GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION, PLASTICITY AND VARIATION.

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GEOGRAPHICAL DISTRIBUTION.

It will be as well for me to begin this section of our paper with a list of the species we have discussed.

List of the Aquatic and Amphibious Mollusca of the Manipur Valley.

GASTROPODA.

Order PECTINIBRANCHIATA.

HYDROBIIDAE.

1. *Amnicola* (*Alocinma*) *orcula* (Frauenfeld).
2. *Digoniostoma pulchellum* (Benson).
3. *Digoniostoma textum*, Annandale.

VIVIPARIDAE.

4. *Vivipara crassispiralis*, Annandale.
5. *Vivipara oxytropis* (Benson).
6. *Vivipara micron*, Annandale.
7. *Lecythoconcha lecythis* (Benson).

MELANIIDAE.

8. *Melanoides tuberculatus* (Müller).
9. *Acrostoma variabilis* (Benson).
10. *Paludomus pustulosa*, Annandale.

AMPULLARIIDAE.

11. *Pachylabra maura* (Reeve).

Order PULMONATA.

SUCCINEIDAE.

12. *Succinea rutilans*, Blanford.
13. *Succinea elegantior*, Annandale.

LIMNAEIDAE.

14. *Limnaea acuminata*, Lamarck.
15. *Limnaea ovalis*, Gray.
16. *Limnaea andersoniana*, Nevill.
17. *Limnaea ovalior*, Annandale and Prashad.

PLANORBIDAE.

18. *Indoplanorbis exustus* (Deshayes).
19. *Gyraulus convexiusculus* (Hutton).
20. *Gyralus cantori* (Benson).
21. *Hippeutis* (?) *umbilicalis* (Benson).
22. *Segmentina calathus* (Benson).
23. *Camptoceras lineatum*, Blanford.

ANCYLIDAE.

24. *Ancylus* (*Ferrissia*) *viola*, Annandale and Prashad.
25. *Ancylus* (*Ferrissia*) *verruca*, Benson.
26. *Ancylus* (*Ferrissia*) *ceylanicus*, Benson.

PELECYPODA.

UNIONIDAE.

27. *Indonaia occata* (Lea).
28. *Indonaia bonneaudi* (Simpson).
29. *Indonaia scobina* (Hanley).
30. *Indonaia theobaldi* (Preston).
31. *Indonaia lima* (Simpson).
32. *Lamellidens marginalis* (Lamarck).
33. *Lamellidens consobrinus* (Lea).
34. *Lamellidens corrianus* (Lea).
35. *Trapezoideus misellus* (Morelet).

CYRENIDAE.

36. *Corbicula occidens*, Deshayes.
37. *Corbicula striatella*, Deshayes.
38. *Corbicula subradiata*, Prime.
39. *Sphaerium indicum*, Deshayes.
40. *Sphaerium austeni*, Prashad.
41. *Pisidium clarkeanum*, G. and H. Nevill.
42. *Pisidium hydaspicola*, Theobald.

Twenty-two genera and subgenera are mentioned in this list of forty-two species. Of the genera and subgenera only six call for any special comment, the remaining fourteen being of wide and general distribution in the Oriental Region if not over the whole world. The six are *Alocinma* (subgenus of *Amnicola*), *Digoniostoma*, *Lecythoconcha*, *Camptoceras*, *Indonaia* and *Trapezoideus*. The first of these is known from Mesopotamia Seistan, all parts of Peninsular India, Upper Burma and Manipur. Its headquarters are in Peninsular India. The genus *Digoniostoma* has recently been described to contain certain Peninsular Indian species. It is common all over India proper and Assam, but has not been found west of the Indus or in Burma. *Lecythoconcha*, on the other hand, is an eastern genus, the range of which extends from Manipur (and

possibly Sylhet) in the west across Upper Burma and China to the Philippines, Formosa and Japan. The precise geographical range, which at present appears discontinuous, is probably unknown. Species have been found in Kashmir, the valleys of the Ganges and Brahmaputra, Manipur and Japan. Our present knowledge of the anatomy of the Oriental Unionidae is too incomplete to render it possible to lay down exact geographical boundaries for the genera, *Indonaia* is apparently characteristic of the eastern parts of the Indian Empire, but extends well into Peninsular India, while *Trapezoideus* probably does not occur west of Eastern Assam and has its headquarters in the Indo-chinese peninsular area.

