THE PELVIC GIRDLE OF ZEUGLODON, BASILOSAURUS CETOIDES (OWEN),[1] WITH NOTES ON OTHER PORTIONS OF THE SKELETON.

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Notwithstanding the length of time that the Zeuglodon has been known and the comparative abundance, though usually in a more or less fragmentary condition, of its vertebræ and ribs in many parts of the Gulf States, portions of its structure have remained somewhat problematical. This is particularly true of its limbs, and it has been an open question whether or not even vestigal hind limbs were present.

The fact that Zeuglodon bones are found in comparatively soft, superficial deposits that have been deeply gullied by the action of water, to the consequent loss of the smaller bones, is largely responsible for this lack of information, though it may also be noted that little systematic search has been made for Zeuglodon bones.

In 1894 Mr. Charles Schuchert, of the United States National Museum, visited Alabama for the express purpose of obtaining remains of Zeuglodon and succeeded in securing parts of several animals, including 24 consecutive vertebræ from the anterior portion of one individual running from the atlas to the third lumbar. This material which also comprised the scapula, humerus, radius, and ulna was briefly described[2] and used as the basis for the restoration shown at the Atlanta Exposition in 1895.

In 1896 Mr. Schuchert again visited Alabama and this time secured 35 consecutive vertebræ of one individual, counting from the penultimate forward, the small rounded vertebra which terminates the vertebral column of cetacea being apparently wanting.

[1] Harlan's name of *Basilosaurus* antedates Owen's of *Zeuglodon* and should therefore be used; Zeuglodon remains a good popular name and is thus employed in this paper.

[2] The American Naturalist, August, 1895, pp. 745–746.

Mr. Schuchert has kindly prepared the following brief account of his two visits to Alabama, which shows the conditions under which remains of Zeuglodon occur:

The wonderful stories as to the abundance of *Basilosaurus* (=*Zeuglodon*) bones in the Gulf States, particularly in the region of Clarke County, Alabama, and the complete absence of specimens in the United States National Museum led the writer to investigate their occurrence. In this he received the hearty support of the late Dr. G. Brown Goode and Dr. George P. Merrill. The first trip was made in November, 1894, and the second in October and November, 1896. Large portions of three skeletons were secured which, together, gave a nearly complete understanding of the osseous structure of *Basilosaurus*. In addition other bones and invertebrate fossils were secured which will be mentioned beyond.

In the pioneer days of southern Alabama settlers found most of the territory wooded, but here and there were found small treeless areas which they called "prairies." These prairies in Choctaw County, Alabama, are unlike those of Illinois in that they are always situated on more or less gullied land; in fact are miniature "bad lands." They are usually a few acres in extent, but in the region of Cocoa and between Isney and Fail are several miles in length. These open places were the first to be cultivated, and being of a marly nature were easily tilled and more easily gullied by the rains. Many of these spots are now "worn-out" plantations with no particular value other than grazing land.

The collector of *Basilosaurus* remains remembering the statement as to the abundance of these bones described in text-books and elsewhere, that stone walls are built of them, will be surprised to find their abundance for economic purposes restricted to an occasional large dorsal vertebra supporting the corner of a "corn-crib." One rarely finds these bones around the habitations or fences, but badly weathered centra are often scattered over the "plantations."

The bones may occur isolated and scattered, in which case the majority are the centra of dorsal or caudal vertebræ, or more or less of a skeleton may be found in position and undisturbed or in a confused interlocking heap. Undoubtedly the then sea bottom was not a soft one since the vertebræ have generally undergone considerable disintegration, and occasionally there are marks of teeth, and slight incrustation by worm tubes and oysters. Good skulls are rarely seen; in fact but one is known, collected by Dr. Albert Koch, near Fail, and now in a German museum. The nasal region is always ruined, and if a part is present it is usually the thick back region. The teeth and ear bones or a ramus of a jaw are more apt to be present. The preservation of these animals in a normal marine deposit may be accounted for in the complete absence of regular Echinoids which as scavengers are known to grind with their jaws the bones for food.

