

MORPHOLOGY AND HISTOLOGY OF THE AIR-BLADDER OF CERTAIN
SCIAENOID FISHES WITH THE DESCRIPTION OF A NEW TYPE
OF EAR-AIR BLADDER CONNECTION *

by P. N. SRIVASTAVA, Zoology Department, Allahabad University

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INTRODUCTION

In the fishes of this family, whose musical performances probably have given rise to the Homeric fable of the song of the sirens, the air-bladder, with a few exceptions, show the most extraordinary development of short ramified caeca on the sides and at the two extremities. Due to these interesting developments the present author worked on some of the Indian sciaenoid fishes and has come across an altogether new type of ear-air-bladder connection.

MATERIAL AND TECHNIQUE

The family is circumtropical in distribution and some of the forms are found even in the temperate seas. In the Indian rivers they ascend up to very good distances and have been caught at places 600 miles from the sea. *Sciaena coitor* (Ham.) and *Pama pama* (Ham.) are found locally at Allahabad, whereas *Sciaena albida* (Day) and *Sciaena miles* (Cuv. & Val.) were collected at Bombay.

Fishes were dissected along the mid-ventral line and the bladders were first fixed in situ and then removed from the fish. The fixative generally used was Bouin's picro-formal-acetic fluid. The sections were mostly treated with Delafield's haematoxylin counterstained with 0.5%-1% alcoholic eosin.

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OBSERVATIONS ON *SCIAENA COITOR* (HAM.)

A. *External Morphology*

The air-bladder (Plate IX, fig. 1) is large (about one-third of the total length of the fish), shaped like a bag and pointed behind. In a fish measuring 7 inches in length the air-bladder was found to be 2.5 inches long. The anteriormost part of the bladder bulges out laterally in a transverse manner to the rest of the bladder. The pointed posterior region ends in the vicinity of the anal opening.

On either side the air-bladder is furnished with ten to eleven short caeca (Plate IX, fig. 1, *Cae*) which are sub-divided into smaller and smaller branches and are surrounded by voluminous lobes of fat. A few caeca found in the hindmost part of the air-bladder may sometimes remain undivided. The cavity of the air-bladder continues in these caeca as well (Plate X, fig. 3) which contains the same gas as the air-bladder. A cluster of caecum of one of the anterior branches ends under the fine transparent skin of the opercle. In the region of the head, the caeca enveloped by the fat and conjunctiva tissue and the cephalic prolongation, need a very careful dissection in order to separate them. Some of the caeca of the head region are connected with the auditory organs and this condition is described presently. The bladder is of the physoclistous type.

B. *Histology*

The wall of the air-bladder is quite thick, the outer membrane being fibrous and very compact and presents a shining silvery white hue. The wall has got two distinct layers (Plate X, fig. 3, *Tu.ex.*, *Tu.in.*)—(i) Tunica externa and (ii) Tunica interna. The tunica externa is formed by elastic and non-muscular fibres. The tunica interna usually consists of a layer of conjunctiva tissue which lodges the blood capillaries.

C. *The Gas-gland*

It is situated on the ventral wall of the anterior region of the air-bladder and can be noticed after opening the bladder cavity (Plate IX, fig. 1, *G.Gl*). It consists of a mass of many layers of cells forming a massive glandular epithelium (Plate X, fig. 1, *G.Gl*). The rete mirabile is always continuous with the glandular epithelium (Plate X, fig. 1, *RM*). The blood capillaries of the rete do not join before supplying the gland and are thus of the type of rete mirabile unipolar duplex. Occasionally we find definite spaces as gaps in the gas gland (Plate X, fig. 2, *G.gl.L.*).

D. *The Oval*

Situated on the dorsal side of the air-bladder opposite the gas-gland, we find the opening of the oval (Plate IX, fig. 1, *OV*). This organ of the air-bladder is meant for removing gas from the air-bladder and is functionally analogous with the pneumatic duct of the physostomous fishes. In the wall of the oval we find numerous blood capillaries, which at the time of need absorb the gas of the air-bladder. Round the opening of the oval we find circular muscle fibres and a few longitudinal ones as well which control the opening like sphinctor muscles. The name 'oval' was first given by Corning (1888) due to the characteristic shape of its opening.

