Genital pore median, ventral, postpharyngeal and 0·58 mm behind the anterior end. Testes two, ovoid, lying side by side in the posterior extremity but the right one displaced slightly anterior to the left one, measuring 0·16 × 0·13 mm and 0·17 × 0·13 mm, respectively. Cirrus pouch encloses only the ejaculatory duct and the pars prostatica. Seminal vesicle saccular and comparatively small.

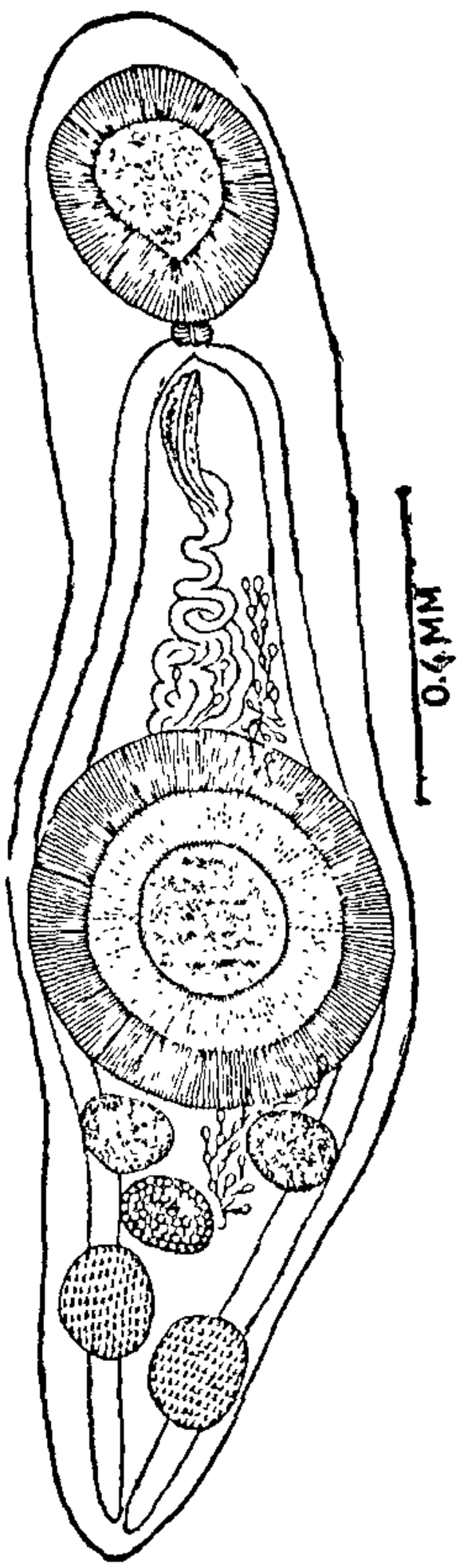


FIG. 1. *Hemipera ovocaudata.*

Ovary 0·12 × 0·14 mm, lying in front of the testes but behind the vitellaria. Vitellaria two, compact, rounded bodies, 0·12 mm in diameter and situated behind the ventral sucker and just above the ovary on either side. Uterus coiled, intercaecal with its main bulk lying anterior to the ventral sucker. Eggs oval, slightly curved, 0·035-0·040 × 0·010-0·012 mm with a filament at the anoperculate pole.

Though the members of the genus *Hemipera* have not been reported earlier from India and from the present host yet the general topography of the organs and finding of only one specimen direct to recognise it as *Hemipera ovocaudata*, despite some differences in measurements of different organs and in the location of the ovary which is not intervitellarian as shown by Skrjabin[3] and Dawes[4] but postvitellarian (present form) which may be due to faulty preservation.

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Department of Zoology, H. S. NAMA.
University of Jodhpur,
Jodhpur-342001,
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## LATERAL LINE SYSTEM IN THE TADPOLE OF THE INDIAN FROG *RANA TIGRINA* (DAUD)

LATERAL line system is a part of the acoustico-lateral or neuromast system and is present in all craniates from cyclostomes to man. While typically developed only in aquatic forms, it survives in others as the ear (internal), for it becomes differentiated into two parts: (1) the neuromasts of the lateral line system proper, and the related superficial organs, and (2) the auditory labyrinth and its contained sensory organs. The first is stimulated by slow vibrations of the watery environment[2,3] and serves for the orientation of the body in relation to waves and currents[11]. The second has two distinct functions—equilibrium in space or balance, and hearing.

