

CHANGES IN THE INTERNAL STRUCTURES OF THE AIR-BLADDERS OF *EUTROPIICHTHYS VACHA* (HAM.), *CLUPISOMA GARUA* (HAM.) AND *AILIA COILA* (HAM.) DURING GROWTH.

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Presumably for lack of material, Bridge and Haddon¹, in their contributions to the anatomy of fishes, did not describe the air-bladder of *Eutropiichthys vacha* (Ham.). However they examined a dry skeleton of the fish and relying on the resemblances between the modifications of the skeletal structures usually associated with the air-bladder in this species with those found in *Clupisoma garua* (Ham.), concluded that the air-bladder of *E. vacha* may also be of the same vestigial and degenerate type as is found in *C. garua*. Dr. Hora^{2, 3}, has already shown that even externally the air-bladder of *E. vacha* though vestigial and degenerate, is not similar to that of *C. garua*; the former has a tubular and horseshoe-shaped bladder while in the latter it is a thick-walled, heart-shaped structure. The present article deals with a comparative study of the internal structures of the air-bladders of *Eutropiichthys* Bleeker, *Clupisoma* Swainson and *Ailia coila* (Ham.). Attention is specially directed to the differences between my preparations of the internal structures of the air-bladders of these fishes and the descriptions of the same by Bridge and Haddon. I have examined in each case the bladders of a series of specimens ranging from a fairly small size to full grown individuals of a large size.

I have to record my grateful thanks to Dr. Bains Prashad, Director, Zoological Survey of India, for affording me the necessary facilities for work. I am greatly indebted to Dr. S. L. Hora under whose supervision and guidance the work has been carried out, for the material, valuable suggestions and constant encouragement.

***Eutropiichthys Vacha* (Ham.).**

The air-bladder of the adult specimen of this species is a horseshoe-shaped tubular structure with its concavity directed anteriorly. It consists of a transverse portion lying across the ventral surface of the fifth vertebra, and of two lateral cornua which extend forwards into the recesses formed by the modified transverse processes. With the exception of the transverse portion, the rest of the bladder is enclosed in bone.

In the bladder of an adult specimen about 395 mm. in total length there is a very broad longitudinal septum (*ls.*) which divides the cavity

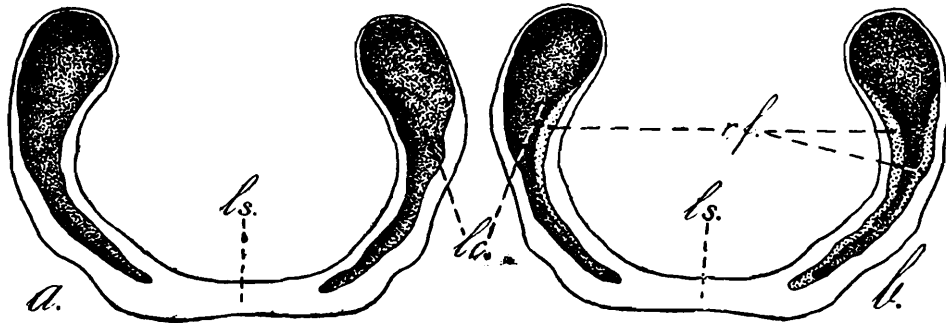
¹ Bridge, T. W. and Haddon, A. C.—*Phil. Trans. Roy. Soc. London*, (B), CLXXXIV, pp. 201-202 (1894).

² Hora, S. L.—*Journ. Bombay Nat. Hist. Soc.*, XXXIX, p. 434 (1937).

³ Hora, S. L.—*Journ. Bombay Nat. Hist. Soc.*, XXXIX, p. 663 (1937).

of the bladder into two lateral chambers (*lc.*). The cavities of these lateral chambers are very shallow owing to the walls and the root-like fibrous growths, except at the anterior ends which are more or less protected by the modified transverse processes. The walls are extremely thick and no trace of a pneumatic duct could be found.

