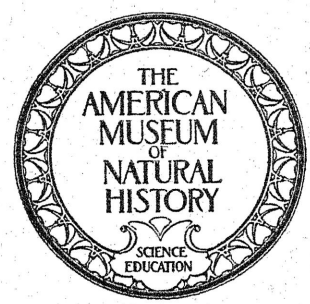
ON THE STRUCTURE OF *MESOPLODON DENSIROSTRIS*, A RARE BEAKED WHALE

BY HENRY C. RAVEN



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Article II.—ON THE STRUCTURE OF *MESOPLODON DENSIROSTRIS*, A RARE BEAKED WHALE

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Figures 1 to 26; Tables I to VI

INTRODUCTION

The type of *Mesoplodon densirostris* was described by De Blainville in 1817 from a piece of the rostrum of the skull about 225 mm. in length. The locality of origin of the type, which is in the Paris Museum, is unknown. In the years between its discovery and 1924, when Sir Sidney F. Harmer published a résumé of the history and taxonomy of this species, only six more specimens had come to light, making seven known specimens in all up to that time. The records of these seven specimens are as follows:

1. Part of a rostrum, 9 inches long, of unknown origin, in the Paris Museum (type of the species).

2. Skull, also in the Paris Museum, sent from the Seychelles by M. Leduc in 1839. Gray gave it the name of *Ziphius seychellensis* and later followed Gervais in placing it in *Dioplodon*.

3. Skeleton, nearly complete, in the Sydney Museum, from Lord Howe Island.

4. Rostrum (No. 2908) from the shore near Algoa Bay, South Africa, in the Museum of the Royal College of Surgeons, London. Presented by C. Westendorp, 1872.

5. Skeleton in the Museum of the Boston Society of Natural History of a specimen described as a young female, 12 feet, 2 inches in length, Annisquam, Massachusetts coast, August, 1898.

6. Skeleton in the Academy of Natural Sciences of Philadelphia of a fully adult animal, 14 feet, 5 inches long, obtained June 18, 1913, at Corson's Inlet, New Jersey.

7. Skull, nearly complete, with part of the lower jaw, wanting the teeth, of a specimen stranded at Porto Santo, Madeira, in 1917.

To these there can now be added two more:

8. Skeleton, nearly complete, parts of the rostrum of the skull and parts of the lower jaw missing, of a young individual with most sutures open, stranded at Southampton, Long Island, New York, and recovered by Dr. H. E. Anthony, May 12, 1925, specimen now No. 69579 in the Department of Mammals of The American Museum of Natural History.

9. Skeleton and thoracic and abdominal viscera of an old male, 14 feet, 5 inches total length, secured at Peggy's Cove, near Halifax, Nova Scotia, February, 1940, specimen now in The American Museum of Natural History, Department of Mammals, No. 139931 (skeleton); Department of Comparative Anatomy, No. 2516 (viscera).

True in 1910 pointed out that the young female specimen taken at Annisquam, Massachusetts, in 1898 was probably *M. densirostris* and thus the first American record of this species, as previously this species was unknown from the Atlantic Ocean. Glover M. Allen, who first described the specimen from Annisquam, believed it to be *Mesoplodon bidens*. However, Allen noted its differences from another *Mesoplodon* specimen which he identified as *M. bidens*, secured at North Long Branch, New Jersey. One of the skull characters by which *M. densirostris* can be easily and positively separated from the other members of the genus is the groove or furrow which is situated just forward of the maxillary foramen and contains the structures issuing from it on either side of the base of the rostrum. Of this Allen (1906) wrote, "In the Annisquam specimen the maxillary foramen is very large and its opening is below the level of the surrounding parts. It is continued forward as a deep groove or canal to the base

of the rostrum, which is a feature practically lacking in the skull from Long Branch."

The second American record of this species was that described by Dr. R. C. Andrews, the specimen taken at Corson's Inlet, New Jersey, on June 18, 1913, the skeleton of which is in the Museum of the Academy of Natural Sciences of Philadelphia. Of this specimen Andrews said, "The skeleton shows that the individual from which it was taken, although not old, was fully adult, for the mesorostral cartilage is thoroughly ossified and all the epiphyses are firmly ankylosed to the vertebral bodies."

No mention of the sex of this animal was made, and possibly it was not noted while the animal was in the flesh. However, the sketch of it and the photograph of the mandible leave little doubt that it was a male, and as Andrews said, "although not old, was fully adult...." The tooth had probably not perforated the skin of the jaw, for it is not shown in the sketch nor is any mention made of it. Furthermore, in the photograph of the mandible (Pl. XVIII, fig. 7), the tooth is seen to have a very sharp unworn tip, to be very broad, anteroposteriorly at the level of the alveolus. Except for being unworn this agrees with the figure of the tooth in Van Beneden and Gervais (Pl. XXV, fig. 3), which is recognized as a male. It differs in size and shape from the tooth of the female figured by G. M. Allen. Recently Frederick A. Ulmer, Jr., has published on this specimen in a paper entitled "*Mesoplodon mirus* in New Jersey, with additional notes on the New Jersey *M. densirostris*, and a list and key to the ziphoid whales of the Atlantic coast of North America."

The third American record was the one secured at Southampton, Long Island, for The American Museum of Natural History in 1925. Up to the present time this had not been identified as to species. The rostrum of the skull and both rami of the mandible were very badly broken. It was only after the numerous pieces of the mandible were associated that the true form of the rami could be seen (Figs. 12B, 13A). This in its measurements corresponds very closely to those given by Allen (1906, p. 362) of the Annisquam specimen. The measurements and the form of the teeth of these two specimens are so nearly alike that the most evident conclusion is that the animal stranded at Southampton in 1925 was also a female and of about the same age as the one from Annisquam.

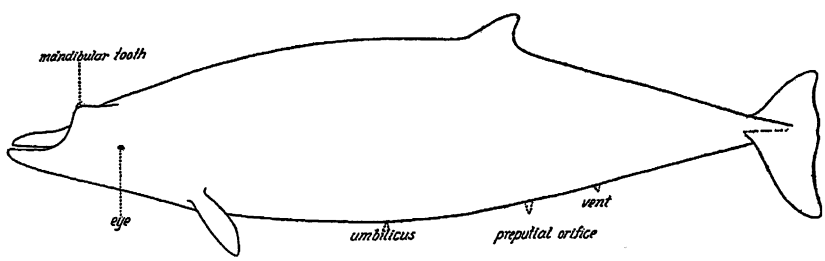


Fig. 1. *Mesoplodon densirostris*. Outline of the whole animal.

It is clear from the thickness, the width and the form of the teeth in these two specimens that they would not have developed into teeth such as are seen in the adult male of this species, for already the pulp cavity is constricted and nearly closed, indicating that the growth of the tooth is almost complete.

The fourth American record and ninth known specimen of this species is the one mentioned above and about to be described.

This specimen was brought to our attention through the kindness of Mr. R. A. McKenzie of the Fisheries Experimental Station, Halifax, Nova Scotia. It was captured by Mr. Lester Hubley at Peggy's Cove about thirty miles south of Halifax early in February and lay frozen in a shed

there until shipped entire to The American Museum of Natural History, New York, where it was received March 25, 1940.

I am indebted to Dr. Harold E. Anthony, Curator of the Department of Mammals, for the privilege of examining the various cetacean skeletons in his charge for comparison with this new material.

DESCRIPTION

Color

Nearly completely black; some reddish patches on the under side between the flippers and about preputial opening and some irregular spots on the belly may have been light gray, blue gray or white in life.

Form

Its body form, as well as the form of its dorsal fin, flukes and flippers, was practically identical with that of four other species of *Mesoplodon* (Fig. 1) I have seen in photographs or in the flesh. This leads me to believe that the dorsal fin of *densirostris* figured by Andrews was probably multilated or otherwise abnormal since it is decidedly truncate, while in all other specimens of *Mesoplodon* the dorsal fin was much higher and with a rounded point. The most striking thing about the external appearance of this small whale was its relatively enormous lower jaw and teeth, the latter sticking up above the level of the top of the head (Figs. 2, 3).

The following measurements were taken on the carcass before it was dismembered:

Table I.—External Measurements of *M. densirostr* Adult Male, No. 139931, in mm.

Tip of rostrum to eye	610
" " " " flipper	1015
" " " " rostral border of dorsal fin	2525
" " " " caudal border of dorsal fin	2840
" " " " vent	3225
" " " " notch in flukes	4390
" " " " blow hole	515
Circumference at eye	1343
" " rostral border of flipper	1825
" " " " " dorsal fin	2157
" " vent	1357
" " caudal peduncle	430
Width of flukes	1040
" " caudal peduncle	88
Depth of caudal peduncle	190
Umbilicus to vent	1142
Preputial opening to vent.	432

The carcass weighed 1783 pounds, plus several pounds of blood which was lost. It was weighed piecemeal after being cut up. Its condition, for a cetacean, was extremely thin.