E. Ear-Air-Bladder connection

From the anterior region of the air-bladder arise two caeca each of which are again sub-divided into three groups of smaller caeca. A cluster of these caeca proceeds upwards and forwards by the side of the corresponding auditory capsules which has on its anterior side an opening closed by a membrane (Plate IX, fig. 1). The caecal prolongation of the air-bladder comes into contact with the membrane on the outer side which on the inner side has the perilymph fluid surrounding the internal ear.

OBSERVATIONS ON *PAMA PAMA* (HAM.)

The air-bladder is a very prominent structure in the cavity beneath the vertebral column. In a fish 8.5 inches long, the air-bladder was found to be 3.9 inches in length and the maximum width which is found in the anterior region being 0.8 inches (Plate IX, fig. 2, *AB*). The bladder has a shining silvery appearance and gradually tapers posteriorly till it becomes pointed and extends to a short distance beyond the anal opening. From the hindmost part of the air-bladder arise two narrow tubes (Plate IX, fig. 2, *Tub*) which proceed anteriorly without dividing. At the point where the bladder ends anteriorly the tubes divide into a number of caeca (Plate IX, fig. 2, *Cae*) and one of the caecum on either sides proceeds upwards and becomes connected with the auditory organs just as in the case of *S. coitor* (Ham.) with the only difference that in *Pama pama* (Ham.), only one caecum becomes connected with the membrane on the anterior side of the auditory capsule, whereas in *S. coitor* (Ham.) a cluster of caeca get attached. The air-bladder is of physoclistous type.

The bladder wall is very thick and but for this, the histological structures of the bladder wall, the gas-gland, the rete mirabile and the oval are just similar to that of *S. coitor* (Plate X, figs. 4, 5). The position of these organs are also identical in both the fishes.

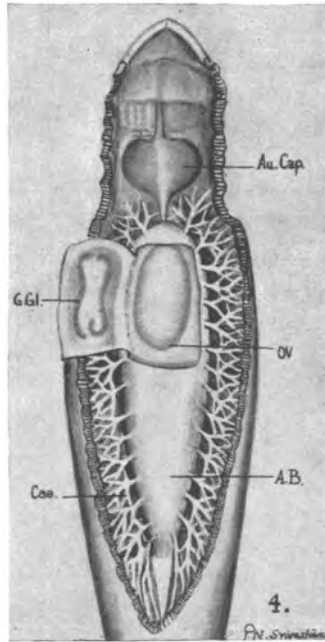
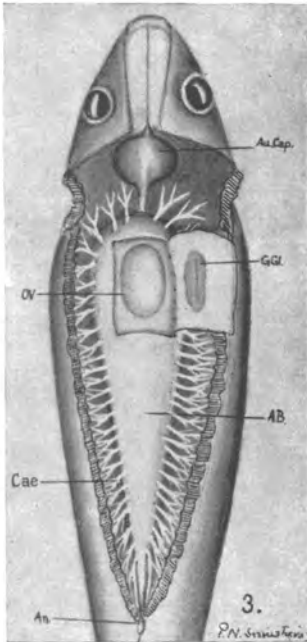
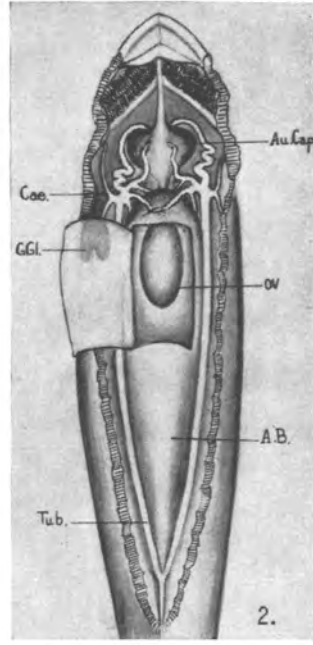
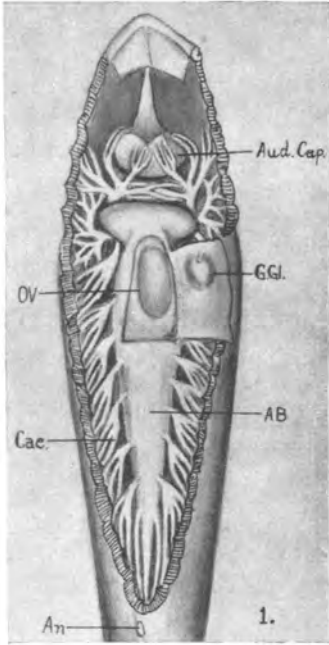
OBSERVATIONS ON *SCIAENA ALBIDA* (DAY)

