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SHELL MODIFICATIONS IN INDIAN LAND OPERCULATES AND THEIR SIGNIFICANCE

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ABSTRACT

There are about 35 genera of land operculates in India. Among these, at least 12 genera show various modifications in their shell characters. Four genera, viz. *Alycaeus*, *Dioryx*, *Pearsonia* and *Rhaphaulus* possess perfectly built tubes. *Pterocyclus* and *Rhiostoma* have imperfectly built tubes. Others, viz. *Pupina*, *Tortulosa*, *Schistoloma*, *Megalomastoma*, *Cyclotus*, and *Diplommatina* show various minor modifications like grooves, notches, canals or even simple tooth-like projections. These structures have been described generawise and the possible significance of the same has been discussed.

Introduction

Terrestrial molluscs belong to two different subclasses, Prosobranchia (operculates) and Pulmonata (non-operculates).

Adaptation to terrestrial habitat involves mainly the maintenance of internal water which is influenced by the humidity. Though phylogenetically terrestrial molluscs belong to two different classes all have to face certain problems in aerial respiration and in tiding over the unfavourable conditions. As an answer to these problems of aerial life each mollusc has developed its own devices.

Slugs, the evolution of which has taken place as a result of natural selection in a condition of plentiful moistute and scarcity of calcium (Solem, 1974) face no such problem since they have no shell to withdraw themselves. They just burrow inside the soil and aestivate and have no difficulty in carrying on respiration.

Terrestrial pulmonates have developed their own methods for withdrawing and shutting rhemselves inside the shell during aestivation. They secrete thin membranaceous epiphragms (either one or more than one). These epiphragms are permeable and usually with slit-like openings, through which passage of air is maintained.

Terrestrial prosobranchs, which are operculates, find it difficult to maintain exchange of air once they close their hard calcareous operculum. Possibly, to overcome this, it becomes necessary for them to resort to structural modifications. These modifications take different shapes to provide