The three adult males of this species were remarkably uniform in size. The length of the one from Lord Howe Island was 14 feet, 9 inches[1]; that from Corson's Inlet, New Jersey, 14 feet, 5 inches,[2] and this one from Nova Scotia, also 14 feet, 5 inches. *M. densirostris* is thus somewhat smaller in body size than the other species of *Mesoplodon*. The nearly adult female *densirostris* from Annisquam measured 12 feet, 2 inches in length or 84 per cent of the length of the adult males.

Skeleton

Skull.—In this species which has large teeth in the mandible behind the symphysis and a consequent deepening of the jaw in that region there is a resultant dorsal shift of the remnant of the alveolar groove on the side of the rostrum of the skull. This is much more pronounced in old males with extremely large teeth, and in these individuals the breadth of the rostrum is less proximal to the center than at the center, and measured at this constriction its depth is greater than its breadth.

The rostrum of this individual was badly broken when received, but most of the pieces could be fitted together, and the rostrum reconstructed. The apparent great weight of some of the pieces of the rostrum was so noticeable that having seen the following statement "... the long, cylindrical rostrum of the skull, of more than ivory denseness..."[3] I was prompted to measure its specific gravity which proved to be 2.30, whereas that of the tympanic bone of a sperm whale was 2.16, of ele-

[1] Van Beneden and Gervais, 1880, p. 409, "environ 4 mètres 1/2..."
[2] Andrews, R. C., 1914.
[3] Flower and Lydekker, 1891, p. 256.

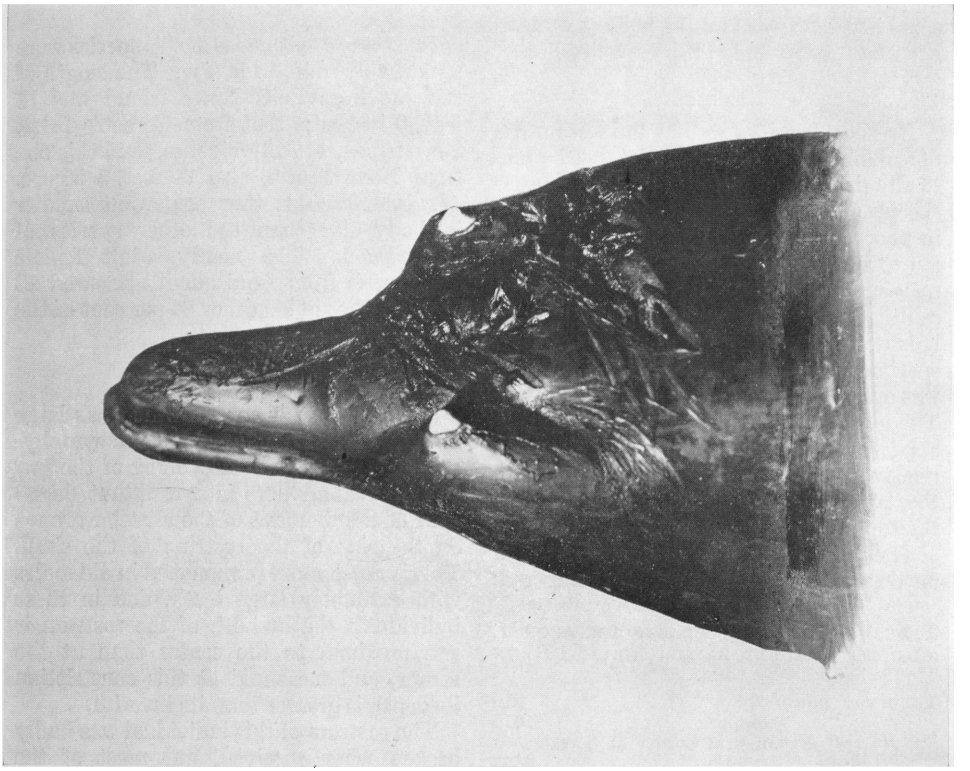


Fig. 2. *Mesoplodon densirostris.* Photograph of head from above and to the left.

Fig. 3. *Mesoplodon densirostris.* Photograph of head from below and to the left.

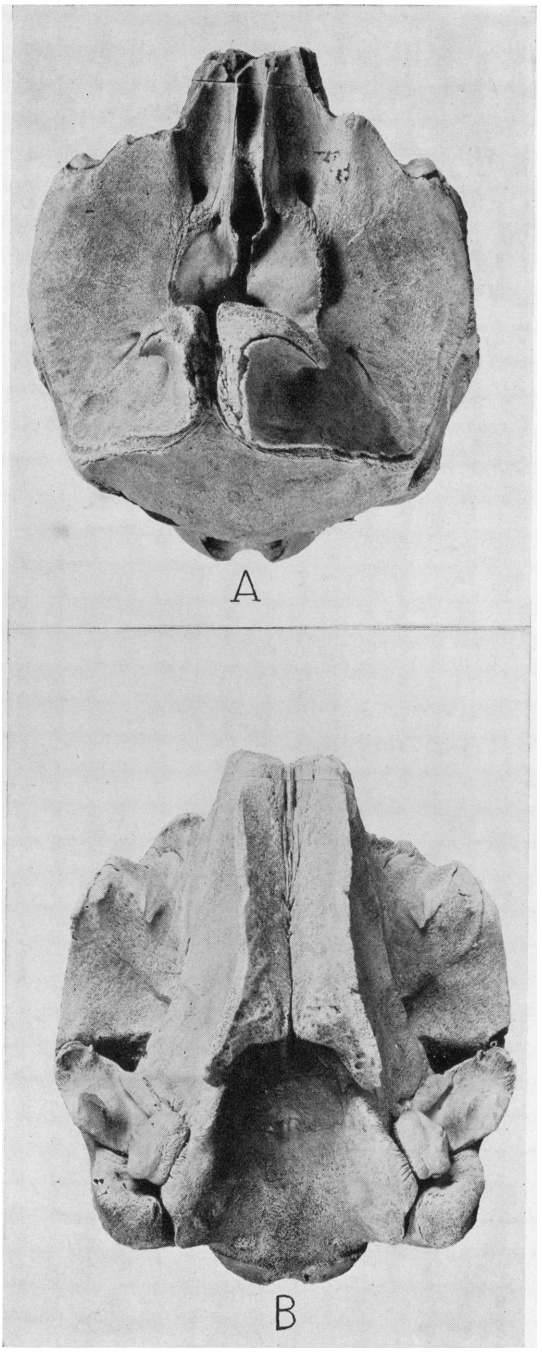


Fig. 6. *Mesoplodon densirostris*. Skull (female): A, dorsal, and B, ventral view.

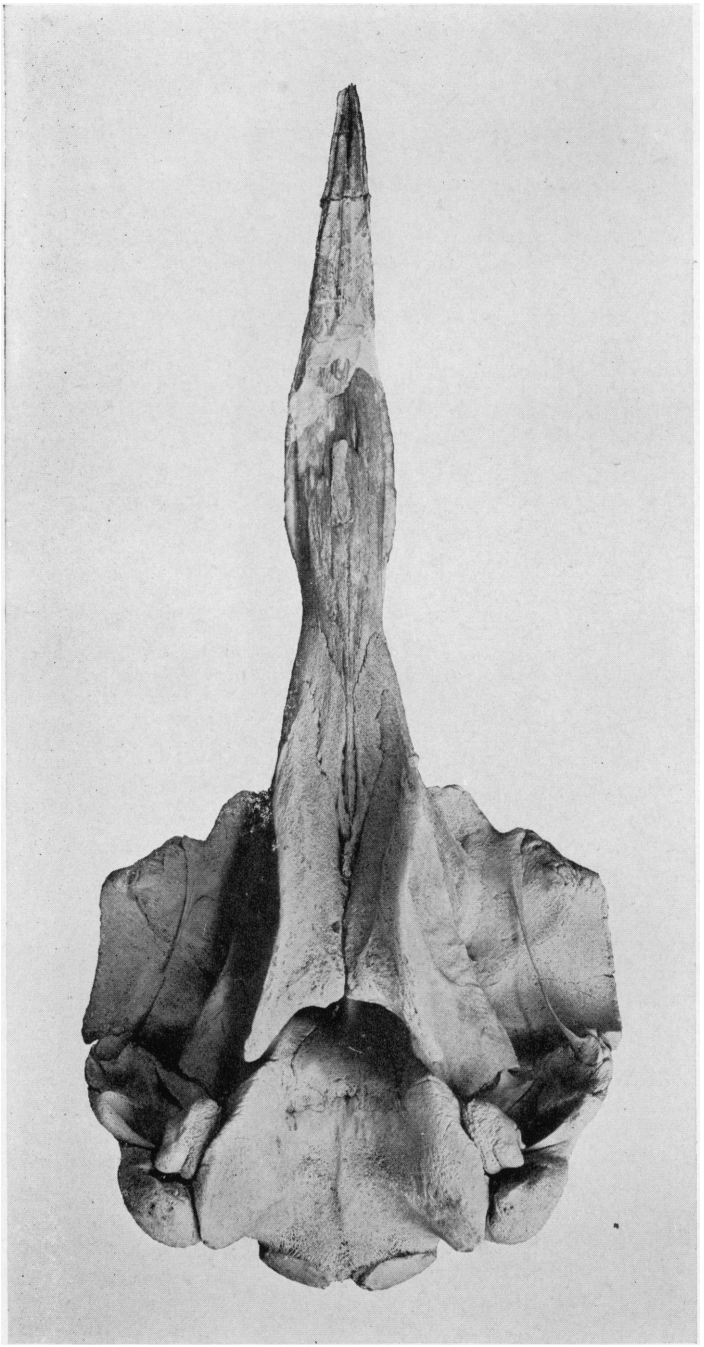


Fig. 7. *Mesoplodon densirostris.* Skull (male), ventral view.

