A FOSSIL PHYSETEROID CETACEAN FROM SANTA BARBARA COUNTY, CALIFORNIA

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The discovery of a skull of a fossil physeteroid whale anywhere is worth recording, and when one is found on the Pacific Coast of North America, the occurrence is all the more important in view of the present inadequate record of their presence there during tertiary times. The living sperm whale is almost cosmopolitan in its distribution, and there is considerable evidence to support the assumption that the geographical range of many, if not all, of the fossil representatives of this family included the Pacific as well as the Atlantic ocean. The suggestion may be offered here that these cetaceans, in particular, will eventually prove to be very useful for purposes of intercontinental geological correlation. Sooner or later, these widely scattered occurrences of fossil sperm whales will assist in either corroborating or modifying some of our concepts as to the age of various marine formations.

Comparative measurements indicate that a complete skull of this species will measure between 4 and 5 meters (12 and 15 feet) in length. If this estimate is correct, then the skull of this species is more than twice as long as that of *Physodon patagonicus* Lydekker from a lower Miocene tuff formation on the coast of Chubut Territory, Patagonia, and probably represents the largest Miocene physeteroid thus far described. This specimen is tentatively referred to the genus *Ontocetus* of Leidy. Although only a small portion of the skull is available for description at present, it obviously represents a distinct type, and requires a name.

Through the interest of Dr. J. P. Harrington of the Bureau of Ethnology, this specimen was presented to the United States National Museum by Mrs. Charles O. Roe, of Santa Barbara, California. I am indebted to Mr. C. W. Gilmore, curator of the Division of Vertebrate Palaeontology, for the opportunity to describe this specimen.

ONTOCETUS OXYMYCTERUS, new species

Type specimen.—Cat. No. 10923, Division of Vertebrate Palaeontology, United States National Museum. The material includes the distal end of the rostrum, the extremities of both mandibles with the roots or portions of 10 or 11 teeth in place, as well as several imperfect teeth which were found in the adjoining matrix.

Type locality.—The occurrence is as follows: Near latitude 34° 20′ 12″ north, and longitude 119° 43′ 20″ west, in the sea cliff which follows the beach north of the Santa Barbara lighthouse, Santa Barbara County, California. Range 27 west, township 4 north, Santa Barbara special map, United States Geological Survey.

Horizon.—The specimen was discovered by Mr. Charles O. Roe some 35 years before he finally removed it to his home in Santa Barbara during the year 1909. The rostrum and mandibles were found projecting from the sea cliff at an elevation of about 12 feet above the high water mark. The sea cliff is nearly 80 feet high at the point where the skull was found, but the writer can not give any estimate as to the thickness of the stratum or as to the relative position of the specimen within it. I am indebted to Mr. Earl V. Shannon, Assistant Curator of Geology, for the following report on the matrix.

The specimen submitted for examination consists of a dense almost aphanitic laminated rock of medium olive buff color. Superficially it resembles a rhyolite with a flow structure more than a sedimentary rock and this resemblance is heightened by scattered nearly spherical cavities a millimeter or two in diameter which, under a binocular microscope, are seen to be lined with minute, sparkling, rhombohedral, colorless, or slightly yellowish crystals. In dilute (1:1) hydrochloric acid the rock effervesces slowly in the manner characteristic of a dolomite and upon warming in the acid large pieces are completely dissolved leaving little residue and with the separation of a considerable amount of oily matter. The solution, after removal of iron, lime, etc., in the usual manner, reacts copiously for magnesia with microcosmic salt. The rock is evidently a fairly pure bituminous dolomite.

No direct reference to the deposits which comprise the sea cliff west of the Santa Barbara lighthouse can be found and Arnold[1] writes that "the structure of the coast west of Punta del Castillo was not studied." This stratum of bituminous dolomite, however, probably represents one of the calcareous deposits which alternated with siliceous deposits to form the thick series known as the lower division of the Monterey formation. In the report by Arnold and Anderson,[2] reference is made to "massive beds of peculiar sand-colored limestone with characteristic lamellar weathering." Again in re-

[1] Arnold, R., Geology and Oil Resources of the Summerland District, Santa Barbara County, California. Bulletin No. 321, U. S. Geol. Surv., Washington, D. C., p. 38, 1907.

[2] Arnold, R., and Anderson, R., Geology and Oil Resources of the Santa Maria Oil District, Santa Barbara County, California. Bulletin No. 322, U. S. Geol. Surv., Washington, D. C., p. 34, 1907.

ferring to a bituminous limestone [=bituminous dolomite as shown by No. 11 in table of analyses, p. 45] from the Redrock Mountain,[3] northeast of Lompoc, Santa Barbara County, they report as follows: "The last analysis (No. 11) represents limestone typical in lithologic appearance of the limestone of the Monterey." The age of this formation is probably Helvetian or later.

