THE PHARYNGEAL POCKETS IN THE INDIAN OIL SARDINE, *SARDINELLA LONGICEPS* VALENCIENNES AND A FEW OTHER CLUPEIFORMES FROM INDIAN WATERS

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The pharyngeal pockets, also known as pharyngeal organs, present in certain clupeiform species, have received attention in recent years. These were first named by Hyrtl (1855; 1863) and subsequently dealt with by Lagler and Kraatz (1945), Kapoor (1954*a;* 1954*b;* 1954*c;* 1957), Iwai (1955; 1956), Kutkuhn (1957) and Miller (1964).

Among Indian species their presence is reported so far in *Gadusia chapra* (Kapoor, 1954 *a*), *Chanos chanos* (Kapoor, 1954 *b*) and *Hilsa ilisha* (Kapoor, 1954 c). The present communication deals with their presence in nine more Indian species, all marine: *Sardinella sirm* (Walbaum), *S. albella* (Valenciennes), *S. jussieu* (Lacépède), *S. dayi* Regan, *S. fimbriata* (Valanciennes), *S. longiceps* Valenciennes, *Macrura kelee* (Cuvier) = *Hilsa kanagurta* (Bleeker), all family Clupeidae; *Anodontostoma chacunda* (Hamilton-Buchanan) and *Nematalosa nasus* (Bloch), both family Dorosomidae; together with a preliminary account of their morphology and internal structure.

As these organs in all the above species are structurally related to one another and are located in the same position, those in *Sardinella longiceps*, the Indian oil sardine, alone are described in detail. Individual variations in their structure in the other species are dealt with comprehensively. It may be noted in this connection that the present account deals with the adult condition.

Structure of the Pharyngeal Pockets in *Sardinella longiceps*

These organs are paired, each lying on either side of the median line and above the hinder region of the supra-branchial chamber. The pharyngeal pocket on each side can be easily located after removal of the operculum, the first three branchial arches and the branchial filaments borne by the epi-branchial bone of the fourth branchial arch, to which it is attached (Figure 1). The epibranchial has an expanded thin blade-like bony process which covers and protects the lateral surface of the pocket; and a long slender semi-curved hyaline cartilagenous extension arising from its lateral aspect and forming a protective support all along the course of the pocket (Fig. 2). Each pocket is also attached to the ventro-lateral border of the vertebral column by connective tissue and to the parasphenoid region of the cranium by loose fasciae and connective tissue. The pockets are supplied with strong and stout nerves.

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Each pharyngeal pocket in *S. longiceps* is a curved and blind tube, the curve following a brief anterio-median direction. Only the distal portion of the pocket is free from connective tissue and it is placed within the proximal curve of the pocket (Fig. 3). The tip of the pocket is directed in a dorso-median angle and can be seen after removal of the tissues and pulling the base a little laterally. Each pocket opens proximally into the hinder region of the pharynx by a large aperture, dorso-lateral in position. It also opens on its proximo-lateral aspect into the peribranchial chamber by a short groove which represents the fifth gill opening.