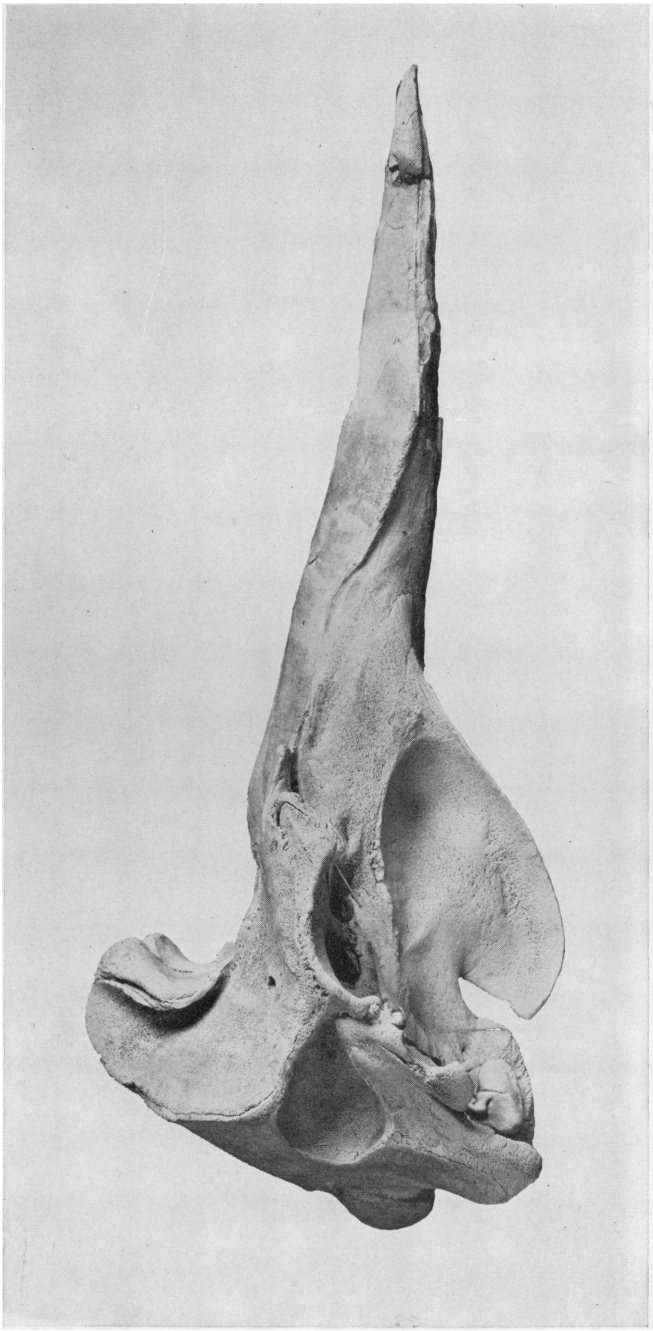


Fig. 8. *Mesoplodon densirostris.* Skull (male), lateral view.

phant ivory, 1.71 and the rib of a manatee, 1.80. In other words, the pieces of the rostrum of the adult male *M. densirostris* have a specific gravity 34 per cent greater than that of elephant ivory and thus possibly are the densest of vertebrate structures.

With the exception of this very dense rostrum the rest of the skeleton is composed of bone so permeated by fine vessels that when cleansed of blood and grease there remained only a porous structure of great friability. It was undoubtedly due in part to this condition that several of the ribs and spinous processes of the vertebrae were found to be broken when the skeleton was cleaned.

A comparison of the fine figures of the skull of this species in Van Beneden and Gervais with those of photographs in True (1910), Andrews (1914) and Harmer (1924) shows the uniformity of skull structure in all these specimens.

I therefore feel that a detailed description of its characters is unnecessary, especially as the following tables of measurements and the photographs depict these very clearly.

Fig. 10, showing the contour of the dorsum of the skull between the antorbital notches, brings out one of the most diagnostic characters of *M. densirostris*, viz., the deep grooves immediately rostral to the maxillary foramina in an adult male and a nearly adult female (Figs. 6–9). In the latter the vomer is still concave dorsally, forming a groove between the premaxillae, purely an age character (Fig. 11).

TABLE II.—SKULL MEASUREMENTS OF MALE AND FEMALE *Mesoplodon densirostris* IN MM.

	A.M.N.H. 139931	A.M.N.H. 69579	Annisquam
Total length	770	...	653*
Height, vertex to inferior border of pterygoids	314	282	248
Width at center of orbits	328	286	278
Width across zygomatic processes of squamosals	325	293	266
Width across occipital condyles	108	100	...
Rostrum, length from level of bases of antorbital notches	495	...	...
Rostrum, width between bases of antorbital notches	192	195	166
Rostrum, width at middle	70	...	38
Rostrum, depth at middle	66	...	...
Least width of rostrum proximal to middle	50	...	...
Depth of rostrum at point of least width proximal to middle	81	...	...
Breadth of expanded proximal ends of premaxillae	122	119	...
Least breadth of premaxillae opposite anterior nares	94	95	...
Breadth of premaxillae opposite premaxillary foramina	70	71	...
Greatest breadth of anterior nares	48	42	...
Least distance between maxillary foramina	50	56	...
Distance from posterior border of maxillary foramen to rostral extremity of maxillary protuberance	65	65	...
Length of portion of vomer visible on palate	...	...	...
Length of mandible	683	635*	...
Length of symphysis	185	180*	...
Greatest height of mandible at coronoid process	130	110*	...
Depth of mandible at posterior margin of tooth	170	85	...

* Estimated.

The rostral portion of the pterygoid fossa, which is occupied by part of the otic diverticulum, is deeper and with a sharper edge in the old male than in the younger female.

In the dorsal view of the skull (Figs. 5, 6) the relation of the maxillary to the premaxillary foramina shows clearly the more rostral position of the former, but if the skull were to be weathered, the roof of the maxillary foramina might be broken, which would give them the appearance of being located more caudally than they actually are.

The mandible and teeth of *M. densirostris* are of diagnostic value. The symphysis is long, and in both The American Museum of Natural History specimens the

rami are partly coalesced at the symphysis so they did not separate during maceration (Figs. 12, 13). The angle of the mandible is its most caudal extension; it is rounded as seen in ventrolateral aspect, and the bone is of almost paper thinness. The mandibular condyle is irregularly semilunar, with its convex border produced laterally and its articular surface directed caudally. The coronoid process is small and thin as it would naturally be in an animal with its temporalis muscle so reduced. The whole of the middle third of the ramus is dominated by the huge tooth in the male. Just behind the symphysis the alveolar margin rises abruptly to the tooth, and behind the tooth is a long thick osseous loph which in life was surmounted by dense fibrous connective tissue.

In the female the proximal and distal thirds of the jaw resembled those of the male, but in the middle third there was no marked deepening of the jaw and only a gentle curve up to the location of the tooth which remained buried within the alveolus; behind it was no indication of the thick loph seen in the male. It is probable that the tooth in the male *M. densirostris* does not erupt until the animal reaches maturity or even comparatively old age and that in the female the tooth remains unerupted throughout life (Figs. 15, 16).