Rostrum.—As the base of the rostrum and the braincase still remain in the sea cliff near Santa Barbara, an exact idea of this physeteroid's relation to previously described skulls can not be given at present. The general outlines of the skull, however, were probably similar to *Scaldicetus.* According to the figures of *Scaldicetus mortezelensis* given by Abel,[4] the extremity of the rostrum of that species is not characterized by a lateral compression. This is the most apparent difference between the rostrum of the Santa Barbara cetacean (pl. 1) and that of *Scaldicetus.* The size of the teeth and the general appearance of their dentinal axes indicate some relationship with *Ontocetus.* All previously described skulls of fossil physeteroids, in so far as can be judged from the imperfectly preserved specimens now known, were characterized in part by the presence of three teeth in the extremity of each premaxilla. In these forms the extremity of the rostrum is formed by the premaxillae alone. In this Santa Barbara skull, also, the premaxillae take part in the formation of the extremity of the rostrum and three of the teeth on each side are implanted in the premaxilla. The lateral compression of the distal portion of the rostrum is quite noticeable in certain genera, particularly so in *Physodon patagonicus* and *Diaphorocetus mediatlanticus.* The extremity of the rostrum of this fossil physeteroid was constricted from side to side and the inner margins of the premaxillae are in contact along the median line as in *Physodon patagonicus*, forming a roof for the mesorostral gutter. On comparing the dorsal view of this Santa Barbara rostrum with that of *Physeter*,[5] other peculiarities become apparent. In the latter, the rostrum is more or less attenuated anteriorly, but the abrupt constriction or lateral compression of the distal portion of the rostrum has disappeared with the horizontal expansion of the rostrum.

While removing the matrix it became evident that this skull had partially decayed before it was completely buried in the sediments which preserved it. Furthermore, some of the teeth were broken off in the alveoli previous to its burial, for on removing the matrix which covered the right mandible, the roots of the teeth were ex-

[3] Arnold, R., and Anderson, R., Geology and Oil Resources of the Summerland District, Santa Barbara County, California.

[4] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 3, p. 67, fig. 5 1905.

[5] Van Beneden, P. J., and Gervais, P., Ostégraphie des Cetacés vivants et fossiles, Paris, Atlas, pl. 19, figs. 5–6. 1880.

posed to view. Other teeth dropped out of the alveoli in the upper jaws after the skull was covered with sediments as several were found in the matrix. The outer surface of the maxilla is worn, more so in some places than in others. Nevertheless, it appears that the anterior alveoli in the maxilla are separated from the outer surface by a very thin plate, hardly more than 15 mm. in thickness. The lateral border of the maxilla overhangs the alveoli more noticeably posteriorly than anteriorly. The alveoli in the maxillae agree in size with those for the corresponding teeth in the mandibles. At least eight alveoli are present in the distal end of each maxilla and a complete skull may have carried 18 or more teeth in each jaw. From the inferior margin, the maxilla curves upward to the premaxilla in a gradual curve which becomes more pronounced as the maxilla attains a greater depth posteriorly. Apparently, the horizontal plate-like inwardly projecting portions of the premaxillae do not roof the mesorostral gutter to the extremity of the rostrum, but this can not be stated with any degree of certainty for although they taper rapidly their extremities are clearly mutilated. The maxillae gradually increase in breadth toward the base of this section of the rostrum and then appear to suddenly expand as would be expected in a skull characterized by a lateral constriction of the extremity of the rostrum. From a lateral view the maxillae increase in depth as they approach the base; whereas the premaxillae decrease.

The mesorostral gutter extends the full length of the rostrum. Its distal extension is made up entirely by the premaxillae which meet mesially on the floor in a linear suture. Posterior to the third pair of alveoli is the distal extremity of the vomer which contributes the floor of the gutter for most of its length, and on each side is mortised into the ventral extensions of the premaxillae and they in turn are applied to the inner borders of the maxillae. From its extremity posteriorly, the vomer increases in width and eventually gains a position on the walls. The dorsal wall or roof of the vomerine gutter is formed, as mentioned above, by the overhanging plate-like portions of the premaxillae. From the level of the third pair of alveoli posteriorly, the premaxillae retain a nearly uniform breadth.