The structure of the bladder of this fish varies during growth. In a small specimen, about 81 mm. in total length, the inside cavity is continuous, there being no transverse and longitudinal septa. There is, however, a projection from the posterior wall of the transverse portion of the bladder into the cavity, this projection does not bring about any division of the cavity into two, though the wall of the cavity between it and the anterior wall is somewhat raised. The cavity is free from any root-like fibrous growths and the walls are very thin. Even at this very early stage no pneumatic duct could be seen.



TEXT-FIG. 1.—Air-bladder of a specimen of *Eutropiichthys vacha* (Ham.) 395 mm. in total length. $\times 3$.

a. Dorsal half. b. Ventral half.

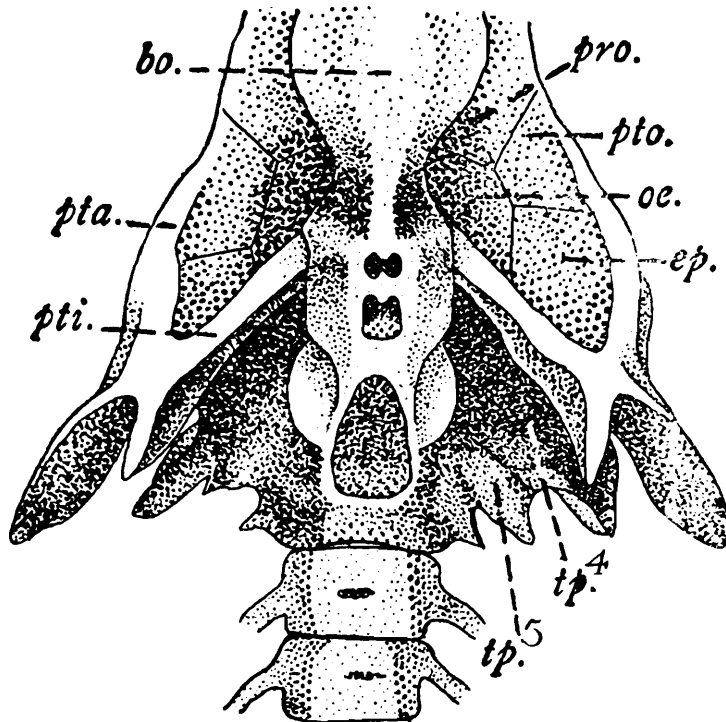
lc. lateral chambers; *ls.* longitudinal septum; *rf.* root-like fibrous growths.

With the growth of the fish the small projection from the posterior wall of the transverse portion of the bladder referred to above develops into a continuous longitudinal septum, which divides the cavity into two lateral chambers; it is very narrow to begin with, but with the growth of the fish it becomes broader and broader till it occupies almost the whole of the transverse portion of the bladder (text-fig. 1). Though, as a rule, the longitudinal septum is entire and continuous, when formed, I found in a specimen 114 mm. in total length, a narrow communication between the lateral chambers through the tissue of the septum. The presence of such a communication may be an abnormality since even in younger specimens the longitudinal septum is invariably complete.

The root-like fibrous growths appear in specimens over 105 mm. in total length; they are found along the anterior and posterior walls of the transverse portion of the bladder, and grow outwards and forwards into the cavities of the lateral chambers with the result that they are partially obliterated.

The air-bladder in the early stages of growth is quite hollow, with thin walls, but in the later stages its cavities become more and more shallow owing partly to the development of the root-like fibrous growths and partly to the thickening of the walls. The entire shape of the bladder also undergoes a slight change; Its gradual flattening shows that it is being pressed by the underlying organs.

Bridge and Haddon do not give any separate description of the skeletal modifications associated with the air-bladder of *E. vacha* but



TEXT-FIG. 2.—Skeletal structures connected with the air-bladder of a specimen of *Eutropiichthys vacha* (Ham.) 348 mm. in total length. $\times 2$.