Among the Salientia the lateral line system is present in the aquatic larvae but usually absent in the adults. They are found in the adults of Pipidae[4] and of such aquatic types as *Bombina* and *Ceratophrys laevis*.

The morphology and physiology of the amphibian lateral line system have been described by several workers[1-12] but nothing is known of this system in the Indian frogs. This author has been working on the Indian Anuran amphibia for quite some time now, and

has found outstanding differences in the anatomy and physiology of the Indian frog *Rana tigrina* from the European frogs of the same genus This paper is aimed to describe the lateral line system in the tadpole of *Rana tigrina*, and thus to add to the knowledge of this widely used and studied Indian frog.

*Material and Method*

Live tadpole larvae of *Rana tigrina* were collected in the months of July to September from the ponds in and around Lucknow. Tadpoles of all stages and sizes were taken into account. They ranged from 10 mm in length when there was no trace of limb-buds but a tail was present, to 25 mm when tail was fully developed and the hind limb buds had developed. The largest tadpoles collected were about 5 cms long. Very young frogs with short tails were also collected and examined. All tadpoles were preserved in Bouin's fluid. Very small tadpoles were dehydrated and made into permanent mounts. In larger tadpoles the tail was cut and made into balsam mounts. From the rest of the body, in some tadpoles skin was removed, the underlying muscles were cleaned and the skin casts were treated for unstained as well as stained preparations for microscopic study. In some larger tadpoles after skinning, the body was examined for the course of the lateral line system with a powerful magnifying lens and binoculars.

*Observations and Findings*

The lateral line system of the frog *Rana tigrina*, presents varied patterns at different stages of the life of the tadpole. (A) In the young tadpoles in which limb-buds had not yet developed, the lateral line system was confined to the body surface and was lying entirely in the epidermis. The lateral line system in such tadpoles consisted of clusters of sense cells sunk into tiny pits in the epidermis. The pits ranging from 2 to 6 were arranged serially into groups. The axis of each group of pits was either parallel or vertical to the main line of the system. The main lines of the lateral line system over the head and body of the tadpole were bilaterally thus: (*i*) *supra-orbital line*—this line began from behind the external naris, it passed back and inclining towards the dorsal side, crossed over the orbital region, then descended behind the orbit to join the infra-orbital line; (*ii*) *infra-orbital line*—this also took off from behind the external naris and passing backwards, it descended in the infra-orbital region, *i.e.*, below the eye, and eventually joined the supraorbital component behind the orbit; (*iii*) *oral line*—a small line that branched off from the infraorbital line somewhat midway between the external naris and the orbit and passed down to the ventral side of the head in the region of the chin; (*iv*) *hyomandibular* or *angular line*—it took off from a place shortly behind the union of the supraorbital and infraorbital lines past

