than those from others.

Hutton states that *L. truncatula* is common in the marshlands bordering the Helmand at Girishk and also in similar situations at the Kogrick Pass and at Quetta. The fact that it was not found at Quetta in winter is, therefore, interesting. The species seems more susceptible to drought and unfavourable conditions than most of the genus [1] and probably conceals itself in cold weather. Had it occurred at all commonly in Seistan, however, dead shells would probably have been recovered from the recent deposits examined at the edge of the Hamun and elsewhere. The presence of a liver-fluke of the genus *Fasciola* in the country does not necessarily imply that this mollusc is the intermediate host of the liver-fluke, for *L. truncatula* does not occur in North America and yet *Fasciola hepatica* is prevalent in some districts [2]; moreover, as Mr. Kemp points out in a note appended to this paper, the Seistan liver-fluke is not identical with the European one.

Limnaea hordeum, Mousson.

(Pl. vii, fig. 5.)

1874. *Limnaea hordeum*, Mousson, *Journ. Conchyl.* XXII, p. 42.

The shell is extremely small and rather thick, narrowly elongate but blunt at the apex. Our single specimen is bleached white and has a somewhat porcellaneous appearance. There are four whorls but the apical one is very small and projects little. The suture is impressed and very oblique, so that the spire is much shorter in the ventral than in the dorsal view. The third whorl is more than 3 times as long as the second and the body-whorl considerably longer than the spire. The mouth is small and rather narrow, almost straight and practically oval, being little contracted and not at all pointed posteriorly. The lip is somewhat expanded and has a thickened appearance due to a blunt ridge running round it a short distance inside the margin. The columella is slightly folded, its callus narrowly expanded over the rimate umbilicus. The callus is joined posteriorly to the outer lip. The surface of the shell is marked with faint longitudinal striae, which are regular and set close together.

We have compared our single specimen with two of Mousson's species from the edge of the river Euphrates and can find no difference. The species was originally described from that river. Our Mesopotamian specimens are from Nasariyeh. We obtained a single dead shell in a drift at the edge of a small pool in the

[1] Walton, *Parasitology* X, p. 243 (1917).
[2] Ward, *Fresh Water Biol. N. America*, p. 389 (1918).

desert some two miles south of Nasratabad in Seistan. The pool in flood-time is connected with a branch of the Helmand river. The following are the measurements (in millimetres) of our Persian specimen:—

Length	5
Maximum breadth	2·7
Length of aperture	2·2
Breadth of aperture	1·4

Family PLANORBIDAE.

The three species belonging to this family and known from Baluchistan and Seistan are all small and all occur commonly throughout Northern India and the adjacent countries. It is with some reluctance that we feel obliged to recognize the two groups represented by the three species as distinct genera, but they differ so much not only in shell but also in anatomy that no other course seems possible to us. We assign, therefore, two of the species (*Planorbis euphraticus*, Mousson and *P. convexiusculus*, Hutton) to the genus *Gyraulus*, Agassiz, and one (*Planorbis calathus*, Benson) to the still more distinct genus *Segmentina*, Fleming.

Genus **Gyraulus**, Agassiz.

1837. *Gyraulus*, Agassiz, *Nouv. Mem. Soc. Helv.* I (*fide* Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 118, 1915).

In this genus the shell is small, thin, flat, pale, translucent or transparent, without strong transverse ribs, with or without spiral epidermal cilia, with or without peripheral keel, with few whorls, with a simple lip, without teeth or partitions on the internal surface, with a dextral spiral. The radula has the central tooth bicuspid and the laterals bi- or tricuspid, the marginals with several sharp cusps. The edge of the mantle is not thickened. The vas deferens is continued distally into a narrow penis, which projects straight into an elongate bulbous chamber or penis-sheath and is armed at its termination with a well-developed horny stylet.

Type-species. Planorbis albus, Müller (Palaearctic).

There has been much confusion about the two species of this genus that occur in Baluchistan and Seistan, chiefly because conchologists have rarely seen specimens from the original localities. The correct names for these species are in our opinion *G. convexiusculus* (Hutton), of which *G. saigonensis*, Crosse and Fischer, is a synonym, and *G. euphraticus*, Mousson, to which Hutton and later Benson applied the preoccupied name *Planorbis compressus*.

Gyraulus convexiusculus (Hutton).

1850. *Planorbis convexiusculus*, Hutton, *Journ. As. Soc. Bengal* (2), XVIII, p. 657.

1864. *Planorbis saigonensis*, Crosse and Fischer, *Journ. de Conchyl.*, XII, p. 362, pl. xiii, fig. 7.