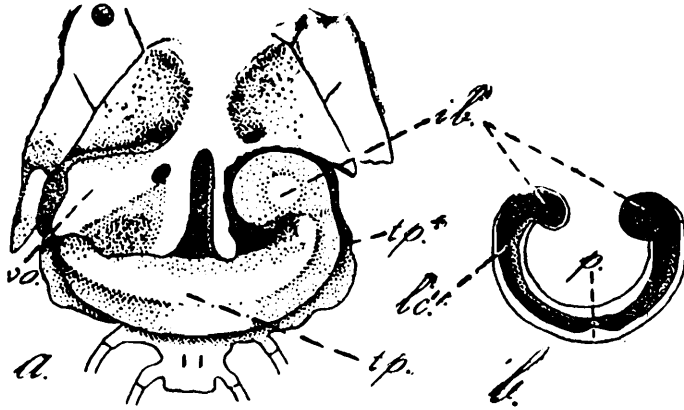
bo. basioccipital; ep. epiotic; oe. opisthotic plates of exoccipital; pro. pro-otic; pta. ascending process of the post-temporal; pti. inferior process or limb of post temporal; pto. pterotic; tp^4 . transverse process of the fourth vertebra; tp^5 . transverse process of the fifth vertebra.

remarked that the description of these structures in *Schilbichthys garua* (= *Clupisoma garua*) will probably apply to those of *E. vacha* with scarcely any alteration. It is stated in the short description of *E. vacha* that the transverse process of the fourth vertebra is broad and greatly expanded, and has its anterior and posterior margins curved directly downwards in such a way as to form a bony semicylinder. In the figure of the anterior part of the vertebral column of *E. vacha*, the transverse process of the fourth vertebra is shown as bent on itself to such an extent that it forms almost a cylinder instead of a semicylinder as described. In my preparations (text-fig. 2) the transverse process of the fourth vertebra only forms a semicylinder. Again, regarding the position of certain bones connected with the skull, there is some difference between the figure of Bridge and Haddon and my preparations. For example, I find that the pro-otic bone (*pro.*) is visible on the ventral surface, besides the other three bones, namely the epiotic (*ep.*), pterotic (*pt.*) and the opisthotic plates of the exoccipital (*oe.*).

***Ailia Coila* (Ham.).**

The air-bladder of *Ailia coila* (Ham.) (text-fig. 3, *b.*) is more or less similar to that of *Eutropiichthys vacha* (Ham.). It consists of a transverse portion (*tp.*) lying across the ventral surface of the sixth vertebra, and also of two lateral cornua (*lc.*) which extend forwards and are accommodated in the recesses formed by the modified transverse processes

(*tp*⁴.) and the ventral outgrowths (*vo.*). The bladder is tubular, horse-shoe-shaped and of a fairly uniform size. The anterior extremities of the lateral cornua (*ib.*), however, bulge inwards. The cavity of the bladder is continuous, as there are no transverse or longitudinal septa.



TEXT-FIG. 3.—*a.* Air-bladder and the connected skeletal structures of a specimen of *Ailia coila* (Ham.) 120 mm. in total length. $\times 5$. *b.* Dorsal half of the air-bladder of a specimen of *Ailia coila* (Ham.) 124 mm. in total length. $\times 3$.

ib. inwardly bulging anterior extremities of the lateral cornua; *lc*¹. lateral cornua; *p.* projection from the posterior wall of the transverse portion, jutting into the cavity of the bladder; *tp.* transverse portion; *tp*⁴. transverse process of the fourth vertebra; *vo.* ventral outgrowths.

According to Bridge and Haddon¹, however, there is no free or open communication between the anterior caecae through the transverse portion. A growth (*p.*) from the posterior wall of the transverse portion of the bladder projects into the cavity similar to that described above in the early stages of the growth of the bladder of *E. vacha*. There is a certain amount of loose tissue in the cavity of the bladder, but I could not detect any network of fibrous tissue to which Bridge and Haddon make a reference.