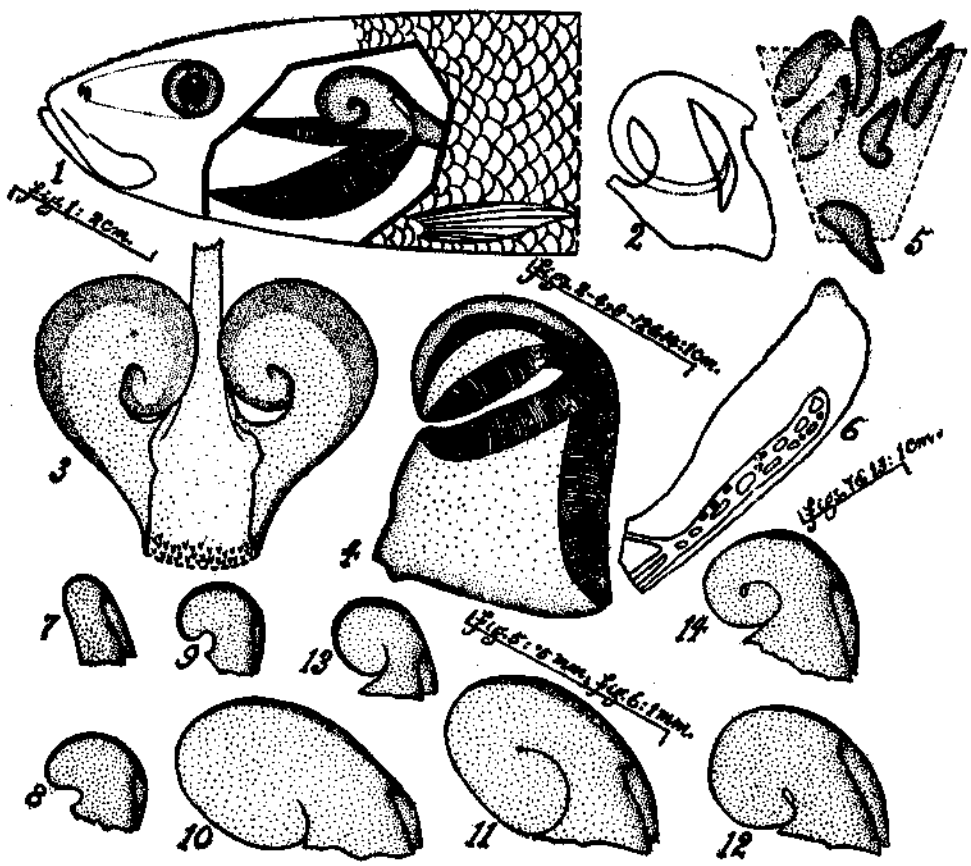


Fig.1-14 Sketches showing the morphology and anatomy of the pharyngeal pockets in the differen species. Figs. 1-6 in *Sardinella longiceps*. Fig. 1 left side view of the head of a specimen of 182 mm., total length showing the left pharyngeal pocket, Fig. 2 the lateral view of the skeleton protecting the left pocket in a specimen of 175 mm., Fig. 3 dorsal view of the pockets in a specimen of 184 mm. Fig. 4 the right pocket of a specimen of 174 mm. split open to show the lamellar rows, Fig. 5 the papillae of the inner wall, Fig. 6 a lamella. Figs. 7-14 lateral views of the left pocket in the other species; Fig. 7 in *Sardinella sirm* of 186 mm., Fig. 8 in *S. albella* of 121 mm., Fig. 9 in *S. jussieu* of 141 mm. Fig. 10 in *Anodontostoma chacunda* of 159 mm., Fig. 11 in *Nematalosa nasus* of 153 mm., Fig. 12 in *Macrura kelee* of 175 mm., Fig. 13 in *Sardinella dayi* of 148 mm., and Fig. 14 in *S. fimbriata* of 160 mm.

The pharyngeal pocket can be split open easily on its dorso-lateral margin along the course of the cartilagenous skeleton (Fig. 4). The internal wall of the pocket is provided with innumerable fusiform papillae (Fig. 5).

On splitting the pocket fully open can be seen on either side a row of thin flat membraneous leaf-like processes which may be called *lamellae*. The two lamellar rows are continuous with two rows of similar structures bordering the anterior and posterior margins of the fifth gill opening. They are transparent and delicate and are charged with a net work of anastamosing capillary system (Fig. 6).