1876. *Planorbis convexiusculus*, Hanley and Theobald, *Conch. Ind.*, p. 48, pl. xcix, figs. 8–10.
1886. *Planorbis convexiusculus*, Clessin, *Die Fam. Limnaeiden* in Martini and Chemnitz's *Conch. Cab.* (ed. Küster), p. 127, pl. xvii, fig. 9.
1897. *Planorbis compressus*, v. Martens, *Süss-u. Brackw. Moll.* in Weber's, *Zool. Ergebn. Niederl. Ost.-Ind.* IV, p. 13, pl. i, figs. 17–22, pl. xii, figs. 7, 10.
1909. *Planorbis saigonensis*, Germain, *Rec. Ind. Mus.*, III, p. 117.
1918. *Planorbis saigonensis* (?), Annandale, *Rec. Ind. Mus.*, XIV, p. 112, pl. xi, fig. 12.
1919. *Planorbis, convexiusculus*, id., *Rec. Ind. Mus.*, XV, p. 166.

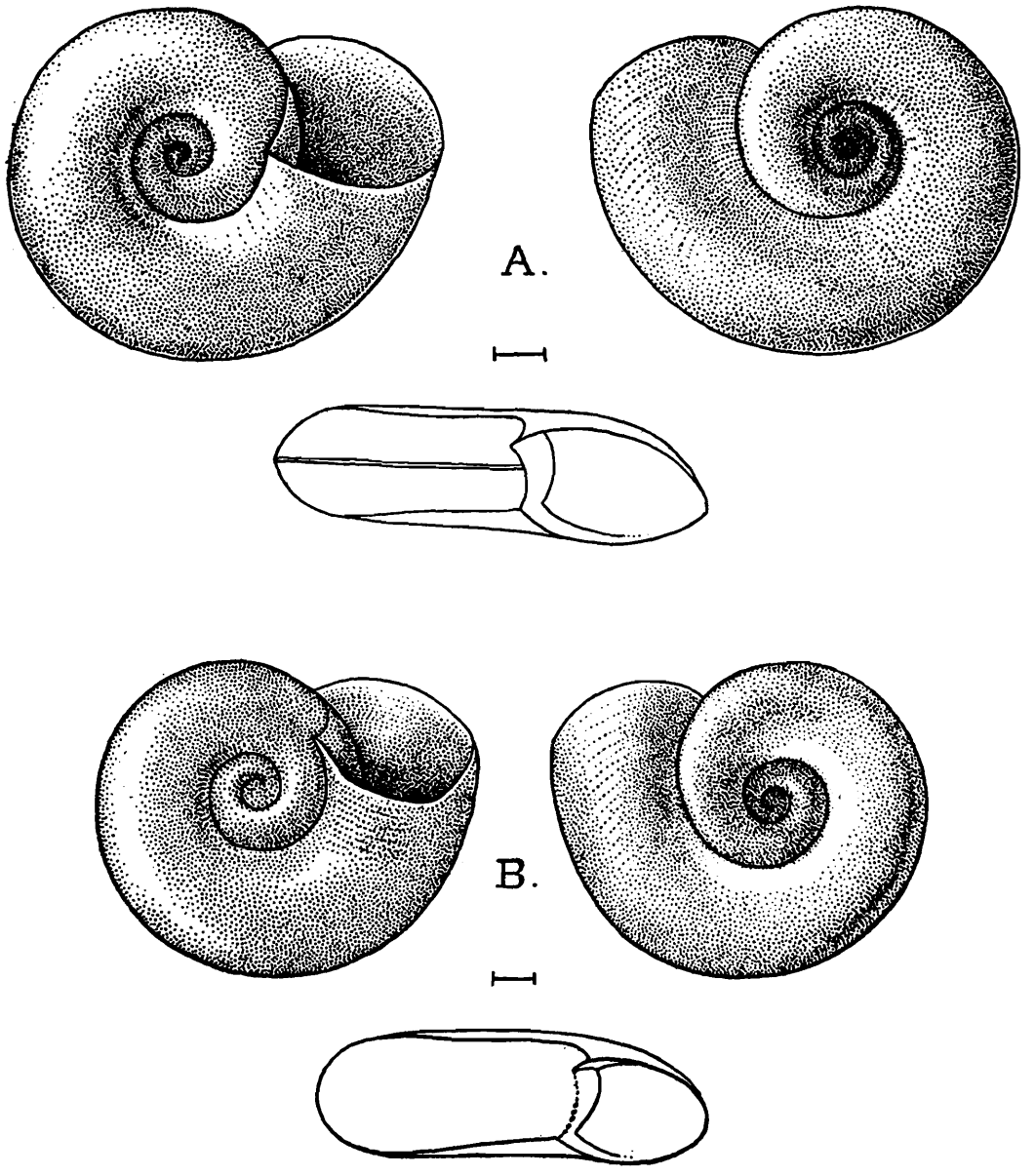

FIG. 7.—Shells of *Gyraulus* from pool in Residency garden, Quetta, Baluchistan.

