

is longer than that of *Brontosaurus*, the absence of limbs in the whale would reduce the water displacement and weight.

Several new features are brought out in relation to the proportions of *Brontosaurus*. While a number of terminal vertebræ are undoubtedly missing, the tail is less elongate and massive than was supposed by the writer at one time. There is no evidence that it served for the support of the body, nor was the fin development for propulsion in water so great as in *Diplodocus*. A second point of interest is that the sacrum, while the center for motion, was not certainly the highest point in the body, as at one time supposed by the writer. The center of the vertebræ arch upward in front of the sacrum, and while the neural spines rapidly subside, the highest point appears to have been about the middle of the back; unless, indeed, the fore limbs were very much more flexed than appear in the present mount.

There is still room for wide differences of opinion as regards the habits and means of locomotion of these gigantic animals. Some hold the opinion that the limbs were far more flexed at the knee and elbow than they are in the present mount, that on land at least the animal had rather the attitude of the alligator, and that only while submerged beneath the water were the limbs straightened for the purposes of walking along the bottom, the claws serving to keep the feet from slipping in the mud.

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THE DRUMMING OF THE DRUM-FISHES (SCIENIDÆ).

It is rather remarkable that so common a function as the drumming of fishes should have remained so long misunderstood; that so much speculation should have been indulged in regarding a phenomenon so easily investigated in most parts of the world; and that a conspicuous specialized drumming muscle should have been either overlooked or ignored by ichthyologists.

For several years, as opportunity was afforded, I have been studying the peculiar drumming sounds made by those fishes in which this function is so strikingly developed

that it has determined the family name, the inquiries being in continuation of some observations and experiments on the squeteague (*Cynoscion regalis*) carried on by Professor R. W. Tower, at Woods Hole, in 1901 and 1902, and noted by me in the Report of the U. S. Fish Commissioner for 1902 (page 137).

The diverse notions prevailing among modern writers on fishes may be seen from the following quotations from a few standard works.

Günther, in 'An Introduction to the Study of Fishes' (1880), makes only a single reference to drumming, and that a highly edifying one in connection with *Pogonias cromis*:

These drumming sounds are frequently noticed by persons in vessels lying at anchor on the coasts of the United States. It is still a matter of uncertainty by what means the drum produces the sounds. Some naturalists believe that it is caused by the clapping together of the pharyngeal teeth, which are very large molar teeth. However, if it be true that the sounds are accompanied by a tremulous motion of the vessel, it seems more probable that they are produced by the fishes beating their tails against the bottom of the vessel in order to get rid of the parasites with which that part of their body is infested.

Jordan and Evermann, in their admirable 'American Food and Game Fishes' (1902), reassert what was stated in their 'Fishes of North and Middle America' (1898), namely, that the peculiar noise is 'supposed to be produced by forcing air from the air-bladder into one of the lateral horns.'

Boulenger, in the section on fishes in volume VII. of the Cambridge Natural History¹ (1904), discusses 'sound-producing organs' at some length, but appears to be unaware of the special mechanism existing in the drum-fishes. He cites several ways in which sounds are produced through the agency of muscles connected with the air-bladder, and copies from Sørensen² a diagram of the air-bladder and 'musculo-tendinous extensions from muscles of the body-wall' of a croaker (*Micropogon*

¹ Reviewed by Dr. Theodore Gill in SCIENCE, April 28, 1905.

² *Journal of Anatomy and Physiology*, Vol. XXIX., 1895.

undulatus) as an example of fishes in which 'the air-bladder, without possessing special muscles of its own, may, nevertheless, be partially invested by tendinous, or partly muscular and partly tendinous, extensions from the muscles of the body-wall.'

In the latest and best general work on ichthyology, Jordan's 'Guide to the Study of Fishes' (1905), this subject is but incidentally touched on, the principal reference being that 'the grunting noise made by most of the Sciaenidæ in the water is at least connected with the large and divided air-bladder.'

The most satisfactory account of the drumming function is that of Sørensen in his paper 'Om Lydorganer hos Fiske' (Copenhagen, 1884), the essential parts of which in the present connection are restated in the article cited by Boulenger. Sørensen acknowledges, however, that he had examined only a single dead specimen of a single sciaenid species (*Micropogon undulatus*), and it is not clear from his description that he recognized in the muscle in relation with the air-bladder a distinct organ rather than simply an offshoot of one of the abdominal muscles. It is also doubtful whether Dufossé (*Annales des Sciences Naturelles*, XIX.-XX., 1874), whom Sørensen quotes with approval, correctly interpreted the cause of this phenomenon in the drums, as this extract from Sørensen's paper will show (*italics mine*):

By means of dissections [of *Sciaena aquila*] Dufossé has proved that tones can be produced by the activity of *most of the muscles*, which, coated with aponeuroses, are in immediate contact with the diverticula of the air-bladder, but that the most frequent and most intense tones are produced by the activity of those muscles, which, completely naked, are placed around the long branches of the largest diverticula. The tones may be of different pitch, in perfect accordance with their being formed in different places (and *under the influence of different muscles*).