Structure of the Pockets in the other Species

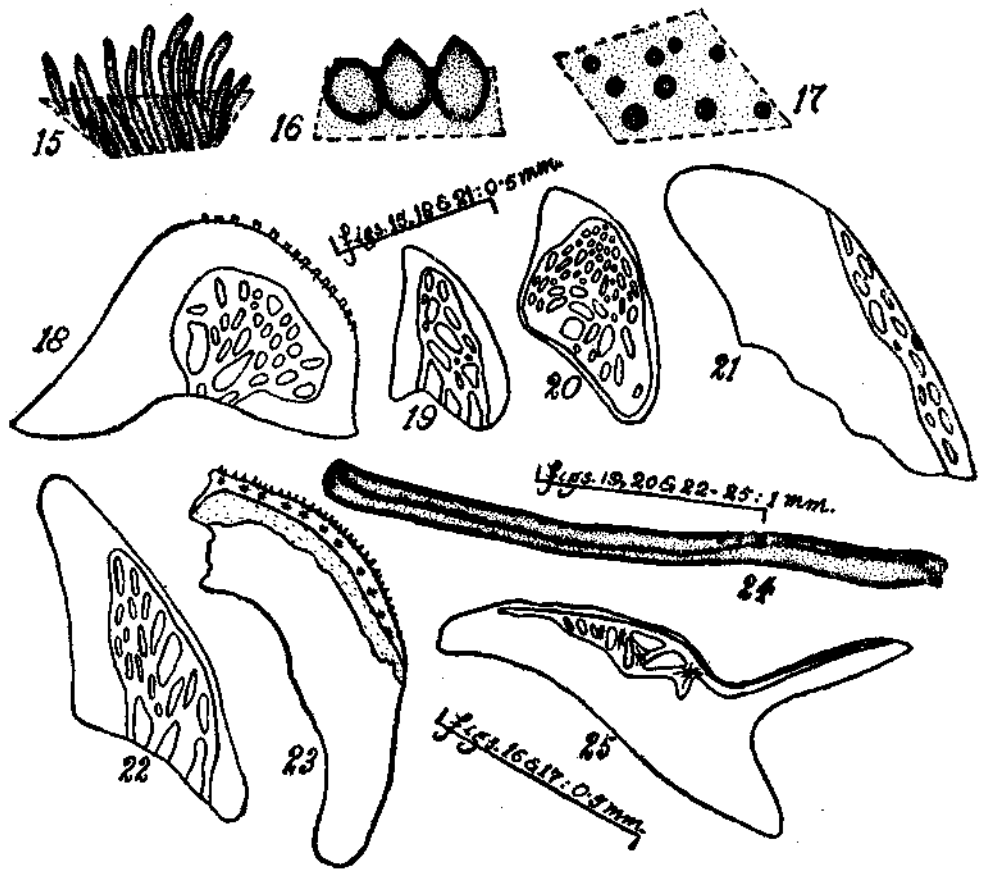
The pharyngeal pockets in all the other species reported in this paper are located in the same position as in *S. longiceps* and are protected in the same way by a skeleton formed partly of bone and of cartilage with minor variations between them.

The pockets in *Sardinella sirm* (Fig. 7), *S. albella* (Fig. 8), *S. jussieu* (Fig. 9), *Anadontostoma chacunda* (Fig. 10) and *Nematolosa nasus* (Fig. 11) are simple in structure, appearing as short pouches of the pharynx. In the case of *Macrura kelee* (Fig. 12), *Sardinella dayi* (Fig. 13) and *S. fimbriata* (Fig. 14) the pockets have a curved structure.

The inner wall of the pharyngeal pockets is provided with villus — like papillae (Fig. 15) in *Sardinella sirm, S. albella* and *S. jussieu*, but globular papillae (Fig. 16) in *S. dayi* and *S. fimbriata*. They are sparsely distributed in *S. albella* and *S. jussieu* while in the others densely so. In *Macrura kelee*, the papillae (Fig. 17) are almost spherical and sparsely distributed. In the Dorosomid species the internal wall is provided with ridges: in *Anodontostoma chacunda* they have an almost transverse disposition while in *Nematalosa nasus* a longitudinal arrangement.