A. *Gyraulus euphraticus*, Mousson. B. *G. convexiusculus*, Hutton.

This shell is apparently very like that of *G. albus*, the type-species of the genus, but the whorls are deeper. It rarely exceeds

5 mm. in maximum diameter. The figure of the mouth in *Conchologia Indica* is not very good, the upper margin being represented as too much elevated. Some variation, however, exists in this respect.

It is undoubtedly to *G. convexiusculus* and not to Hutton's *P. compressus* that Crosse and Fischer's *P. saigonensis* belongs. Specimens from Tibet identified by Germain (who had probably had access to the collections described by the latter authors) as *P. saigonensis* agree closely with shells from Quetta, one of the type-localities of Hutton's species.

The radula has approximately the dental formula 11.9.1.9.11. The two cusps of the central tooth are well developed and sharply pointed. The inner laterals have two stout, sharply pointed cusps, the outer laterals or transitional teeth three. The marginals have from four to six similar but more slender cusps. Von Martens' figure of the teeth is on too small a scale to show their structure clearly.

The genitalia (fig. 5 E, p. 40) belong to Simroth's [1] Typus III and closely resemble his figure of those of *Planorbis vortex* in general structure. All the ducts are, however, much shorter, the penis-sheath is larger and more elongate and the spermatheca smaller and also more elongate.

Planorbis convexiusculus is common with the succeeding species among weeds in water-channels and in pools in the reed-beds in Seistan, also in ponds near Quetta, where it occasionally occurs in large numbers on the muddy bottom of open water-channels. It is almost invariably found with *P. saigonensis*. Its geographical range extends from Lower Mesopotamia through Eastern Persia, Afghanistan and Northern India to Upper Burma, French Indo-China, China, Japan, and the Malay Archipelago.

Like many aquatic Pulmonates this species rises to the surface of the water in the evening and crawls shell-downwards on the surface film. It is, however, apparently unable to swim actively in this position as *G. euphraticus* does (*post.*, p. 56).

Gyraulus euphraticus, Mousson.

1834. *Planorbis compressus*, Hutton (*nec* Michaud), *Journ. As. Soc. Bengal* (2) III, p. 93.
1850. *Planorbis compressus. id., ibid.*, XVIII, p. 117.
1874. *Planorbis* (*Gyraulus*) *devians* var. *euphratica*, Mousson, *Journ. de Conchyl.* (3) XIV, p. 44.
1918. *Planorbis saigonensis*, Annandale, *Rec. Ind. Mus*, XV, p. 166.
1918. *Planorbis saigonensis, id., Mem. As. Soc., Bengal* VI, p. 304.

The shell of this species is so like that of *G. convexiusculus*, and the two are so frequently found together, that we would have felt inclined to regard them merely as dimorphic forms had it

[1] Simroth, "Mollusca (Weichtiere)" III, p. 502, fig. 165, pl. xxvi, figs. 4, 6 in Bronn's *Tier-Reich* (1912).

not been for certain differences in the radula and for the fact that the habits are to some extent distinct. The shell, as one of us has pointed out (*op. cit.*, 1918), differs from that of *G. convexiusculus* not only, as Hutton noted, in being more compressed and more strongly carinate, and having the lip and whorls of a slightly different shape, but also in being larger, more opaque and more coarsely and irregularly sculptured. The last whorl moreover as a rule deviates from the spiral of the upper whorls. These characters are to some extent variable, but the radula differs in having all the teeth narrower, all the laterals tricuspid and the marginals with smaller cusps. The genitalia have all the ducts longer than those of *L. convexiusculus* and the spermatheca much larger. Otherwise they are very similar.