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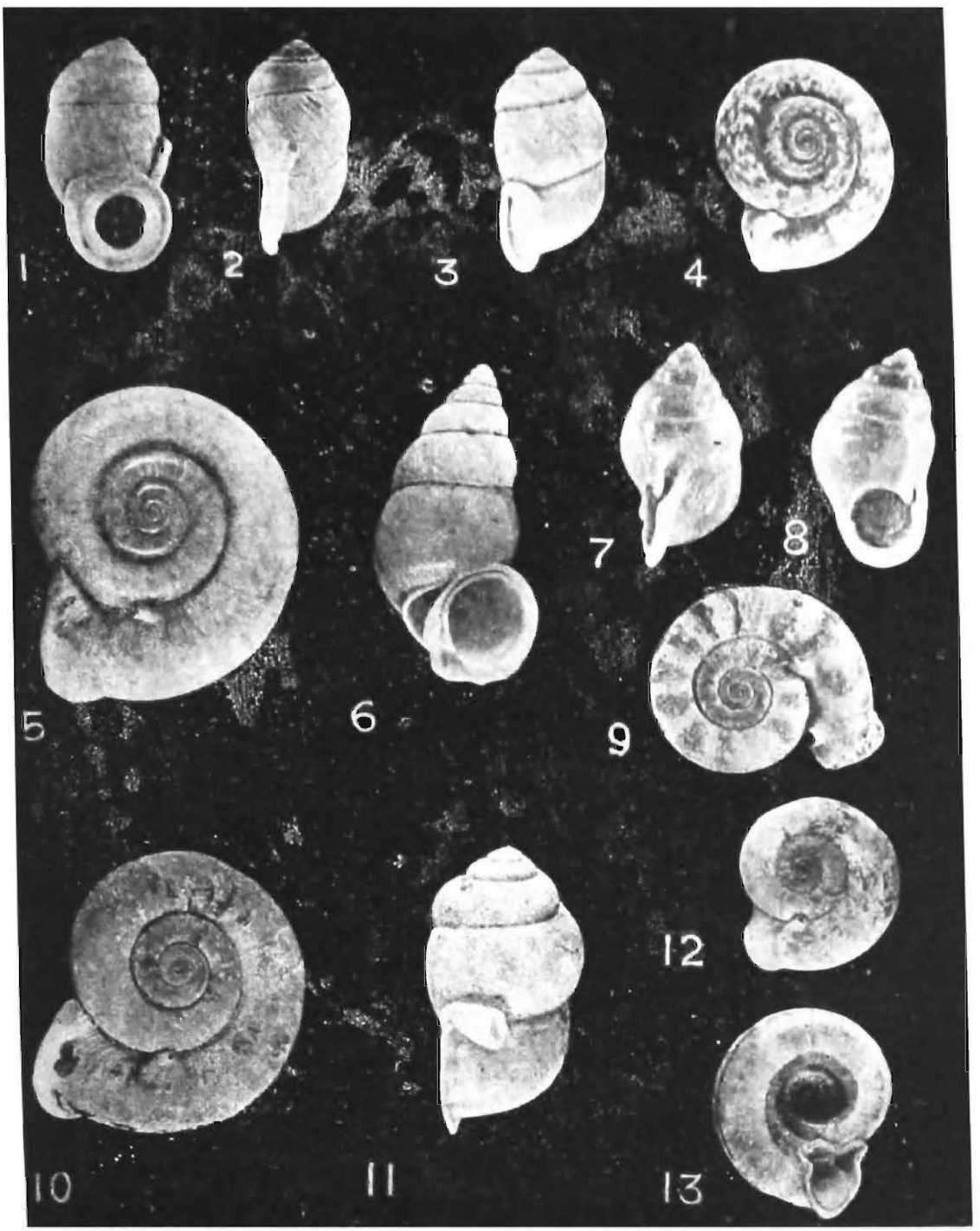
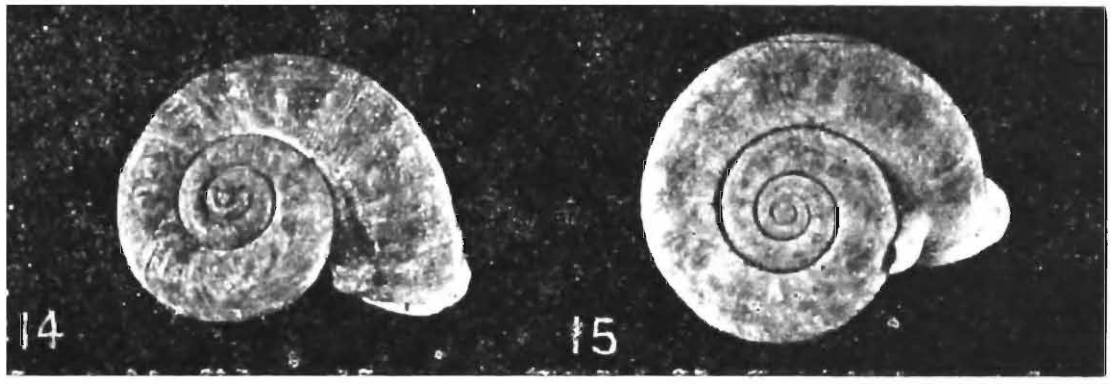


Figs. 1-13. 1. *Rhaphaulus chrysalis* (Pfeiffer), 2. *Rhaphaulus chrysalis* (Pfeiffer), 3. *Rhaphaulus assamicas* Godwin-Austen, 4. *Pterocyclus bilabiatus* (Sowerby), 5. *Pearsonia beddomei* (Blanford), 6. *Tortulosa recurvatus* (Pfeiffer), 7. *Pupina imbricifera* Beuson, 8. *Pupina imbricifera* Benson, 9. *Pearsonia bitubifera* (Theobald), 10. *Pearsonia nevilli* (Godwin-Austen), 11. *Rhaphaulus aborensis* (Godwin-Austen) 12. *Pearsonia fairbanki* (Blanford), 13. *Pearsonia fairbanki* (Blanford)