VERTEBRAE.—The vertebral formula for this adult male specimen from Nova Scotia appears to differ from the others. Its formula is compared below with other skeletons of *M. densirostris:*

Nova Scotia, male	C. 7;	T. 11;	L. 8;	Cd. 21 = 47
New Jersey, male[1]	C. 7;	T. 10;	L. 11;	Cd. 18 = 46
Lord Howe I., male[2]	C. 7;	T. 10;	L. 11;	Cd. 17 = 45

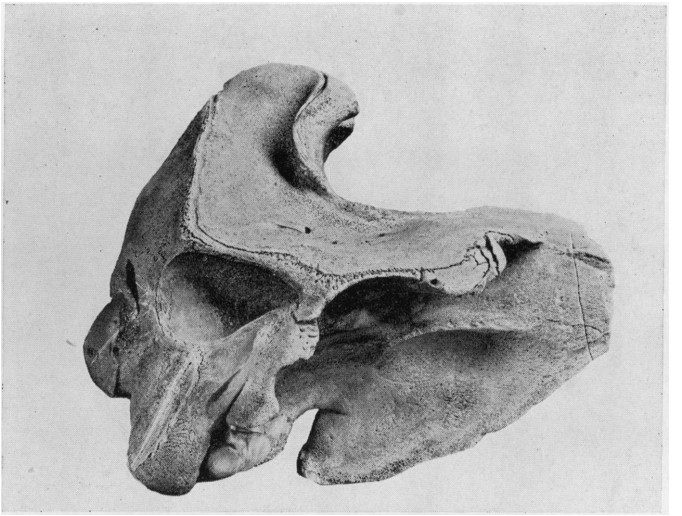


Fig. 9. *Mesoplodon densirostris.* Skull (female), lateral view.

The following measurements were taken of the vertebrae: length of the seven cervical vertebrae (Figs. 17, 20), centra, in apposition, 120 mm.; breadth of the rostral articular surface of the atlas, 112 mm.

The first three cervical vertebrae are coalesced, having a single fused spinous process and fused centra; only the transverse processes remain separate.

The neural arch of the fifth cervical was not coalesced dorsally; the left side bears the spinous process. The sixth cervical

[1] Andrews, 1914, p. 439.
[2] Van Beneden and Gervais, 1880, p. 409.

likewise was not coalesced dorsally, and the right side was 5 mm. higher than the left. In the younger female example from Southampton, Long Island, New York, the arch of the fifth cervical is not joined dorsally, and the sixth has a groove on the rostral aspect of its neural arch, which cuts more than halfway through the bone. The irregular severance of the neural arches of the fifth and sixth cervical vertebrae, therefore, may be a common character of *M. densirostris*.

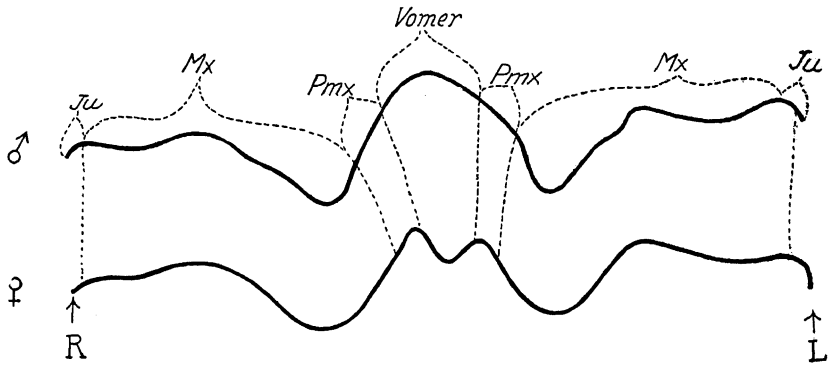


Fig. 10. *Mesoplodon densirostris.* Contour across dorsum of male and female skulls just rostrad of maxillary foramina.

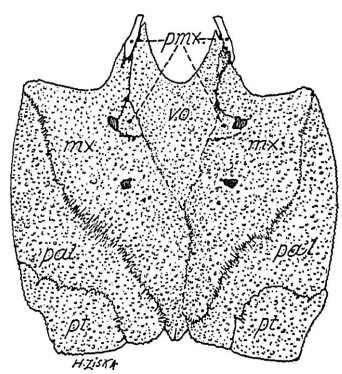


Fig. 11. *Mesoplodon densirostris.* Vertical section of the base of the rostrum of a female.

The transverse process of the seventh cervical, which is closely appressed to that of the first thoracic, has grown forward so that its extremity is directly lateral to the rostral border of the fifth cervical. The rather than behind, the cervicals. The lower transverse process of the seventh cervical vertebra bears a facet for articulation with more than three-fourths of the capitulum of the first rib, and the tuberculum of the first rib articulates to a small degree with the upper transverse process of the seventh cervical vertebra.

The thoracic vertebrae (Fig. 17) increase in length of centrum and in height of spinous process from the first to the last. Pre- and post-zygapophyseal processes and their articular surfaces are progressively reduced from before backward and are absent behind the eighth and ninth thoracic vertebral joint. The first distinguishable metapophysis is on the third thoracic vertebra as a low, dorsally placed protuberance near the extremity of the transverse process. On the fourth thoracic the metapophysis has a rostrally directed extension a centimeter in length. By the time the seventh thoracic vertebra is reached the metapophysis is located more medially. That on the eighth thoracic is definitely raised and plate-like. The succeeding ones (Figs. 18, 19) are all flat, vertically placed structures, each pair embracing the caudoproximal part of the preceding spinous process back to the fifth

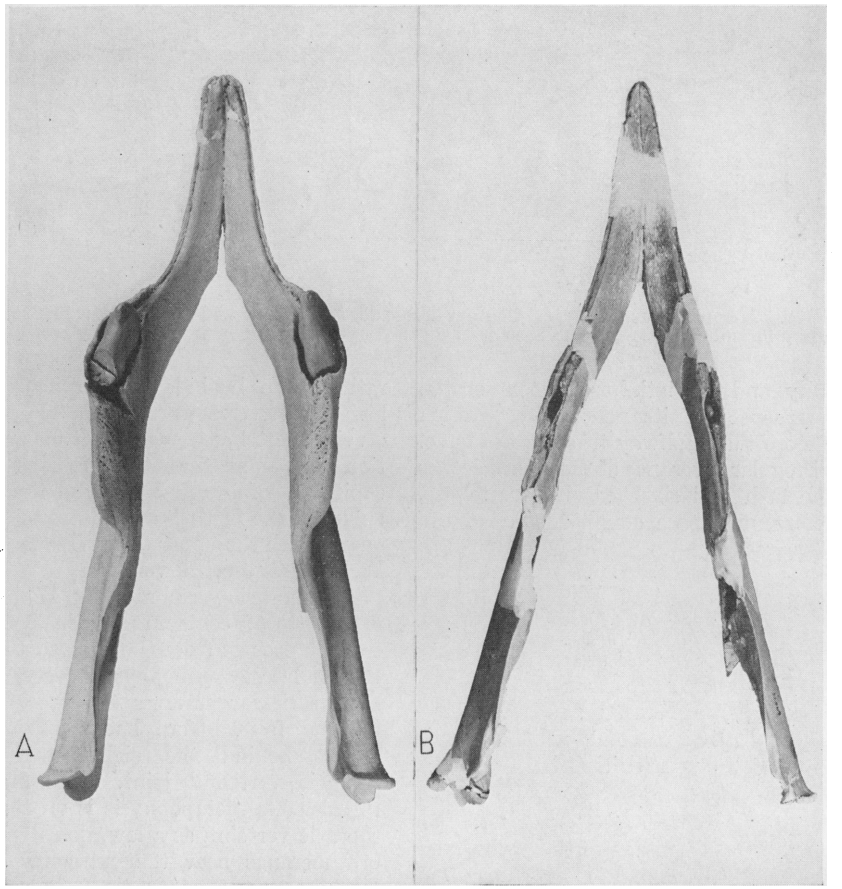


Fig. 12. *Mesoplodon densirostris.* Mandible: dorsal view of male, A, and female, B.