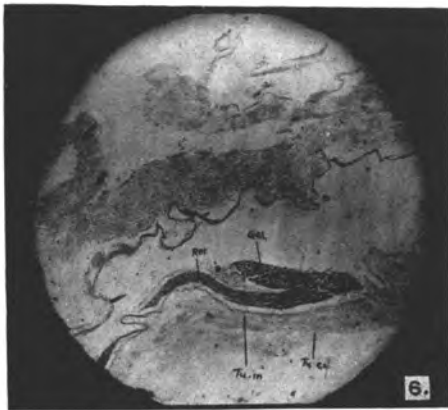
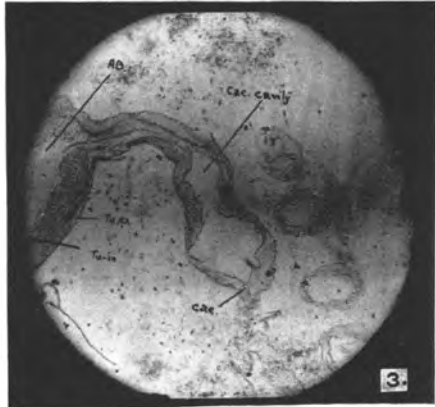
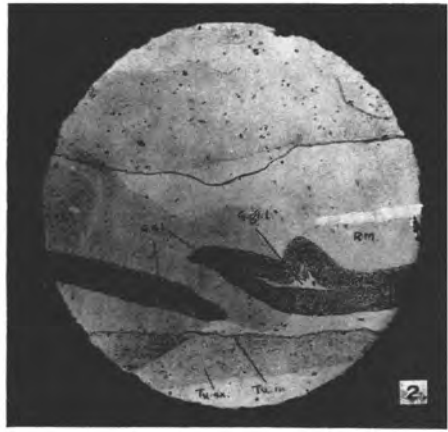
The air-bladder of *S. albida* is somewhat similar to *S. coitor* with a few differences. The bladder is shining and is 2.2 inches in length in a fish measuring 6.3 inches (Plate IX, fig. 3, *AB*). Posteriorly it tapers and ends in the vicinity of the anal opening. On the sides, the bladder is furnished with twenty-seven caecal outgrowths of a simple nature (Plate IX, fig. 3, *Cae*). The lumen of the air-bladder is continuous with that of the caeca. The most important difference with *S. coitor* is that in this case the caecal outgrowths do not proceed forwards and as such the ear-air-bladder connection is wanting.

The position of the gas-gland and the Oval (Plate IX, fig. 3, *G.Gl, OV*) are the same as in *S. coitor* (Ham.). Histologically also the gas-gland shows the same type of glandular epithelium and the rete is of the type of rete mirabile unipolar duplex (Plate X, fig. 6).

OBSERVATIONS ON *SCIAENA MILES* (CUV. & VAL.)

The air-bladder of *Sciaena miles* has the most shining colour than those seen in the preceding species. In a fish 8.2 inches long the air-bladder measures 2.7 inches in length, the maximum width being 0.75 inches (Plate IX, fig. 4, *AB*). Posteriorly this bladder also tapers down and ends in the vicinity of the anal opening. From the sides of the air-bladder are given off 15-16 caecal outgrowths (Plate IX, fig. 4, *Cae*) which branch dicotomously and are not simple as in *S. albida* and *S. coitor*. These outgrowths are more prominent. As in the other sciaenoid fishes the caeca are covered with fat. The ear-air-bladder connection is lacking as in *S. albida*.





The shape and position of the Oval and the gas-gland are almost similar to those of *S. coitor* and *S. albida* (Plate IX, fig. 4, *OV*; *G.Gl.*).

DISCUSSION ON THE NEW TYPE OF EAR-AIR-BLADDER CONNECTION

Weber (1820) while working on five groups of fishes, described three types of ear-air-bladder connection differing entirely from one another in anatomical characters. These three types of connections are as follows:—

First type: It is essentially in a relation of simple apposition of a precoelomic diverticulum of the air-bladder to the base of the auditory capsule. It is present in Notopterus, Sparidae, and some species of Serranidae and Gadidae.