Figs. 14-15. 14. *Rhiostoma simplicilabris* Pfeiffer, 15. *Pterocyclus magnus* Godwin-Austen

various notches, grooves, pores and tubes. The:e are 35 genera of land operculate snails in India, distributed in 6 families, viz, Hydrocenidae, Helicinidae, Cyclophoridae Pomatiasidae, Pupinidae and Diplommatinidae. Out of these, at least 12 genera belonging to the families Cyclophoridae, Pupinidae, and Diplommatinidae, have modifications of some kind or other in their shells, either at the peristome or close to it or both.

Sporadic reports on this aspect, on American forms (Handerson and Bartsch, 1920), Indo-Auitralian forms (Benthem Jutting, 1948) and the forms from the Indian sub-continent (Godwin-Austen, 1910 : Gude, 1921 and Blanford, 1863), are available. Rees, (1964) in his study considered the tropical land operculates as a whole. Since, the modifications of shells of land operculates occurring in India and neighbouring countries have not been given much attention by previous workers, an attempt is made to make a report on them and discuss the possible significance of such modifications.

Observations

Detailed observations, on the modifications in the shells of different species of land operculates, present in National Zoological Collections, Zoological Survey of India, were made and are described generawise.

Rhaphaulus : Peristome is double, thick, strongly reflected, notched at columella with a well built tube on the sutural side. The tube is open at both ends and runs upwards [e.g. *R. chrysalis* (Pl. I, fig. 1), *R. blanfordi*], downwards [e.g. *R. assamica*] (Pl. I, fig. 3) or runs horizontally as in *R. aborensis* (Pl. I, fig. II). In *R. luyorensis* the sutural tube is flattend and finely perforated at intervals.

Pearsonia : Here the sutural tube originates from a little behind the aperture, opens at both ends. It is usually curved backwards [e.g. *P. nevilli*] (Pl. I, fig. 10) or forward [e.g. *P. beddomei*], (Pl. I, fig. 5) sometime arched [e.g. *P. hispida*], (text fig. 3) or erect (e.g. *P. assamensis*). Besides, a sinusl resulted from an incision of the peristome with a wing at the point where the peristome meets the bodywhorl, is also present. In *P. fairbanki* (Pl. I, fig. 12, 13) in addition to the wing and thin sutural tube, a gutter shaped projection is present at the base near the columellar margin. In *P. bitubifera* (Pl. I, fig. 9) the wing near the aperture takes the shape of an imperfect tube.

Alycaeus : Body whorl is much distorted, swollen and again constricted in front of aperture, a closed sutural tube runs backward adhering to the shell, aperture trumpet-shaped,. The blind tip of the tube is comparatively thin and seems to be porous (Fig. 1).

Dioryx : Modifications are same as in *Alycaeus*, only the sutural tube is comparatively longer in size (Fig. 2).

Rhiostoma : Body whorl detached and descending near the aperture, peristome free, notched above, a prominent but rather imperfactly built tube is present at the aperture (Pl. II, fig. 14).

Pterocyclus : Peristome is interrupted above to produce a sinus, outer peristome arched forming a wing-like projection over the sinus. In *P. bilabiatus* (Pl. I, fig. 4) the

wing curls and takes a tubular shape. In *P. magnus* (Pl. II, fig. 15) the projection is far more developed and shapes like an imperfect tube opening inside the mouth.

Pupina : Two distinct canals, produced by the incision of the peristome, one at the sutural side and the other at columellar side (Pl. I, figs. 7, 8).