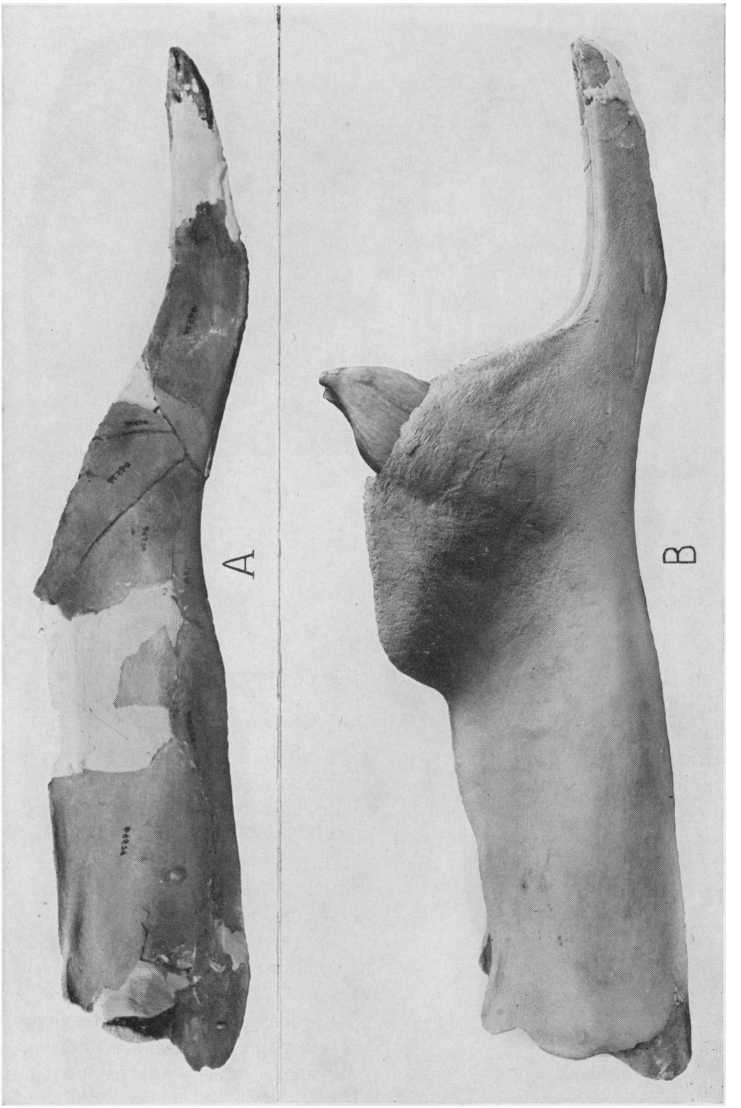


Fig. 13. *Mesoplodon densirostris.* Mandible: lateral view of male, A, and female, B, reversed.

lumbar. Behind the fifth lumbar the metapophyseal plates are progressively reduced until the third caudal is reached; there their plate-like character is lost, but their reduction in size on the caudals continues until they are eliminated entirely behind the thirteenth caudal.

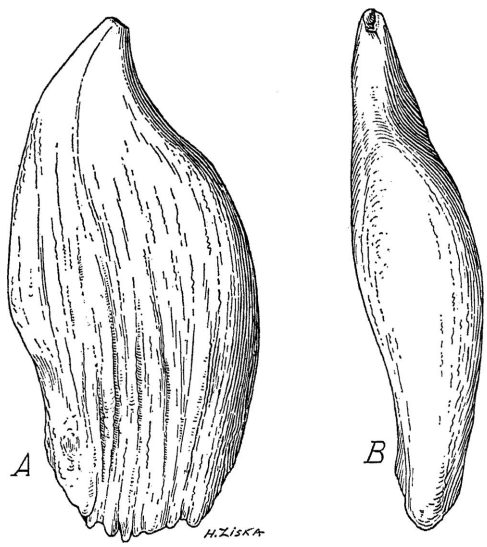


Fig. 14. *Mesoplodon densirostris*. Right tooth of male: A, medial view; B, caudal view.

The transition in character between the hinder thoracic vertebrae and the first lumbar is very striking, as can be seen by consulting the table of measurements of the width across the transverse processes of the ninth, tenth and eleventh thoracics and the first lumbar. Were it not that we have rudimentary ribs, which articulate with the transverse processes of the last thoracic, it would be impossible to identify this positively as a thoracic vertebra, for the articular facets on the caudal extremities of its transverse processes are not well marked. The lumbars are fairly uniform. Their metapophyses are plate-like, the neural spines are tall and broad, the transverse processes are horizontal, broad and long, and the centra of each bears a median ventral keel. This keel, though low, assumes its definitive character as far forward as the eighth thoracic and is last to be seen on the first caudal.

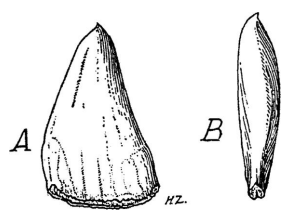


Fig. 15. *Mesoplodon densirostris*. Left tooth of female: A, lateral view; B, caudal view.

The first caudal vertebra, though having a median ventral keel like the lumbars, possesses a pair of articular facets on its ventrocaudal border for the attachment of the first pair of haemapophyses. The first eleven caudals have similar articular facets, but the twelfth has the articular facet on its rostroventral aspect for the haemal arch, which is attached mainly to the eleventh caudal. The last neural spine is on the eleventh caudal. The caudals twelve to twenty-one are embedded in that part of the tail occupied by the flukes.

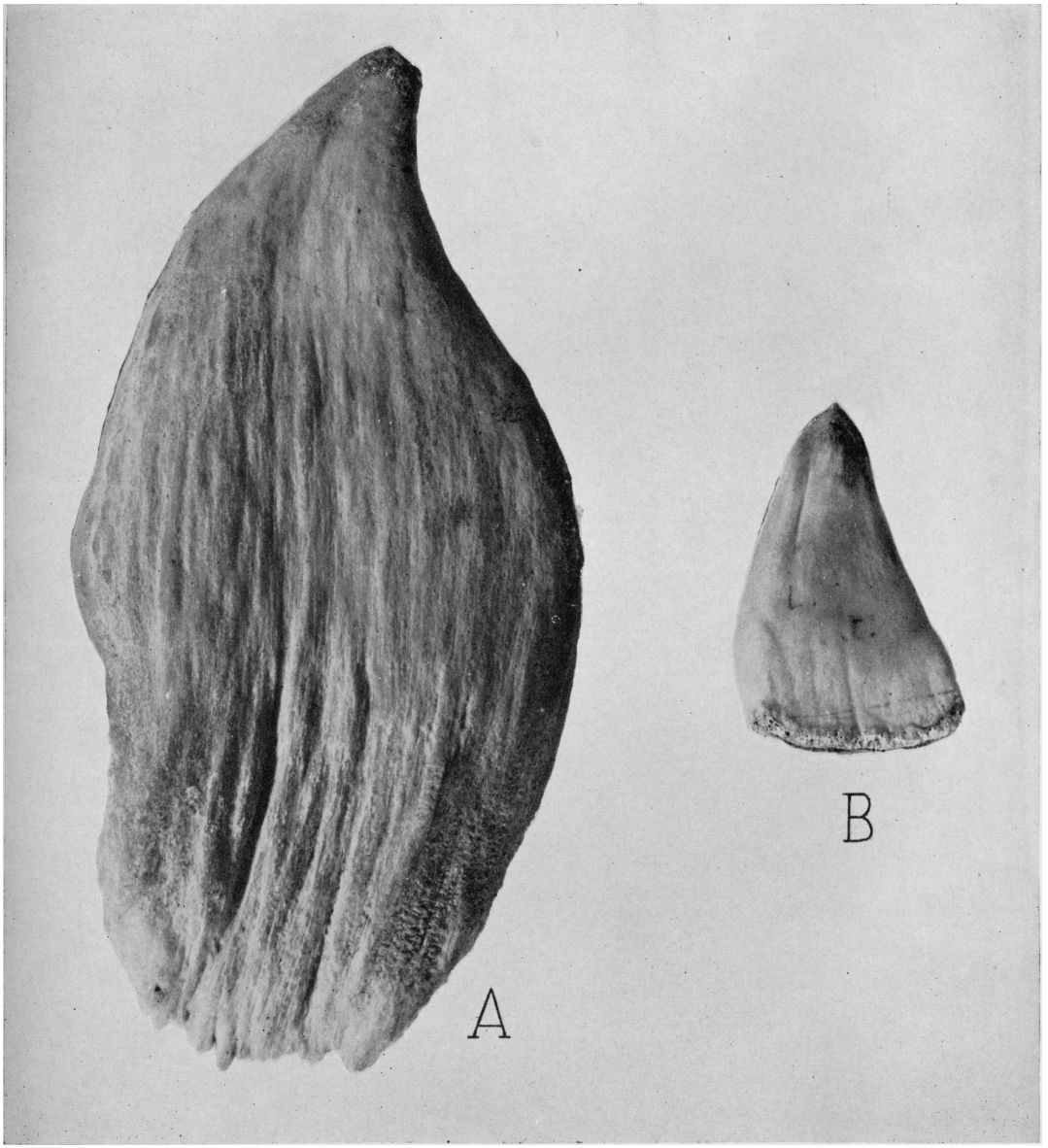
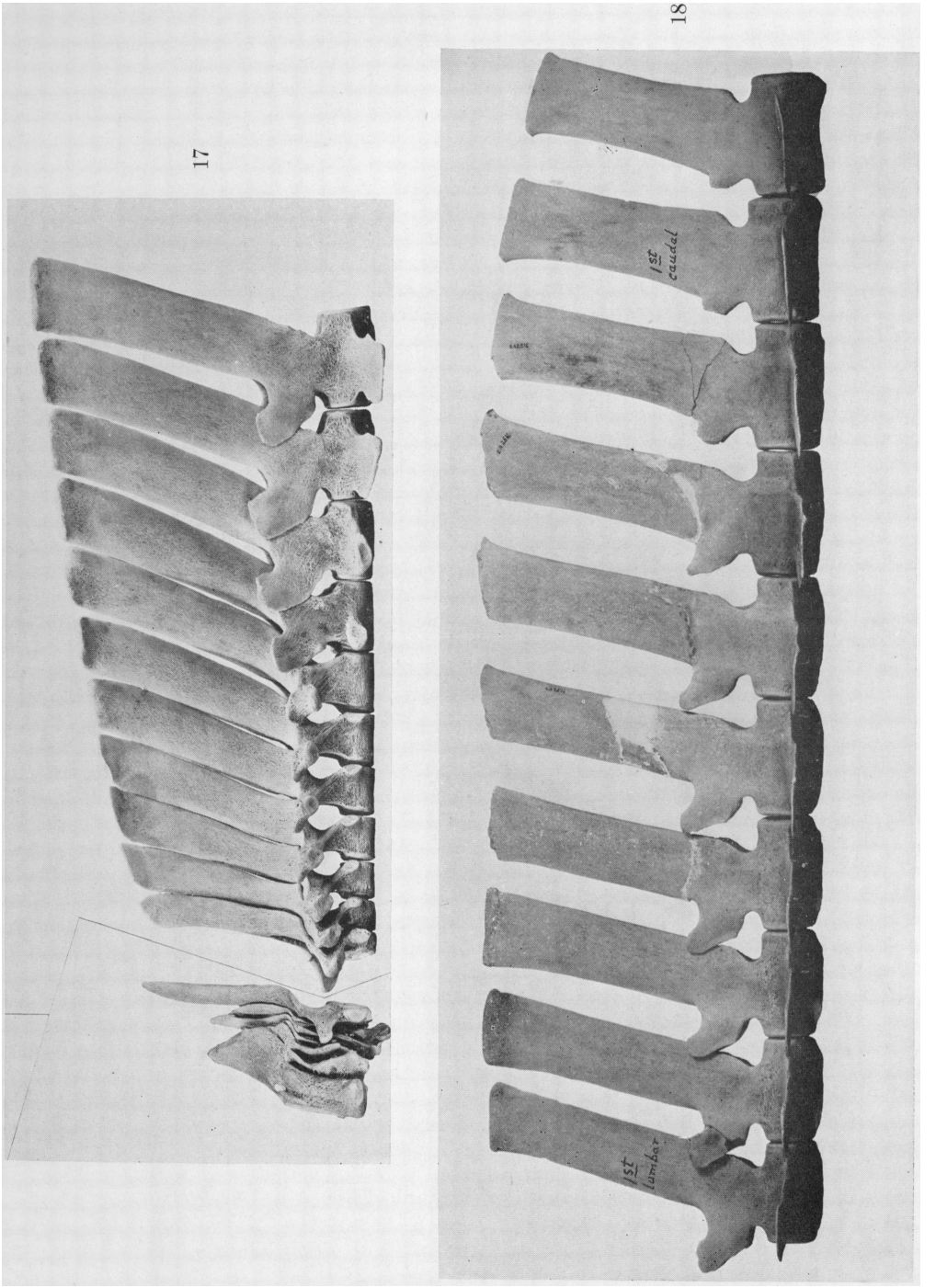


