

Biological Observations
on *Mesoplodon carlhubbsi*
(Cetacea: Ziphiidae)

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and
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ABSTRACT

Mead, James G., William A. Walker, and Warren J. Houck. Biological Observations on *Mesoplodon carlhubbsi* (Cetacea: Ziphiidae). *Smithsonian Contributions to Zoology*, number 344, 25 pages, 11 figures, 4 tables, 1982.—The literature reports of *Mesoplodon carlhubbsi* strandings are confusing, owing to the erroneous identification of *Mesoplodon* species. *Mesoplodon carlhubbsi* is distinct from *M. stejnegeri* and closely related to *M. bowdoini*. Adult *M. carlhubbsi* are recognized by white (males) or light-colored (females) beaks. We report 31 strandings of this species from both the east and west coasts of the North Pacific. Scarring is very marked in older males and probably results from intraspecific aggression. Calving season is in the summer. Length at birth is about 250 cm. Both females and males reach 488–532 cm at physical maturity. Food items are fish and squid. Distribution extends from the confluence of the Kuroshio and Oyashio currents in the west to the mixed region of the California current in the east.

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Biological Observations on *Mesoplodon carlhubbsi* (Cetacea: Ziphiidae)

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Introduction

At present there are five species of *Mesoplodon* recorded from the North Pacific Ocean: *M. stejnegeri*, *M. carlhubbsi*, *M. ginkgodens*, *M. hectori*, and *M. densirostris*. Moore (1963) defined the distinctions between the species of *Mesoplodon* then known to inhabit the North Pacific (*M. stejnegeri* and *M. carlhubbsi*) and in a subsequent paper (Moore, 1966) distinguished all other species of *Mesoplodon* then known from North American shores, including the then recent records of *M. densirostris* from the North Pacific (Galbreath, 1963). Nishiwaki and Kamiya (1958) provided an extensive description of *M. ginkgodens* and a comparison with all other known species of this genus. *Mesoplodon ginkgodens* was subsequently recorded from the west coast of North America by Moore and Gilmore (1965). Mead (1981) recorded *M. hectori* from California. There are now enough new biological data on *M. carlhubbsi* to justify a review of its biology and morphology.

Erroneous identifications consistently caused

serious problems in studying these species. Orr (1953), using the limited material then available, considered *M. bowdoini*, *M. carlhubbsi*, and *M. stejnegeri* to be conspecific and attributed the observed differences to age. Although this was covered adequately by Moore (1963, 1966), McCann (1964, 1976) again lumped all three species into *M. stejnegeri*, confusing an already bewildering distributional record. Although Moore clearly separated *M. carlhubbsi* and *M. stejnegeri*, it also was evident that *M. carlhubbsi* and *M. bowdoini* were closely related, and further work was needed to define their status and the degree of their relationship.

The following abbreviations are used to designate museum collections:

BCPM	British Columbia Provincial Museum, Victoria, B.C.
CAS	California Academy of Sciences, San Francisco, Calif.
HSUZ	Department of Zoology, California State University, Arcata, Calif.
LACM	Los Angeles County Museum, Los Angeles, Calif.
MVZ	Museum of Vertebrate Zoology, University of California at Berkeley
SJSU	San Jose State University, San Jose, Calif.
UBC	University of British Columbia, Vancouver, B.C.

James G. Mead, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560. William A. Walker, 21 Barkentine Road, Rancho Palos Verdes, California 90274. Warren J. Houck, Division of Biological Sciences, California State University, Arcata, California 95521.

USNM former United States National Museum, collections in the National Museum of Natural History, Smithsonian Institution

ACKNOWLEDGMENTS.—Michael Bigg of the Fisheries and Marine Service of Canada kindly provided information on the whereabouts of photographs of UBC 9307 and the Prince Rupert animal. These were retrieved from the files of the late G. C. Pike, which are currently housed at the Arctic Biological Station, Fisheries and Marine Service, Sainte Anne de Bellevue, Quebec. R. W. Campbell of the British Columbia Provincial Museum made their specimen available to us and provided us with a photograph of UBC 9416 and the measurements of UBC 9360. Francis H. Fay of the University of Alaska kindly provided us with the photographs of the specimen of *Mesoplodon stejnegeri*. Clifford Fiscus of the National Marine Fisheries Service, Seattle, provided identifications on some of the squid beaks. Malcomb Clarke of the Marine Biological Association of the United Kingdom identified the *Gonatus* sp. beaks. H. Dean Fisher of the University of British Columbia provided access to their collections. John Fitch of California Fish and Game identified the otoliths and commented on the fish that we had found. D. F. Hatler of the British Columbia Fish and Wildlife Branch allowed us to use the measurements of UBC 9416. John Heyning of the Los Angeles County Museum provided the data on the San Jose State University specimens. Eric Hochberg of the Santa Barbara Museum of Natural History made their collections of squid beaks available and was extremely helpful in making identifications. The late Carl L. Hubbs supplied us with information on USNM 278031 and USNM 504883. Robert Jones of the Museum of Vertebrate Zoology at Berkeley provided us with information and the stomach contents of CAS 16596. L. R. Richards took the photographs of MVZ 115607. Aryan Roest provided us with the information on LACM 54576. Jacqueline Schonewald of the California Academy of Sciences provided us with information on their specimens. The manuscript was read and helpful criticisms were given by John Heyning, Los An-

geles County Museum; Rebecca G. Mead, Smithsonian Institution; Joseph Curtis Moore, Lakeland, Florida; Roger Payne, New York Zoological Society; William Perrin, Southwest Fisheries Center; B. J. Verts, Oregon State University.

Species Recognition in the North Pacific

SIZE AND POSITION OF THE TEETH.—Moore (1963) made a detailed comparison of the shape and location of the teeth of adult males of *M. carlhubbsi* and *M. stejnegeri*. He found that the alveolus in *M. carlhubbsi* extends slightly anterior to the posterior end of the mandibular symphysis but lies entirely posterior to it in *M. stejnegeri*. Also he found the apex of the tooth to be situated posterior to the anterior edge of the tooth in *M. carlhubbsi* but in a line with the anterior edge in specimens of *M. stejnegeri*. Our material is in agreement, and our only addition is to note that the peculiar wear noted by Moore (1963:401) and Nishiwaki (1962a:71) on the anterior edge of the teeth of *M. stejnegeri* is seen consistently in teeth of large males of *M. stejnegeri* but in those of *M. carlhubbsi* is prevented by the dorsal extension of the tissue of the lips around the teeth in the latter species (Figure 1). Moore (1963, fig. 8) showed the exposed crown of the tooth, as indicated by the transverse line dividing the rough surface of the root from the smoother surface of the crown, as more extensive in *M. stejnegeri* than in *M. carlhubbsi*. The *M. carlhubbsi* teeth illustrated by Moore (1963) (USNM 278031), represent the maximum observed exposure of the crown in this species.

