THE FRESHWATER AND AMPHIBIOUS GASTROPOD MOLLUSCS OF THE INDAWGYI LAKE AND OF THE CONNECTED FRESHWATER AREAS IN THE MYITKYINA DISTRICT, BURMA.

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The Gastropod molluscs dealt with in this paper were collected by Dr. B. Chopra during the cold weather of 1926 in the Indawgyi Lake and its environs, in the plains lying to the north of the lake, and in the freshwater areas round about Kamaing, all in the Myitkyina District, Upper Burma. The lake, as well as the various streams, channels and pools in the areas mentioned above, are indirectly connected with the Irrawady river system in Upper Burma.

The physical features of the lake and the adjoining country are briefly referred to by Dr. B. Prashad and Mr. D. D. Mukerji in their paper on the Fishes of the Indawgyi Lake,[1] and it would be enough to point out here that the physical conditions of the lake do not seem to be particularly conducive to the growth and differentiation of a varied molluscan life. Taking into consideration the size of the lake, its depth, and the suitability of the marginal areas as a zone for aquatic life, the Gastropod fauna actually found in the lake can by no means be said to be rich in species, though the number of inividuals of certain species found living in the lake is large.

The fauna is represented by 7 families of Gastropod molluscs of which four belong to the order Pectinibranchiata, and three to the Order Pulmonata. Twenty-two species belonging to 14 genera were found in the areas surveyed. Six species and one form are new, but of these new species only two belong to the lake fauna proper ; the remaining four are either inhabitants of streams and pools in the neighbourhood of the lake and closely connected with it, or of rocky or muddy streams in the vicinity of Kamaing, about 50 miles north of the lake. All the six species are presumably endemic in the Indawgyi Valley.[2] Of the remaining sixteen previously known species some are widely distributed in the Oriental Region, some are common to India and Burma, while a few are Burmese in origin and distribution.

In this paper I have also given descriptions of two new species of the Melaniid genus *Paludomus* from Lower Burma as they are very closely related to two other species, also new, which were found in the streams and pools in the plains north of the Indawgyi Lake.

In the preparation of this note the field-book of Dr. Chopra containing notes on the physical features and the fauna of the lake and the surrounding country has been of great help to me, and I take this

[1] Prashad, B. & Mukerji, D. D., *Rec. Ind. Mus.*, XXXI, pp. 161-223, pls. vii-x (1929).

[2] For the sake of convenience the words "Indawgyi Valley" are used in this and the following pages to indicate the entire area surveyed by Dr. Chopra from the southernmost point of the lake to the plains in the vicinity of Kamaing in the Myitkyina district.

opportunity to thank him for permitting me to make use of his copious notes.

The drawings illustrating this account have been made under my supervision by Babu A. C. Chowdhury, Senior Artist in the Zoological Survey, with his habitual skill.

Before discussing the general aspects of geographical and ecological distribution of the species of molluscs found in the Indawgyi Valley it will be convenient to enumerate the species occurring in that area.

PECTINIBRANCHIATA.

Viviparidae.

Viviparus bengalensis (Lam.).
* *Viviparus bengalensis* race *doliaris* (Gould).
† *Viviparus indawgyiensis*, sp. nov.

Ampullariidae.

† *Pila theobaldi* (Hanley).

Rissoidae.

Digoniostoma pulchellum (Benson).
* *Parafossarulus sulcatus*, sp. nov.
† *Bithynia* (*Alocinma*) *expansilabris*, sp. nov.

Tiaridae (Melaniidae).

* *Acrostoma baccata* f. *lirata* Rao.
Melanoides tuberculatus (Muller).
Melanoides scabra (Muller).
* *Paludomus regulata* Benson.
† *Paludomus crassicallosa*, sp. nov.
† *Paludomus kamaingia*, sp. nov.

PULMONATA.

Limnaeidae.

Limnaea acuminata f. *patula* Troschel.
† *Limnaea acuminata* f. *pseudohorae*, nov.
Limnaea luteola f. *australis* Annandale & Rao.
† *Limnaea decussatula*, sp. nov.

Planorbidae.

Indoplanorbis exustus (Deshayes).
Gyraulus convexiusculus (Hutton.)
Gyraulus rotula (Benson).
* *Gyraulus velifer* (Annandale).
* *Gyraulus velifer* var. *ciliata* (Annandale).
Segmentina calathus (Benson).
Hippeutis sp.

Succineidae.

Succinea gravelyi f. *deccanensis* Rao.

Species marked with an asterisk are essentially Burmese in origin and distribution, while those marked with a dagger are probably endemic in the Indawgyi Valley.

Most of the genera from the Indawgyi Valley are met with in most parts of the Indian Empire. Some are widely distributed in the Oriental

Region, while a few have a restricted distribution in India and Burma. The genus *Hippeutis* has so far been recorded from the Manipur Valley in Assam. In the Indawgyi Valley it is represented by a few dead shells, the specific identity of which is difficult to determine owing to poor preservation. The discovery of the genus, however, in the relatively contiguous valleys of Manipur and Indawgyi, both of which are indirectly connected with the Irrawady river system, seems to suggest the possibility of a wider distribution of the genus in the hill-tracts of Assam, Burma and China. *Parafossarulus* presumably represents the only distinct Chinese element in the Burmese Gastropod fauna, but its distribution in Burma appears to be restricted to the Shan plateau and to parts of Upper Burma. *Digoniostoma* has hitherto been known only from parts of Bengal and Assam, and from Peninsular India. The present record of its occurrence in Burma is, therefore, of some interest from the point of view of geographical distribution. From the Shan plateau, which lies east of the Irrawady basin and the mollusc fauna of which is now fairly well known, there is no record of this genus from as far as the Shiveli Valley on the Chinese Frontier in the north to the Inle Lake in the south. The subgenus *Alocinma* has a wide range extending from Mesopotamia through Peninsular India to Upper Burma. *Acrostoma* and *Paludomus* have a more or less restricted distribution in the eastern part of India, and in South India and Ceylon ; in Burma, however, they are represented by a large number of species which are common in the river-systems of that province. Perhaps it may be said that they are two of the most dominant genera of the freshwater Pectinibranchs in Burma. The remaining genera are widely distributed in the Oriental Region, if not over the whole world.

With the exception of the six new species, which are probably endemic in the Indawgyi Valley, the distribution of all others is well known. *Indoplanorbis exustus, Melanoides tuberculatus, Melanoides scabra* and *Gyraulus convexiusculus* have a very wide distribution in the Oriental Region. Six species which may be ascribed to India proper are *Viviparus bengalensis, Digoniostoma pulchellum, Limnaea acuminata, Limnaea luteola, Segmentina calathus* and *Succinea gravelyi*, but their distribution within the Indian Empire is either very wide or apparently discontinuous as in the case of the last-named species, which has hitherto been recorded from Madras, the Deccan, the Andaman Islands and Burma.

The following species may well be regarded as Burmese in origin and distribution : *Pila theobaldi, Acrostoma baccata, Paludomus regulata*, and *Gyraulus velifer*. The last named species was first described from the Inle Valley, and is as yet known only from one other locality, *e.g.*, the Indawgyi Lake. *Gyraulus rotula* must still be considered as a rare species. It was originally described from Moradabad in N. India, and was subsequently found in the same locality and in Ceylon. The discovery of this species in Burma is, therefore, of great interest.

It will thus be seen from the facts of distribution given above that the Gastropod fauna of the Indawgyi Valley consists of a large proportion of species having a wide distribution in the Oriental Region or in India proper, and of a comparatively small proportion of Burmese species if we exclude the new species described in this paper. It is clear,

at any rate, that the Gastropod fauna of the valley is of mixed origin, though it is not possible to be definite about the relative numbers of the species derived from the Indian and Burmese areas respectively.

In enumerating the facts of ecological distribution it will perhaps be of some value to arrange the species found in the Indawgyi Valley in accordance with their habitat, and in the following list the species occurring in the valley are distributed in three groups. A species occurring in one or more habitats is put down in as many groups.

Species from the marginal zone of the lake, and also from pools and streams near the shore.	Marginal or deeper parts of the lake only.	Streams and pools of the plains north of the lake not directly connected with it.
—	*Viviparus indawgyiensis.*	—
Viviparus bengalensis	—	—
V. bengalensis race *doliaris*	—	*V. bengalensis* race *doliaris*
Pila theobaldi	—	*P. theobaldi*
Digoniostoma pulchellum	*D. pulchellum*	*D. pulchellum*
Bithynia (Alocinma) expansilabris	—	—
Parafossarulus sulcatus	—	—
Acrostoma baccata f. *lirata*	—	—
Melanoides tuberculatus	—	*M. tuberculatus*
—	*Melanoides scabra*	—
Paludomus regulata	—	*P. regulata*
—	—	*P. crassicallosa*
Limnaea acuminata f. *patula*	—	—
—	—	*Paludomus kamaingia*
—	*L. acuminata* f. *pseudohorae*	—
L. luteola f. *australis*	—	—
—	*L. decussatula*	—
Indoplanorbis exustus	—	*I. exustus*
—	*Gyraulus velifer*	—
—	*G. velifer* var. *ciliata*	—
Gyraulus convexiusculus	—	—
Gyraulus rotula	—	—
Segmentina calathus	—	—
—	*Hippeutis* sp.	—
Succinea gravelyi f. *deccanensis*	—	—

It will be seen from this list that there are few species which exclusively inhabit the lake proper, and still fewer which are, in the strict sense of the term, fluviatile. On the other hand many species, which inhabit the streams and pools not in the immediate vicinity of the lake but also in the plains north of it, are actually found in the marginal zone as well. The species given in the second column of the list have, with one exception, *e.g.*, *Digoniostoma pulchellum*, all been found in the marginal zone of the lake, but nowhere else in the neighbourhood of the lake or in the plains near Kamaing. *D. pulchellum* usually inhabits sluggish streams with a muddy bottom and aquatic plants, and pools or swamps with some amount of weeds. In the lake and the connected waters in its vicinity the species appears to be stunted, whereas it attains its full development in size in the muddy streams and pools round about Kamaing. Specimens from the deeper parts of the lake were all dead. *Viviparus indawgyiensis* and *Limnaea decussatula* both seem to be lacustrine, and have not been found outside the marginal zone of the lake. The evidence for this statement with regard to the latter species (which has been described from a single specimen) is not conclusive, but with regard to the former it may be said that it is the only Gastropod which dominates the molluscan life in the lake. The deeper central parts of the Indawgyi Lake, which consists of soft sticky clay at the bottom and very little macroscopic vegetation, do not seem to support molluscan life, and it is not surprising that so few individuals of any species were found living in the central parts of the lake, and that there were few, if any, living species of Invertebrate animals in these parts. On the other hand Dr. Chopra found molluscs quite abundant in the marginal area, which is, as a rule, shallow in most parts of the lake, and has a fair quantity of aquatic weeds and an abundance of floating microscopic plant-life.