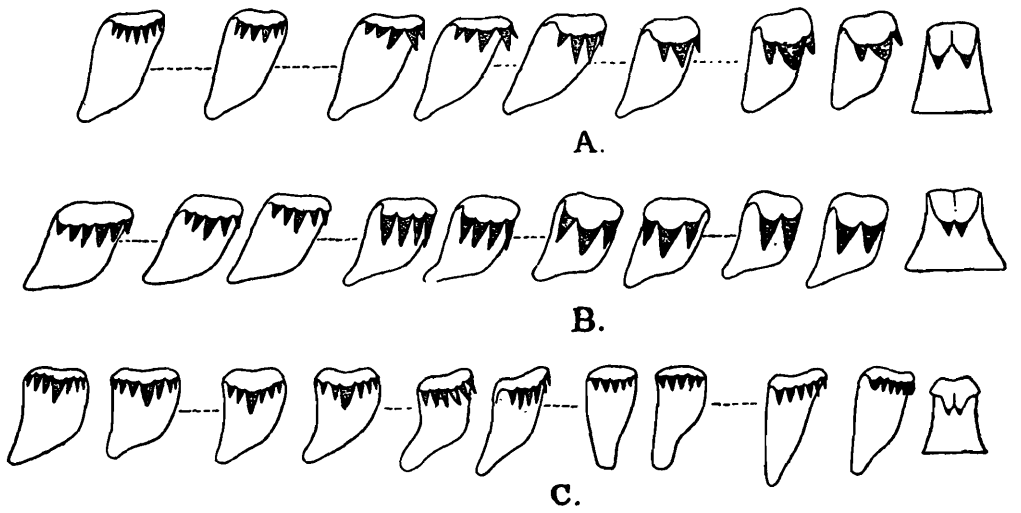

FIG. 8.—Radular teeth of Planorbidae.

A. Teeth of *Gyraulus euphraticus*, Mousson, from Quetta (× 708).
B. Teeth of *G. convexiusculus*, Hutton, from the same locality (× 900).
C. Teeth of *Segmentina calathus* (Benson) from swamp near Gurdaspur, Punjab (very highly magnified).

Germain[1] regards Hutton's *Planorbis compressus* as synonymous with *P. saigonensis*, Crosse and Fischer, but specimens from Northern India have the sculpture coarser and more irregular, the last whorl more oblique, the mouth larger and more oblique and the inner whorls more concave on the lower surface than is shown of *G. saigonensis* in Crosse and Fischer's[2] original figure, with which specimens agree. Specimens of the carinate form from Quetta, however, agree closely with shells of Mousson's *G. devians* var. *euphratica* recently collected by Captain C. L. Boulenger in Mesopotamia. The species would, therefore, appear to be essentially a Palaearctic one, but there has been much confusion as to

[1] *Rec. Ind. Mus.*, III, p. 117.
[2] Crosse and Fischer, *Journ. de Conchyliologie*, XI, p. 362, pl. xiii, fig. 7.

its real distribution. It certainly extends from Mesopotamia to the Kiangsu Province of China.

The habits differ from those of *G. convexiusculus* in that the animal swims actively on the surface in the evening. This we recently observed at Chakradharpur in Chota Nagpur, and we have been able to confirm the observation in Calcutta. While floating shell-downwards like other species of the family with its foot applied to the surface film, it moves forward rapidly in a jerky manner by repeated strokes of its shell in the water. The sole of the foot adheres to the surface-film and the shell is raised almost to a horizontal position with its major axis parallel to but well below the film. It is then rapidly depressed, so that momentarily the axis forms almost a right angle with the surface. After this downward stroke it is rapidly raised again to a horizontal position, and the animal is propelled forwards a little obliquely. The manoeuvre is frequently repeated, each time with a jerk, leverage being provided by the friction between the sole of the foot and the surface-film. Doubtless the flattened, carinate form of the shell is of advantage in its use as an oar, and probably all species with this character behave in the same way. The bacterial "velum", noted in the Burmese species *G. velifer*,[1] is commonly present in *G. euphraticus* also.

Genus **Segmentina**, Fleming.

1828. *Segmentina*, Fleming, *Hist. Brit. Anim.*, p. 270.

This genus consists like *Gyraulus* of small or minute, thin-shelled species, but the whorls are as a rule of a different form, convex above and flattened below and the shell is characterized by the production at intervals on the inner surface of the main whorl of curious opaque, white, transverse teeth or ridges of an enamel-like substance Correlated doubtless with the presence of these is the fact that the edge of the mantle is thickened. The radula differs from that of *Gyraulus* in having the teeth narrower and with smaller cusps and all the lateral multicuspid. The genitalia are also of a different type in that the penis, though produced into the penis-sheath, is directed into it from one side and is not provided with a horny stylet.