The genera of aquatic molluscs found in Manipur do not, therefore, provide any very clear guidance as to the origin of its aquatic fauna, except in so far as they indicate the presence of a distinct Far Eastern element. *Lecythoconcha* is the most noteworthy in this respect. It is also noteworthy, however, that the characteristic Burmese genera *Hydrobioides*, *Taia* and *Temnotaia* have not been found in Manipur.

In analysing the list of species from a geographical point of view it will be as well to consider the Gastropoda and the Pelecypoda separately, for they follow different rules in their dispersal. There are twenty-six names of Gastropod species on the list. Three of these have a very wide range in the Oriental Region namely *Indoplanorbis exustus*, which is common all over the plains of the Indian Empire east of the Indus, Siam, the Sunda Isles, etc.; *Melanoides tuberculatus*, distributed practically all over the Ethiopian and Oriental Regions (except at high altitudes) and found also in adjacent parts of the Palaearctic and Australasian Regions, and *Gyraulus convexiusculus*, the range of which extends on the mainland from Mesopotamia to Eastern China and includes a considerable part of the Malay Archipelago.

Nine species may be called "Indian," being found both east and west of the Bay of Bengal but not, or only a short distance beyond, the eastern boundaries of the Indian Empire and not or hardly west of the Indus. They are:—

Amnicola orcula.
Acrostoma variabilis.
Limnaea acuminata.
Limnaea ovalis.
Hippeutis (?) *umbilicalis.*
Segmentina calathus.
Ancylus verruca.
Ancylus ceylanicus.
Gyraulus cantori.

The first of these species is essentially Gangetic and is replaced in Peninsular India and Ceylon by a closely allied species or race, *A. stenothyroides* (Dohrn). It has not been found in Burma. *Limnaea acuminata* and *L. ovalis* are found all over the Indo-Gangetic plain and Peninsular India. The former is known from Upper Burma; the latter has not previously been recorded from any place east of the Bay of Bengal, and is very rare in Manipur. *Gyraulus cantori* is a scarce species, closely related to the widely distributed *G. convexiusculus* and at present known

only from the Ganges Valley and Manipur. *Hippeutis* (?) *umbilicalis* has a similar range but was described from Sylhet. It is the most abundant Planorbid in the Manipur Valley, but is scarce in that of the Ganges. The range of *Segmentina calathus* extends from Seistan, beyond the western frontiers of the Indian Empire, to Upper Burma and Sumatra. The two species of *Ancylus* have both been found in Ceylon as well as in Peninsular India. The origin of most of these species is probably to be sought in the Gangetic plain or Peninsular India, but the species assigned doubtfully to *Hippeutis* may be of Assamese origin. This is still more probable of *Acrostoma variabilis*, which is common throughout the plains of Burma and Assam but in India west of the Bay of Bengal extends only for a short distance up the Gangetic system, where its numerous varieties and phases have usually a dwarfed facies and do not exhibit the same sturdy appearance that they do further east.

The "Indian" element among the freshwater Gastropods of Manipur may thus be regarded as of mixed origin, partly Indian in a strict sense, partly immigrant into India proper from further east. But on the whole the former element predominates.

The aquatic fauna of Assam has less of an indigenous element than that of the Ganges Valley and is, indeed, largely compounded of a mixture of that of India proper and that of Burma. The indigenous element, however, is not wholly wanting in the Brahmaputra watershed, and to this element we must assign three of the Manipur Gastropods, viz. *Digoniostoma pulchellum*, which is hardly more than a local race of the Gangetic *D. cerameopoma*, *Pachylabra maura*, which bears much the same relationship to the Gangetic *P. globosa*, and *Camptoceras lineatum*. This last species was originally discovered in what is now the Dacca District of Eastern Bengal, at a place beyond the political frontiers of Assam, but within the limits of the Brahmaputra system. It is noteworthy as the only species of its genus that has been found at more than one place, and its rediscovery in Manipur has, therefore, some interest. The species is abundantly distinct from any other. Its nearest ally is *C. subspinosum* from the valley of Kashmir in the western Himalayas.