The aquatic species noted in the first column are generally inhabitants of ponds and swamps or sluggish streams, but *Acrostoma baccata* f. *lirata* and *Paludomus regulata* do not strictly belong to this habitat group, and their occurrence in the lake area is probably accidental. The occurrence of the remaining species (some of which are more or less paludine in habit) in the marginal zone of the lake is to be accounted for by the fact that during heavy rains the water brought down by the various hill-streams flowing into the lake swells its volume to such an extent that the swamps and pools on the shores of the lake in normal times are submerged and become part of the lake. Consequently the inhabitants of the swamps come to occupy the shallower regions of the lake where the conditions of life approximate to those of a swamp. Of the species enumerated in the third column the two new species of *Paludomus* from Kamaing are inhabitants of rocky streams, and are probably rupicolous; the remaining species are much at home in the marginal zone of the lake as in muddy streams and pools of the plains in the valley.

Family Viviparidae.

Viviparus Montfort.

1928. *Viviparus*, Rao, *Rec. Ind. Mus.*, XXX, p. 416.

This genus is represented in the fauna of the lake and of the surrounding country by only two species. One is the well known

V. bengalensis so common in most parts of India, and the other is a new species found only in the lake, and probably endemic in it. Of the former, the race *doliaris* seems to have a wide distribution in Burma, while the forma *typica* is represented by a dwarfed phase which is not common in Burma as it is in parts of India.

Viviparus bengalensis (Lamarck).

1921. *Vivipara bengalensis*, Annandale, *Rec. Ind. Mus.*, XXII, pp. 267-271, pl. i, figs. 1—3.

Individuals of this species belong to the forma *typica*. In form they are relatively dwarfed, and smaller than specimens taken in various parts of India. Presumably they never grow to a large size. The spiral bands on the shell are not usually conspicuous. The umbilicus is obsolete, but rarely takes the form of a small chink. In some young individuals the secondary spiral ridges of the embryo persist.

Specimens of this species were taken in small numbers from the shallower parts of the lake near the shore at Lonton, Loimon and Nyaungbin, small villages close to the lake.

There seem to be very few records of the forma *typica* from Burma. It is probable that this form was at one time dominant in Burma and that its place was later on taken by the race *doliaris*, which at present seems to be the commonest representative of *V bengalensis* in that province.

Viviparus bengalensis race **doliaris** (Gould).

1928. *Viviparus bengalensis* race *doliaris*, Rao, *Rec. Ind. Mus*, XXX, p. 416.

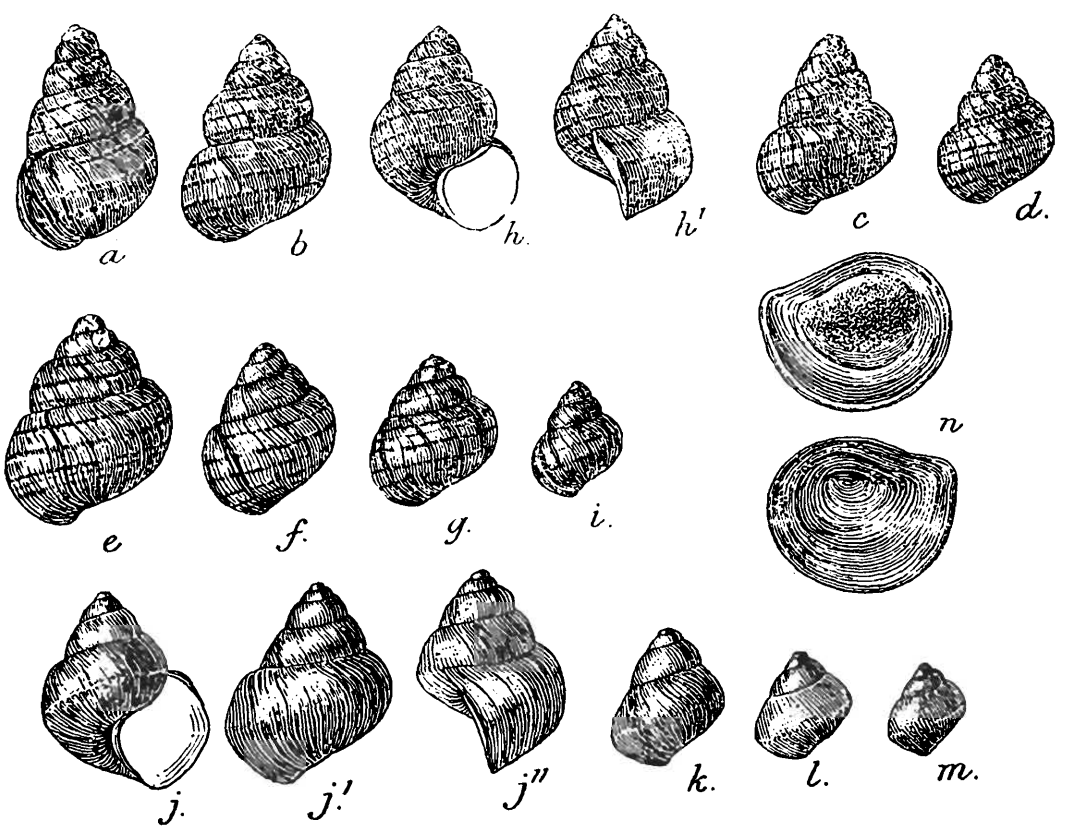
This is by far the commonest form in the ponds and sluggish streams in the country surrounding the lake, and in the shallower parts of the lake itself near the shore. Large numbers of shells and a few living specimens were dredged from the shallower regions of the lake in the vicinity of Loimon and Lonton; but some were found living on the submerged posts and stones forming the foundation of the Shwemyzu Pagoda, 3 miles south of Loimon. This form was also common in pools, near Lonton and Loimon, and in muddy or rocky streams in the vicinity of Kamaing, Hopin, Nyaungbin and Loimon.

This is apparently a well-established race in Burma. Its normal habitat is in muddy streams or pools. The occurrence of individuals of this race in large numbers in the shallower parts of the lake seems to be accidental. Owing to an exceptionally heavy rainfall in the year 1926 and the consequent flooding of the country round about the lake many of them had been washed down into the lake from the neighbouring pools and streams. Conditions of life in the shallower parts of the lake were presumably more or less similar to those obtaining in muddy ponds and streams, and the fact that a few continued to live in the lake seems to strengthen that presumption. Deep-water conditions in the lake are probably inimical to them, and it is not surprising, therefore, that a great proportion, if not all, of the specimens dredged from the deeper regions of the lake were dead.

Dr. Chopra informs me that the Shans break the shell partly and suck out the animal in the living condition.

Viviparus indawgyiensis, sp. nov.

The shell is of moderate or small size, ovate to ovate-conical in outline and rather thick. The apex of the shell is usually blunt on account of its being worn. The colour of the shell varies from an olive-green to an olive-brown. There are usually eight well-defined but narrow brown spiral bands on the outside of the shell. There are 6-6½ gradually increasing convex whorls, and the suture is deeply impressed. There is very little flattening outside the suture, and the whorls present a telescoped appearance, the shells thus approaching a roughly scalariform condition. The sculpture consists of very minute spiral striae which are completely masked by the oblique, curved, longitudinal impressed lines which are well-marked on the last two whorls. These longitudinal lines give a characteristic appearance to the shell. On the body-whorl they are very prominent and often indistinguishable from the lines of growth found on the outer edge of the body-whorl. The number and prominence of the spiral bands on the body-whorl are subject to variability, but there are usually 8 bands, of which the third, fifth and sixth from above downwards are broader than the others. The body-whorl is slightly oblique. The aperture is broadly oval and never much longer than broad. Its anterior margin is broadly arched. The outer lip



Text-fig. 1.—*Viviparus indawgyiensis,* sp. nov. *a-m,* shells of different sizes; the three figures marked *b, h, h'* are of the holotype; *n,* outer and inner views of the operculum.

is somewhat dome-like in outline and often broadly sinuate in the middle. It is thin and joins the inner lip posteriorly forming an acuminate projection directed towards the columellar side. The inner lip is relatively thick and its margin is somewhat raised but never reflected. The

interior of the mouth is smooth, bluish in fresh specimens of moderate rize, white owing to a deposit of calcareous matter in dead shells, and deep-brown in good-sized, comparatively thick, fresh shells. The umbilicus is open and more or less rounded, into which the impressed longitudinal lines on the body-whorl converge.