In adult males of *M. ginkgodens*, the teeth lie posterior to the symphysis (as in *M. stejnegeri*) but are much shorter than in either *M. carlhubbsi* or *M. stejnegeri* and have the apex centrally located instead of displaced anteriorly.

The shape of the teeth in female and juvenile *M. carlhubbsi* and in all *M. stejnegeri* is similar; however, positional differentiation is greater in juveniles and adult females of these two species than in adult males, with teeth of *M. carlhubbsi*

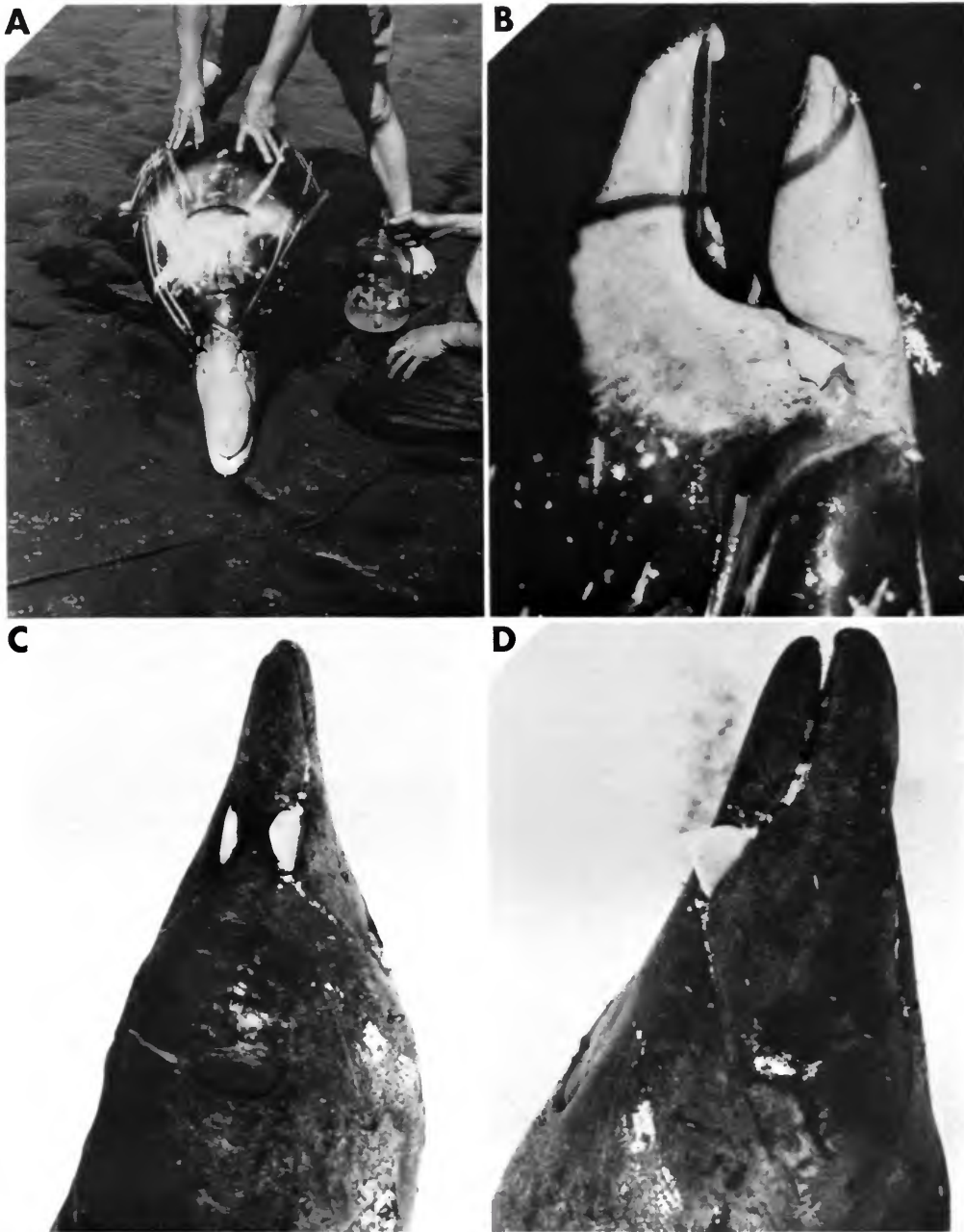


FIGURE 1.—Comparison of heads of *Mesoplodon carlhubbsi* (MVZ 115607) and *Mesoplodon stejnegeri* (525 cm male, stranded 13 Nov 1977 at Homer, Alaska; skeleton preserved by Homer Society of Natural History): A, B, dorsal and lateral views of head of MVZ 115607; C, D, dorsal and lateral views of head of Homer specimen. Note difference in pigmentation and degree to which gum covers tooth.

lying entirely anterior to the posterior border of the symphysis, and those of *M. stejnegeri* entirely posterior. In comparing female or juvenile teeth of the preceding two species with those of *M. ginkgodens*, it is apparent that the anterior and posterior edges of the teeth of the former are very nearly straight (Figure 2), whereas those of *M. ginkgodens* (Nishiwaki and Kamiya, 1958, fig. 13, right) are more noticeably convex.

The teeth of *M. hectori* are much smaller than the teeth of adult males of *M. carlhubbsi* (Mead, 1981). There is size overlap in juveniles and adult females of *M. carlhubbsi*, but there should be little trouble in differentiating them, as the teeth in *M. hectori* are at the anterior tip of the mandible.

The teeth of *M. densirostris* of all ages and sexes are relatively narrower and thicker than any of the other three species and can be distinguished readily from them (Nishiwaki and Kamiya, 1958, fig. 9, pls. xiv, xv, xvii; Kasuya and Nishiwaki, 1971, pls. iv, v; Besharse, 1971, fig. 8). In addition, the mandibles of this species have a characteristic sinusoidal curve in lateral view.

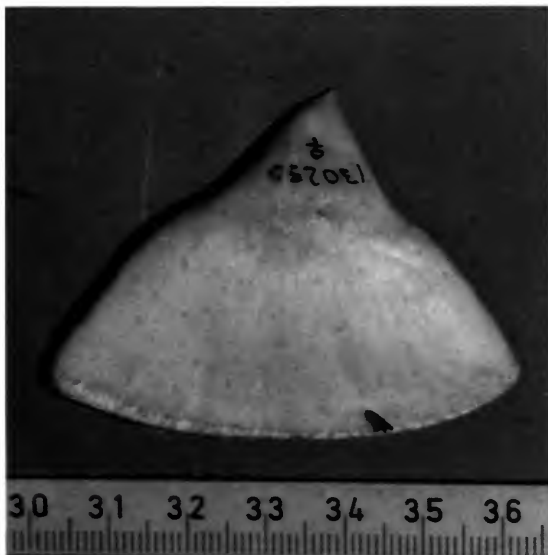


FIGURE 2.—Tooth of female *Mesoplodon carlhubbsi* (MVZ 130250). (Scale in cm.)