Associated with *Basilosaurus* and about as common is the little cetacean *Dorudon*, occasionally vertebræ of a large aquatic snake (*Pterosphenus schucherti* Lucas), or the shell of the large fresh-water turtle (*Hadrianus schucherti* Hay). Vertebræ of fishes of three species and an occasional spine or shark's tooth are also met with. But the most abundant fossil in the region of Cocoa are an irregular echinoid (*Hemiaster*), *Terebratulina*, and *Ostrea falco* Dall. These are the guiding fossils to the upper limit of the "Zeuglodon bed," and but a single find of bones was made immediately above this zone. The lower limit of the "Zeuglodon bed" is marked by a great abundance of *Pecten perplanus* Morton.

The "Zeuglodon bed" in the region examined has a very limited thickness (never exceeding 10 feet and generally is restricted to about 5 feet), but apparently is of great geographical extent, since *Basilosaurus* bones are reported from Florida to Arkansas. In Choctaw County the strata are buff to whitish marl, with some green glauconitic sand. Around the bones the marl is often indurated and hardened so

that they have to be chiseled out. While the associated invertebrate fossils are numerous, but few others than those mentioned can be gathered, due to the incoherent, chalky nature of the test or its complete removal by water.

The following generalized section shows the horizon in Choctaw County, Ala., for *Basilosaurus*.

Generalized section of the Zeuglodon bed (terminology that of W. H. Dall.)

Oligocene Vicksburgian (Red Bluff formation):

Iron-stained, reddish marl, with a hardened band about 3 feet thick near the center. The characteristic fossils are *Ostrea vicksburgensis*, *Spondylus damosus*, and *Pecten cocoanus*. About 10 feet seen.

Eocene Jacksonian (Zeuglodon beds):

Soft yellowish-white marl abounding in small lime concretions and foraminifera. But one occurrence of *Basilosaurus* known here. Thickness, about 5 feet.

Echinoid bed. Invertebrates of a few species common—*Hemiaster*, *Terebratulina*, and *Ostrea falco*. The general horizon for *Basilosaurus*, *Dorudon*, and other vertebrates immediately below the echinoids and throughout the next zone. Thickness, 2 feet.

Soft whitish marl abounding in *Pecten perplanus*, *Ostrea trigonalis*, and *Bryozoa;* also *Cypræa fenestralis*, *Auria alabamensis*, and *Scala ranellina*. Thickness, 7 feet.

Other Jacksonian horizons come here, followed by the Claibornian.

In spite of the number of vertebræ present, these two series do not seem to quite complete the vertebral column, which apparently lacks one or two at the point of junction of the two series. The number so far known is 58, distributed as follows: Cervicals 7, dorsals 13, lumbocaudals 38.

Associated with the second series of bones were the two ossa innominata, one of which was found near the twenty-first vertebra counting from the posterior end of the series, the other near the twenty-second, as well as a bone considered to be the femur.

As this skeleton had been but little washed about after deposition, the chances or probabilities are that the pelvis belongs somewhere near these vertebræ.

Neither of the bones appears quite complete, but there is some reason to suppose that the abruptly truncated posterior end of the left os innominatum is natural, and not, as the first glance suggests, the result of a fracture. This supposition is based on the fact that the straight posterior end is slightly roughened, as if it had been, as in so many animals, capped or terminated by a cartilaginous epiphysis.

The pelvis of the eared seals, *Otariida*, seems to throw the most light on the morphology of the pelvis (just as the skull of *Eumetopias* was of the most service in restoring the cranium), and by its aid we are able to say that ilium, ischium, and pubis are all present, although the ilium is almost aborted and the component bones are fused in one.

The pectineal process, which is large, arises from the ilium, and not the pubis, as is shown by the pelvis of a young fur seal.

The obturator foramen is large, and seems, in spite of the degenerate

condition of the pelvis, to have been traversed by a large iliac artery. It is a curious fact that in the eared seals the artery may either directly traverse the pubis or simply pass through the anterior angle of the obturator foramen, or it may be at first free and later on inclosed by bone. There is nothing to determine whether the pelvic halves were attached to the vertebræ or lay free in the flesh, as in the Cetacea, but this last supposition seems the most probable.