Mandibles.—Since this specimen projected from the face of the cliff and was exposed to the action of the elements for 35 years at least, it is not surprising that the inferior surfaces of the mandibles should exhibit evidence of considerable erosion. From a ventral view, numerous branching canals are now visible, although they are filled with matrix, which afforded passage for nerves and blood vessels. In places, this wear has amounted to an inch or more in thickness.

The extremities of the mandibles are relatively large in comparison to the rostrum and in general conformation are somewhat similar to those of *Physeter*. Pressure or other factors resulted in the separation of the mandibles at the symphysis. The left mandible does not lie in its normal position and its inner face is appressed against the ventral surface of the rostrum. The proximal portions of the mandibles were not collected and as the inner faces of these mandibles begin to diverge some 170 mm. in front of the point where they were broken off, it is evident that all of the symphysial region is represented. If this is the case then the symphysis of the mandible is coextensive with the first eight pairs of teeth. Both mandibles curved upward from the posterior end of the symphysis forward. The distal extremity of each mandible is obliquely truncated in a dorso-ventral direction while the external and internal faces of the mandible descend abruptly from the dorsal surface which is relatively flat.

The tooth-bearing portion of the mandible is relatively massive and the bone itself is rather dense. The alveoli (pl. 2) are large and the posterior ones occupy more than half of the width of the mandible. In this fossil, the series of teeth in each mandible consists of more than eleven slightly curved and conical teeth. The first and third teeth are the smallest of the mandibular series. The roots of all the teeth available for examination from the upper jaw are terminated obtusely and no doubt those of the mandible are similar in appearance. Two teeth, the inner one much smaller than all of the following with the exception of the third, project obliquely forward from the extremity of each mandible.

Teeth.—Turning to the teeth, we find that they are all very large and that some of them may have projected 4 or 5 inches beyond the jaws. They are separated by intervals or septa narrower than the thickness of the cement. In respect to their mode of implantation in the jaw, the teeth differ from those of *Physeter* in that they are lodged in distinct alveoli and the septa extend the full depth of the alveolus. These alveoli are too large to hold the teeth in place independently of a dense ligamentous gum which accounts for their absence from the alveoli in the upper jaw. The position of the mandibles prevented the teeth from falling out of the alveoli and in some instances the matrix in the alveolus which encircles the root attains a width of 20 mm. or more. This interval affords another indication of how loosely the teeth were implanted in the jaws. All the crowns of the teeth, with the exception of the third in the right mandible, either were broken off at the time the specimen was removed from the sea cliff or were destroyed before burial. The summit of the crown of this tooth is abraded and the enamel is ornamented with coarse longitudinal striae.

The crown of the third mandibular tooth is broken off obliquely in an interno-external direction. The enamel forms a band encircling the crown of the tooth, about 1 mm. in thickness and approximately 35 mm. in depth when complete. The crown and upper part of a tooth which broke away from the end of the root in the mandible at the time the specimen was removed from the sea cliff measures 153 mm. in length. The greatest transverse diameter of the base of this apical section of the tooth equals 68 mm. and the maximum thickness of the cement is 9.5 mm. At the level of the superior face of the mandible, the outer coat of cement varies from 10 to 19 mm. in thickness. From these measurements it is evident that a short section of the root which intervenes between this apical portion and the distal extremity is missing. A large mandibular tooth will measure at least 300 mm. in length. The roots of these teeth are fusiform, remarkably robust, and very large in proportion to the crown. They are almost straight at the basal two-thirds, but curved toward the crown so that the latter appears to be obliquely placed upon it.

The enamel on the crown does not form an enlargement at the base and passes into the cement on the root without any perceptible increase or decrease in the diameter of the neck. Hence there is no distinct neck and no constriction at this point can be observed on any of the teeth which are sufficiently preserved to offer any data. The distal extremities of all the teeth are present in the left mandible. At their upper ends, a small pulp cavity is exposed in the second and ninth teeth, measuring 3.5 and 7.5 mm. respectively in diameter. This indicates that the lower portions of the roots were pervaded by a slender pulp cavity, irregular in diameter because of the presence of nodosities on the sides.

As seen in cross section, the teeth consist of an internal cone of ossified pulp and dentine which is covered externally by a thick layer of cement. This outer coat of cement is usually brownish in contrast to the light cream-colored dentine, and on the eighth tooth of the right mandible is equal to about one-fourth of the transverse diameter of the root. The dentinal axis is formed in concentric layers while the cement on the other hand appears to be composed of thin and narrow longitudinal strips or laminae. In cross section, the ends of these laminae are so arranged that their axes correspond to lines radiating from the center of the pulp cavity.