The operculum is thin, broadly ovate in outline and concave on the external surface. The sculpture consists of coarse concentric striae. The muscle-scar on the internal surface is close to the internal margin, *i.e.*, the columellar side of the operculum. It is thickened and raised into a boss and has a rough texture. Its colour is deeper than the rest of the operculum, and a faint whitish ring encircles the muscle-scar. The ground colour of the operculum varies from an yellowish-brown to claret, and in the centre the muscle-scar presents the appearance of a dark spot on the inner surface.

The measurements, in millimeters, given below are of a small series from various parts of the Indawgyi Lake :—

Locality.	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
Loimon .	21·5	17·5	10·5	9·2
	19·0	16·5	11·0	8·5
	19·5	16·0	10·0	8·0
Lonton	23·0	18·5	11·5	9·5
	23·0	16·0	11·5	8·5
	19·0	17·0	11·0	9·0
	19·0	15·5	10·0	8·0
Shwemyzu Pagoda . . .	20·0	15·0	10·5	8·5
	18·0	15·0	9·5	8·0
Nyaungbin . .	21·0	17·0	11·0	9·0
	21·0	15·5	9·0	7·5
	17·5	15·5	10·0	8·0

The edge of the mantle is moderately thick with a fairly well-developed sphincter muscle. It bears on its free margin several minute triangular or finger-like processes which vary in number and prominence. Their appearance in the living condition is not known as the expanded animal in nature has not been closely observed, but in most preserved specimens two or three finger-shaped processes and several comparatively small triangular ones may be detected. The gill-lamella is elongate and its base is slightly broader than the free part of the lamella.

The radular teeth closely resemble those of *V bengalensis* and are subject to the usual variation and abnormalities observed in many species of freshwater molluscs. The internal anatomy is very similar to that of *V. bengalensis.* In the male the right tentacle is comparatively large and thickened. In the uterus there are usually one or two full-grown embryos and 6-8 ova, but exceptionally there may be as many as 5 embryos. The proportion in the numbers of male to female individuals is not the same in lots collected from different localities. In some places the males and females are equal in number, in others the females predominate. The embryonic shell consists of 3-4 whorls and

has a roughly diamond-shaped outline. The body-whorl is biangulate and bears no prominent spiral ridges or striations.

The embryonic shell is somewhat gray in colour and without spiral bands. It has 3 primary rows of chaetae and several secondary parallel ridges, but the chaetae are liable to drop off when the membranous covering of the embryo is removed. In the larger embryos, however, traces of the primary chaetae may be detected in a minute series of pits on the body-whorl. The secondary parallel ridges are often too minute to be detected. The sculpture of the embryonic shell undergoes modification as the individual grows. The spiral sculpture of the embryonic shell is more or less completely masked in the adult shell by the development of oblique longitudianal striae. The spiral ornamentation appears at first as fine olive-green lines on shells which have grown to a height of 10-15 mm., and as the shells grow further the spiral lines broaden out into bands.

Holotype.—M. $\frac{12841}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Several hundreds of individuals of the species were dredged from various parts of the Indawgyi Lake, chiefly in the shallower regions near the shore at the north and the south ends of the lake, at Loimon and Lonton, and in the vicinity of the Shwemyzu Pagoda. Many of them were dead shells, but a comparatively small proportion consisted of living individuals. Dr. Chopra observed that samples of dredging in the deeper parts of the lake contained a large number of dead shells and very few living ones. This species seems to be restricted, therefore, to the shallower parts of the lake. The bottom consists of soft, sticky clay of a black colour in the deeper parts of the lake, of reddish clay in the shallow parts, and of a mixture of sand and mud in the intermediate zone. The water is usually clear, but has a greenish tinge on account of the great quantities of minute floating algae. The species seems to live on vegetable debris at the bottom. The Polyzoan *Hislopia lacustris* Carter is found growing on many shells from the marginal region.

There are two shells in the Zoological Survey collection found by the late Dr. R. Hungerford in what is called the 'Endawyne Lake, Burma', and labelled '*Vivipara sumatrensis* Dunker' I have not been able to find a lake of that name in some of the standard atlases and maps of Burma which I have consulted, and the lake referred to in the label is presumably no other than the Indawgyi itself. The name has obviously been misspelt in transcription. The shells referred to are very different from specimens of *V sumatrensis*, authentic examples of which have been recently presented to the Zoological Survey by Prof. Max Weber. In texture and ornamentation the two shells under discussion are almost identical with the new species described.

V indawgyiensis appears to be dimorphic as evidenced by two forms which may be distinguished in collections from most parts of the lake. One is narrow and elongate, and the other is broad and compressed. Both the forms are always found together and in almost equal proportions.

The species is undoubtedly closely related to *Viviparus bengalensis* but differs in having a thicker shell, more convex whorls with deeply

impressed suture, and in the sculpture and ornamentation. The Assamese species *Viviparus crassa* (recorded also from Bengal and Burma) resembles the present species in sculpture and in having a thick shell, but the resemblance seems to be superficial as it differs from the latter in important features such as the form of the mouth, and in the total absence of spiral bands.

Family Ampullariidae.

Genus **Pila** Bolten.

1915. *Pila*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 96.

Pila theobaldi (Hanley).

1925. *Pila theobaldi*, Prashad, *Mem. Ind. Mus.*, VIII, p. 77, pl. xv, fig 3.
1928. *Pila theobaldi*, Rao, *Rec. Ind. Mus.*, XXX, p. 425.

Several living and dead individuals of this species were obtained from small, muddy streams and ponds in the vicinity of Lonton, Loimon, Kamaing and Hopin. Also from the western shores of the lake a few shells in a fresh condition were collected. They had presumably been washed down to the lake from the neighbouring streams and ponds. The examples from the Indawgyi system are all of moderate size, and are yellowish-green in colour. The spiral bands are more or less conspicuous in most of them. In larger specimens the spire is depressed, and the umbilicus is deep and broad.

The species is common in Upper Burma, and has been previously recorded from Bhamo, and from the Chinese Frontier of the N. Shan States. Its range in countries east and north of Burma is still imperfectly known.

The Shan inhabitants of the villages in the Indawgyi Valley, I understand, eat the animal by breaking the shell and sucking it out.

Family Rissoidae.

This family is represented by three genera, *e.g.*, *Bithynia*, *Digoniostoma* and *Parafossarulus*. The first two are widely distributed in India, but the last is confined to China and Burma. Two species belonging to the first and the last named genera respectively are new to Science. *Digoniostoma* is represented by one species, hitherto known only from Assam.

Digoniostoma Annandale.

1920. *Digoniostoma* Annandale, *Ind. Journ. Med. Research*, VIII, p. 104.

Digoniostoma pulchellum (Benson).

1921. *Digoniostoma pulchellum*, Annandale, *Rec. Ind. Mus.*, XXII, p. 541.

The species is recorded for the first time from Burma. It was found in large numbers in the shallow as well as in the deeper parts of the lake near Lonton and Nyaungbin, in small pools and paddy fields near the shores of the lake at Lonton, in streams flowing into the lake at various

points, and in muddy pools or sluggish streams in the vicinity of Kamaing. Specimens from many parts of the lake do not seem to grow to as large a size as those living in pools and streams in the neighbourhood of Kamaing.

The distribution of the species is still imperfectly known. The species appears to be common in parts of Assam, and the adjoining districts of Burma. There are a few records from Calcutta in Bengal, Madras, Ellore and Secunderbad in S. India.

Bithynia[1] Leach.

1928. *Bulimus*, Rao, *Rec. Ind. Mus.*, XXX, p. 427.

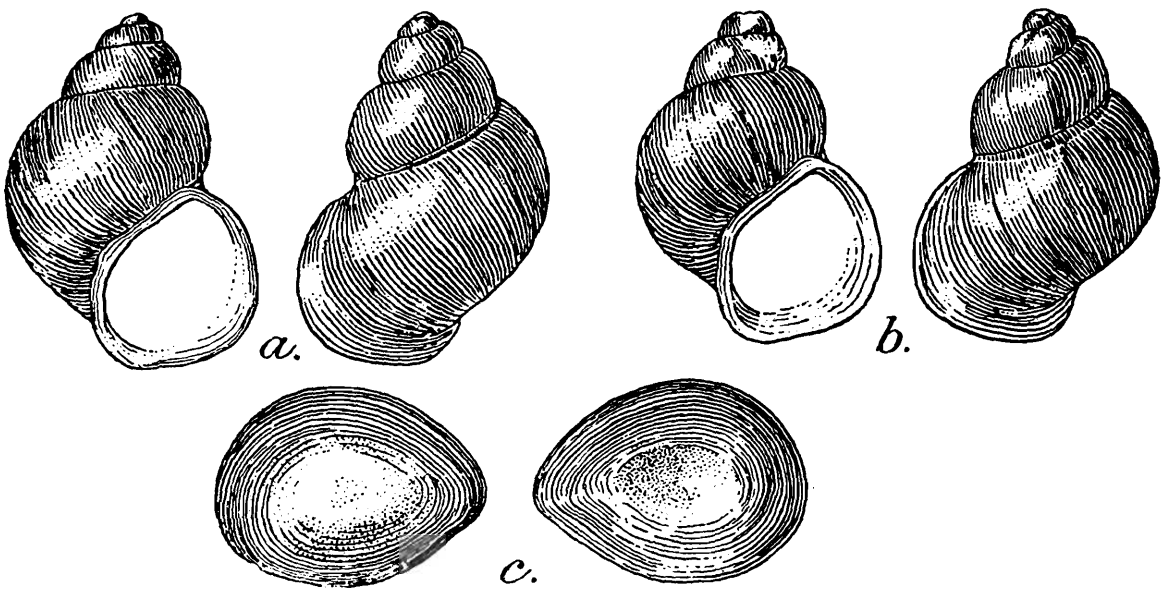
A single species hitherto undescribed and belonging to the subgenus *Alocinma* was found in various parts of the lake.