Two Gastropod species on our list have as yet been found only in the Manipur Valley and at Dimapur in the plains of North-eastern Assam just north of the Naga Hills. They are *Limnaea ovalior* and *Ancylus viola*.

The isolation of the Manipur Valley renders the existence in it of endemic species by no means surprising. So far as our knowledge goes, five Gastropod species on our list belong to this category, namely *Digoniostoma textum*, *Vivipara crassispiralis*, *V. micron*, *Paludomus pustulosa*, *Succinea elegantior*. Half of these belong to the genus *Vivipara* and it is worthy of mention that each of the two species belongs to a different section [1] of the

[1] *Rec. Ind. Mus.* XIX, pp. 112–114 (1920).

genus, *V crassispiralis* to the Viviparae bengalenses and *V micron* to the Viviparae dissimiles. Each species, however, is quite distinct from any other, as are also *D. textum* and *S. elegantior*, the resemblance between the shell of the latter and that of the Indo-Burmese *S. semiserica* being superficial. The *Paludomus*, on the other hand, is closely allied to *P. conica*, a remarkably plastic Assamese species with many local races, amongst which the Manipur form might perhaps be included.

Considered as a whole the Gastropod molluscs of the ponds, swamps and streams of Manipur are thus remarkable from a geographical point of view in only one feature, in the small evidence they afford of a close connection with those of Burma such as might have been postulated from the fact that the river-system of the Manipur Valley, in which the great majority of them live, is directly connected with the largest tributary of the Irrawadi and completely isolated from all other systems.

We may now consider the geographical distribution of the bivalve molluscs of Manipur. Among these six genera are represented, *Indonaia*, *Lamellidens*, *Trapezoideus*, *Corbicula*, *Sphaerium* and *Pisidium*. The first three genera belong to the Unionidae, the last three to the Cyrenidae. As the two families have different means of dispersal and also different limitations in their dispersal, we may consider them separately. The parasitic period in the life of the Unionidae and the fact that the different species are attached to different species of fish in this period give the members of the family a peculiar means of progression from one part of a river-system to another and at the same time correlate their geographical distribution with that of their hosts. We might expect, therefore, that the Unionidae of the Manipur Valley would be more exclusively Burmese than either the Gastropods or the Cyrenidae. Mr. Sunder Lal Hora, who has worked out the large collection of fish he made in Manipur, tells me that he finds among them a large proportion of Burmese species and that he obtained evidence, direct and indirect, that certain species migrate up the Imphal River at certain seasons. That such fish should bring with them from Burma the glochidia of Burmese Unionidae would be what might be expected. But the evidence for this is not very strong. The genus *Trapezoideus* is certainly in the main a Burmese and Indo-chinese genus and the only species found in Manipur (*T misellus*) is a Burmese and Indo-chinese species, but the occurrence of another, hitherto undescribed species (*T dhanushori*, Prashad) north of the Naga Hills considerably discounts the value of this piece of evidence, though it does not run counter to it. *Indonaia*, although it has its headquarters in the north-eastern part of the Indian Empire, is by no means exclusively Burmese. Three of the four species found in Manipur have also been found in Assam if not in India proper, and only two of these in Burma, while the fourth is known only from the Manipur Valley.

Even from the Unionidae, therefore, evidence for any but a

recent connection with Burma is by no means strong, and the Assamese and Bengali element in the fauna is clearly shown.

The three genera of Cyrenidae represented in the Manipur fauna are all of exceedingly wide range, *Sphaerium* and *Pisidium* being almost cosmopolitan, while *Corbicula* is found in the warmer parts of all regions.[1] The species of these genera known from Manipur, with two possible exceptions, have a wide range in northern India, the two exceptions being *C. subradiata*, for which the Manipur Valley is the only precise locality recorded, and *S. austeni* which is only known from Manipur and the Naga Hills. Of the others, *C. occidens* and *C striatella* occur all over the plains of India, while *S. indicum*, *P. clarkeanum* and *P. hydaspicola* have been found at considerable altitudes in northern India as well as in widely separated localities in the Indo-Gangetic plain.

The Cyrenidae, indeed, provide as little evidence for long-established connection between the Manipur Valley and Burma as any other family of aquatic molluscs.