PROMINENTIAL NOTCHES.—A review of the distinguishing cranial characters of these species is beyond the scope of this paper; however, the presence of a prominent notch in *M. carlhubbsi* is useful in distinguishing it from the species with which it is most commonly confused, *M. stejnegeri*, which lacks this notch. The notch is prominent in the type specimen of *M. carlhubbsi* (Moore, 1963:14), an adult male, and is clearly absent in the type specimen of *M. stejnegeri* (USNM 21112) and adult males described by True (1910, pl. 3: fig. 2) and Nishiwaki (1962a, pl. 11). The presence of this character in adult female specimens of *M. carlhubbsi* was demonstrated by Roest (1964, pl. 11), and its absence in adult female specimens of *M. stejnegeri* by Moore (1963, fig. 4). Neonates of both species are shown in Figure 3, and it is readily apparent that this character will serve to distinguish these two species at any age.

APPEARANCE OF THE INTACT HEAD.—Adult males of North Pacific species are easy to recognize from the external appearance of an intact head. The white snout and the prominence anterior to the blowhole in *M. carlhubbsi* set it apart from males of all other species. The faint indications of lighter pigmentation about the rostrum of an adult male *M. stejnegeri* in Nishimura and Nishiwaki (1964, pl. xxii: figs. 3, 4) apparently resulted from abrasion of the snout (see Nishimura and Nishiwaki 1964, pl. xxi: fig. 1). In adult males of *M. ginkgodens*, the snout is uniformly dark, and only the tip of the tooth is erupted (Nishiwaki and Kamiya, 1958, pl. 1). The shape of the forehead in lateral view is intermediate between the depressed forehead of *M. stejnegeri* and the elevated prominence of *M. carlhubbsi*. Adult males of *M. hectori* have a relatively shorter rostrum than *M. carlhubbsi* (Mead, 1981). Adult males of *M. densirostris* have a relatively stouter rostrum, flattish forehead, and heavy, prominent teeth, easily distinguished from the very thin teeth of the other four species (Pringle, 1963:62). Whereas both *M. carlhubbsi* and *M. stejnegeri* males tend to accumulate heavy linear scarring along



FIGURE 3.—Neonatal skulls: A, *Mesoplodon carlhubbsi* (CAS 13505); B, *M. stejnegeri* (HSUZ 61-1 H56). *Mesoplodon stejnegeri* is represented solely by dorsal view of right maxilla and premaxilla. Note difference in prominent notches, already apparent.

the flanks, such marks are much lighter in *M. densirostris* and *M. ginkgodens*.

Females and juveniles of ziphiids in general and of species of *Mesoplodon* in particular are difficult to differentiate based on external characters. If the pigmentation pattern can be observed, the light-colored rostrum of *M. carlhubbsi* adults serves to distinguish them from other North Pacific species. This is useful, however,

only in live or very fresh specimens. The heads in adult females of *M. stejnegeri* and *M. hectori* are dark dorsally with some light countershading ventrally, whereas those of *M. ginkgodens* are lighter all over. Adult females and juveniles of *M. densirostris* have characteristically heavy rostra, with flattened foreheads and relatively uniformly gray pigmentation, slightly lighter ventrally. Leatherwood et al. (1967, fig. 83) give a good view of the

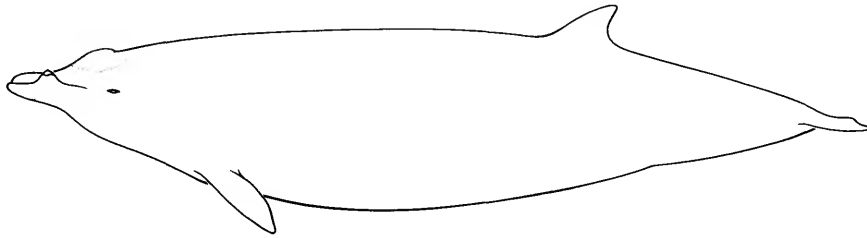


FIGURE 4.—Composite drawings of adult male *Mesoplodon carlhubbsi*, lateral view.

depressed forehead in this species. Although both individuals illustrated by them are young males, this forehead shape is also characteristic of females of all ages.

Description of *Mesoplodon carlhubbsi*

BODY CONFIGURATION.—Average length at birth is estimated at 250 cm, based upon the smallest individuals in the sample (SJSU 2055 at 247 cm; SJSU 2834 estimated at 250 cm; SJSU 2197 at 258 cm). Admittedly these are sparse data, their only strength lying in the presumption that the greatest mortality is likely to be among neonates, and so the near coincidence of the sizes of the small specimens is probably due to death very near the time of birth. *Mesoplodon carlhubbsi* reaches a maximum length of about 530 cm and a weight of about 1500 kg, with no discernible size difference between the sexes.

The body shape is typical of beaked whales, characterized by a relatively large thorax, with a small head and tail (Figures 4, 5A–C). The indentation in the ventral body wall marking the position of the anus delimits the anterior limit of the caudal region. The dorsal fin is moderately falcate (Figure 5E) and is placed well posterior to the middle of the body but is still anterior to the caudal region. It is possible that the position of this appendage is more closely related to the point of maximum flexure of the caudal region than to overall body dimensions, hence its consistent posterior position in beaked whales is probably related to their relatively long thoracic and short caudal regions. The height of the dorsal fin in

adults is remarkably consistent at 22–23 cm. The forelimb is smaller than that seen in most other odontocetes and is of a characteristic ziphiid shape (Figure 5D), the result of relatively long propodial elements and short phalanges. There is a distinct depression in the body wall just posterior to the flipper, into which the flipper can be appressed. We have observed this “flipper pocket” in *M. carlhubbsi*, *M. ginkgodens*, *M. stejnegeri*, *M. densirostris*, *M. europaeus*, and *M. mirus*; it is present, though less pronounced, in *Ziphius*. It seems to be characteristic of ziphiids in general. The flukes present nothing unusual (Figure 5F) and, save for the absence of a median notch, are very similar to those of many medium-sized whales, such as the minke whale (*Balaenoptera acutorostrata*). As a general rule, body shape and proportions are extremely conservative in the ziphiids, the only readily apparent differences, particularly within the genus *Mesoplodon*, being in the shape of the head and in external pigmentation patterns.