Fig. 16. *Mesoplodon densirostris.* Teeth of male, A, and female, B.


17
18
1st lumbar
1st caudal

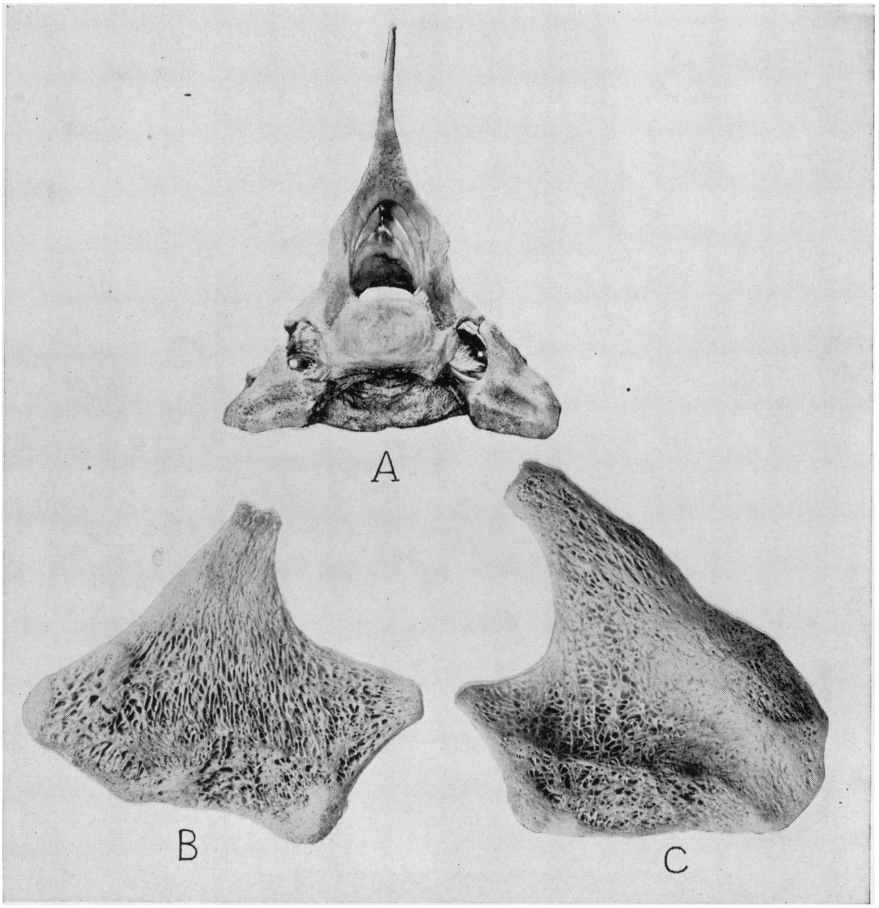


Fig. 20. *Mesoplodon densirostris*. A, cervical vertebrae with cervical ribs in place, caudal view; B, cervical rib of left side, caudal view; C, cervical rib of right side, caudal view.

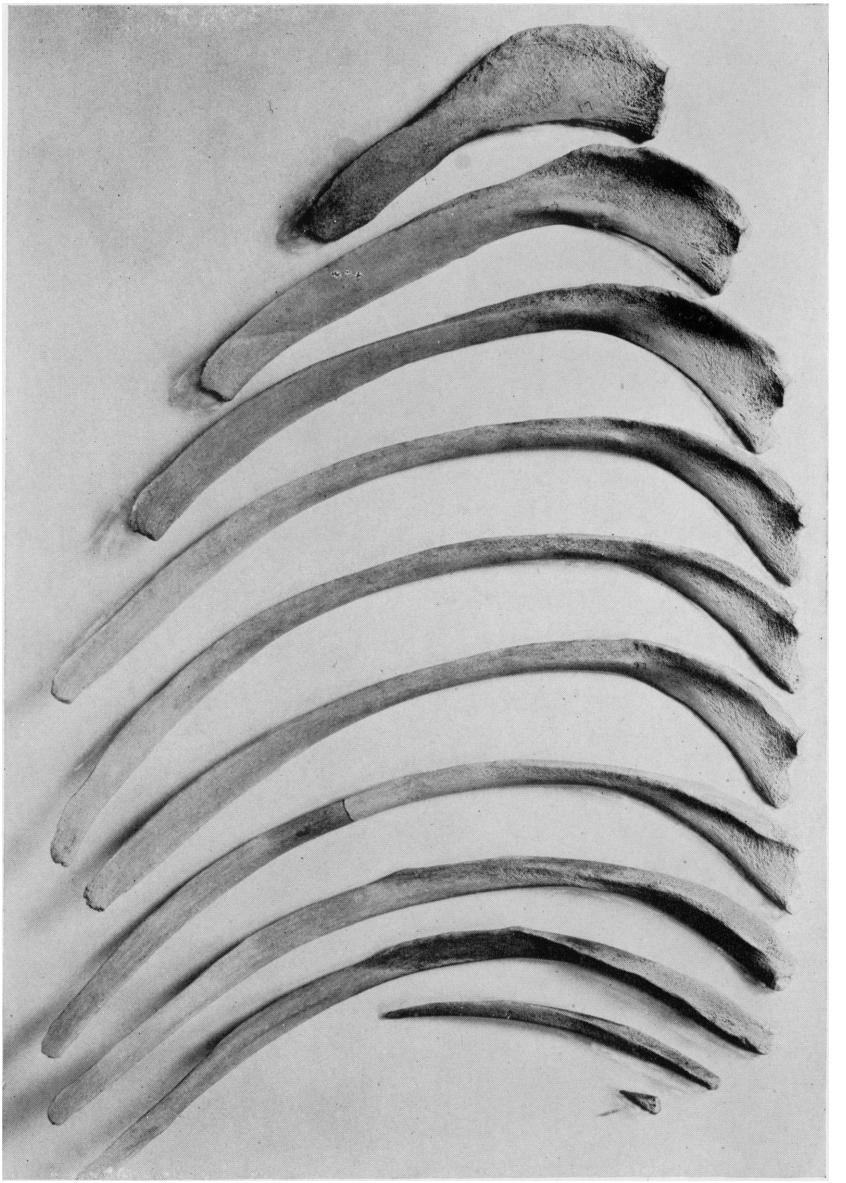


Fig. 21. *Mesoplodon densirostris.* Ribs of the left side, medial view.