To sum up, therefore, the geographical affinities of the aquatic and amphibious Mollusca of Manipur as revealed by the distribution of genera and species, it may be stated briefly that these affinities are rather with the molluscs of Assam and the Gangetic Valley than with those of the valley of the Irrawadi or the Salween and that the Burmese element is much smaller than might be expected from the close connection between the river-system of the Manipur Valley and of the Irrawadi.

ECOLOGICAL DISTRIBUTION.

As might be expected in a swampy valley like that of Manipur, the aquatic fauna is largely paludine. Even in the Loktak Lake there has been no evolution of a true lacustrine fauna, and, indeed, the number of species of aquatic molluscs is comparatively small. The species found actually in the lake are—

Vivipara oxytropis.
Lecythoconcha lecythis.
Limnaea acuminata.
Indoplanorbis exustus.
Gyraulus cantori.
Hippeutis (?) *umbilicalis.*
Lamellidens corrianus.
Sphaerium indicum.
Pisidium clarkeanum.

The majority of these species are common in small ponds in the Gangetic Delta and none of them have been found in a true lake, except *Indoplanorbis exustus*, which in the Inlé Lake haunts only the swampy marginal zone and in the Talé Sap in Siam is found only among beds of weeds near the shore. The only species that are in any way characteristic of the Loktak Lake are the two Viviparidae. These attain their maximum development only in the deeper part of the swamp, but both are found also in ponds and smaller swamps throughout the valley. No definite zones of life can be recognized here, but *Lamellidens marginalis* and *Pisi-*

[1] It occurred in England in Tertiary times.

dium clarkeanum, burrowing species, were found only at the extreme edge of the northern part of the lake where the vegetation is less congested, while the third bivalve (*Sphaerium indicum*), which swarms freely among the branches of water-weeds, was most abundant in the deeper parts.

Limnaea ovalior probably occurs in the Loktak Lake when it is full as we found it in small pools that would be included at that season, but it is even more of an exclusively paludine species than those discussed as inhabitants of the lake. Indeed, it seems to be almost amphibious in habits and thus from an ecological point of view may almost be classed with *Succinea elegans*, a species found in abundance at the edge of the northern part of the lake.

Only a few species were found in running water, but here it is necessary to recognize a fundamental difference between the rapid-running streams of the hills, with their clear water and stony bed, and the sluggish, turbid rivers of the valley. In hill-streams the only Gastropods commonly observed were *Paludomus pustulosa* and the narrowest phase of *Limnaea andersoniana*. Bivalves were rather more common and included the following species, *Corbicula occidens*, *Indonaia bonneaudi*, *I. theobaldi* and *I. lima*, all thick-shelled forms, as is also *P. pustulosa*. At least two other species make their way into muddy, comparatively still pools in such streams, viz. *Melanoides tuberculatus* and *Acrostoma variabilis*.

In the larger rivers of the valley the muddy bottom is favourable to these two Melaniidae and also to the thin-shelled Unionidae of the genus *Lamellidens*, while in small, sluggish streamlets and water-courses *Ancylus viola*, *Limnaea acuminata*, *Corbicula occidens* and *Pisidium clarkeanum* are sometimes not uncommon. It was in such a streamlet also that we found *Camptoceras lineatum*.

Generally speaking, the species of *Paludomus*, *Acrostoma* and *Indonaia* are inhabitants of running water. *Paludomus* is found as a rule in mountain streams or at any rate in running water near the base of hills and on a stony bottom, while *Acrostoma* and *Indonaia* need mud and therefore less rapid water. As is suggested in Dr. Baini Prashad's part of this paper, the genus *Lamellidens* can probably be divided into two sections from an ecological point of view, one, which produces very large numbers of embryos and as a rule frequents running water, the other, with a smaller number of embryos, that affects ponds and swamps. These observations, to which there are of course exceptions, are on the whole substantiated in Manipur, but in applying them it must be remembered that conditions in a very sluggish, weed-choked stream often approximate closely to those in a swamp and attract paludine forms.

Variation and Plasticity.