Bithynia (Alocinma) expansilabris, sp. nov.

The shell is of moderately small size, conico-ovate, longer than broad, and translucent in the fresh condition. It has 4-4½ moderately convex whorls which increase rapidly in size. The apex when not eroded is somewhat obtuse, and the protoconch is very little elevated. The whorls are oblique, particularly the last, in dorsal view. The suture is well-defined and transverse and leaves a minute step just outside it. The body-whorl has a broad trumpet-shaped outline in dorsal view. Its outer side is quite convex, while its anterior end is somewhat broadly produced. The aperture is oblique, roughly elliptical, produced both above and below, and broadest a little below the middle. The peristome is continuous. The outer lip is much more convex than the inner, expanded and slightly reflected at the edge, and is depressed broadly between its middle and the anterior projection. Its edge is smooth and sharper than the inner lip. The columella forms a smooth narrow ridge which has a silky lustre. The umbilicus is entirely closed, and even in very young individuals no chink is left between the body-whorl and the columellar ridge. The sculpture is minute and consists of longitudinal impressed striae. On the body-whorl the impressed striae converge towards the inner edge of the aperture. Traces of very minute spiral lines can sometimes be detected on the body-whorl when the shell is examined under the high power of the binocular microscope. These spiral lines probably represent the ground sculpture in the embryonic shell traces of which persist in the adult. The operculum is oval, produced above and rounded below, depressed in the centre of its outer surface and raised in the corresponding position on the inner side. The

[1] In a recent paper (*Rec. Ind. Mus.*, XXX, p. 427, 1928) on the Molluscs of the N. Shan States I revived the generic name *Bulimus* Scopoli for *Bithynia* Leach on obviously insufficient grounds, following Pilsbry and Bequaert (*Bull. Amer. Mus. Nat. Hist.* LIII, p. 21, 1927). European Malacologists appear, at any rate, to have decided to ignore *Bulimus* as a substitute for *Bithynia*, as Kennard and Woodward have shown (*Proc. Malac. Soc. London*, XVI, pp. 125-127, 1924) that *Bulimus* is a typographical error for *Bulinus*. I am indebted to Mr. Woodward for kindly drawing my attention to this reference which I had unfortunately overlooked. I also understand that the whole question has been referred to the International Commission on Zoological Nomenclature for final opinion.

paucispiral figure is clearly seen on both sides and occupies a greater part of the central area of the operculum. It is enclosed by a number



TEXT-FIG. 2.—*Bithynia* (*Alocinma*) *expansilabris*, sp. nov. *a*, dorsal and ventral views of the holotype ; *b*, the same views of another shell ; *c*, outer and inner views .of the operculum.

of concentric lines. The shell is translucent and is of a dull cream colour in the fresh condition, but opaque and of an yellowish or grayish colour in the dead shell.

Measurements in millimeters.

Locality.	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
Lake near Nyaungbin pools	5·5	4·5	3·0	3·0
Pools near Lonton	5·5	4·5	3·5	3·5
Shores of lake near Lonton	5·8	4·2	3·0	3·0
Pools near Nyaungbin	5·0	4·0	3·0	3·0
Lake near Lonton	4·8	3·8	2·8	2·8

The radular teeth agree in many respects with the *Alocinma* type, but the central is slighly different. The basal ends of the central tooth are claw-like and produced inwards, and the processes in the centre of the tooth are relatively prominent. The genitalia closely resemble those of *Alocinma sistanica*.

Holotype.—M. $\frac{12843}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The species was found living in small pools or streams near Lonton and Nyaungbin, and in the shallower parts of the lake near the shore at these places and on submerged posts of the Shwemyzu Pagoda. A large proportion of the specimens taken from the lake were, however, dead shells.

The affinity of this species to Indian, Burmese or Chinese species of *Bithynia* is not quite clear, but the species seems to belong to the fourth group or the *B. fuchsiana* group of Walker.[1] The species is

[1] Walker, *Amer. Journ. Hygiene*, Monographic Series, No. 8, p. 226 (1927).

probably endemic in the Indawgyi Valley, and does not resemble any of the known Indian or Burmese species of *Alocinma*. In the shape of the mouth and in the character of the lip it stands quite distinct.

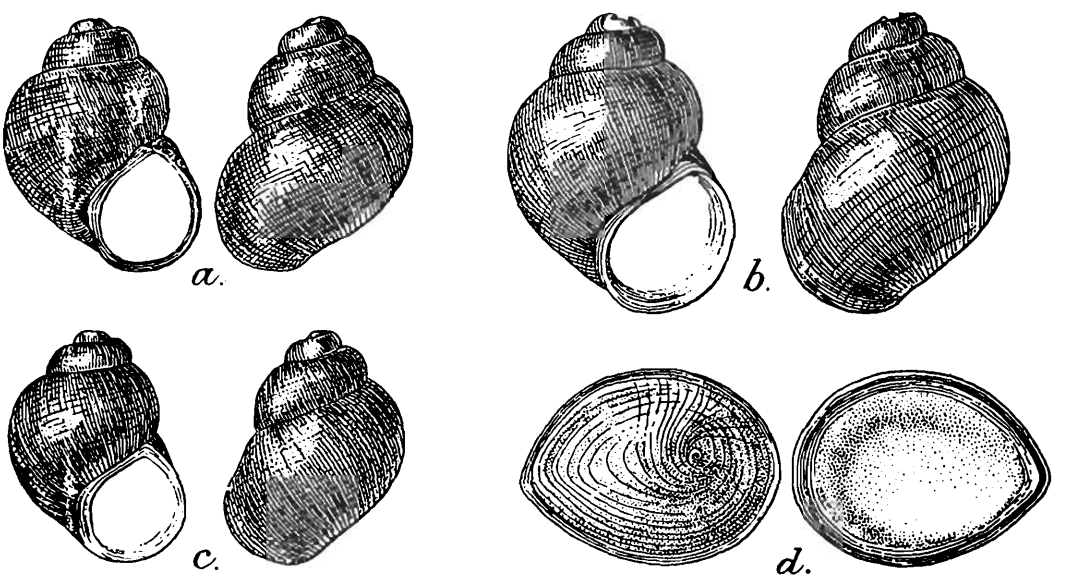
Parafossarulus Annandale.

1928. *Parafossarulus*, Rao, *Rec. Ind. Mus.*, XXX, P. 429.

This genus is represented by a single undescribed species. It is probably confined to the hill-districts of Upper Burma, but with only two records from Burma it is impossible to say anything definite about the distribution of the genus in that country.

Parafossarulus sulcatus, sp. nov.

The shell is oval, only slightly longer than broad, and has $3\frac{1}{2}$-4 convex whorls which increase rapidly in size. The apex is obtuse and often broadly flattened. The whorls are oblique, particularly the last. The suture is clearly defined and well-impressed, and the whorls outside it are slightly flattened. The body-whorl is large, broader than high, and evenly convex. The breadth at the base of the penultimate whorl is three-fourths of the maximum breadth of the body-whorl. The aperture is nearly half as high as the shell, broadly oval, and widest at or a little below the middle. Its posterior extremity is produced, while its anterior is more or less rounded, but where the inner and outer lips meet in front a right angle is formed. The peristome is continuous and the inner lip is relatively thick, smooth and shining, and exceptionally laminated near the posterior end. The umbilicus is almost closed, but a slight chink may be detected in an oblique ventral view between the columellar callus and the shell. The naked-eye appearance of the shell is smooth, but under a lens the sculpture



TEXT-FIG. 3.—*Parafossarulus sulcatus*, sp. nov. *a*, dorsal and ventral views of the holotype ; *b*, *c*, the same views of the paratypes ; *d*. outer and inner views of the operculum.

of the shell is seen to consist of very close and strongly impressed spiral striae. The first two whorls are smooth but the last two have the

sculpture strongly developed. Oblique longitudinal lines are present on the body-whorl, particularly near the margin of the outer lip. The interior of the mouth is smooth. The shell is hyaline and pale yellowish-brown in colour. The operculum is calcareous, oval, acute above and rounded below, concave on the outside and convex on the inner surface. The paucispiral figure is situated a little below the middle part, and is much less clearly visible on the inner than on the outer surface. The peripheral concentric lines are well developed. The edge of the operculum on the inner surface forms a narrow ridge to the periphery of the convex portion.

The radular teeth resemble those of *Bithynia* (*Alocinma*) *sistanica*, but the central is relatively broad, and has, as a rule, four latero-basal denticulations on each side, while the inner lateral has a comparatively long and broad ventral process projecting from below the cusps.

The male intromittent organ has a relatively stout spindle-shaped lateral process.

Measurements of type-specimens (in millimeters).

Locality.				
Shores of lake, Lonton	5·5	4·5	3·0	2·0
Nyaungbin	4·5	4·0	2·3	2·0

Holotype.—M. $\frac{12845}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Only six specimens were found in a living condition near Lonton and Nyaungbin on the western and northern shores of the lake respectively.

In form and sculpture, and in the characters of the radula and the male organ this species differs from other known species of *Parafossarulus* from Burma and China.