There is practically no difference in the internal structure of the air-bladder in specimens ranging in total length from 42 mm. to 124 mm.

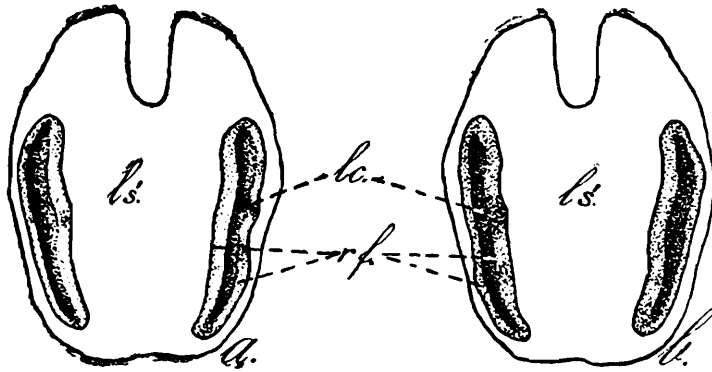
I give here a figure of the air-bladder of *Ailia coila* (Ham.) *in situ*, with the associated skeletal structures; the ventral bony outgrowth of one side is removed (text-fig. 3*a.*) to show the manner in which the anterior bulging portions of the cornua are accommodated within the bony capsules. The walls of the transverse portions are thick but those of the inwardly bulging anterior portions are extremely thin.

Clupisoma Garua (Ham.).

The air-bladder of *Clupisoma garua* (Ham.) is heart-shaped with the apex pointing anteriorly. It is much flattened and is provided with greatly thickened walls even at a very early stage of its development. During growth the anterior half of the bladder apparently grows more quickly than the posterior, and in an adult specimen it assumes the shape as shown in text-fig. 4; it is very tough and smooth to the touch.

¹ Bridge, T. W. and Haddon, A. C.—*Phil. Trans. Roy. Soc. London*, (B), CLXXXIV, p. 210 (1894).

In a young specimen, about 108 mm. in total length, there is a very big transverse septum, almost filling the entire cavity, and a complete



TEXT-FIG. 4.—Air-bladder of a specimen of *Clupisoma garua* (Ham.) 377 mm. in total length. $\times 2$.

a. Dorsal half. *b.* Ventral half.

lc. lateral chambers; *ls'* longitudinal solid structure; *rf.* root-like fibrous growths.

longitudinal septum which, in reality, is the constricted posterior portion of the transverse septum. These two septa divide the cavity into an anterior chamber, lying in front of the transverse septum and two lateral chambers, one on either side of both the septa. The cavities are deep in spite of the root-like fibrous growths on either side of the septa in the ventral half. The opening of the pneumatic duct is situated in front and just about the middle of the transverse septum in the ventral half. As the bladder grows, the transverse septum also grows and meets the anterior wall of the bladder, thus obliterating the anterior chamber and limiting the whole cavity into two symmetrically placed lateral chambers. For example, the air-bladder of a specimen 214 mm. in total length there are no transverse or longitudinal septa as such, but only a median, longitudinal, solid structure along the antero-posterior axis of the bladder. This solid structure along with the root-like fibrous growths gradually fill the cavities of the lateral chambers. In the air-bladder of a specimen 377 mm. in total length (text-fig. 4), there are only two narrow cavities on either side of the longitudinally placed solid structure. The opening of the pneumatic duct into the bladder disappears along with the obliteration of the anterior chamber by the transverse septum.

From their account, it appears that Bridge and Haddon¹ described the bladder of a specimen between 214 mm. and 377 mm. in total length.

¹ Bridge, T. W. and Haddon, A. C.—*Phil. Trans. Roy. Soc. London, (B)*, CLXXXIV, pp. 211-213 (1894).