Tortulosa : Peristome is reflected and interrupted, producing a circular groove at

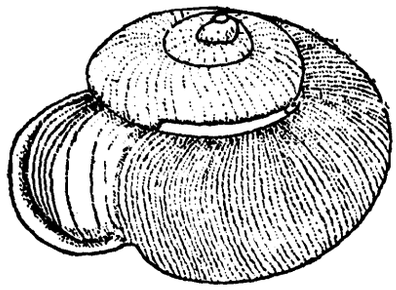


fig. 1

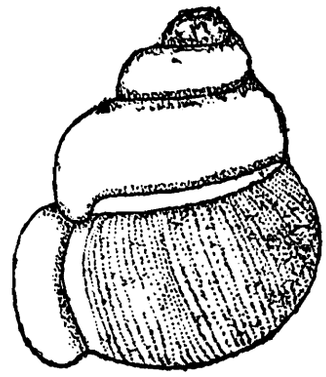


fig. 2

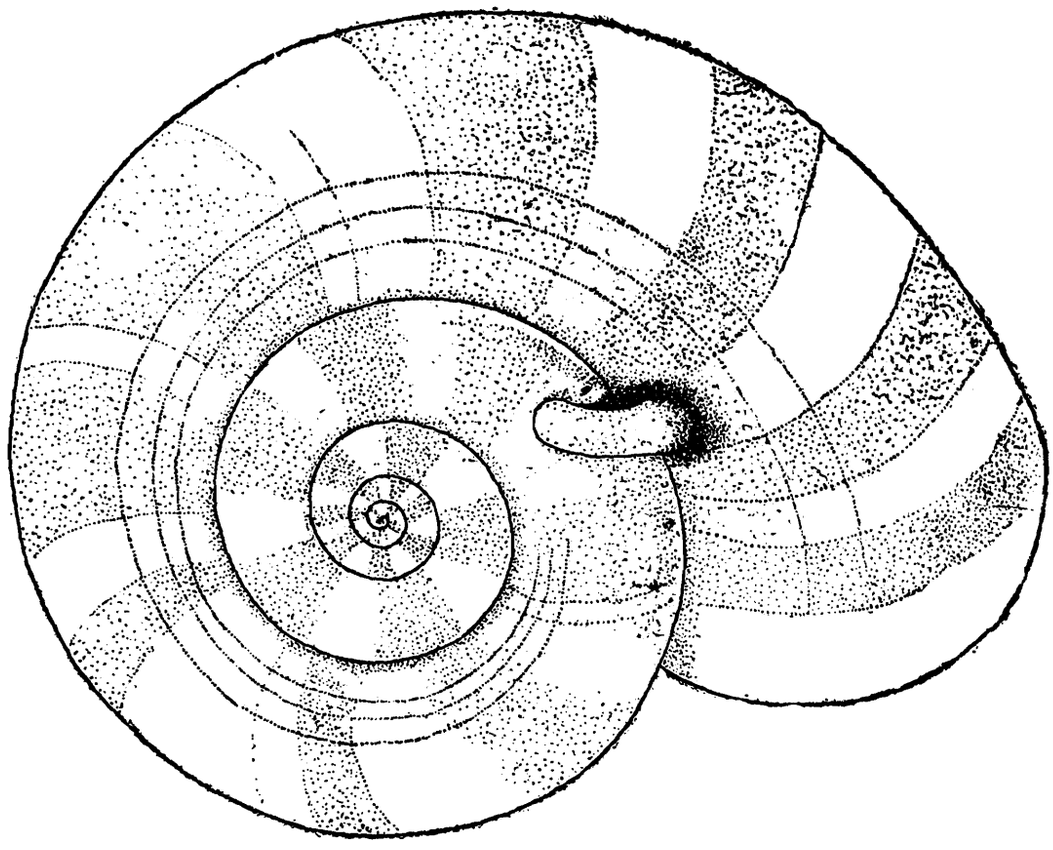


fig. 3

Figs. 1-3 : 1. *Alycaeus stylifer* Benson ; 2. *Dioryx urnula* (Benson), 3. *Pearsonia hispida* (Pearson).

the base on the left side. The opening of the groove is never blocked by the operculum (Pl. I, fig. 6).