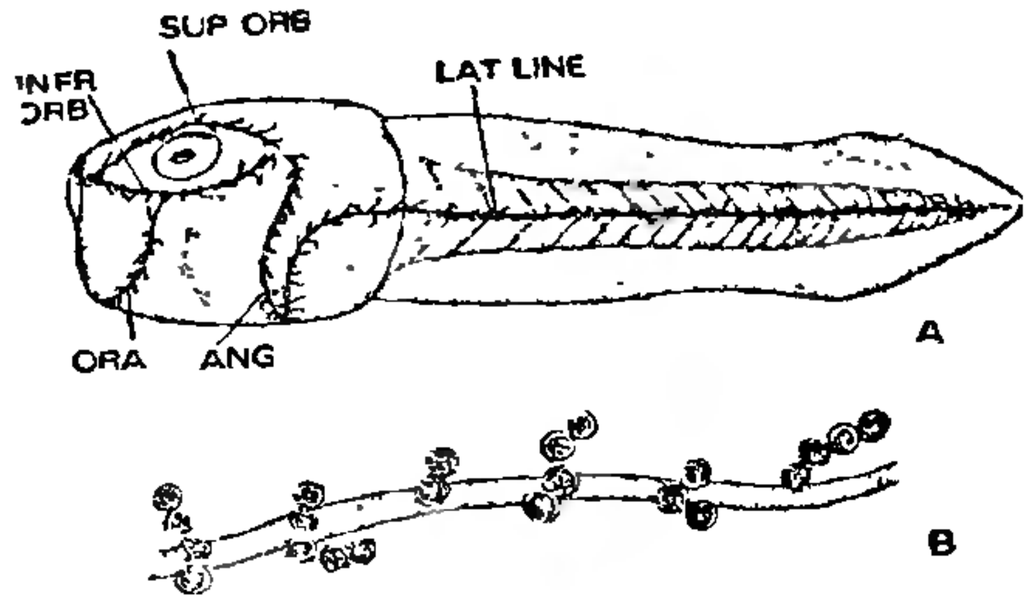


FIG. 1. (A) Diagram of the lateral line system of a young tadpole of *Rana tigrina* × 3. SUP ORB supraorbital line, INFR ORB infraorbital line, ORA oral line, ANG angular line, LAT LINE lateral line. (B) The supraorbital line and its neuromasts × 240.

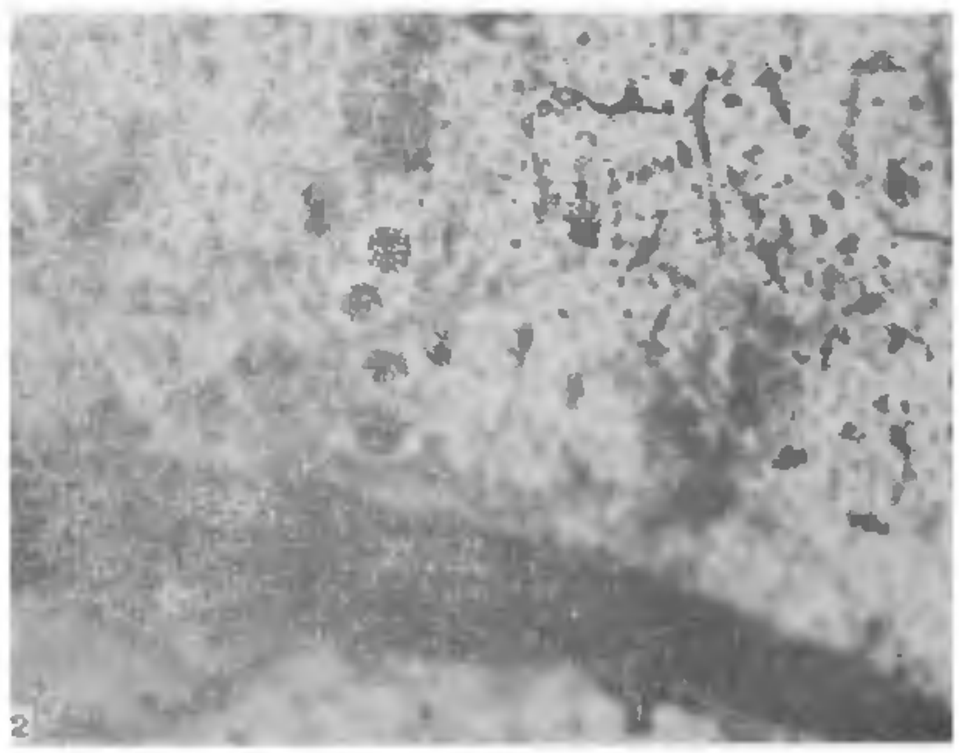

FIG. 2. Photomicrograph of the lateral line system of sense organs on the head of a young tadpole of *Rana tigrina* ×400.