The transverse processes of the twenty-second and twenty-third vertebræ differ slightly from those preceding or succeeding them in being a little thicker, rougher, and slightly trihedral at their free extremities; but, unfortunately for the possible deduction that the pelvis was directly attached to either or both of these vertebræ, the roughening occurs on the superior face of the process.

The acetabulum is of good width and depth, exceeding in size that of a male fur seal, *Callorhinus*, and nearly equaling that of a fully grown female sea lion, *Eumetopias*.

There is an irregular, roughened depression, as if for a ligamentum teres, although it is a little difficult to see the necessity for a ligament in so degenerate a pelvis as that under consideration. Moreover, the round ligament is absent (according to Owen) in the eared and earless seals, although both groups have large depressions in the acetabulum.

Found near the nineteenth vertebra was a small, slender bone suggesting a femur, and so considered. There is no articular surface at either end, one extremity, which is slightly weathered, having been apparently capped with cartilage, the other having lost a portion while being taken away from the matrix. Found near the twenty-second vertebra, however, was a rounded fragment of bone of the proper size and shape for a portion of the head of the femur, and if the broken part of the supposed femur were to be restored after this fragment, it would harmonize with the os, to which it is believed to have belonged.

If the interpretation placed on this bone be correct, it will be seen that a large third trochanter is present. This, however, need not be considered surprising, since, however distant the relationship may be between Zeuglodon and the seals, it is a relationship that seems to exist, and Scott and Wortman both consider the seals to be descended from the primitive carnivores, through the Creodonts, and these are characterized by the presence of a third trochanter on the femur. Also, while it may seem a little singular to find such a definitely formed, though slender, femur present, if it and the pelvis were completely buried in the flesh, yet from the great bulk of the tail of *Basilosaurus* it appears probable that such was the case.

It may be said that the last 6 caudals present (the small terminal nodule seems to be lacking) are small, as if embedded in a fluke; that the tenth caudal from the end bears a distinct transverse process, and

that the caudals increase rapidly in length from the ninth forward, as is shown by the following measurements:

Antero-posterior length of centrum of fifth vertebra, $2\frac{5}{8}$ inches; sixth vertebra, $3\frac{1}{4}$ inches; seventh vertebra, 6 inches; eighth vertebra, 8 inches; ninth vertebra, 10 inches; twelfth vertebra, 13 inches.

The length of the left os innominatum, allowing 5 mm. for the broken portion, is 245 mm. from the anterior end of the pectineal process to the posterior end of the ischium. The length of the femur is 196 mm.

The material in the collections of the United States National Museum enables us to add a little to the diagnosis of the *Basilosauridæ*, and to differentiate the genera *Basilosaurus* and *Dorudon*. The family may be thus characterized: Dentition, i. $\frac{3}{3}$ c. $\frac{1}{1}$ pm. $\frac{4}{4}$ m. $\frac{3}{2}$?; incisors caniniform, lower molariform teeth deeply serrate on one or both edges; premaxillaries and maxillaries elongate; cervicals with compressed centra, not ankylosed, but so interlocked by processes as to be practically immovable; anterior ribs more or less expanded distally; scapula with a slender coracoidal and elongate acromial process, both directed forward as in Cetacea; forearm movable on humerus; metacarpals and phalanges elongate as in *Otariidæ;* pelvis and hind limb vestigial; femur with a third trochanter.

Basilosaurus.—Molariform teeth serrate on both edges, save last lower molar and first upper pre-molar; bodies of lumbo-caudals much elongated, with low neural arch over center of centrum.

Dorudon.—Molariform teeth serrate on posterior edge only; bodies of lumbo-caudals short with high neural arch over anterior part.

In conclusion it may be said that the writer believes *Basilosaurus* left no successors, but considers that like *Hesperornis* among birds this highly modified form represents a side branch of the ceto-phocine tree.

EXPLANATION OF PLATES

PLATE V.

External aspect of right os innominatum of *Basilosaurus cetoides*, reduced.

PLATE VI.

Internal aspect of left os innominatum of *Basilosaurus cetoides*, reduced.

PLATE VII.