Type-species. Planorbis nitidus, Müller (Palaearctic).

Segmentina calathus (Benson).

1850. *Planorbis calathus*, Benson, *Ann. Mag. Nat. Hist.* (2) V, p. 348.
1876. *Planorbis calathus*, Hanley and Theobald, *op. cit.*, pl. xxix, figs. 4-6.
1918. *Planorbis calathus*, Annandale, *Rec. Ind. Mus.* XIV, p. 113.

The shell is very much like that of the type-species of the genus (*Planorbis nitidus*, Müller), to which it apparently bears

[1] Annandale, *Rec. Ind. Mus*, XIV, p. 112, pl. xi, figs. 7–11.

much the same relation as *Gyraulus convexiusculus* does to *G. albus*. The radula has approximately the formula 13.10.1.10.13. The teeth are rather small. The terminal part of the central tooth is distinctly bilobed. The inner laterals have six small, sharp cusps, the other teeth of the same series five. The inner marginals have six cusps very similar to those of the inner laterals, while the outer marginals have seven cusps, the central cusp being considerably larger than the others.

Our material is not well preserved for anatomical investigations, but in a specimen from the Punjab the terminal part of the male duct belongs to Simroth's Typus II. The blind sac-like appendages shown in his diagram (*op. cit.*, p. 502, fig. 165) are however, very poorly developed.

The species is common in swamps in Northern India, but somewhat local in its distribution. It is recorded from several places in the Himalayas, Bengal, Assam, Burma, Ceylon and Siam. One of us recently found it to be common in a swamp near Peshawar on the North-West Frontier of India and also obtained a specimen in a similar situation at Gurdaspur in the Punjab. Two dead and whitened shells were found at the edge of a pool in the desert near Nasratabad, Seistan. The shells are very small, but otherwise fairly typical.

CLASS **LAMELLIBRANCHIA** (=PELECYPODA).

This class is represented in our collections from Seistan and Baluchistan by large series of specimens of two species, *Corbicula fluminalis* (Müller) and *Lamellidens marginalis* (Lamarck). Hutton (*Journ. As. Soc. Bengal*, XVIII, p. 659: 1850) has described under the name *Pisidium paludosum* a third species from Chaman, now on the Afghan frontier of Northern Afghanistan, but we have seen no shells of this form. It may be a young *Corbicula*.

Corbicula fluminalis, which also occurs in ponds and streams at Quetta, and the *Unio* are both so abundant in Seistan, both recent and subfossil, that their shells are a feature of the country. They are found lying on the surface, wherever the land is occasionally flooded, in thousands and the banks of ancient streams and lakes are full of the shells of *Corbicula*. This is the case at many places now completely desert. Though the shells are frequently bleached and sometimes wind-worn and sand-eroded, they are usually in a remarkably perfect condition.

Family CYRENIDAE.

Genus **Corbicula**, Megerb.

This genus provides many difficult problems in taxonomy, increased by the fact that there is no recent, well-illustrated monograph. Undoubtedly many of the so called species now generally accepted will have to retire into the synonymy of others.

Corbicula fluminalis (Müller).

(Pl. viii, figs. 1–6.)

1774. *Tellina fluminalis*, Müller, *Verm. terr. et fluv. Hist.* II, p. 205.
1818. *Cyrena cor*, Lamarck, *Anim. sans. Vert.* V, p. 552.
1854. *Cyrena crassula*, Mousson, Bellardi's *Cat.*, p. 54
1864. *Corbicula cor*, Prime, *Ann. Lyc. Nat. Hist. N. York*, VIII, p 7, fig. 8.
1866. *Corbicula crassula, id., ibid.*, p. 216, figs. 44, 45.
1883. *Corbicula fluminalis+C. crassula*, Locard, *Arch. Mus. Hist. Nat. Lyon* III, pp. 222, 256, 258, pl. xxii, figs. 17, 18, 25, 26.
1913. *Corbicula fluminalis*, with var. *cor*, Germain, *Bull. Mus. Hist. Nat.* (Paris), p. 472.