The drumming act has been more thoroughly studied in the squeteague than in any other sciaenid species; and the facts regarding it, as determined by Professor Tower, may here be repeated substantially as stated by me in 1902 (*l. c.*), but in somewhat greater detail:

1. There is in the squeteague a special

drumming muscle, lying between the abdominal muscles and the peritoneum and extending the entire length of the abdomen on either side of the median line, the muscles of the two sides being united dorsally by a strong aponeurosis. The muscle is of a decided red color, in sharp contrast to the pale muscles of the abdominal parietes, and the fibers are very short, running at right angles to the long axis of the muscle.

2. The muscle, with the aponeurosis, is in close relation with the large air-bladder, and by its rapid contractions produces a drumming sound, with the aid of the tense air-bladder, which acts as a resonator. Experimentally, the removal of the air-bladder or the section of the nerves supplying the muscle abolishes the sound; if a removed air-bladder is restored to its place the drumming is resumed; and the substitution for a removed air-bladder of any hollow, thin-walled vessel of suitable size permits the resumption of drumming when the special muscle is stimulated.

3. The muscle exists only in the males, and only the males are able to make a drumming sound.

It is probable the drumming mechanism and function as existing in the squeteagues are typical of a majority of the genera of Sciaenidæ; but there are some interesting variations in the limited number of genera which I have been able to examine in the field and laboratory. Thus in the croaker (*Micropogon undulatus*) the special drumming muscle is present in both male and female, and both sexes make the drumming sound; while in the so-called king-fishes or whittings (*Menticirrhus*) the drumming muscle and air-bladder are absent in both sexes and no drumming sounds are made. The seven commonest genera of drum-fishes found along the Atlantic coast may be thus classified with reference to the drumming function:

- i. Drumming muscle present in both male and female, and drumming sound made by both sexes *Micropogon*.
- ii. Drumming muscle present only in male, and drumming sound produced only by the male.
Pogonias, *Sciaenops*, *Cynoscion*,
Leiostomus, *Bairdiella*.

- iii. Drumming muscle absent in both male and female, and no drumming sound produced by either sex *Menticirrhus*.

It has been observed in *Pogonias* and other genera that the drumming sounds are heard most frequently during the spawning season; and it is evident that this function is primarily sexual. Coexistent with the ability to make sounds there should be the ability to appreciate them; and Dr. George H. Parker's recent study of the squeteague ear, at the Woods Hole laboratory of the Bureau of Fisheries, has shown in that species a well-developed sound-perceiving organ. It is a suggestive fact that in the *Sciænidae* the otoliths are exceptionally large; and as a meager contribution to this interesting subject I may mention that in *Menticirrhus* (in which no drumming sounds are produced) the otoliths are relatively smaller than in any of the other genera that have been examined.

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PETER ARTEDI.

ON March tenth of this year occurred the bicentenary of the birth of Artedi, distinguished Swedish naturalist, founder of modern systematic ichthyology, friend and preceptor of Linnæus, and coworker with the latter in various departments of natural history. Prematurely cut short in his career, he left an imperishable legacy to science in his own writings, and in so far as he helped stimulate the activity of his more famous fellow countryman. It is little wonder that Artedi's name should be held in pious regard by nearly all students of his favorite science, and that the two-hundredth anniversary of his birth should have been commemorated by some tribute of homage.

On behalf of the Swedish Royal Academy of Science, a biographical sketch of Artedi, with an appreciation of his service as an investigator in biological science, was prepared by Professor Einar Lönnberg, of Upsala University, and has been translated into English by W. E.

Harlock.¹ This is a plain and straightforward narrative, interesting and instructive, sympathetic but without pretense of eulogy; and though the mutual dependence of the two twin-stars of Swedish natural science is clearly set forth, there is no attempt to add luster to the one at the expense of the other. Brother students and pioneers, their relations are as pleasing to contemplate as those between Darwin and Wallace, and such comparisons as are drawn between them in this bicentenary memoir have every appearance of being true and fair-minded.

Many details of Artedi's life, his difficulties, devotion, temperament, methods of work and other matters not generally known are told in this brief biography. Those interested are commended to read the sketch itself. Only a word may be said here in appreciation of his ichthyological writings. The high regard professed for them by Dr. Günther and President Jordan in their popular works on 'Fishes' is well known, and it is rare that one meets with less favorable comments. Dr. Gill, however, is inclined to take a somewhat depreciatory view, since he remarks in *SCIENCE* (XXII., p. 140): "I can by no means assent to the estimate as to 'the extremely valuable historical and bibliographical works of Artedi.' * * * " We hope that our learned critic will not take it amiss if we set over against his opinion the following extracts from the biography now in our hands:

The fourth part of Artedi's 'Ichthyologia' is called 'Synonymia Nomium Piscium.' In it, as Günther truly remarks, references to all previous authors are arranged for every species, very much in the same manner as is adopted in the systematic works of the present day; these references and quotations are inserted under the diagnosis of each several species, entailing for the author a vast amount of labor, as Linnæus had occasion to find out when editing the work, for Artedi had not quite finished off the copying of them in. The laboriousness of the task becomes patent to all, when it is known that Artedi was so conscientious that he went back even to the ancient Greek and Latin writers, and endeavored to eluci-

¹ 'Peter Artedi: A Bicentenary Memoir,' by A. J. E. Lönnberg. Upsala and Stockholm, 1905, pp. 44.