Head shape is similar to that of other species of *Mesoplodon*, with long, narrow rostrum, smoothly tapering forehead with no demarcation between the melon and the rostrum, and a prominent pair of ventral throat grooves. The line of the mouth, when viewed laterally, has a noticeable sinusoidal curve, characteristic of those *Mesoplodon* species with large teeth placed well back from the anterior end of the jaw. Those with smaller, more anteriorly placed teeth have a straighter mouthline. In adult males there is a very prominent pair of teeth set about midway along the line of the mouth. In this species, the skin of the lips extends

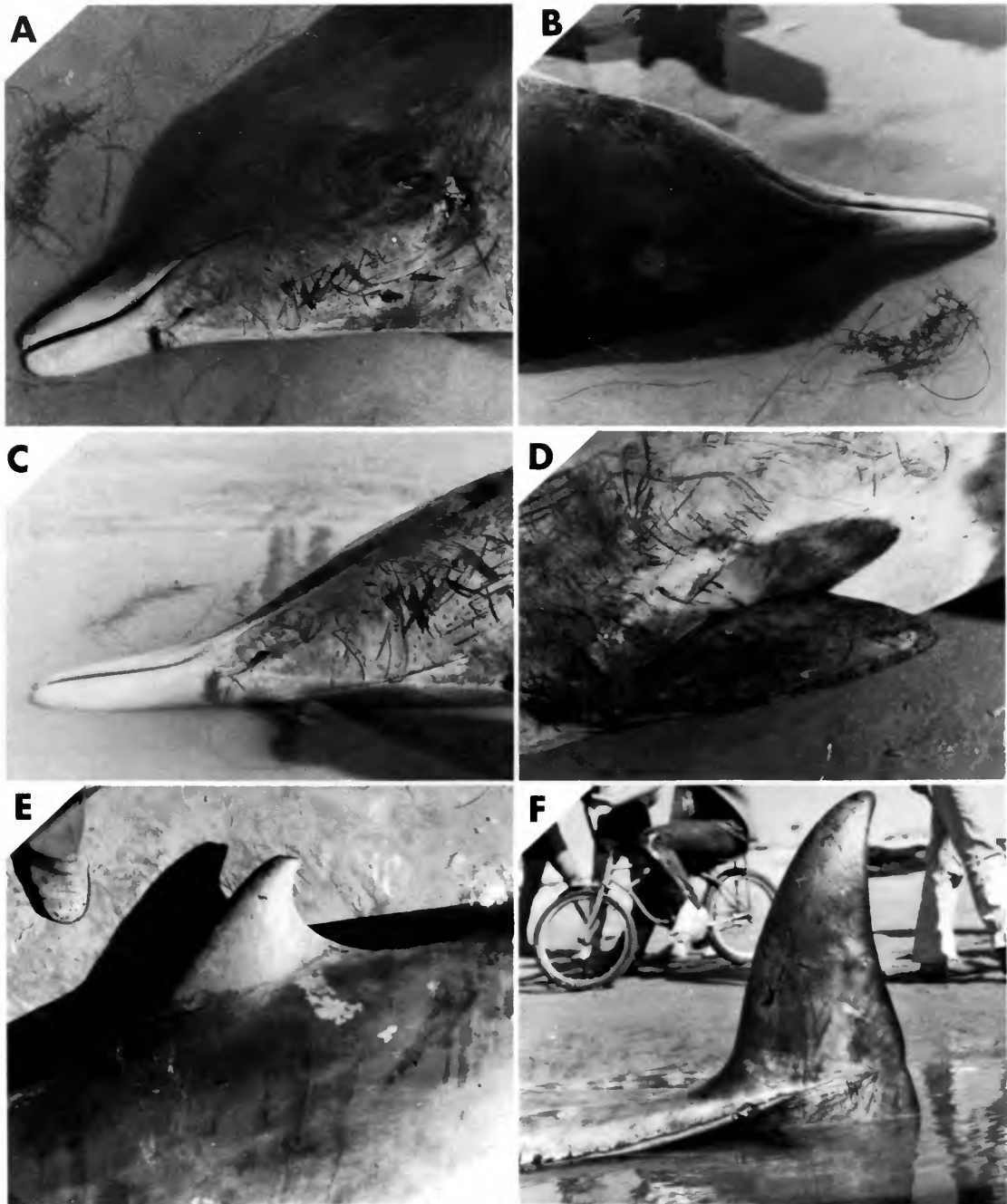


FIGURE 5.—*Mesoplodon carlhubbsi* (USNM 504128) adult female: A, lateral view of head; B, dorsal view of head; C, ventral view of head; D, lateral view of left flipper; E, lateral view of dorsal fin; F, ventral view of flukes.

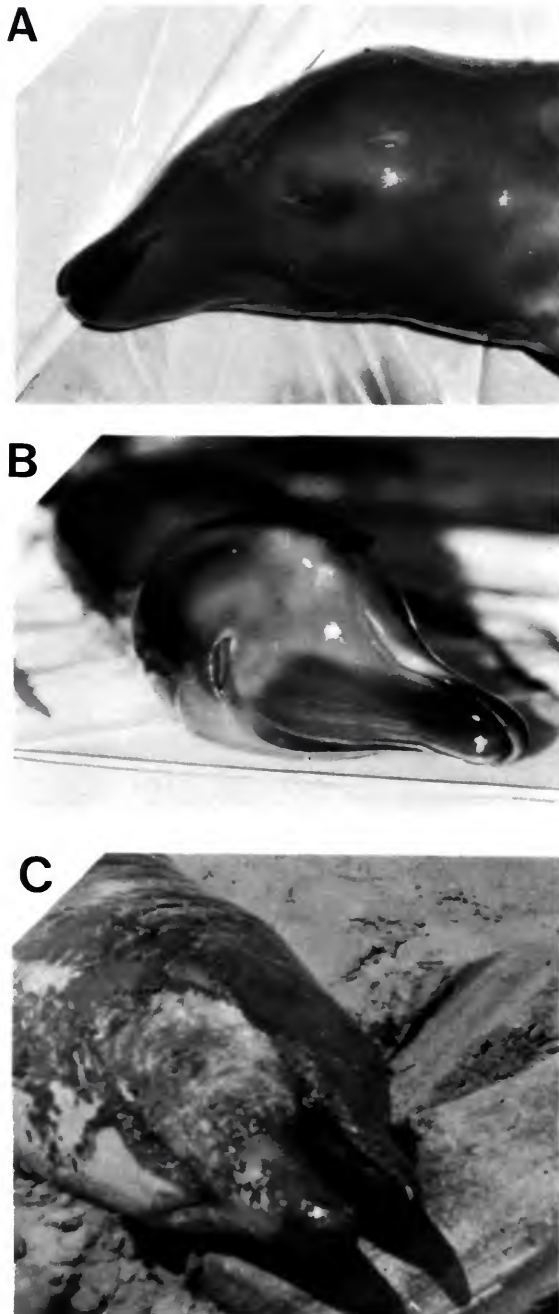


FIGURE 6.—90 cm fetus of USNM 504128: A, lateral view; B, oblique antero-dorsal view. UBC 9037: C, antero-ventral view. Note dark pigmentation of tip of lower jaw and forehead anterior to blowhole.

dorsally along the tooth such that only a small portion of the tip of the tooth is exposed. As in all known species of *Mesoplodon*, the teeth erupt only in adult males. In dorsal view (Figure 1A), the rostrum of adult males is strongly constricted by the projecting mandibular teeth. There is a definite prominence developed on the dorsal surface of the melon just anterior to the blowhole in adult males (Orr, 1950:14). The blowhole is wide and is concave anteriorly as it is in all other odontocetes except *Berardius* and the physeterids.