Family TIARIDAE (MELANIIDAE).

The genera common to many parts of India and Burma, namely *Acrostoma*, *Melanoides*, and *Paludomus*, are represented in the lake fauna by a few species, some of which are very widely distributed in the Oriental Region, and others are peculiar to Burma.

Genus **Acrostoma** Brot.

1928. *Acrostoma*, Rao, *Rec. Ind. Mus.*, XXX, p. 442.

Acrostoma baccata f. **lirata** Rao.

1928. *Acrostoma baccata* f. *lirata*, Rao, *op. cit.*, p. 445.

This form is represented in the lake fauna by a single incomplete shell collected by Mr. D. Mukerji from the southern shore of the lake near Lonton. The apical part of the shell is missing and there are only 3 whorls present. The mouth is shorter, relatively broad, and rounded at its anterior extremity. The shell is devoid of tubercles, but the ridges characteristic of this form are present on the lower part of the last whorl. The upper two whorls are comparatively smooth except for a shallow groove near the suture.

Acrostoma baccata and its forms in Burma are all inhabitants of streams in the uplands, chiefly in the Shan plateau.

The various parts of the lake were dredged by Dr. Chopra and his party but not a single specimen of this form was found in the bottom mud, which generally contained large numbers of shells of Viviparidae and Tiaridae. Its occurrence in the lake, therefore, is probably accidental. The shell found by Mr. Mukerji on the shore was presumably washed down into the lake from an adjoining stream during flood time.

This form is known only from Tangyan in the S. Hsemod State of the N. Shan States.

Genus **Melanoides** Brot.

1928. *Melanoides*, Annandale & Prashad, *Rec. Ind. Mus.*, XVIII, p. 21.

Melanoides tuberculatus (Muller).

1918. *Melania tuberculata*, Annandale, *Rec. Ind. Mus.*, XIV, p. 114, pl. xii, figs. 1, 2.
1928. *Melanoides tuberculatus*, Rao, *Rec. Ind. Mus.*, XXX, p. 448.

The species is very common on the shore and at the bottom of parts of the lake, and in small streams in the vicinity of Kamaing and Chaungwa. Specimens from the bottom of the lake were mostly dead, relatively narrow, and considerably eroded and bleached. Those from streams were all living but of small size, not exceeding 20 mm. in height and 10 mm. in breadth. They were black in colour with faint brownish marks on the body-whorl.

Melanoides scabra (Muller).

1844. *Melania* (*Plotia*) *scabra*, Nevill, *Handlist Moll. Ind. Mus.*, II, p. 281.
1915. *Tiara* (*Plotia*) *scabra*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 35.
1919. *Melania scabra*, Annandale, *Rec. Ind. Mus.*, XVI, p. 147, pl. v, fig. 6.

Several dead and worn shells of this species were dredged from the shallower parts of the lake near Lonton and Loimon. They are of small size, but the characteristic features of the species in form and sculpture are distinctly present. The distribution of this species in Burma is not fully known. The species does not occur in the Shan States, but it seems to have a fairly wide distribution in Lower Burma. The range of the species in the East is certainly wide, but in the Indian Empire it is somewhat restricted. The species has been recorded from the Bombay and Madras Presidencies, Lower Bengal, Assam, Burma and Ceylon.

Genus **Paludomus** Swainson.

1919. *Paludomus*, Annandale, *Rec. Ind. Mus.*, XVI, p. 147.

Though the number of species of this genus known from India, Burma and Ceylon is very large, the characters by which the species are distinguished from one another are not clearly understood. The species can presumably be assigned to a few sections or groups having certain distinguishing features in the operculum. The shell-form is

obviously an important character, and most of the well-defined species are based on this character. This is, however, difficult to make out in many species of the genus as the spire is in most instances worn, often up to the last whorl. Sculpture, texture, colour, and ornamentation are also characters used for the identification of the species, but these characters are often so very variable even in individuals of the same species that their reliability is open to question. Besides some species are liable to form local races which are often given specific rank. The anatomy of most, if not all, of the species is unknown, but so far as my knowledge of the anatomy goes, particularly of the radula, the mantle-edge and the gills of a few Indian and Burmese species, there is no diagnostic feature of value in these characters which will help in the identification of the species.

The genus as a whole stands in need of a thorough revision. Species of *Paludomus* have hitherto been found chiefly in Assam, Burma, South India and Ceylon.

Three species of *Paludomos* were found in the Indawgyi Valley. One is the common *P. regulata* of Burma and the other two are new to Science. The latter do not belong to the lake system or the valley. They were found in streams in the vicinity of Kamaing, about 50 miles north of the Indawgyi Lake.

I have thought it convenient to include in this paper the description of two more new species which do not belong to the lake fauna. Individuals of both these species are from Burma, presumably from the deltaic region of the Irrawady, and have been preserved in the Zoological Survey collection for many years without receiving a name. They are, however, related to other species dealt with in this paper.

Paludomus regulata Benson.

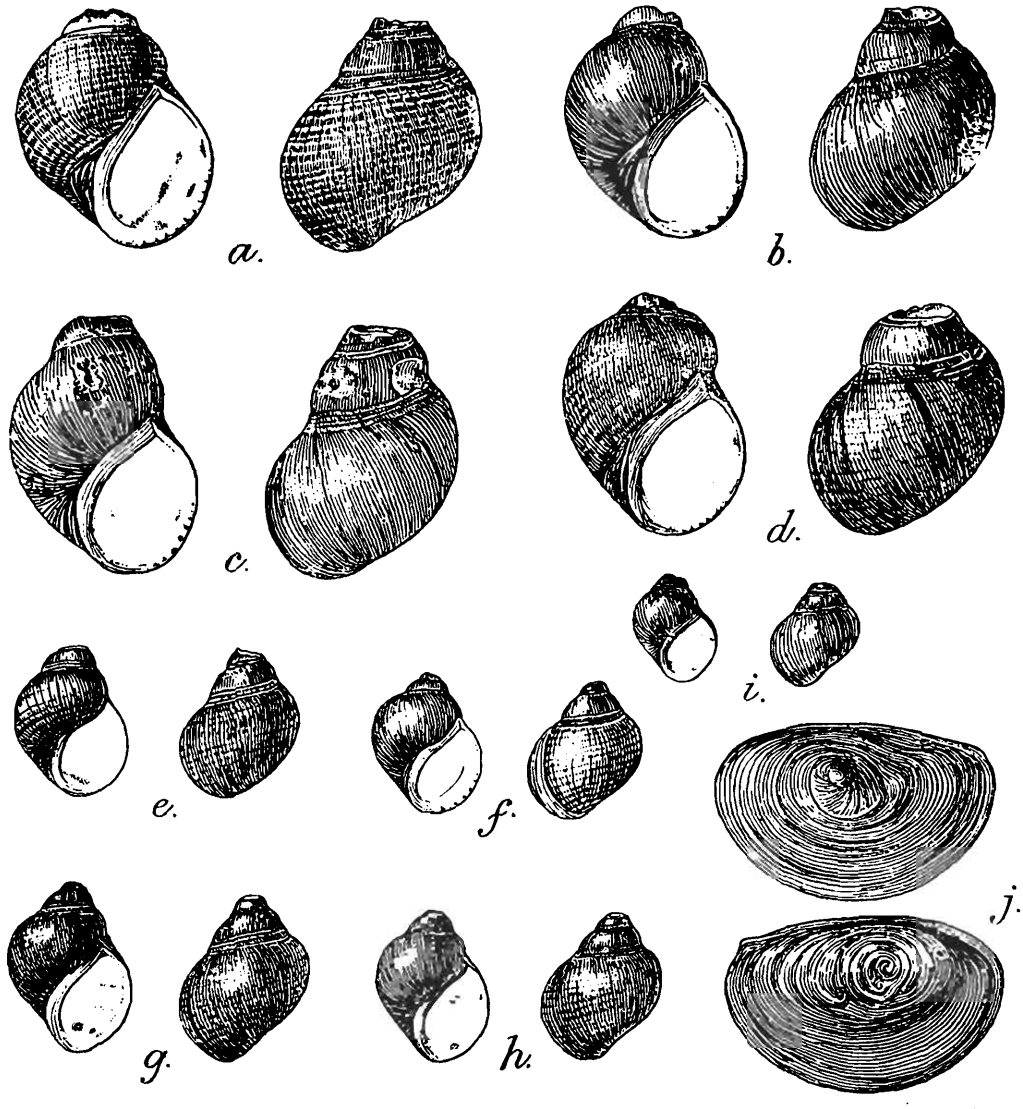
1928. *Paludomus regulata*, Rao, *Rec. Ind. Mus.*, XXX, p. 452.

Several individuals of this species were obtained in a living condition from streams and pools near Lonton and Loimon on the shores of the lake, and from rocky streams in the vicinity of Namma and Hopin. A few living specimens were also dredged from the shallower parts of the lake near Loimon.

Paludomus crassicallosa, sp. nov.

The shell is conico-ovate, not much longer than broad, and is usually decollate, much more in the adult stage than in the young shells, which have as a rule 2-2½ whorls in the spire. The sculpture consists of rather ill-defined spiral ridges, which are obliterated in many shells, with the result that the shells appear to be smooth. The shells are, however, never absolutely smooth, a few ridges near the suture perisisting in almost all the individuals. The spire is slightly oblique, minute and very little impressed. The aperture is slightly variable in form, being narrow in some and expanded in others. It is more or less regularly oval in form, acuminate above and rounded below. The columellar callus is relatively thick, convex, and somewhat reflected above with a very minute chink outside it in some individuals. It is broader and thinner

above than below. The interior of the mouth and the columellar callus have a bluish tint and are smooth and polished. There are not more



Text-fig. 4.—*Paludomus crassicallosa*, sp. nov. *a-i*, dorsal and ventral views of shells of different sizes; *a*, represents the holotype; *j*, outer and inner views of the operculum.

than four colour bands which are never continuous. They are broken up into a series of dashes or irregularly-shaped spots. These bands are not visible externally on the outside of the shell, except in younger individuals, in which a dark deposit has not begun to form. The colour of the shell is generally a dirty yellow, obscured by a thin black deposit.