Second type: In this case, the anterior diverticulum of the air-bladder, in the form of minute capillary tube, extends into the head on each side, and ends in two large expanded vesicles which occupy an extensive and complicated cavity in the bones of the lateral and basilar region of the skull. This type of connection is found in Clupeidae.

Third type: This type of connection is affected by means of an articulated chain of small bones developed from the anterior vertebrae which serve to connect the anterior end of the air-bladder with the perilymph cavity. This type is known as 'Weberian mechanism' and is found in the families Cyprinidae, Siluridae, Characidae and Gymnoti.

Besides these, I came across a connection of ear and air-bladder in *Sciaena coitor* (Ham.) and *Pama pama* (Ham.) belonging to the family Sciaenidae. In these cases certain caeca arise from the side of the air-bladder and some of them proceed anteriorly towards the auditory capsule which has got an oval opening on its anterior side closed by a membrane. The caecal prolongation of the air-bladder comes into contact with this membrane on the outer side while on its inner side lies the perilymph fluid surrounding the membranous labyrinth of the ear. This type of connection falls in altogether a different category than those described by Weber and as such it should be regarded as a fourth type of connection between the ear and the air-bladder.

SUMMARY

The air-bladder in *Sciaena coitor* (Ham.), *Pama pama* (Ham.), *Sciaena albida* (Day) and *Sciaena miles* (Cuv. & Val.) are large and about one-third of the total length of the fish, shaped like a bag and pointed behind. All of them except *Pama pama* (Ham.) are furnished with numerous short caecal outgrowths which are surrounded by fat. In *Pama pama* (Ham.) only two outgrowths arise from the sides of the air-bladder from the hindmost region which proceed upwards and divide anteriorly. The gas-gland, and oval are well developed in all the cases. *Sciaena coitor* (Ham.) and *Pama pama* (Ham.) show the new type of ear-air-bladder connection, the like of which has not yet been recorded in any fish. This connection is wanting in *Sciaena albida* (Day) and *Sciaena miles* (Cuv. & Val.).

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ABBREVIATIONS USED

AB—Air-bladder; *An*—Anal opening; *Au.Cap*—Auditory capsule; *Caec*—Caecal outgrowths; *G.Gl*—Gas gland; *G.gl.L.*—Gas gland Lumina; *RM*—Rete mirabile; *Tub.*—Tubular outgrowth of the air-bladder; *Tu.ex*—Tunica externa; *Tu.in*—Tunica interna; *OV*—Oval.

EXPLANATION OF PLATES

PLATE IX

- FIG. 1. *Sciaena coitor* dissected ventrally to show the air-bladder in situ, showing the positions of the gas gland and oval; connection of the air-bladder with the auditory capsule can be seen.
- „ 2. *Pama pama* dissected ventrally to show the air-bladder in situ. Two tubes are seen arising from the posterior end of the air-bladder. Positions of gas gland, oval and the air-bladder auditory capsule connection can be seen.
- „ 3. *Sciaena albida* dissected ventrally to show the disposition of the air-bladder in situ. Red gland and the oval can be noticed. There is no connection with the ear.
- „ 4. *Sciaena miles* dissected ventrally to show the air-bladder in situ. Caecal outgrowths are dichotomously branched. Oval and the gas gland are seen opposite each other. Connection between the air-bladder and the ear is lacking.

PLATE X

- FIG. 1. *Sciaena coitor*. Section showing the prominent retia mirabilia and gas-gland together with the two layers of the air-bladder wall.
- „ 2. *Sciaena coitor*. Sections showing the bladder wall, retia mirabilia and gas-gland lumina which appears as clear gap.
- „ 3. *Sciaena coitor*. Section passing through the air-bladder and caecal outgrowths showing that the cavity of the air-bladder is continuous with that of the caeca. The two layers of the bladder wall can be very clearly seen.
- „ 4. *Pama Pama*. Section passing through the gas-gland and rete mirabile. Blood vessel supplying the rete can be noticed.
- „ 5. *Pama pama*. Section showing the bladder wall, gas-gland, rete mirabile and the gland lumina as clear gap.
- „ 6. *Sciaena albida*. Section showing the two bladder walls, gas-gland and the rete mirabile.

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