PIGMENTATION.—The most prominent external features of this species are in the pigmentation of the head, particularly in adult males. The rostrum and anterior portion of the mandible back to the posterior edge of the tooth are a brilliant white in adult males (Figure 1) and, although there is less contrast in females and subadults (Figure 5A–C), this same area is decidedly lighter than the rest of the head. The extent of the light pigmentation around the rostrum is possibly more variable in females, as Roest's (1964:130) photos of MVZ 130250 show only a narrow area of white on the tip, extending posteriorly a short distance along the margin of the lips, whereas the light pigmentation extends considerably further in USNM 504128 (Figure 5A–C). The extent of this pigmentation may be age related, since Roest's specimen was a relatively young individual. It is interesting to note that this same pigmentation was observed in the 90 cm female fetus of USNM 504128, except that it was reversed, with the anterior portions of the rostrum and mandible being black. This pattern was also seen in photographs of a neonate (UBC 9037, Figure 6), contradicting MacAskie's drawing of the same specimen (Pike and MacAskie, 1969:11), which shows the rostrum and mandible lighter than the rest of the head. At some point this pattern must shift over to the adult configuration, and so it would be expected that juveniles would pass through a stage where the rostrum and mandibles are relatively uniform in color. In adult males there is also a very distinctive white patch of variable extent, centered on the dorsal prominence of the melon.

Views of the heads of adult males are given by Hubbs (1946:252), Orr (1950:14), and Nishiwaki and Kamiya (1959, pl. 1); views of adult females by Roest (1962:130) and Campbell and Stirling (1971:221); and drawings of a juvenile by Pike and MacAskie (1969:11).

In adult males, the remainder of the body is relatively uniform dark gray to black, with no discernible differentiation between dorsal and ventral surfaces. In subadults of both sexes and adult females, however, the ventral surface is lighter, grading from white on the midventral portions to a medium gray dorsally (see Figure 7, a ventral view of UBC 9416). In females, the "flipper pocket" is distinctly darker than the adjacent areas of the thorax (Figure 5d). In both sexes the ventral surface of the flukes is lighter than the dorsal surface and is marked with concentric striations radiating anteriorly from the position of the terminal caudal vertebra (Figure 5f). Scarring is also present on the flukes but does not seem to contribute materially to their coloration as implied by Hubbs (1946:252). The dorsal surface of the flipper is slightly darker than the adjacent thorax in adult females, with a faint light patch on the distal posterior edge. This light patch is more noticeable in adult males and can be seen in Orr's (1950:14) photos of CAS 9833 and in photos of MVZ 115607 (Figure 8). Unfortunately the ventral surface of the flipper has not

been examined, but in most ziphiids it is lighter than the dorsal surface. There is no discernible pigmentation around the genital slit in either sex, although this is commonly seen in other species of *Mesoplodon*.

Life History

DISTRIBUTION.—In defining the relationship of *M. carlhubbsi* to water-mass distribution, we have relied upon the definitions given by Favorite et al. (1976), who recognized a complex of water-mass domains and current systems in the subarctic Pacific.

The distribution of *M. carlhubbsi* along the coast of Japan (Table 3) is restricted to the northeast coast of Honshu, near the confluence of the cold, southerly flowing Oyashio current, and the warm, northerly flowing Kuroshio current at about 38° north latitude. It has not been recorded south of this area in the Kuroshio current itself, nor has it been recorded farther north along the coasts of Hokkaido or the Kuril Islands. There are numerous records of *Mesoplodon* species along the southeast coast of Japan and the coast of Taiwan, all of which are either *M. ginkgodens* or *M. densirostris*, neither of which are recorded north of 36°. There are no records of *Mesoplodon* north of 38° along the coasts of Hokkaido or the Kuril Islands, indicating a lack of cetological activity in this area.



FIGURE 7.—Ventral view of adult female *Mesoplodon carlhubbsi* (UBC 9416) (British Columbia Provincial Museum, photoduplicate file PDF 142).



FIGURE 8.—Antero-lateral view of thorax of MVZ 115607. Note light patch on trailing edge of flipper.

The distribution of *M. carlhubbsi* along the Pacific coast of North America (Table 3) extends from San Diego (33° N) to Prince Rupert (54° N). The known northern limit probably represents the actual northern distribution of this species, as there are abundant records of *M. stejnegeri* north of there. The southern limit, on the other hand, may be the product of a lack of cetological investigation, as there are no *Mesoplodon* records along the Pacific coast of Central America from the latitude of the southernmost record of *M. carlhubbsi* to the equator.

Using the schematic diagrams of the water masses in the subarctic Pacific (Favorite et al., 1976, fig. 41), the distribution of *M. carlhubbsi* along the Japanese coast coincides with the surface Transition Domain and at depth with the origins of the Subarctic Current System, com-

prised of mixing of deep elements of the Kuroshio and Oyashio currents. Along the coast of North America, the distribution of this species corresponds with the Dilute and Upwelling domains on the surface and with the confluence of the Subarctic Current and the California Current systems at depth.

The distribution of *M. carlhubbsi* is probably not directly related to the character of the water mass but rather follows the distribution of the prey species upon which it feeds. In this case, the distribution of prey species (mesopelagic squid and fish) is presumably tied to the character of intermediate and deep, rather than surface water masses.

FOOD HABITS.—Stomach contents were available from five adult animals. They consisted of squid beaks, fish otoliths, and fish bones. The

results of the squid beak analysis are presented in Table 1. There was difficulty in arriving at the identification of beaks that are herein listed as *Gonatus* sp.; therefore, we have provided illustrations of the beaks as documentation (Figure 9).

Fish remains were found in only one stomach (HSUZ 2680). They consisted of the bones of *Chauliodus macouni* (Pacific viperfish) and otoliths of *Lampanictis regalis* (28 otoliths), *Lampanictis* cf. *L. regalis* (10 otoliths), *Poromitra crassiceps* (2 otoliths from separate fish), cf. *Poromitra* sp. (2 otoliths), *Chauliodus macouni* (7 right, 5 left otoliths), *Ichthyos lockingtoni* (1 right, 2 left otoliths), *Melamphaes acanthomus* (1 right, 1 left otoliths), 4 partly digested otoliths of an unidentified melamphiid,

and 1 unidentified otolith. *Chauliodus macouni* was represented by four more or less complete skeletons. Measurements were taken of the first tooth in the dentary (the longest tooth), and the estimated standard length was then derived from a linear regression of the length of that tooth versus standard length of the fish ($y = 13.1x + 7.01$, $n = 10$, range = 68–192 mm standard length, $r = .93$, fishes identified as *C. macouni* in the collections of the National Museum of Natural History, Smithsonian Institution). The tooth lengths ranged from 13.1 to 15.3 mm, and the corresponding predicted standard lengths ranged from 175 to 206 mm.