Measurements in millimeters.

Locality.	Height of shell.	Maximum breadth of shell.	Height of aperture.	Maximum breadth of aperture.
Rocky stream, Kamaing	14·5	12·5	9·0	6·0
Stream near Pandawmu cave	14·0	12·0	8·2	5·2
Kamaing-Jade Mines Road	13·5	12·0	9·0	5·5

Holotype.—M. $\frac{12353}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The holotype was obtained in Sankha, a large hill-stream between Kamaing and Mogaung.

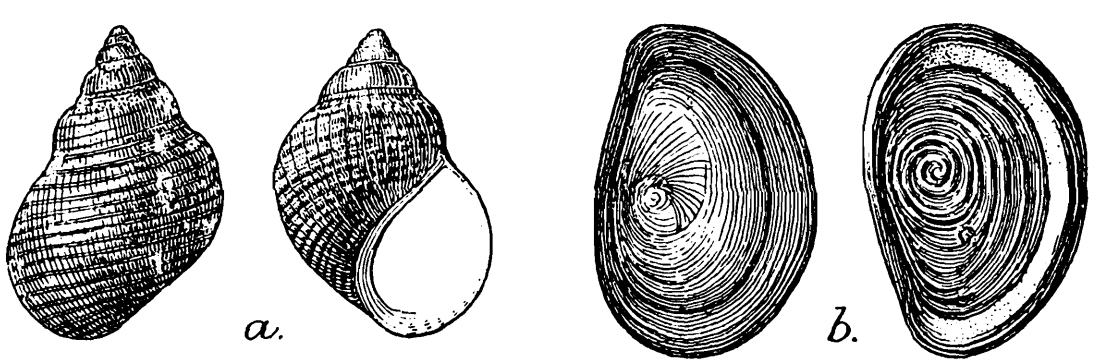
The radular teeth agree with the feature characteristic of the *Paludomus* type. The laterals and marginals are inclined at an angle of about 45° with the line connecting the bases of the teeth. The central has large cusps, the median being enlarged. The inner lateral tooth has also large cusps, but the 3rd or the 4th from the inner or axial side is much enlarged and squarish. The outer lateral has usually seven large and conical cusps. The marginal has numerous, elongate, narrow and sharp denticles on the margin which are usually about 18 in number. The short, broad-based conical process on the central is somewhat depressed in the middle.

Several hundred specimens of this species were obtained in the living condition from rocky or muddy streams within a radius of 10-15 miles from Kamaing.

This species seems to be closely related to *Paludomus nana* Nevill described below from Pegu in Lower Burma, but differs from the latter species in having a decollate spire and more convex body-whorl, in the more prominent sculpture, in the columellar callus being convex instead of sloping inwards, in colour, and in having interrupted colour bands.

Paludomus kamaingia, sp. nov.

The shell is conico-ovate, of moderately small size, not exceeding 15 mm. in height, and is moderately thick. It has 6-6½ whorls gradually increasing in size. The breadth of the spire at its base is a little more than half the breadth of the last whorl, and its height nearly half that of the entire shell. The whorls are moderately convex, and there is a slight shelf between successive whorls of the spire so that the outline of the shell is somewhat interrupted. The body-whorl in dorsal view is oblique, and below the middle on its left side is abruptly narrowed down. The suture is very minute and not impressed. The aperture



TEXT-FIG. 5.—*Paludomus kamaingia*, sp. nov. *a*, dorsal and ventral views of the holotype; *b*, outer and inner views of the operculum.

is oval, acuminate above and rounded below. The outer lip is relatively thin, crenulated as in most species of *Paludomus*,[1] and very slightly

[1] This crenulation seems to follow closely the contour of the mantle-edge and is doubtless the result of its activity.

depressed at its commencement above. The inner lip is relatively less arched. The columellar callus is well developed, rather thin at its junction with the apex of the aperture, relatively narrow, and flattened. It has a bluish tinge, and appears to be smooth to the naked eye, but is in reality minutely pitted or granular, and never conspicuously reflected, if at all. The interior of the mouth is smooth and shining. Three conspicuous but discontinuous brown bands are usually visible on the inner surface of the shell when the mouth is viewed. A fourth, which is sometimes clear, is found near the apex of the aperture close to the suture. These broken bands take the form of irregular dots or dashes. The sculpture consists of a number of spiral ridges, which are alternately broad and narrow. Immediately below the suture there are two or three much narrower but well-defined ridges. On the whorls of the spire and on the ventral side of the body-whorl the sculpture is somewhat feeble. Very minute longitudinal striae form the ground-work of the sculpture, but they can only be detected under the high power of the binocular microscope near the edge of the outer lip in adult shells or on the body-whorl in young individuals. The colour of the shell is yellow but is obscured by a black deposit which could not be removed except by prolonged treatment with a dilute solution of caustic potash.

The young shells are globular in form with the spire decollate. The sculpture is as prominent as in the adult, and the colour bands can be detected on the outside of the shell.

The operculum of the adult is narrowly ovate with its apex directed towards the columella ; it is concave above and convex below. The paucispiral is clearly visible on both sides of the operculum with the nucleus situated near the columellar side and a little below the middle. Fine concentric lines are present outside the area occupied by the paucispiral. On the inner side the spiral is marked by well-defined ridges flanked by a smooth, broad ridge on the columellar side. The operculum is always covered on the outer surface by a firm, black deposit which can be removed by treatment with caustic potash and by scratching the surface with a fine scalpel or needle.

Measurements in millimeters.

	Height of shell.	Breadth of shell.	Height of aperture.	Breadth of aperture.
Holotype	15·0	11·0	8·5	5·5
	14·5	11·3	8·5	5·5
	14·2	10·5	8·0	5·0

Holotype.—M. $\frac{12851}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The radular teeth closely resemble those of *P. crassicallosa* but are subject to slight variations in individuals.

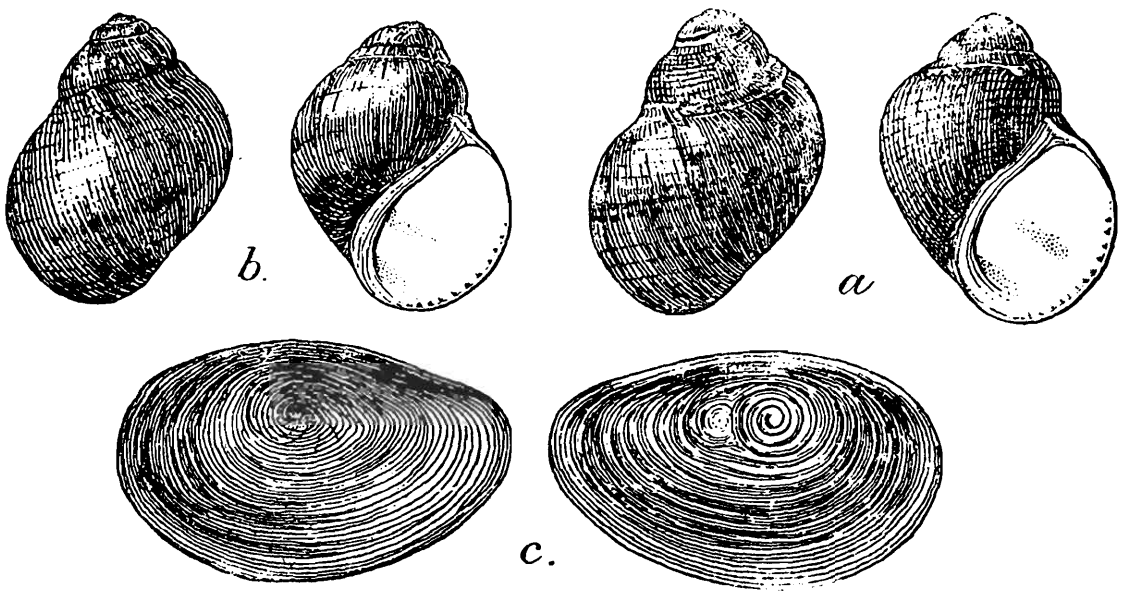
Several living specimens were collected from a small rocky stream near Kamaing.

The species is closely allied to *P. crassicallosa* but differs chiefly in the columellar callus not being convex, and in having a relatively prominent sculpture.

Paludomus nana Nevill.

1881. *Paludomus andersoniana* subsp. *peguensis* subvar. *nana*, Nevill, *Journ. As. Soc. Bengal*, L, p. 160.