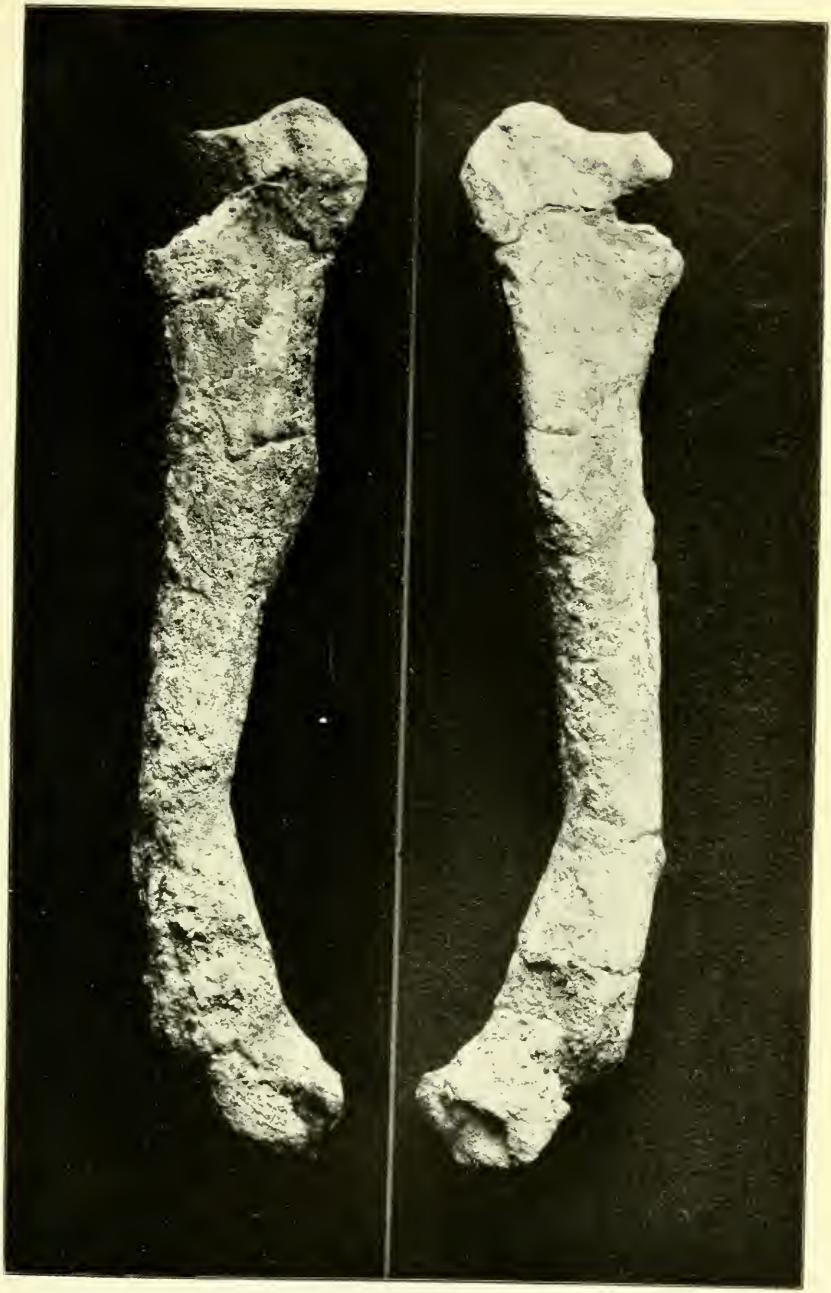
Posterior and anterior aspects of right femur of *Basilosaurus cetoides*, reduced.

EXTERNAL ASPECT OF RIGHT OS INNOMINATUM OF BASILOSAURUS CETOIDES.

FOR EXPLANATION OF PLATE SEE PAGE 331.

INTERNAL ASPECT OF LEFT OS INNOMINATUM OF BASILOSAURUS CETOIDES.

FOR EXPLANATION OF PLATE SEE PAGE 331.



POSTERIOR AND ANTERIOR ASPECTS OF RIGHT FEMUR OF BASILOSAURUS CETOIDES.

FOR EXPLANATION OF PLATE SEE PAGE 331.