The species is a very variable and plastic one and has a very wide geographical range in Africa and Asia. It was originally described from the Euphrates. We have examined a large series of fresh and subfossil shells from Seistan, the Afghan desert and Northern Baluchistan. Those from the Afghan desert were collected by the Seistan Boundary Commission of 1902–1903. Several small shells were also obtained in a spring of distinctly brackish water at Saindak in the west of the Baluchistan desert. In most of the series comprised in this collection, including those of fresh shells from the Hamun-i-Helmand, the specimens can be separated easily enough into two groups, one agreeing well enough with the majority of shells from the Euphrates, the other with the breadth proportionately narrower and the umbonal region more prominent. The former form is undoubtedly the true *Tellina fluminalis* of Müller, while the latter agrees closely with Prime's figures of *Corbicula cor* (Lamarck). In one large series from the desert on the banks of the Helmand in Afghan territory some of the shells are still narrower and come very near the same author's figures of *Corbicula crassula*, Mousson; while in several series shells intermediate between *C. fluminalis* and *C. cor*, *C. cor* and *C. crassula* are readily selected. *C. cor* and *C. crassula* may, therefore, be recognized at most as varieties, if this be convenient, but not as distinct species.

All the shells we have examined from Mesopotamia, Seistan or Persia are small, and the species in Asia Minor (in which also, however, it is (*fide* Locard) plastic in size) apparently attains larger dimensions in favourable circumstances. The largest fresh specimens we obtained in Seistan is a single valve 27·5 mm. broad by 24·5 mm. high. It exhibits an interesting abnormality in the hinge, in which only one, the central, cardinal tooth is developed. The colour of the periostracum varies from bright green to black; that of the inner surface is violet. Mesopotamian shells are often decorated with broad, whitish, transverse bars externally.

The species commonly hides itself in mud or sand in winter. We found very few living examples in Seistan, in spite of the abundance of fresh shells everywhere. Several living individuals were, however, dug from mud at the bottom of small pools in the Randa stream near Jellalabad, about 12 miles north of Nasratabad, in November.

Family UNIONIDAE.

Genus **Lamellidens**, Simpson.

1900. *Lamellidens*, Simpson, *Proc. Nat. Mus.* (*Washington*), XXII, p. 854.
1911. *Lamellidens*, Ortmann, *Nautilus*, XXIV, p, 106.
1918. *Lamellidens*, Prashad, *Rec. Ind. Mus.* XV, p. 145.
1919. *Lamellidens, id., ibid.*, XVI, p. 293, fig. 4.

The occurrence of this genus in Seistan proves the existence of a distinct Indian element in the fauna.

Lamellidens marginalis, Lamarck.

Subsp. **rhadinaeus**, nov.

(Pl. iii, figs. 9, 10; pl. viii, figs. 7–11.)

Shells from Seistan only differ from those of the *forma typica* from Bengal in a few particulars, but the differences are constant in a large series. In shape the shell is somewhat variable, but is close to that of the var. *corrianus*, Lea, being more transverse and having the upper margin straighter than that of the *forma typica*. In this respect it is intermediate between the two varieties. It is slightly more tumid than either and in old shells one or other of the valves is as a rule bent outwards slightly at the point at which the foot emerges, causing the shell to gape at this point. The sculpture of the young shells is finer and sharper than in the common Indian varieties. The teeth of the hinge are more prominent than in either form, the pseudocardinals stouter and the laterals more bent. In their stoutness the teeth approach those of the species or variety *L. jenkinsonianus* (Benson) of Bengal and Assam.

The older part of the shell is pale cream-colour or silver-grey externally. This usually deepens, as the shell grows, to chestnut, and sometimes even to black. Some shells, however, are pale greenish; there is usually at least one pale yellowish zone on the darker region, and the margin is sometimes pale. The nacre is bluish white and has a china-like lustre with very little iridescence.

Two phases can be distinguished, the difference being visible even in very young shells.

Phase A.—The shell is of considerable size and thickness, with the growth-lines strongly developed, the epidermis of the lower part dark and the hinge-teeth unusually stout and prominent, approaching those of some species of *Unio* in development.

Phase B.—The shell is smaller, thinner, less inflated and paler in colour and the hinge-teeth are less stout and not so prominent.

The young shell seems to be slightly more elongate in phase B than in phase A and is distinctly smoother in the former. It does not differ in essential characters from that of the typical form of the species, but has the sculpture less well developed; it is rather shorter in proportion than that of the var. *corrianus*. Its sculpture is very well preserved even in old shells, the glochidial shell often remaining as a minute tubercle. When about 25 mm. long the shell has a fairly prominent dorsal " wing " and is thin, almost translucent and of a greyish colour.

Measurements of Shells (in millimetres).

Specimens A—C belong to phase A : specimens D—F to phase B.