It is particularly interesting to contrast the Manipur Valley with that of the Inlé Lake in reference to the variability and plasticity of the aquatic molluscs. As I have pointed out in the Introduction to this paper, the two valleys have certain physical fea-

tures in common, others, which are perhaps more important, widely divergent. Comparatively few species of molluscs are identical in the two localities, and the general facies and composition of the fauna is very different. In the Inlé Valley the two families of molluscs most remarkable for their plasticity are the Viviparidae and the Limnaeidae. As this is also so in the Manipur Valley, it will greatly simplify my comparison if I confine my remarks to these two families. I will begin to do so by drawing up in tabular form the main differences between the Viviparidae of the Inlé Lake and those of the Manipur Valley.

	INLÉ VALLEY.	MANIPUR VALLEY.
Genus represented	*Taia*, *Lecythoconcha*.	*Vivipara*, *Lecythoconcha*.
Predominant genera	*Taia*.	*Vivipara*.
Number of living species	*Taia* 5, *Lecythoconcha* 1.	*Vivipara* 3, *Lecythoconcha* 1.
Fossil forms known	Four (*Taia*).	None.
Number of species with highly sculptured shells	5 recent, 4 fossil (*Taia*).	2 recent (*Vivipara*).
General character of shell-sculpture in such forms	Nodular, squamose or spinose ridges.	Smooth ridges.

In considering the meaning of the differences thus summarily expressed we have to take into account not only the differences in environment but also the idiosyncracies of the different genera represented, for there is no fact more evident in the study of the freshwater molluscs than that different genera have different tendencies in the matter of variation and plasticity. At present we have three genera to consider, *Vivipara*, *Lecythoconcha* and *Taia*. It will be convenient to take *Lecythoconcha* first.

Although this genus is present in both valleys it is so scarce in the Inlé Valley, and I know so little about it there, that I must confine my remarks, so far as my own observations go, to its peculiarities in Manipur. I have selected this genus as the protagonist in my argument because its case is not complicated by the production of an abnormal and exuberant shell-sculpture. We may indeed, so far as Manipur is concerned, regard *Lecythoconcha* as a smooth-shelled genus. Further east, especially in Japan, we find shells presumably of this genus with a type of sculpture very like that of *Vivipara oxytropis*, but we know nothing of their anatomy and they must for the present be ignored. It is probable that their case is similar to that of the species of *Vivipara* already mentioned and to be discussed further.

The one species of *Lecythoconcha* found in Manipur extends the range of the genus a considerable distance westwards from its

headquarters in China, but it has colonized the Manipur Valley successfully and is at home in practically every part of its waters except in streams and rivers. Its plasticitv is remarkable, and has probably aided it in taking possession of a very large territory. In the Manipur Valley we found no less than four phases common, each in its proper environment, and, so far as I know, only one of these phases has been found outside the valley, unless the locality "Sylhet" is correct for the *forma typica*, which I doubt greatly. Should my doubt prove unfounded it will not alter my argument. Of the four phases the largest and best developed is the one found in the central parts of the Loktak Lake, amidst dense submerged vegetation but in comparatively clean water of relatively considerable depth. The shell in this phase provides less evidence of interrupted growth than any of the others, less individual variation and as a rule a greater symmetry in proportions. It is, indeed, of just such a type as might be expected to occur in conditions in every respect favourable to the species. The only approximation, however, to a true lacustrine type exhibited by it is its comparative thinness. It has no tendency whatever to assume the elongate conical outline of the lacustrine species of *Taia*. Indeed, it is more globose than the shell of either the phase found at the edge of the great swamp or that found in ponds. The rice-field phase, on the other hand, is still more globose than the deep-water one, but does not possess its symmetry or constancy to type.

It is evident that we are here dealing with plasticity of a somewhat different type from that illustrated by the genus *Taia* in the Shan States, and with one in which the direct result of environment on the individual may be more safely postulated.

Indirectly the structure and post-embryonic development of *L. lecythis* cast an interesting sidelight, though the adult shell is smooth or nearly so, on the question of the development of prominent spiral sculpture on the shells of the Viviparidae in certain circumstances, but this point can be discussed more clearly after the facts about *Vivipara oxytropis* have been summarized.

Of the three species of *Vivipara* found in Manipur two are very scarce and have not been seen by me in their natural surroundings. The third (*V oxytropis*) is, however, abundant and shares with *L. lecythis* the position of a dominant species throughout the valley. Two points have to be considered in reference to this species, its plasticity and its peculiar sculpture, the latter not so much for its own sake as for the light it throws, taken with certain facts in the life-history of *L. lecythis*, on larger questions.

