

VIII. "Note on the Production of Sounds by the Air-bladder of certain Siluroid Fishes." By Professors T. W. BRIDGE and A. C. HADDON. Communicated by Professor A. NEWTON, F.R.S. Received April 17, 1894.

Dr. William Sørensen, of Copenhagen, has drawn our attention to the fact that, in our memoir on "The Air-bladder and Weberian Ossicles in the Siluroid Fishes," published in the 'Philosophical Transactions' last year (vol. 184, pp. 65—333), we failed to do justice to the results of certain investigations which are embodied in his paper, entitled "Om Lydorganer hos Fiske: en physiologisk og comparativ-anatomisk Undersøgelse," and published at Copenhagen in 1884. In this paper Dr. Sørensen treats of the various methods of sound production in Fishes in general, and in the case of the Siluroid Fishes, describes the production of sounds by means of certain stridulating mechanisms (friction of the dorsal and pectoral spines), the "elastic spring" apparatus, and the paired extrinsic muscles of the air-bladder in the *Pimelodine*. We do not here wish to criticise his morphological conclusions, but to point out that, contrary to the assumption on pp. 270 and 301 of our paper, Dr. Sørensen did make some experiments on living Fish. After describing the nature of the "elastic spring" and the disposition of its muscles in the South American Siluroid, *Doras maculatus*, on p. 88 of his paper, he says, concerning this Fish:—

"Observations on the Production of Sounds.—When one opens the abdomen of a recently caught fish and quickly extracts the intestines with everything that is attached to them so that the swim-bladder is exposed, one can very easily perceive that the swim-bladder is in a convulsive vibratory motion at the same time that the sound is produced. It is a very deep murmuring note, which is so strong that it can be distinctly heard at a distance of 100 ft. when the animal is out of the water. Unlike the sounds produced by the movements of the pectoral fin, the tones produced by the swim-bladder are not grating, and therefore not disagreeable to the ear. As far as I am able to judge, the swim-bladder commands only one note, but this can be stronger or weaker according to the will of the fish. If one moves the fingers backwards and forwards over the swim-bladder, one will soon perceive that the vibrating motion, beginning at the same time as the sound, is strongest in the front, especially at the "muscle-springs," and also that the muscles passing to these contract at the same time that the sound is produced. If the muscles are cut through, the sound is no longer produced. If one makes a little hole in the swim-bladder, the sound will not be very much weaker; but if

a larger opening is made in it, the sound will considerably diminish in strength. If one takes out the swim-bladder, the note will become very weak, but may still be heard; it is then produced only by the vibrations of the springs. By ordinary observations I have not been able to prove that those bars or cross-walls (transverse septa) which project into the lumen of the chief compartment of the swim-bladder, or its external diverticula, assist in the production of sound; but if one compares this with what I state later on in *Pseudaroides*, I believe it would prove very doubtful, on account of their incomplete partition walls, that the diverticula of the swim-bladder even to a great degree serve to strengthen the sound by the air passing to and fro over them. By looking more particularly one will observe that the anterior cutaneous plate at the side of the body also vibrates when the sound is produced. I suppose that the action of the ligament, which connects it with the circular plate of the muscular spring, besides transferring the sound vibrations of the swim-bladder to the water, consists in preventing a too violent recoil of the spring when the muscle is relaxed."

After describing the air bladder, and the arrangement of its paired extrinsic muscles in *Platystoma orbignyanum*, and *Pseudaroides clarias*, Dr. Sørensen continues (p. 93):—"When the swim-bladder is laid open in the living animal, it is very easy to perceive that the contractions of the previously mentioned muscles [extrinsic muscles] occur at the same time as the production of a strong, deep, murmuring sound, whilst the wall of the swim-bladder is put into strong vibratory motion. The majority of the specimens I have examined of *Pseudaroides* had at the most a total length of 25—35 cm. The walls of the swim-bladder were, therefore, not so thick, but I was able to distinguish the internal transverse septa as darker transverse lines; I could therefore see very distinctly that when the sounds were produced, the septa were in a state of rapid vibration forwards and backwards. This is sufficient to prove that they play a very important part in tending to increase the sounds by the fact that the air vibrates over their free edges, from one chamber to the other. If one makes a small hole in the swim-bladder of *Platystoma*, the strength of the sounds will not be very much diminished. If an even smaller incision is made the sound becomes fainter and fainter, and at length dies away, even though the muscles are functional."

"So far as I have been able to see, only one muscular contraction takes place, as in *Doras*, for every time sound is produced. This always lasts a certain period, is fainter at the end, but ceases suddenly. About the nature of the sound, the same can be said as I have stated about *Doras*. The sound a *Platystoma* produces can be heard at a distance of more than 20 feet, when the animal is on the land."

From these observations it is also clear that the sounds produced by these fishes are not caused by the expulsion of air through the ductus pneumaticus, as erroneously assumed by us on pp. 298 and p. 301 of our memoir, but are caused by the vibration of the air within the air-bladder, which is set in motion either by the "elastic spring" apparatus, or by the extrinsic muscles.

The investigations of Dr. Sørensen seem to show that, under certain conditions, the "elastic spring" mechanism, and the paired extrinsic muscles of the *Pimelodina*, are structures subordinate to sound production, and are not, as we suggested, related to any method of adjustment to varying hydrostatic pressures. Had we appreciated this fact earlier, we should have modified certain of the tentative conclusions suggested on pp. 298—301 of our memoir. On the present occasion we wish to draw the attention of those interested in the subject to Dr. Sørensen's researches, and at the same time to express our regret at the injustice we have unintentionally done him.

The Society adjourned over Ascension Day to Thursday, May 10.

Presents, April 26, 1894.

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