	A	B	C	D	E	F
Length	97·8	90	90·2	71·3	73·6	51·6
Height	55·5	49·9	47·8	38·4	39·1	28·3
Thickness	37·4	33·4	33·3	25	25·3	16·1

Lamellidens marginalis subsp. *rhadinaeus* is common all over

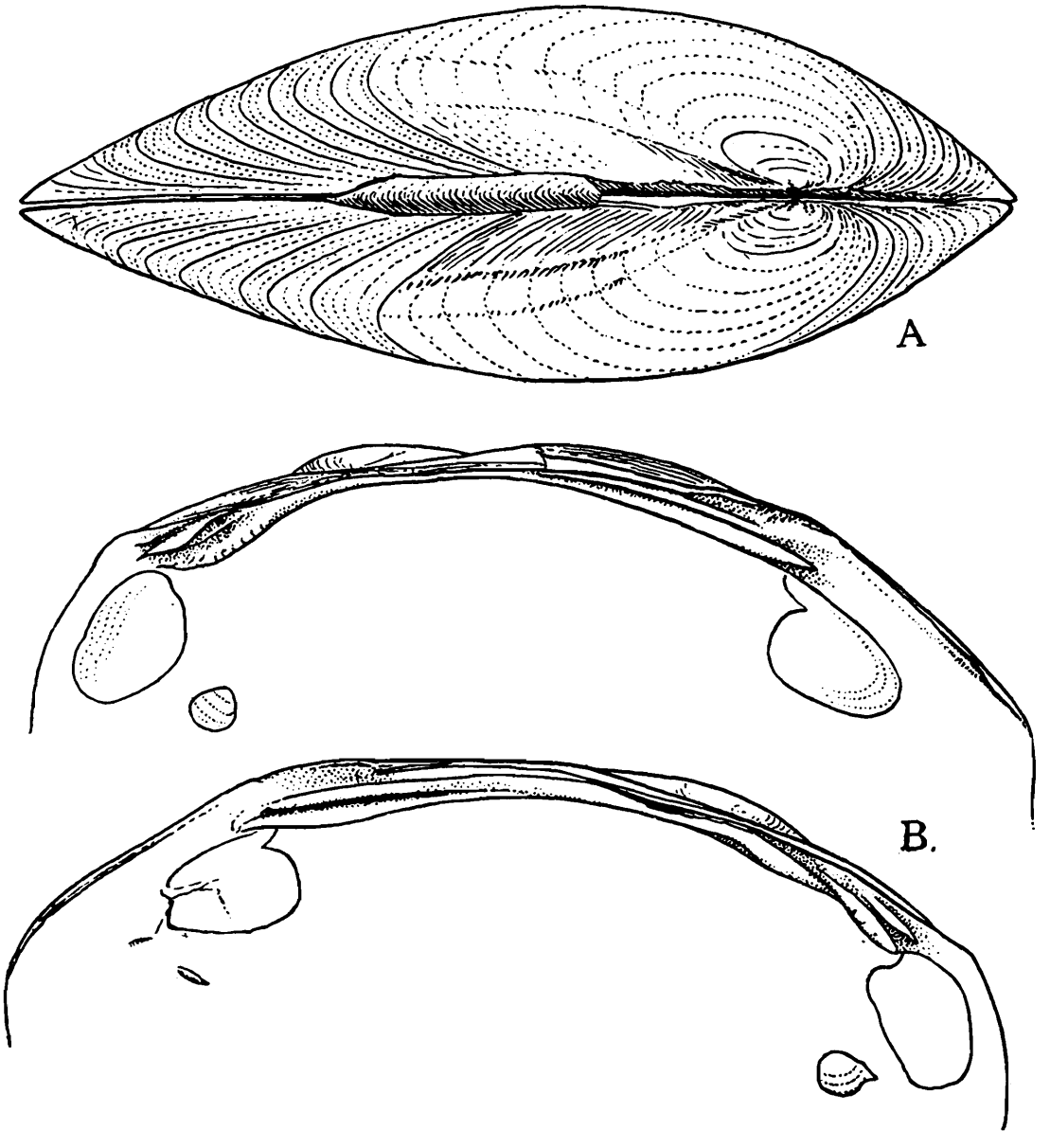

FIG. 9.—Shells *Lamellidens marginalis rhadinaeus*, subsp. nov. (natural size).

A. Dorsal view of type-specimen from a backwater of an effluent of the Helmand near Nasratabad, Seistan.

B. Hinges and scars of the same specimen.

Seistan and broken shells from the Afghan desert evidently belong to the same form. It appears to be quite distinct from the var. *candaharica*, with specimens of which we have compared our series. The range of the species, which is a very plastic one, is more

extensive than Simpson (*op. cit.*, p. 855) stated, extending from the mountains of Afghanistan to Ceylon and from Seistan to Burma, possibly even to Java and South China.