The structure of the lamellae in the other *Sardinella* spp. (Figs. 18 to 22) resembles the condition in *S. longiceps* but roughly have the contour of a triangle with minor variations between the different species. In the case of *S. sirm* the lamellae are provided with minute squares-like dental structures along their distal margin. Conical teeth are present along the distal margin of the tongue-like lamellae in *Macrura kelee* (Fig. 23), below which a series of stellate chromatophores is present followed by a cornified zone. A capillary system appears to be absent in the lamellae of this species.

In *Anodontostoma chacunda* the lamellae (Fig. 24) are long, thick and have a semi-folded structure enclosing a groove along the long axis. They appear to be muscular and capillary system appears to be absent. The lamellae in



Figs. 15-25 *Camera lucida* sketches of the papillae in the inner wall and of the lamellae in the species. Figs. 15-17 the papillae in *Sardinella sirm*, *S. fimbriata* and *Macrura kelee* respectively. Figs. 18-25 the lamellae in *Sardinella sirm* (Fig. 18), *S. albella* (Fig. 19), *S. jussieu* (Fig. 20), *S. dayi* (Fig. 21), *S. fimbriata* (Fig. 22), *Macrura kelee* (Fig. 23), *Anodontostoma chacunda* (Fig. 24) and *Nematalosa nasus*. (Fig. 25).

Nematalosa nasus (Fig. 25) somewhat resemble those in *M. kelee*, but in the former conical teeth are absent and a capillary system is recognisable.

General Remarks

The pharyngeal pockets are present only in a few families of the clupeiformes such as Clupeidae, Dorosomidae and Chanidae. A study of a few Indian species of the genera such as *Dussumieria, Anchoviella, Thrissocles, Coilia, Setipinna* and *Elops*, points out that they are mostly absent in the families Dussumieridae, Engraulidae and Elopidae.

Within the family Clupeidae only a few genera such as *Sardinops, Sardinella* and *Macrura* (=*Hilsa*) are known to possess these organs. A study of a few

other Indian Clupeid species indicates that they are absent in *Kowala coval* (Cuvier), *Pellona ditchela* Valenciennes and *Opisthopterus tardoore* (Cuvier). Among Dorosomidae the pharyngeal pockets are reported in such species as *Dorosoma cepedianum* (Lagler and Kraatz, 1945), *Dorosoma petenense* (Miller 1964), in addition to the present observation on *Anodontostoma chacunda* and *Nematalosa nasus*.

The specific nature and function of the pharyngeal pockets, if any, are not fully known. However, it is generally agreed that they assist in the process of concentration of the minute food organisms ingested by the gill processes and aid in passing them on into the oesophagus. Lagler and Kraatz (1945) felt that these organs in *Dorosoma cepedianum* may hold some water that is voluntarily forced to aid ingestion of food particles. Iwai (1955) working on these organs in *Sardinops caerulea* suggested that they may facilitate in the process of swallowing food. *Sardinella longiceps*, the Indian oil sardine, is a feeder on minute organisms in the plankton. It is quite probable that these organs serve to congregate the food organisms filtered by the gill processes and aid in passing them on into the oesophagus.

The pharyngeal pockets are met with, generally, in Clupeiform species which have a filter-feeding habit on microscopic organisms like diatoms, dinophysids, small crustaceans etc. But they are absent in filter-feeding fishes belonging to other groups such as the Indian mackerel, *Rastrelliger kanagurta* (Cuvier) (family: Scombridae), whose food-habits are almost similar to those of *Sardinella longiceps*. It would be interesting to know whether other organs having similar role like the pharyngeal pockets are present in such cases.

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Summary

A preliminary account on the morphology and internal structure of the pharyngeal pockets present in *Sardinella longiceps*, *S. sirm*, *S. albella*, *S. jussieu*, *S. dayi*, *S. fimbriata*, *Macrura kelee*, all family Clupeidae; *Anodontostoma chacunda* and *Nematalosa nasus*, both family Dorosomidae, is reported in the paper.

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