The shell is of moderately small size, the largest not exceeding 16 mm. in height and 12 mm. in breadth, ovate, and has 4-4½ moderately convex whorls which increase in size more or less rapidly. The spire is, as a rule, entire and rarely decollate, but the protoconch is scarcely, if ever, exserted, with the result that the apex of the spire is nearly always obtuse. The suture is transverse, distinct but lightly impressed. The body-whorl is about two-thirds as high as the shell, swollen and broadest in the middle. The aperture is ovate, acuminate above and relatively rounded below. The outer lip is thin and sharp and much more arched than the inner lip. The columellar callus is broad above and slightly narrow below towards the anterior end of the aperture. It is more or less flat and slopes down from the umbilical margin towards the interior of the mouth. No chink is left between the callus and the umbilical region. The callus is cream-white in colour, smooth and shining, but very minutely pitted. The sculpture is rather poorly developed, and there is a tendency for smoothness in the shells. Both longitudinal and spiral sculpture can, however, be easily made out with the help of a lens. The shell



TEXT-FIG. 6.—*Paludomus nana* Nevill. *a*, dorsal and ventral views of the holotype; *b*, the same views of another specimen; *c*, outer and inner views of the operculum.

is blackish or a dark brown in colour. Looking into the aperture four colour bands may usually be seen but these bands are subject to great variation. In young shells and in some adult ones traces of the colour bands are often present on the outside of the body-whorl. The operculum is thin, narrowly ovate, slightly depressed in the centre of the outer surface, and has no granular thickening in the centre of the inner surface. The paucispiral is visible from the inner surface also.

Measurements in millimeters.

	Height of shell.	Breadth of shell.	Height of aperture.	Breadth of aperture.
Holotype	14·5	11·5	10·0	6·0
	15·0	12·5	10·5	6·5
	16·2	13·0	10·0	7·0

Holotype.—M. $\frac{12847}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Nothing is known about the anatomy. The shells have been cleaned and no trace of the animal is left behind.

A few shells of this species were collected by the late Dr. F. Stoliczka in Pegu in Lower Burma. Nevill considered them to be an undescribed variety of the subsp. *peguensis* of his species *Paludomus andersoniana.*[1] On careful comparison of the specimens catalogued by Nevill in his ' Hand-List ' with *P. regulata* I find sufficient justification to give them a distinct specific status.

P. nana differs from *P. regulata* in several features but chiefly in the proportionately shorter and broader spire, in the relatively well-developed and somewhat flattened columellar callus, in the shell being comparatively thick, and in the operculum being devoid of a granular thickening in the centre of the inner surface. In sculpture and colour also the difference between the two species is apparent.

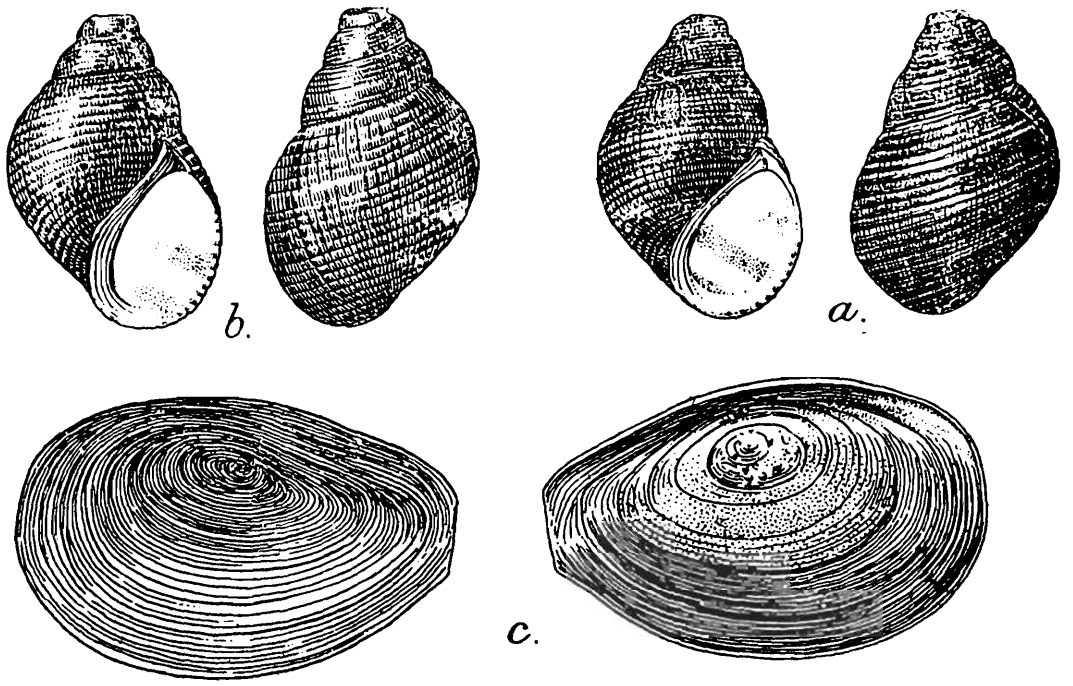
The Burmese species of *Paludomus* seem to have evolved from forms resembling *P. regulata* which is widely distributed in Burma. They seem to exhibit a certain degree of plasticity, and the differences in habitat have probably contributed their share to the factors operating on the evolution of various slightly differing forms from a common stock.

Paludomus parvula, sp. nov.

The shell is regularly ovate or roughly elliptical, slightly decollate, and has only four whorls which are not at all swollen. The body-whorl is nearly as broad as high and two-thirds as high as the entire shell. The suture is oblique, well-defined and moderately impressed, and the outline of the shell is only slightly interrupted by the aperture. The aperture is elongate, oval, acuminate above and rather narrowly rounded below. The outer lip is thin and crenulated at its margin and is not very much arched, though more conspicuously than the inner lip. The columellar callus is flattened, fairly broad, of equal breadth throughout its entire length, and is continued to the anterior end of the aperture. The interior of the mouth is smooth, and has four broad bands, of which the third from above is the broadest. If the shell surface is without a black deposit these bands are also clearly visible on the outer surface of the body-whorl. The sculpture is very prominent and consists of broad spiral ridges separated by deep grooves. The ridge near the suture is

[1] In a previous paper on the Molluscs of the N. Shan States (*Rec. Ind. Mus.*, XXX, p. 452 1928) I have shown that Nevill's species is a synonym of *P. regulata* Benson.

particularly thickened. The ground sculpture consists of minute longitudinal striae visible on the ridges and in the grooves. The operculum



Text-fig. 7.—*Paludomus parvula*, sp. nov. *a*, dorsal and ventral views of the holotype; *b*, the same views of another specimen; *c*, outer and inner views of the operculum.

is ovate, broadly pointed at apex, concave on the outer surface and convex on the inner. The paucispiral is visible from both surfaces, but the ridges of the nuclear part are very feebly developed on the inner surface. The concentric lines are minute.

Measurements in millimeters.

	Height of shell.	Breadth of shell.	Height of aperture.	Breadth of aperture.
Holotype	14·8	10·5	9·8	5·2
	15·5	11·0	9·5	5·5
	15·0	10·5	9·3	5·5

Holotype.—M. $\frac{12849}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Only seven shells from an unknown locality in Burma are preserved in the Zoological Survey collection. They do not match with any known species from that country. They, however, resemble in external features only the Ceylonese *P. sulcata* var. *minor* Nevill. The operculum of the two species are so different that there can hardly be any specific relationship between them. From a label with the name *parvula* on it found along with the shells it seems possible that Benson intended to regard them as a new variety of *P. regulata*. I cannot find any reference to this name in literature, or any published figures with which the shells in question agree in every respect.

The radular teeth closely resemble those of *P. regulata*, particularly in having fewer denticles on the outer lateral and marginal teeth, and in the median cusp on the central not being conspicuously enlarged.

Family Limnaeidae.

This family is represented by three species of which one is new to Science.

Only one species, *L. acuminata*, occurs in great abundance in the lake and its surroundings. Two specimens of another species, *L. luteola*, and a few of a new form of *L. acuminata* were also taken from the shores and shallow regions of the lake. The description of the new species is based on a single example from the lake.

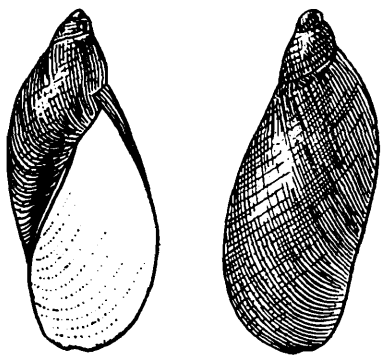
Limnaea acuminata f. **patula** Troschel.

1925. *Limnaea acuminata* f. *patula*, Annandale & Rao, *Rec. Ind. Mus.*, XXVII, p. 181, fig. iii, 9, fig. vi, 1 & 2.

Several hundred specimens of this form in various stages of growth were taken in ponds and pools round about Lonton and Nyaungbin, and in the shallow parts of the lake near the shore in the vicinity of Lonton, Loimon, Nyaungbin and the Shwemyzu Pagoda.

Limnaea acuminata f. **pseudohorae,** nov.

Though in size and sculpture this form approaches *L. horae* Annandale & Rao, it has, I think, no specific relationship with it. In the form of the shell and the spire, and in the nature of the columellar callus, which though very thin is always distinct, this form is undoubtedly closely allied to *L. acuminata*, particularly to the form *patula*, but in having minutely decussated longitudinal striae, which are so characteristic of *L. horae*, its resemblance to this species is remarkable.[1]



Text-fig. 8.—*Limnaea acuminata* f. *pseudohorae*, nov. Dorsal and ventral views of the holotype.

Holotype.—M. $\frac{12858}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

Three fresh shells were taken along with *L. acuminata* f. *patula* from the shallow part of the lake near Shwemyzu Pagoda. The animals were unfortunately not preserved.

Limnaea luteola f. **australis** Annandale & Rao.

1925. *Limnaea luteola* f. *australis*, Annandale & Rao, *Rec. Ind. Mus.*, XXVII, p. 184.