The most obvious distinction between these teeth and that of *Ontocetus emmonsi* is the relative thickness of the outer layer of cement. In cross section the central axis of dentine appears to be more or less ovoidal in the anterior mandibular teeth in contrast to the circular outlines of the posterior ones, but this may be due in

part to differences in the direction of the teeth in the alveoli, the former being implanted more obliquely than the latter. Thin ridges which encircle the dentinal axis and which have been referred to as annular lines of growth are present. Longitudinal grooves or fluting, varying in number and in depth among the several teeth at hand, further characterize the external surface of the dentinal axis. The teeth of *Scaldicetus caretti*, a physeteroid whale from the Anversian of Belgium, agree with those of this Californian species in size.

All of the teeth are imperfectly fossilized and the dentine especially is rather soft and pithy. In their present state, difficulties which are familiar to anyone who has attempted to preserve tusks of mastodons, are encountered when the teeth are freed from the matrix. The teeth fracture and crumble even when every precaution is taken for their preservation.

Measurements of the rostrum and mandibles

	mm.
Total length of rostral fragment along the median line	845
Width of right premaxilla at proximal end of rostral fragment	97
Width of right premaxilla at level of second alveolus	91
Depth of right premaxilla at proximal end of rostral fragment	190
Depth of right premaxilla above maxillary suture at level of fifth alveolus	69
Breadth of rostral fragment at proximal end (left maxillary surface worn off)	405
Breadth of rostral fragment at point 100 mm. posterior to distal end	170
Breadth across combined premaxillae at proximal end of rostral fragment	213
Breadth across combined premaxillae at level of fifth alveolus	211
Total length of fragment of right mandible	965
Depth of right mandible at proximal end	192
Depth of right mandible at extremity	117
Breadth of right mandible at proximal end	175
Breadth of right mandible at extremity	123
Total length of fragment of left mandible	920
Depth of left mandible at proximal end	196
Depth of left mandible at extremity	115
Breadth of left mandible at proximal end	180
Breadth of left mandible at extremity	117
Greatest transverse diameter of root of first tooth, left mandible	54
Greatest transverse diameter of root of second tooth, left mandible	74
Greatest transverse diameter of root of third tooth, left mandible	70
Greatest transverse diameter of root of fourth tooth, left mandible	66.5
Greatest transverse diameter of root of fifth tooth, left mandible	67.5
Greatest transverse diameter of root of sixth tooth, left mandible	70
Greatest transverse diameter of root of seventh tooth, left mandible	78.5
Greatest transverse diameter of root of eighth tooth, left mandible	89
Greatest transverse diameter of root of ninth tooth, left mandible	90.5
Greatest transverse diameter of root of tenth tooth, left mandible	71
Length of enamel crown of third tooth, right mandible (apex missing or worn off)	30+

	mm.
Greatest antero-posterior diameter of enamel crown of third tooth at base, right mandible	32
Eighth tooth, right mandible:	
Transverse diameter of tooth at level superior face mandible	82
Transverse diameter of dentinal axis	50
Greatest width of cement in same place	18
Pulp cavity closed.	
Eighth tooth, left mandible:	
Transverse diameter of tooth at level superior face of mandible	93
Transverse diameter of dentinal axis	62
Greatest width of cement in same plane	19
Pulp cavity closed.	
Ninth tooth, right mandible:	
Transverse diameter of tooth at level of superior face of mandible	80
Transverse diameter of dentinal axis	46.3
Greatest width of cement in same plane	19
Transverse diameter of pulp cavity at same plane	7.5

EXPLANATION OF PLATES

PLATE 1

Dorsal view of type rostrum and mandibles of *Ontocetus oxymycterus*
The internal face of the left mandible is covered with the matrix.
Abbreviations: *Max*, maxilla; *Pmx*. premaxilla.

PLATE 2

Lateral view of type rostrum and dorsal view of right mandible of *Ontocetus oxymycterus*

This view shows that the extremity of rostrum is formed by the premaxillae; the end of the maxilla, which normally forms the external wall of the fourth alveolus, is missing.
Abbreviations: *Max*. maxilla; *Pmx*. premaxilla.

VIEWS OF ROSTRUM AND MANDIBLES OF ONTOCETUS OXYMYCTERUS

FOR EXPLANATION OF PLATE SEE PAGE 8

VIEWS OF ROSTRUM AND RIGHT MANDIBLE OF ONTOCETUS OXYMYCTERUS

FOR EXPLANATION OF PLATE SEE PAGE 8