Caution must be exercised in interpreting the

TABLE 1.—Results of squid beak analysis (squid beaks divided into size classes and body weights of size classes taken from graphs by family in Clarke (1962); weights of *Gonatus* sp. taken from graph for this genus in Clarke (1980); the one upper squid beak from CAS 16596 is identified as *Onychoteuthis* cf. *O. borealijaponicus*)

Squid beak lower rostral length (mm)	Number of squid beaks found in stomach				Weight of individual squid in grams
	HSUZ 1999	HSUZ 2680	USNM 504128	LACM 54327	
<i>Gonatus</i> sp.					
3.2		120			30
3.6			13		40
4.5	3	470	16		90
5.8			12		170
6.5		48			250
Upper beaks	0	592	28		
<i>Onychoteuthis</i> <i>borealijaponicus</i>					
5.1		7			250
5.8				2	350
6.5–7.0	2	35			500–600
Upper beaks	0	27		1	
<i>Octopoteuthis deletron</i>					
3.8		2			30
4.8–5.0	4	21		1	50
7.5		6			150
Upper beaks	1	33		1	
<i>Histioteuthis</i> cf. <i>H. dofleini</i>					
3.7–4.2		51		4	100
Upper beaks		63		1	
<i>Gonatus</i> sp.					
4.2–4.4		7			60
Upper beaks		3			
<i>Mastigoteuthis pyrodes</i>					
3.4–3.8			7		60
Upper beaks			8		

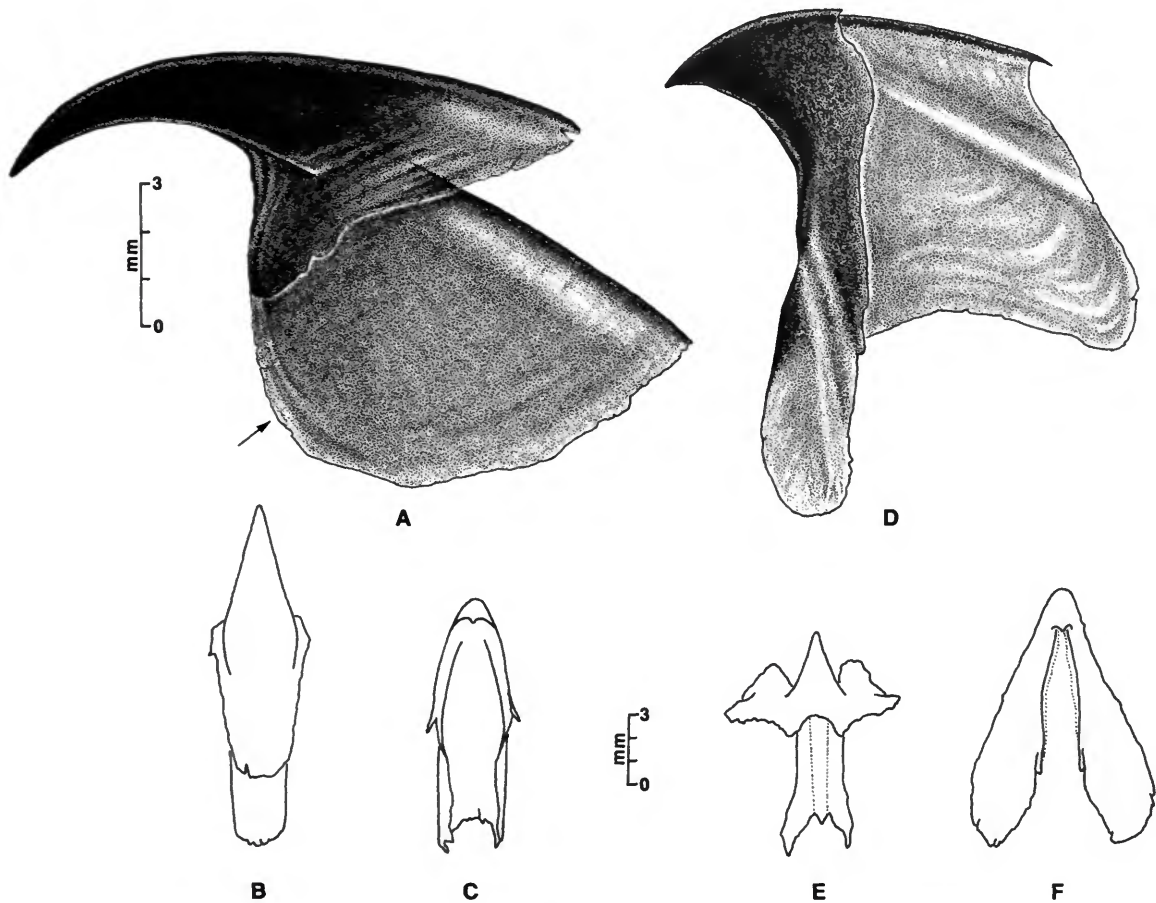


FIGURE 9.—Beak of *Gonatus* sp. from HSUZ 2680 (scale to left of A also applies to D; scale for B, C, E, F is between C and E). Upper beak: A, lateral view; B, outer view; C, inner-anterior view (see arrow on A). Lower beak: D, lateral view; E, outer view; F, anterior view. (Santa Barbara Museum of Natural History 31784.)

food habits of an animal from remains in its stomach, because if some of the remains are of predatory animals, others are possibly remains of their prey (Perrin et al., 1973). Of the squids found in stomachs that contained squid only, it seems that the following were the biggest and therefore had to have been eaten by the whale: HSUZ 1999, *Onychoteuthis borealijaponicus*; LACM 52437, *O. borealijaponicus*; CAS 16596, *O. borealijaponicus*; USNM 504128, *Gonatus* sp. HSUZ 2680 had *O. borealijaponicus* as the largest squid but also had fresh material (that could not have been

eaten by a squid) of the predatory fish *Chauliodus macouni*. *Ichthyos lockingtoni* may also have been consumed by HSUZ 2680, but the rest of the otoliths are from small fish that could have been eaten by either *C. macouni* or by some of the larger squids.

MATURITY.—The five physically mature males ranged from 496 to 530 cm; no immature males have been reported. There are two mature females at 532 and 490 cm and one immature female at 500 cm. Although a larger sample of immature specimens would be desirable, a rea-

sonable estimate of length at physical maturity is about 500 cm. Growth thereafter occurs at a presumably much lower rate until the maximum length of 530–535 cm is reached.

Ovarian data are available only for USNM 504128, a 532 cm individual that was carrying a large fetus and had numerous corpora albicantia in the ovaries. UBC 9416, at 526 cm, was probably also mature, and it is likely that the other physically mature specimens, at 500–510 cm (estimate) and 490 cm (estimate), were also sexually mature, as sexual maturity in cetaceans is usually reached well before physical maturity. It is unlikely that the smallest female, MVZ 130250 at 440 cm, was sexually mature.