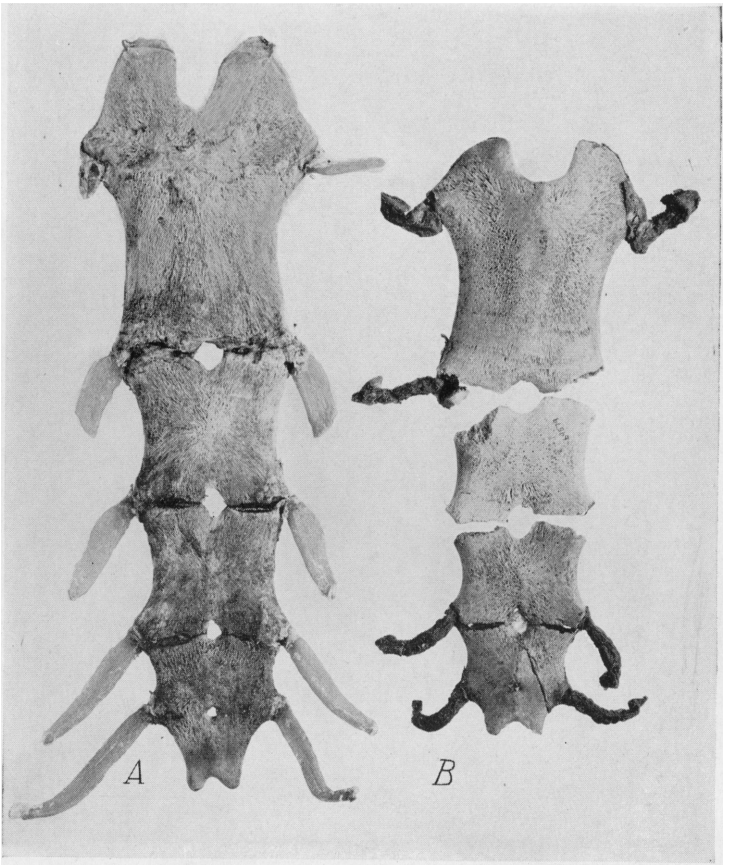


Fig. 22. *Mesoplodon densirostris.* Sterna: A, male; B, female.

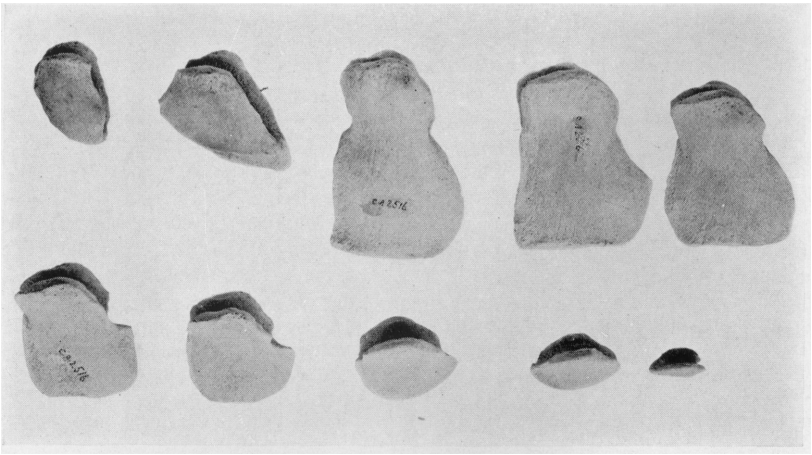


Fig. 23. *Mesoplodon densirostris.* Chevrons. The first is on the upper left; the tenth, at the lower right.

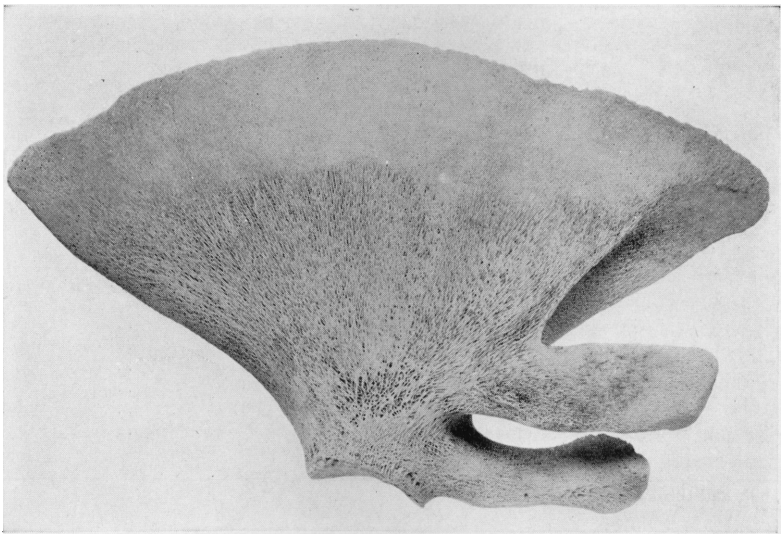


Fig. 24. *Mesoplodon densirostris.* Right scapula of male.

TABLE III.—MEASUREMENTS OF VERTEBRAE OF *Mesoplodon densirostris*, ADULT MALE, No. 139931, IN MM.

		Greatest length of centrum	Greatest height in midline	Greatest width = transverse process	Greatest height of neural canal	Greatest width of neural canal
Atlas		54*	170*	185	35	55
Axis		*	*	178	37	55
3rd	Cervical	*	*	135	40	49
4th	"	13	113	126	43	42
5th	"	14	157	136	56	41
6th	"	16	138	116	65	43
7th	"	18	235	125	62	45
1st	Thoracic	24	266	145	65	47
2nd	"	30	295	158	60	49
3rd	"	40	317	163	56	49
4th	"	49	333	163	58	47
5th	"	54	348	156	60	45
6th	"	60	365	151	60	43
7th	"	74	386	145	55	42
8th	"	80	398	104	53	38
9th	"	91	402	151	51	35
10th	"	103	405	260	52	30
11th	"	110	408	300	50	27
1st	Lumbar	114	408	310	52	28
2nd	"	117	410	310	48	27
3rd	"	121	410	310	47	30
4th	"	127	401	305	45	27
5th	"	133	413	302	45	27
6th	"	138	415	300	37	25
7th	"	143	413	295	32	24
8th	"	144	397	283	26	22
1st	Caudal	141	375	274	21	19
2nd	"	133	350	251	20	15
3rd	"	128	321	226	14	11
4th	"	121	288	210	12	11
5th	"	113	261	181	11	10
6th	"	105	220	151	10	7
7th	"	104	194	125	7	6
8th	"	100	169	95	6	7
9th	"	97	147	75	5	5
10th	"	90	128	66	4	4
11th	"	69	98	64	3	3
12th	"	46	72	63	..	..
13th	"	36	54	57	..	..
14th	"	32	47	52	..	
15th	"	31	40	55	..	..
16th	"	30	36	49	..	..
17th	"	28	31	42	..	..
18th	"	27	24	34	..	..
19th	"	21	20	26	..	..
20th	"	19	16	22	..	..
21st	"	7	7	9	..	..

* Atlas, axis and third cervical fused.

There are ten haemal arches (Fig. 23). The first arch is formed of two independent plates, a right and a left. In other words, the distal part of the arch is not coalesced as it is in the succeeding ones. The first four caudals have articular facets for the haemal arches only on their caudoventral borders. Caudals 5 to 11, inclusive, have articular facets for haemals, both rostrally and caudally. The twelfth, however, has articular facets for the haemal only on its rostral aspect, which indicates another haemal may have been present as a nodule and lost in preparation.

RIBS.—There is one pair of cervical ribs (Fig. 20). These are asymmetrical, irregular, plate-like structures. The right one is 80 mm. in greatest length. Its capitulum bears no articular facet. It may have been broken off, for there are corresponding facets on the rostrolateral aspect of the centrum of the seventh and caudolateral aspect of the sixth cervical. This rib also articulates with, or is appressed to, the caudal aspect of the enlarged lower transverse process of the sixth cervical. The tuberculum is represented by a well-defined process with a distinct articular facet, for articulation with the upper transverse process of the seventh cervical. The nearly semicircular cavity between capitulum and tuberculum of this rib forms part of the ventral aspect of the extremely short vertebra-arterial canal.

there any articular facet on either the sixth or seventh centra for the reception of such a process. Both cervical ribs possess broad shallow grooves on their caudal surfaces extending lateroventrally. These grooves doubtless formed the rostral walls of channels in which were located nerves of the cervicobrachial plexus.