V oxytropis is not quite so abundant or so universally distributed in the Manipur valley as *L. lecythis*. It is very nearly if not quite as common in the Loktak Lake, but much scarcer in most ponds and practically absent from the smaller swamps. This may perhaps be correlated with two facts, firstly that it is not nearly so plastic (i e. cannot adapt its external form to different types of environment so well), and secondly that it is so largely parasitized not only by a trematode (*Leucochloridium* encysted in its mantle,

as is also *L. lecythis*) but also by a leech of the genus *Glossosiphonia* (against which the *Lecythoconcha* has a special protection, p. 549) that it is probably able to survive only in favourable circumstances. Moreover, we may correlate with these phenomena also the fact that the species has a very limited range, not having been found outside the valley except in one swamp in Tenasserim. That it is a highly specialized form there can be no doubt. The main features in which it differs from the majority of its congeners and of the species of *Lecythoconcha* are the uninterrupted conical outline of its shell, the prominent but hollow spiral ridges on the shell and the great relative length of the processes on the edge of its mantle. Its large size is also a characteristic feature.

The conical outline of the shell is a specific, or rather group character, not subject to marked individual variation or to plasticity. *V oxytropis* shares it with the much smaller and less highly specialized *V microchaetophora* from the plains of Eastern Assam. The spiral ridges on the shell are evidence of higher specialization and are not shared with *V microchaetophora*; but they are remarkably constant in the species and are certainly correlated with the third anatomical character already mentioned.

The processes on the edge of the mantle, though exceptionally well developed in *V oxytropis*, are not peculiar to that species, but are found, in a less highly developed or rather more degenerate condition, in *V bengalensis*, in which they correspond in position with the dark spiral bands on the shell just as they do with the prominent ridges, which are also deeply pigmented, in *V oxytropis*. Moreover, similar processes are present in young individuals even of smooth-shelled species such as *L. lecythis* and then correspond with spiral rows of chaetae on the shell which disappear as maturity is attained. In the young mollusc, whether of *L. lecythis* or of *V. oxytropis*, there are three such processes, but whereas they disappear altogether in the adult of the former species, they become more numerous both in that of *V oxytropis* and of *V bengalensis*. In the adult *V bengalensis* they are quite short even when fully expanded and project from the edge of the mantle, but in *V oxytropis* they are much longer and are bent back into the grooves on the internal surface of the shell that corresponded with the raised ridges on the external surface. The primary reason for their hypertrophy is probably, as I have pointed out on p. 549, that they function as an accessory breathing organ. The ridges on the shell in which they are lodged serve to protect them and have thus a definite use, unlike the sculpture on the shells of *Taia* or *Margarya*.

As these processes and ridges on the surface of the shell of *V oxytropis* are constant they have little direct reference to either variability or plasticity. Indeed, the species is neither remarkably variable nor remarkably plastic. Male and female shells differ somewhat in outline, and individuals from ponds vary more, have not quite the same regularity of outline and do not as a rule grow so large as those from the Loktak Lake, but no more can be said.

The importance of *V oxytropis* in the study of these phenomena only becomes apparent when we compare the structure of its mantle and shell with those of the mantle and shell of *Taia* and contrast the constant character of the Manipur species with the plasticity and variability of such a species as *T naticoides*. This I have done in another paper[1] in the *Records of the Indian Museum*.

We may now turn to the Limnaeidae of the Inlé and Loktak Lakes. In the former body of water three species have been found, namely *Limnaea shanensis*, Annandale, *L. andersoniana*, Nevill and *L. mimetica*, Annandale. The last is a small and highly peculiar species only known from the Inlé Lake and not exhibiting noteworthy variability or plasticity, except in so far that it is probably as a species the product of plasticity in some form of the *L. acuminata* group. *L. shanensis* is not, strictly speaking, a variable species, and we only know that it is or has been highly plastic through the existence of fossil or subfossil phases. With *L. andersoniana* I will deal presently.

In the Loktak Lake the only species of *Limnaea* collected was *L. acuminata*, but we may consider with it two other species found in swamps or ponds in the Manipur Valley. These are *L. ovalior*, sp. nov., and *L. andersoniana*, Nevill.