Gonadal data for males of this species is even more scarce. Hubbs (1946:253) reported that the testes of USNM 278031 were "only about 3×4 inches in size" (7.5×10 cm). The total length of this specimen was 505 cm, but the vertebral epiphyses were closed, indicating physical maturity. Unless it was an anomalous individual, it should also have then been sexually mature. For LACM 52437, a 498 cm male, the right testis measured 17.3×7.3 cm and weighed 245 gm, while the left measured 16.5×7.2 cm and weighed 255 gm. Histological examination indicated active spermatogenesis, but there was no sperm on gross examination of the epididymis. The epiphyses were closed in this animal as well, hence it was physically and sexually mature. Testes in *Mesoplodon* species are in general very small.

An attempt was made to subjectively arrange the large male specimens in order of degree of mesorostral ossification and external body scarring (Table 2), both of which are logically related to age. It is immediately evident that this does not correlate directly with the total length of the specimens. Either the age-length relationship is subject to considerable individual variation, or appreciable random observer errors occurred in determining the actual lengths of the specimens. Condylbasal length and mesorostral ossification follow one another quite closely, and it may prove that they will be the best estimators of relative

age. The length of the tooth would seem to be a good indicator of relative age, at least in young males. Unfortunately the entire sample is of older males.

BREEDING SEASON.—The dates of collection of the presumed neonatal specimens in this sample are 12 June (LACM 54576), 23 June (SJSU 2834), 17 July (SJSU 2197), and 17 August (SJSU 2055). An additional datum can be extracted from the fetus of 504128, if a number of assumptions are made. If the gestation period is about 12 months, as it appears to be in most cetaceans, and if fetal growth is nonlinear for the first 30 or 40 days, the major growth (approximately linear with time) occurs in about 11 months. If, as assumed earlier, the length at birth is about 250 cm, the growth rate estimate is 23 cm per month. The 90 cm fetus of USNM 504128, collected on 3 October, had about 160 cm of growth left before birth or about seven months, giving an estimated time of birth of about mid-May. While this is admittedly tenuous, it is reasonable and does coincide approximately with the time of collection of the neonates, suggesting that calving in this species takes place in summer.

SCARRING.—As noted by Hubbs (1946:250) and Orr (1950:15), the most obvious feature of adult males is extensive scarring of the body. Although scarring is concentrated on the flanks, occasional scars occur all over the body. The scars are of three general types: long narrow ones up to about two meters in length, smaller oval scars commonly about 4×8 cm, and punctate scars 0.5–2 cm in diameter. The long scars frequently occur in pairs and, as suggested by numerous earlier authors, are almost certainly the result of intra-specific aggression between adult males. McCann (1974) reviewed scarring in ziphiids and noted that linear scars were essentially confined to males. Although there were a number of excellent published photos of *M. carlhubbsi* (Orr, 1950; Hubbs, 1946) and *M. stejnegeri* males (Nishiwaki, 1962a, fig. 2; Nishimura and Nishiwaki, 1964: pl. 21), showing numerous parallel scars inflicted simultaneously by both teeth, McCann hypothesized that this type of scarring would only occur

TABLE 2.—Specimens of *Mesoplodon carlhubbsi* arranged in order of total length (males scored by degree of mesorostral ossification, with "1" = most complete; subscript "e" = estimate)

Specimen number	Total length (cm)	Condylbasal length (mm)	Thoracic epiphyses	Mesorostral ossification	External scarring	Tooth height (mm)	Vertebral count
MALES							
MVZ 115607	532	844		1	heavy	157	
Ayukawa no. 1	530 _e	800	closed	4		166	46
CAS 9833	509	822		3	medium	155	
USNM 278031	505 _e	820	closed	2	light	133	48
LACM 52437	498		closed	5	medium		46
HSUZ 2680	496		closed	6			
UBC 9037	274	440					
LACM 54576	265	446					
FEMALES							
USNM 504128	532	900	closed		light	051	46
UBC 9360	530 _e	800 _e	open				
UBC 9416	526	820			light		
CAS 16596	488 _e	785	closed				47
MVZ 130250	440	746			light	045	

in species in which the teeth were situated terminally on the mandible. It is evident from the observed pattern of scarring in *M. stejnegeri* and *M. carlhubbsi* that many of the wounds are inflicted by contact with the dorsal surface of the rostrum with the mouth closed. Owing to the far posterior position of the temporomandibular joint with respect to the angle of the mouth, the superficial tissue lateral to the posterior half of the mandible restricts the opening of the mouth to only a few centimeters at the tip of the rostrum and will not allow both teeth to come into play with the mouth open. Of the four adult male *M. carlhubbsi* for which there are views of the flanks, scarring is heaviest in MVZ 115607 (532 cm), intermediate in CAS 9833 (509 cm) and USNM 278031 (505 cm), and lightest in LACM 52437 (498 cm), suggesting that this may represent a series from oldest to youngest, or at least a decreasing series on a scale of social experience. In the more lightly scarred individuals the scarring is concentrated on the ventrolateral surface of the thorax and abdomen, occurring sparsely on other areas. In the most heavily scarred individual (MVZ 115607, Figure 10), the concentration is on the midlateral surface of the thorax and ab-

domen. Whether this represents ontogenetic change in aggression behavior or individual variation is impossible to determine with such a small sample.

A variety of sources have been suggested for the smaller oval scars, including barnacles, lampreys, and punctate, rather than linear, tooth wounds. Such scars are common on a great many species of cetaceans, and it appears that any relatively minor, nonlinear wound will produce them, as the tissue granulation that occurs during healing tends to enlarge the area of the wound and cause it to approach a circular shape (Ivashin and Golubovsky, 1978). On many species that pass through tropical waters, such scars are likely to represent activity of the "cookie-cutter" shark *Isistius*, while in higher latitudes they are apparently more commonly inflicted by lampreys. Orr (1950:15) suggested that barnacles were responsible for the small oval scars, based on "the presence of ridges radiating from the center of the round or oval marks." Although it is not possible to discern details of these scars from any of the available photos of males, a number of similar scars were observed on an adult female (USNM 504128). A few open wounds were already in an



FIGURE 10.—Antero-lateral view of flanks of MVZ 115607, showing scarring characteristic of adult male.

advanced state of granulation and gave no clues as to origin. Most of the healed wounds presented a radiating pattern of dermal ridges, which appears to be a normal result of the mechanics of wound healing in cetacean skin, without regard to the source of the wound. We suspect that these are the "ridges" observed by Orr.

Balanomorph barnacles of the family Coronulidae are the only group that attaches directly to cetacean skin and are quite limited in their distribution. Newman and Ross (1976) give a brief synopsis of this family. They are extremely numerous on humpback (*Megaptera*) and gray whales (*Eschrichtius*) and are apparently regular to some extent on right whales (*Eubalaena*) but are of uncertain and irregular occurrence on other species. The small pseudostalked coronulid *Xenobalanus* is common on the appendages of a great many cetaceans, including ziphiids, but leaves no appreciable scar and rarely occurs along the flanks. Lepadomorph (stalked) barnacles of the genus *Conchoderma* occur regularly on ziphiids and other cetaceans but are unable to attach directly to the skin and must rely upon exposed hard substances such as teeth or balanomorph barnacles. While Mitchell and Kozicki (1975:1020) have recorded the balanomorph barnacle *Tubicinella* from a ziphiid (*Hyperoodon*), this does not seem to be a common occurrence, and we have been unable to locate any further records of balanomorph barnacles on ziphiid whales, suggesting that barnacles are an unlikely source for these scars.