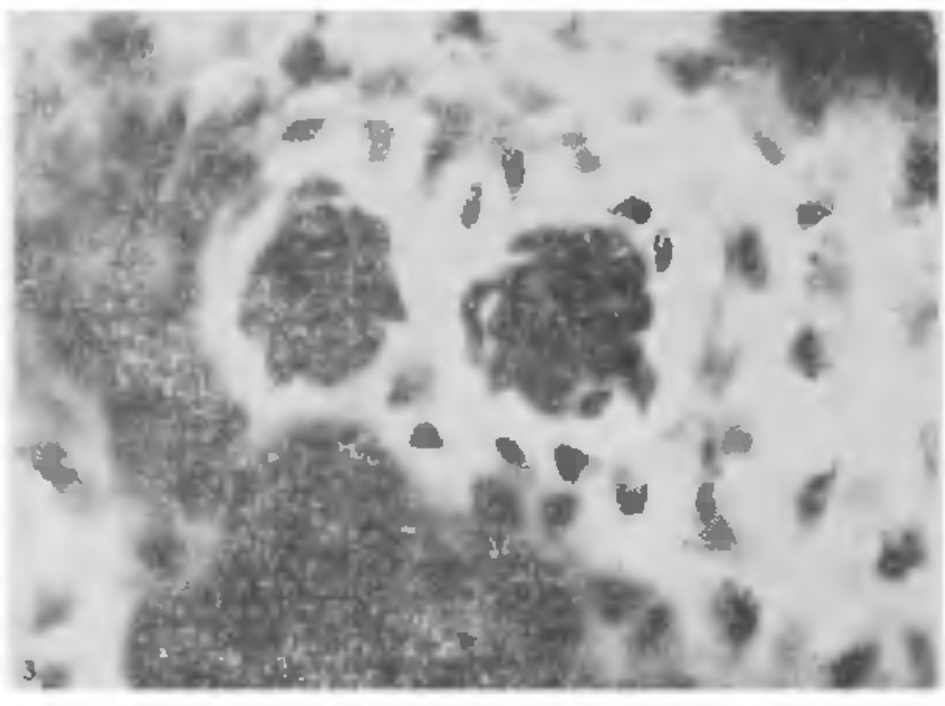

FIG. 3. Photomicrograph of highly magnified lateral line sense organ of the tadpole of *Rana tigrina* × 600.

the orbit, then followed the posterior margin of the operculum (gill cover), after reaching the lower posterior margin of the operculum, this line ascended sharply into the tail; and (*v*) *the lateral line of the tail*—the hyomandibular line after entering the tail became the lateral line of the tail and passing laterally on the middle of the tail terminated at the end.

The number of groups of sense cells gradually decreased as the lateral line advanced in the tail; their number was 1 to 3 as against 4 to 5 in the head region.

(B) In the fully grown tadpoles, with at least the hind limbs developed, the lateral line system was modified. The lateral lines in the head region were sunk-in partly or wholly into the dermis. The lateral line organs were thus carried into the lateral line system of canals. The canals maintained connections with the outside environment by means of little pores along the course of the canals through which the water streamed into the system. The pattern and course of the lateral line canals remained the same as of the lateral lines in the early tadpoles. Supra-orbital, infra-orbital, oral and hyomandibular canals were distinctly marked. Surprisingly there was no change in the distribution and location of the neuromasts in the tail region. No lateral line canal or connecting pores were observed in the tail. Naked neuromasts in the form of groups of sense cells typical of the young tadpole, were present in these advanced tadpoles also. A lateral line system was almost absent in the very young frogs which still bore a stumpy tail.

*Discussion*

The lateral line system is characteristic of all fishes including the Dipnoi. The distribution of lateral line system of organs (neuromasts) in modern Amphibia agrees in general with that of the primitive fishes and is remarkably like that of Dipnoi. This system in fishes is usually in the form of canals sunk into the dermis. In the tailed amphibia which live for the most of their time in water, the lateral line system follows the 'fish plan' but differs from it in the fact that it is not sunk into the dermis and lies in the epidermis. There are, however, some exceptions, for instance in the Urodele *Stereochilus* the lateral lines sink partly into the dermis and the neuromasts in them are placed at the bottom of conspicuous pores on the head and body. Whether the neuromats in the Urodeles are on the surface or partly sunk, the sense cells of the neuromasts have their axes directed anteriorly, *i.e.*, opposing the direction of the lines of the lateral line system. The neuromasts of the tailless amphibia including the Indian frog *Rana tigrina*, in contrast, have the axes of the sense cells directed in the same direction as the lines of the lateral line system. A little variation is found in the young tadpoles of *Rana tigrina;* in them the sense cells of the neuromasts, usually in clusters of 2 to 6 are inclined in the direction of the lines of the system (cranio-caudally) in the supraorbital, infraorbital and lateral lines, but are placed vertically up on the oral and hyomandibular lines. The lines of the lateral line system follow the course of the nerve components of the cranial nerves VII, IX and X.

In the older tadpoles of *Rana tigrina*, all except the lateral lines of tail are sunk in the dermis. This is rather unusual in this species of frog, for, in the modern amphibia the lateral line system of organs lies naked on the surface of the epidermis[1,8,10]. Lateral lines and the neuromasts were not present in the adult *Rana tigrina*, apparently out of use on land, they were lost during metamorphosis of the tadpoles.

Head of Zoology Dept., HARISH C. NIGAM.
Lucknow Christian College,
C–52 Niralanagar,
Lucknow 226 007, India,
*January* 7, 1978.

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