The first five of the thoracic ribs (Fig. 21) are attached to the sternum by progressively longer costal cartilages. The first costal cartilage is about 50 mm., the second about 60, the third 80, the fourth 95 and the fifth 120.

The first seven ribs are articulated by both tubercula and capitula. The remaining four lack tubercula. The proximal part of the first seven ribs is broad; the shafts of the first two are also broad.

STERNUM.—The sternum (Fig. 22) in

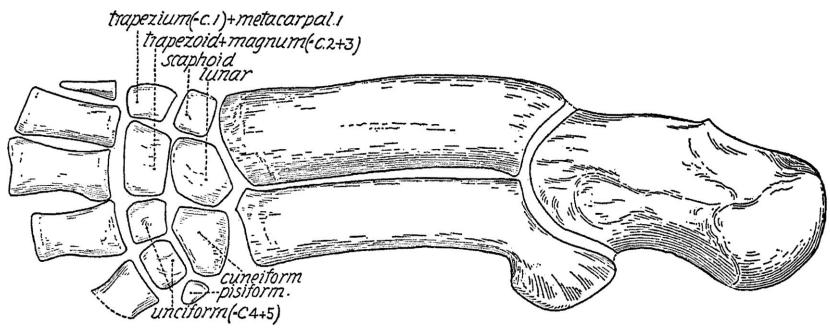


Fig. 25. *Mesoplodon densirostris.* Humerus, radius, ulna, carpals and metacarpals of male.

TABLE IV.—LENGTH (IN MM.) IN A STRAIGHT LINE OF THE RIBS OF *M. densirostris*, No. 139931

	Left	Right
1st	320	319
2nd	455	458
3rd	540	542
4th	610	592
5th	618	620
6th	580	630
7th	610	615
8th	595	583
9th	555	548
10th	273	222
11th	39	43

The cervical rib of the left side is slightly smaller than that of the right, but its facies are homologous. Its capitular process is slender and bears no articular facet nor is

both the male from Nova Scotia and the female from Long Island consists of four segments. The posterior segment of each consists of two parts, the distal one in each case being perhaps an ossified xiphisternum. The manubrium is deeply notched, much as it is in *M. europaeus*, and in this particular specimen it is asymmetrical.

In the female that part of the manubrium rostral to the first costal cartilage is much shorter than in the male, and the notch is very much shorter and wider.

The sternum of the male agrees very closely, even to the asymmetry of the manubrium, with the male from New Jersey described by Andrews in 1914.

The sternum of the female from Long Island agrees fairly well with the female described by Allen from Annisquam except for the rostral processes of the manubrium, which are either undeveloped or imperfectly preserved. All the known specimens of *densirostris* agree as to the number of sternebrae and in having the first segment longer than wide.

bones in other species of *Mesoplodon*. The carpus consists of eight elements (Fig. 25). The pelvis is represented by a single small bone on each side. They lie dorsolateral and rostral to the mammary grooves and 95 mm. beneath the skin. The pelvic rod (Fig. 26) of the right side has been dissected from its position. It measures 75 mm. in length. Its caudal half is the

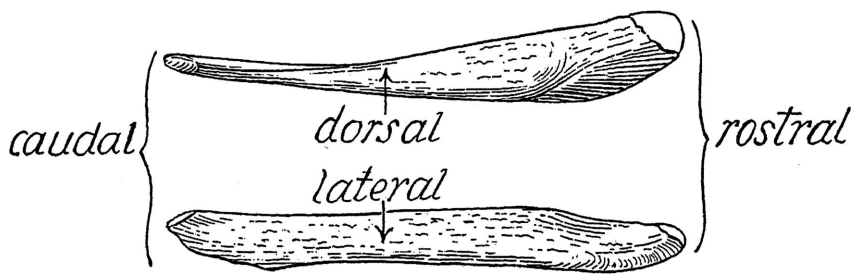


Fig. 26. *Mesoplodon densirostris*. Pelvic bone of the right side of male. Natural size.

TABLE V.—MEASUREMENTS IN MM. OF PARTS OF THE STERNUM OF *M. densirostris*

	A.M.N.H. No. 139931 Nova Scotia ♂	A.M.N.H. No. 69579 Long Island ♀
Total length	530	420
Sternebra 1, length	210	179
" 1, width	159	148
" 2, length	106	85
" 2, width	109	101
" 3, length	94	75
" 3, width	102	97
" 4, length	109	73
" 4, width	91	77
Fontanelle 1, length	18	24
" 2, length	19	21
" 3, length	9	15
" 4, length	7	...

The forelimb, as in other species of the genus, is outwardly small, elliptic and rather long in proportion to its width. This is reflected in the bones of the manus and digits which do not fan out to any considerable degree. The scapulae (Fig. 24) are very broad, thin and with the surfaces of a trabecular nature. The remaining bones of the forelimb are smooth on the surface but also extremely light and cancellous within. The humerus, radius and ulna do not differ conspicuously from the same smaller and is compressed. The rostral half is thicker, somewhat depressed and slightly curved medianward so that, viewed dorsally, the medial aspect of the bone is very slightly concave, whereas its lateral aspect is convex. The rostral extremities of the bones are consequently closer together than are their caudal extremities.

TABLE VI.—MEASUREMENTS IN MM. OF FORELIMB BONES OF *M. densirostris*, NO. 139931

	Right	Left
Scapula		
Height, glenoid to the vertebral border	210	208
Length	263	367
Acromion, along ventral border	120	118
" greatest width	46	41
Coracoid process, length from lip of glenoid	110	112
Coracoid process, greatest width	43	39
Humerus		
Length	131	130
Proximal width	74	75
Radius		
Length	157	152
Proximal width	42	39
" thickness	28	30
Ulna		
Greatest length	168	171
Proximal width of shaft	32	32
Greatest thickness of shaft	25	26

DISCUSSION

I have been able to find little in the literature about cervical ribs in cetaceans except the bare statement that they do occur.

I believe that this is the first recorded occurrence of a cervical rib in *Mesoplodon*. Kellogg (1936) writes, "As an individual variation in the finback the proximal end of the first rib is occasionally split by a short cleft, making it bicipital. The explanation generally accepted for this condition is that a cervical rib is fused with the rostral surface of the first rib."

The statement by Flower that, "The posterior ribs, however, lose the neck and are solely articulated by the tubercle to the transverse process," together with his figures of some of the thoracics in *Physeter*, led me to examine the ribs in a number of cetacean skeletons.

I was surprised to find that there appear to be three different methods for the articulation of the posterior ribs. Apparently, the most primitive have a fusion of tubercle and capitulum on the posterior ribs. In other words, where the ribs are two-headed in the anterior vertebrae, the articular facets grow closer together on the posterior thoracics until they form one point of articulation with the column. This condition is to be found in *Zygorhiza*, *Inia* and *Platanista gangetica*.

In another group the tubercula are retained and the capitula lost, as described by Flower for *Physeter*. To this group also belong the following: *Balaenoptera physalus*, *Neobalaena marginata*, *Rhachinectes glaucus* and *Eubalaena glacialis* among the Mysticetes, and *Phocaena*, *Orcinus*, *Monodon*, *Delphinapterus*, *Delphinus*, *Sotalia*, *Grampus* and *Globiocephalus* among the Delphinidae.

To the third group, those which lose the attachment by means of the tubercle and retain an articulation through the capitulum to the centrum or the transverse process extending laterally from it, as far as I can determine, belong only members of the Ziphiidae, of which skeletons of the following were examined: *Mesoplodon densirostris*, *M. grayi*, *M. mirum*, *M. bowdoini*, *Hyperoödon ampullatus* and *Berardius bairdii*.

In *Mesoplodon densirostris*, as in other species of *Mesoplodon*, the tympanic bone has a very large posteriorly directed process, which in reality is a mastoid process or mastoid portion of the tympanic. In *Mesoplodon* there is no mastoid portion of the periotic. The comparison of the mastoid region in a number of different mammals, including young human, hyena, dog, pinnipedes, as well as a young *Monodon*, seems to show that if the mastoid portion of the petrous bone is retracted so that it does not appear on the surface of the skull, its place may be taken by the entotympanic. This is evident in such an animal as *Hydrurga*.

As Kellogg and others have pointed out, *Mesoplodon* and other ziphioids retain a separate jugal and lacrimal. The lacrimal extends a long way medianward at the anterior border of the orbit. The antorbital notch is formed by the jugal, which lies almost entirely below the maxillary.

The slender descending dactyloid process of the squamosal, which lies against the anterior aspect of the petrous bone, is probably homologous with the entoglenoid process of other mammals.

The fossa for the otic diverticulum, although well marked, is not enclosed in a bony pocket rostrally as it is in various delphinids. It would seem that, although the *Mesoplodon* skull is more specialized in some ways than that of most delphinids, in other ways it is more primitive.

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