Dead shells were found in very large numbers at the following places in Seistan:—at the edge of the Hamun near Lab-i-Baring, in pools in the desert near Nasratabad, in the bed of Randa stream near Jellalabad about twelve miles to the north and in a large backwater of an effluent of the Helmand some miles to the south-east of the capital. They were also observed on the surface and buried in the stiff clay of open plains near Jellalabad which are periodically flooded. Specimens from still water, including the Hamun, belong to phase B, those from water directly connected with larger streams to phase A.

All these shells were in a remarkably good state of preservation, and their surface was not at all eroded. In many instances the valves adhered tightly together and the molluscs had every appearance of being alive. Indeed, many of them were brought us as containing the animal by herdsmen at Lab-i-Baring, and the people were evidently surprised when we opened them and found only mud inside. It is probable that the animal burrows deep into the mud at the approach of winter and in this connection the gape in the lower margin of the shell of many old individuals is of considerable interest, indicating that the foot is particularly large and powerful.

The shells give an indication of the age which the form habitually reaches, but this indication is open to two interpretations. On all the larger shells examined three very distinct regions can be distinguished. Round the umbo there is a region about 25 mm. wide by 13 mm. high in a large shell. The sculpture of this region, though clear-cut, is almost microscopic. It includes the nodulose and sloping ridges characteristic of the species, and also numerous (about 16) concentric longitudinal striae, each of which is compound. This region has a smooth appearance as a whole and is always of a pale colour. The next region is a broad band about 60 mm. broad by 24 mm. high in a large shell. Its general appearance is similar to the first region, but the epidermis becomes darker towards the lower margin, and it bears about the same number of compound striae. The third or outer region is about 30 mm. deep and occupies the full width of the shell. It has a much rougher appearance than the other two and bears four to six bands or groups of compound striae separated by smooth grooves. We are able to state definitely that the first region represents the growth of more than a year From the situations in which fresh shells are found in winter, where we may confidently believe they occur living in the flood-season, it is clear that the animal commonly undergoes a fairly prolonged period of hibernation, and in all probability it breeds when the floods are at their height in April or May. We found several shells in November that correspond precisely with the first region in the adult shells, and one of them still contained remains of the soft parts. Allowing for the period of free larval

and parasitic life, it is improbable that the shell would grow 25 mm. in one season, and we take it that these young shells represent the growth of something more than a year, probably about eighteen months. The second region probably represents that of one year more, but does the third region correspond to the growth of one year or of six? Probably of one, to judge from the striae on a large series of shells. If this be so, *Lamellidens marginalis rhadinaeus* probably lives as a rule for a little over three years and then dies directly or indirectly of old age. The great majority of the shells collected must, if our surmises are correct, have been of this age, and the animals through weakness or for some other reason, have failed to burrow down to the subsoil water through the very stiff clay on the bottom of the basins in which they lived, when the water began to dry up with the retreat of the floods.

NOTE ON THE LIVER-FLUKE OF SHEEP IN SEISTAN.

By STANLEY KEMP, B.A.

When in Seistan we were informed that both sheep and cattle are frequently infected by a liver-fluke which causes a heavy mortality at certain places in the early summer of each year. On enquiry we learnt that the Seistanis associated this parasite with the fact that when the annual floods recede the flocks are grazed on the peculiar vegetation that springs up on recently inundated land.

I was able (in December) to examine the livers of three sheep, the bile-ducts of two of which contained flukes of the genus *Fasciola*, s.s. In one of the livers the worms were unfortunately dead and in a putrefying condition. The other contained eleven specimens, all of which were alive.

Unfortunately the literature on this genus is poorly represented in our Calcutta libraries and several important American memoirs on the subject are lacking. Notwithstanding this fact, however, there appears to be little doubt as to the specific identity of the Seistan form, for most of our specimens agree in every particular except size with the excellent figures of Cobbold's *Fasciola gigantea*, reproduced from Looss by Stevens in "*The Animal Parasites of Man* (London, 1916).

The chief characters by which this species is distinguished from *Fasciola hepatica* are the following :—

(i) The form is generally much more elongate and band-like instead of leaf-shaped, the tapering of the posterior extremity being confined to a very small area.

(ii) The cephalic cone is considerably shorter in proportion to the length of the whole organism.

(iii) The posterior sucker is larger and more prominent and is situated on a line with the junction of the cephalic cone and body, instead of well behind the cone.