This form is recorded for the first time from Burma. It has a wide distribution in India and Ceylon. The form *siamensis* Sowerby, which seems to be more or less in the nature of a local race of the species and known from the Shan States and the Irrawady delta, is curiously absent in the Indawgyi Valley and its neighbourhood.

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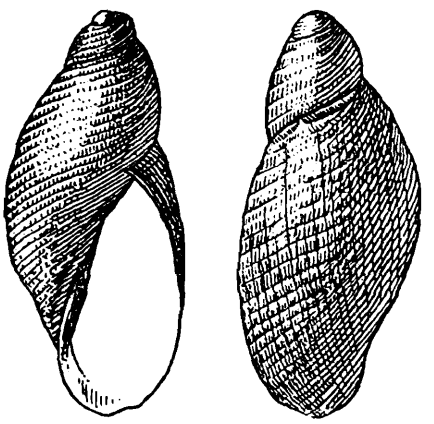
[1] Annandale & Rao, *Rec. Ind. Mus.*, XXVII, pp. 154-176, fig. 2 (1925).

Only two small living specimens were found sticking to aquatic weeds in a clear pool more or less connected with the Indawgyi Lake.

Limnaea decussatula, sp. nov.

The shell is of small size and does not exceed 4 mm. in height and 2 mm. in breadth. It is elongate, narrowly elliptical, thin but not brittle, and consists of three whorls which are not at all swollen. The body whorl is large, and is about two-thirds the height of the entire shell. The apical whorl is small, knob-like, and is a little more than one-third the height of the penultimate whorl. The suture is oblique and moderately impressed. The aperture is elongate, unusually narrow and compressed, but broadens out gradually from the posterior end to the anterior. The columella is well defined, but the callus is thin and poorly developed. It is somewhat twisted in appearance and forms a thin but conspicuous ridge along the greater portion of the periphery of the inner lip. The inside of the mouth is smooth and has an oily lustre. The outer lip is comparatively thin. The sculpture is very minute and peculiar. The ground sculpture is longitudinal, but these longitudinal lines seem to be broken up later on into short decussating vertical but curved lines throughout the second and the last whorls. The concavity of these curved lines is always directed towards the columellar side. Parallel shallow grooves are formed between successive series of decussating lines and give the shell a spirally striated appearance. The apical whorl is smooth.



Text-fig. 9.—*Limnaea decussatula*, sp. nov. Dorsal and ventral views of the holotype.

Holotype.—M. $\frac{12857}{2}$ Zool. Surv. Ind. (*Ind. Mus.*).

The animal is only partially preserved, and I have not been able to study its anatomy.

A single example of this species was found along with specimens of *L. acuminata* f. *pseudohorae*, nov. in the shallow part of the lake near the Shwemyzu Pagoda.

The compressed nature of the shell and the aperture, the curious sculpture, and the columellar ridge mark this species as very distinct from any other Indian or Burmese lacustrine species of *Limnaea*. Though the species approaches *L. horae* in sculpture, it differs from it in having the mouth not at all expanded.

Family Planorbidae.

In the fauna of the lake this family is fairly well represented by four genera and six species. Three of the six species have a wide distribution in the Oriental Region. *G. velifer* has hitherto been known from the Inle Lake, and its occurrence in the Indawgyi Lake seems to show that it is a purely lacustrine species. *G. rotula*, a rare Indian species, is recorded for the first time from Burma.

Indoplanorbis exustus (Deshayes).

1928. *Indoplanorbis exustus*, Rao, *Rec. Ind. Mus.*, XXX, p 457.

The species is very common in the Indawgyi Valley and the adjoining country. Several hundred specimens, living and dead, were taken in ponds near the lake at Lonton and Hopin and near Kamaing. Some of them are of large size. Those collected near the north end of the lake contain a large number of small and young specimens.

Gyraulus velifer (Annandale).

1918 *Planorbis velifer*, Annandale, *Rec. Ind. Mus.*, XIV, p. 112, pl. xi, figs. 7-11.

In the shallow parts of the lake near Lonton and the Shwemyzu Pagoda this species is very common. Several living specimens were collected at these places, some of them from the latter locality being particularly large. The velum is well developed in all specimens. The species has hitherto been known only from the Inle Lake in the S. Shan States. In that lake it is common amongst dense masses of aquatic weeds.

Gyraulus velifer var. ciliata (Annandale).

1918. *Planorbis velifer* var. *ciliata*, Annandale, *op. cit.*, p. 112.

Several examples of this variety were taken along with the typical species mostly in the living condition. They seem to stray occasionally into the deeper parts of the lake. The spiral ridges characteristic of this variety vary in number, but are more numerous than in the specimens from the Inle Lake.

Gyraulus convexiusculus (Hutton).

1928. *Gyraulus convexiusculus*, Rao, *op. cit.*, p. 457.

The species is common in the shallow parts of the lake near Lonton and Nyaungbin. Large numbers of specimens were found in weedy ponds round about Lonton, and amongst submerged floating weeds near the shore of the lake at Nyaungbin.

Gyraulus rotula (Benson).

1850. *Planorbis rotula*, Benson, *Ann. Mag. Nat. Hist.*, Ser. 2, V, p. 351.
1876. *Planorbis rotula*, Hanley & Theobald, *Conch. Ind.*, p. 40, pl. xcix, figs. 2 & 3.

With some hesitation I refer to this species two shells from the shores of the lake near Lonton. They are not quite fresh, and the mouth of the shells is not entire. The sculpture is somewhat coarse and there is no trace of the spiral striae referred to in Benson's original description. The whorls are uniformly convex, and the mouth is small and rounded. The apex is relatively depressed. In the number and general features of the whorls, the shells agree with the description of *G. rotula*.

Shells from Bombay in the collection of the Zoological Survey of India referred to by Nevill (*Hand-List Moll. Ind. Mus.*, I, p. 245) as "*Planorbis* (*Nautilina*) *rotula* (?)" are included by Germain in *G. rotula*

(Benson).[1] I have examined the full-grown shells in this lot and find that they are in no way related to *G. rotula*. In the departure of the last whorl from the axis of the inner whorls and in the presence of a whitish rib within the lip, the shells under discussion agree very well with *G. labiatus* (Benson).

Benson, who first discovered the species at Moradabad as early as 1841, regarded it as a rare species, and this is borne out by the fact that there has been no record of the species since then from any other part of India. Drs. Prashad and Hora, however, rediscovered the species in 1920 in a pond in Moradabad, but unfortunately their collection consists of only one small shell, which agrees very well with Benson's description of the species.

Dr. Prashad [2] has referred to this species shells from Ceylon described by Westerlund as *Planorbis* (*Gyraulus*) *liratus*. His figure of the species compared with the specimen from Moradabad indicates that the Ceylon specimens are identical with *G. rotula*.

The anatomy of the species is totally unknown. Benson has referred to the peculiar mode of progression of this species. I have observed *G. convexiusculus* and *G. euphraticus* in their natural environment perform occasional jerky movements of the shell when suspended from the surface film, but they did not move very far from their original position. The rapid progression of *G. rotula* by sudden jerks is presumably a unique character.

From the little known records of the species, *e.g.*, from the Indawgyi Lake in Upper Burma, from Moradabad in N. India, and from Ceylon in the extreme south, it is only possible to surmise that its distribution is discontinuous.

Segmentina calathus (Benson).

1921. *Segmentina calathus*, Annandale & Prashad, *Rec. Ind. Mus.*, XXII, p. 585.

This species is apparently rare both in the lake and in the streams and pools in the valley and in the plains north of the lake. Only one young example in a dead condition was found along with other species of Planorbidae from the shores of the lake near Lonton. The mouth is not entire, and the whorls are comparatively broad in dorsal view. The internal partitions in the shell, two of them at any rate, are quite distinct though relatively thin.

The species is common in Northern India, Burma and Ceylon. Its range outside India extends up to Seistan in the North-west and up to Siam and Sumatra in the East and South-east.

Hippeutis sp.

Six small dead shells dredged from the south end of the Indawgyi Lake near Lonton are referred to this genus. With some of the generic characters of *Hippeutis*, *e.g.*, the tentacular shape, the convex dorsal and flattened ventral surfaces, and the deep umbilicus, the shells

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[1] Germain, *Rec. Ind. Mus.*, XXI, p. 128 (1922).
[2] Prashad, *Rec. Ind. Mus.*, XXVII, p. 347 (1925).

agree closely, but differ in being greatly depressed and in the rapidly increasing size of the whorls. With only a few dead and much worn shells it is impossible to be certain about its specific identity.

The shells are whitish in colour and have well-defined, impressed, oblique, longitudinal striae. The periphery is carinate, and in one shell it carries a pair of bacterial vela, one below the other, the lower being more prominent than the upper. The aperture is heart-shaped.

Family Succineidae.

This family is very poorly represented in the Indawgyi Valley, the only record being a form of the species *Succinea gravelyi* Rao.

Succinea gravelyi f. deccanensis Rao.

1924. *Succinea gravelyi* f. *deccanensis*, Rao, *Rec. Ind. Mus.*, XXVI, p. 403.

A single example in the living state was found at the edge of a stream near Lonton. Unfortunately the animal is in a bad state of preservation, and I am, therefore, unable to verify my identification by an examination of the internal organs, except the radular teeth, which agree closely with those of *S. gravelyi*. The shell is smaller than any of the typical specimens from India, and is somewhat abruptly narrowed from the middle. The last whorl is not evenly arched in dorsal view. The sculpture is coarse and consists of irregular longitudinal striae.

Succinea gravelyi, like *S. daucina* and *S. godivariana*, seems to have a restricted distribution in India and Burma.