Schistoloma : Inner peristome is slightly grooved at the upper margin.

Megalomastoma : Peristome is slightly notched at the top near the columella.

Cyclotus : A wing is present in some cases.

Diplommatina : A tooth like projection is present on the columellar side inside the aperture.

The opercula in most of these genera are typical with concave inside and convex outside. Edges of the whoris are mostly with raised keels.

Discussion

From the study it is seen that the shells of land operculates have undergone modifications to give rise to various notches, grooves, pores and tubes. Since the location of these modified structures is almost similar in different genera it is clear that the purpose is common to all. Of all these modified structures, the sutural tube is most interesting. It is conspicuous in *Rhaphaulus*, *Alycaecus*, *Dioryx* and *Pearsonia*. The direction of the tube in *Rhaphaulus* and *Pearsonia* varies with the species, perhaps to suit specific mode of life. It appears that species with distinct sutural tube, open at both ends have undergone extreme modifications in serving the desired purpose. On the otherhand, inspite of possesing well developed tubes, members of the genus *Alycaeus* have succeeded in producing micropores instead of a single macropore, probably to check unwanted infiltrations. In this respect, *Alycaeus* may be considered as the highly modified group and at the same time the most primitive. The formation of an imperfect tube (e.g. *Rhiostoma*, *Pterocyclus*) as a result of the extension of the outer peristome, may be considered as a step towards the abolition of the sutural tube. This can be well documented if we look at the gradual changes these modifications have undergone. The cannals produced by the incision of the peristome in *Pupina*, are confined to a groove on the left side of the reflected peristome in *Tortulosa*, again being further reduced to a mere notch in *Megalomastoma* or to just a tooth-like projection in *Diplommatina*.

Obviously, these changes had to be made keeping in view the inconvenience these awkard, yet essential, structures created so far as locomotion and other activities were concerned for these particular snails.

The possible significance of such modifications is an art to give rise to certain structures to facilitate the breathing of the snail species concerened. In most cases the operculum closes the shell aperture at the margin of the inner peristome and the air entering through the tubes comes in contact with the mantle and brings about exchange of gases. The space between the operculum and the opening of the sutural tube is covered by the mantle. But why a good number of species have to develop such devices while other related forms flourish in much the same sort of environment without these, is still a puzzling problem. It is quite possible that the snails without such modifieations bear an operculum which is either porous or the air passes through the interspaces left between the operculum and the inner wall of the shell aperture.

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REFERENCES

BLANFORD, W. T. 1863. On the animals of *Rhaphaulus*, *Spiraculum* and other tube-bearing cyclostomacea. *Ann. Mag. nat. Hist.*, (3) *12* : 55-58.

GODWIN-AUSTEN, H. H. 1910. Land and freshwater mollusca of India. Supplementary to Theobald and Hanley's *Concholagica Indica*, 2(9) London.

GUDE, G. K. 1921. *Fauna British India, Mollusca*—III Land operculates pp. 1-372.

HENDERSON, J. B. & BARTSCH, P. 1920. A classification of the American land operculates mollusks of the family Annularidae. *Proc. U. S. nat. Mus.*, *58* : 49-82.

JUTTING, W. S. S. van Benthem, 1948. Studies on the non marine mollusca of the Indo-Australien Archipelago. I, Critical revision of the Javanese operculate land shells of the families Hydrocenidae, Helicinidae, Cyclophoridae. Pupinidae and Cochlostomidae. *Treubia, 19* ; 539-604.

REES, W. J. 1964-65. A review of breathing devices in land operculate snails *Proc. malac. Soc. Lond., 36* : 55-66.

SOLEN, A. 1974. The shell makers, introducing mollusks. John Wiley & Sons, New York.