L. acuminata provides us with one of the best examples of true or individual variability to be found in the genus. In some districts (see fig. 12, p. 569) there is a very great difference in the shape of different shells from the same environment, but this is not so, apart from aberrations or monstrosities, in the Loktak Lake. A slight plasticity, however, is to be found in that individuals from the less congested parts of the swamp have a distinctly smaller shell and a shorter spire than those from the margin, while those from a small sluggish stream in the vicinity have remarkably pale and fragile shells with a strong but irregular external sculpture.

An interesting aberration is represented in our collection by a single specimen. It is remarkable for the very poor development of its spire, a feature common in lacustrine forms of the genus.

L. ovalior is known only from the swamps that surround the Loktak Lake and from Dimapur in the plains of Assam, north of the Naga Hills. In the latter locality it was found in a single pool of very foul water. Shells from this situation differ from those from the Manipur swamps in the same way as, but to a greater extent than, those of *L. acuminata* from the more congested part of the Loktak Lake do from those of the same species from its open region.

It is in *L. andersoniana*, however, that plasticity occurs in the most highly developed state. In the Inlé Valley two forms of

[1] Vol. XXII, pp. 243–266 (1921).

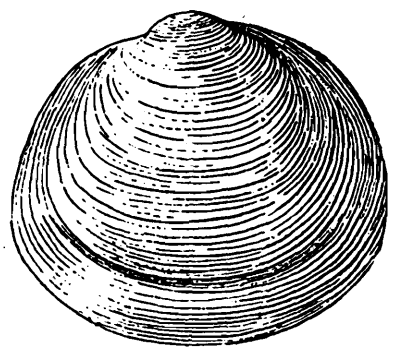
this species have been found—a broad form in ponds and a narrow form in a small stream. In the Manipur Valley and at Dimapur no less than four such phases occur. Two of these are almost identical with the two from the Shan States and inhabit similar types of environment. A third phase, still narrower than that found in rapid running water in the valley, inhabits higher parts of the same streams, where they have the character of mountain torrents. Perhaps, however, the most interesting phase is that found at Dimapur in small cattle-ponds. It may be described as both intermediate in some individuals between the pond phase and the ordinary stream phase, and also, in other individuals, as a more extreme form of the pond phase. A partial explanation is probably to be found in the fact that the ponds it frequents are connected in the rainy season with small streams. The narrower individuals may be those that have grown up in these temporary streams, while the broader individuals are those that have never left the ponds.

We thus see that whereas the type of plasticity characteristic of *L. andersoniana* is essentially similar in the Inlé and Manipur Valleys, that observed in the Viviparidae is different in kind in the two localities. We do not find any species of mollusc in Manipur that exhibits the extreme variability in shell-sculpture of *Taia naticoides*, in the Shan States, and even in *L. acuminata* variability in shell-form is much less marked in the Loktak Lake than it is in many other localities. In the present state of our knowledge it is as well not to speculate further as to the meaning of these observations.

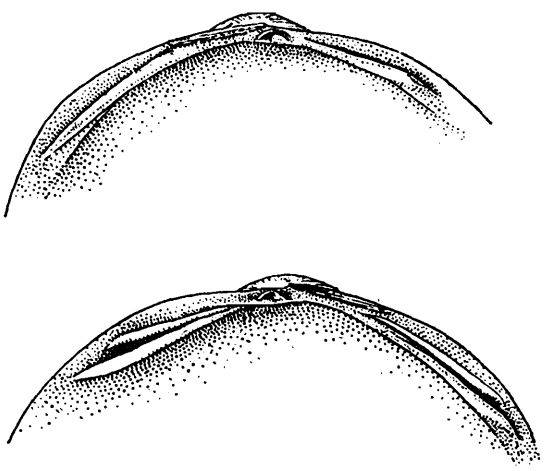
ADDENDUM.

Note on *Sphaerium montanum*, Tapparone-Canefri.

Since this paper went to press I have, through the kind offices of Dr. R. Gestro of the Genova Museum, had an opportu-



TEXT-FIG. 36.—Type-shell of *Sphaerium montanum*, Tapparone-Canefri.



TEXT-FIG. 37.—Hinge of the same.

nity of examining the unique type-specimen of Tapparone-Canefri's *Sphaerium montanum* from Tenasserim, Burma, which I had