McCann (1974:150) suggested that these scars were caused by remoras, which commonly occur on cetaceans but whose flexible mode of attachment leaves no scar (Rice and Caldwell, 1961), or by hagfish, which are benthic scavengers and predators on soft-bodied invertebrates (Strahan 1963:28). While hagfish may scavenge on cetacean carcasses, it is highly unlikely that they prey on living ones.

Hubbs (1946:251) suggested that the oval scars represent puncture wounds rather than slashing tooth wounds inflicted by teeth of older males, which probably accounts for many of the scars.

Most of the small, punctate scars are probably attributable to the parasitic copepod *Penella*, which was found on two of the specimens examined by us (USNM 504128 and LACM 52437). This copepod is common on a great variety of cetaceans, lying with the highly modified anterior portion of its body imbedded several centimeters in the blubber, and the posterior end streaming from a hole 3–4 mm in diameter in the surface of the skin of the host. Ivashin and Golubovsky (1978) have recently shown that *Penella* may be responsible for some of the large oval scars as well.

MEAT PALATABILITY.—There have been a number of observations on the meat of beaked whales (mostly unpublished) suggesting that it is inedible. Scheffer and Slipp (1948:267) reported being told by a Makah indian that he and others had once tried to eat the blubber and meat of a presumed *M. stejnegeri* and found it caused diarrhea. Tomilin (1967:455) presents the opposite opinion. His book is largely a compilation, and since the statement follows a paragraph attributed to Scheffer and Slipp, he may have misunderstood their statement. Hubbs (1946:253) spoke of eating some of the type specimen of *M. carlhubbsi* and said it was good. R. W. Campbell (pers. comm., 1976) said he ate some of UBC 9360 and it was good. W. F. Perrin and J. G. Mead ate some of *M. carlhubbsi* (USNM 504128) and found the meat quite palatable. Mead has since eaten both *M. europaeus* and *M. mirus* with no ill effects. It may be that the blubber in all of these produces diarrhea, but we have no data on that. We feel it is worthwhile to report on this, as there seems to be an unsubstantiated belief that the meat of beaked whales is categorically different from that of other kinds of whales.

Summary

Mesoplodon carlhubbsi is a regular part of the fauna along the west coast of North America. Its southern limit is unknown. Its northern limit is Vancouver Island. It is the dominant species of *Mesoplodon* stranding throughout its range. *Meso-*

plodon ginkgodens is represented by one stranding (Moore and Gilmore, 1965), *M. densirostris* by one stranding (Schonewald, 1978), and *M. hectori* by four strandings (Mead, 1981), and so these probably dwell primarily outside the California Current. *Mesoplodon stejnegeri* occurs to the north of the range of *M. carlhubbsi* and is commonly represented in collections from Alaska.

Mesoplodon carlhubbsi is about 250 cm at birth and reaches a maximum of 532 cm in both sexes. Its minimum length at physical maturity appears to be about 500 cm. Aside from the head in adult males, the body shape is typical of ziphiids. We

were unable to find any way of separating the north Pacific species using the measurements of Norris (1961). The head in adult males is the most striking feature. It is black with a few white scars and naturally white areas on the tip of the rostrum and anterior to the blowhole. In the female the tip of the rostrum is distinctly lighter than the rest of the head. In the males a strong pair of teeth protrudes from the mandibular symphysis. The gums in *M. carlhubbsi* come well up onto the tooth, leaving just a small amount of exposed crown.

Appendix

Known Occurrences of *Mesoplodon carlhubbsi*

The following are the currently known records of *Mesoplodon carlhubbsi* that have been used in this paper. They are listed in alphabetical order by the designation of the specimen or record. Additional data are given in Table 3. This section is intended to describe the nature of the material and to discuss any problems in the interpretation of the data.

Ayukawa no. 1. Adult male taken by commercial whaling vessel. The total length was apparently obtained from the records of the whaling company and was "about 5.3 m" (Nishiwaki and Kamiya, 1959:35). The condylo-basal length of 80 cm, however, suggests that this specimen possibly was closer to 500 cm in total length. The specimen was originally identified as *M. stejnegeri* (Nishiwaki and Kamiya, 1959; Nishimura and Nishiwaki, 1964:331) and was subsequently identified as *M. carlhubbsi* by Moore (1963:399, 1966:56). It was reported as an adult male (Nishiwaki and Kamiya, 1959:47), presumably on the basis of whaling company records. This is corroborated from photos of the head.

Ayukawa no. 2. Adult male taken by a commercial whaling vessel. The animal was listed in whaling records as a 15-foot male *Ziphius* (Nishiwaki, 1962b:79). The only materials mentioned in the original report were the mandibles with the crowns of the teeth broken off. From the size of the teeth it is evident that this animal was an adult male. The mandibular lengths given by Nishiwaki (1962b:80) were 702 and 709 mm, which are intermediate between the same measurements for USNM 278031 (693 mm), a 505+ cm male, and CAS 9833 (710 mm), a 509 cm male (Orr, 1953:247). Accordingly, we have used a minimum estimated length of 500 cm for this individual. Nishiwaki (1962b) originally reported this specimen as *M. stejnegeri*, which Moore (1963:399) corrected to *M. carlhubbsi* on the basis of the shape and position of the teeth in the mandible.

Ayukawa no. 3. Adult female taken by a commercial whaling vessel. This animal was listed in whaling records as a 15-foot male *Ziphius* (Nishiwaki, 1962b:79). The material consists of a single mandible, 700 mm in length, with a

small tooth. Nishiwaki (1962b) commented that "this tooth was under growth and the root is not completed." It is apparent from his photographs (1962b, pl. 11) that the pulp cavity is closed, suggesting that the animal was at least not a juvenile. Nishiwaki's (1962b) original identification of the specimen as *M. ginkgodens* was apparently accepted by Moore, who made no comment on this specimen in his later papers. The position of the tooth is well forward of the symphysis, which is appropriate for *M. ginkgodens* but, as noted in the present paper, is also appropriate for females and juveniles of *M. carlhubbsi*. The shape of the tooth of Ayukawa no. 3 is very similar to the tooth of MVZ 130250 (Figure 2) and differs from that of known females of *M. ginkgodens* in lacking the concave anterior and posterior margins characteristic of that species. We have accordingly interpreted Ayukawa no. 3 as an adult female *M. carlhubbsi*, comparable in length to Ayukawa no. 2 (estimated 500 cm minimum).

Ayukawa (no number). Nishiwaki and Kamiya (1959:35) mention "a tooth of the same species which had been collected in there [sic] boneyard," which was exchanged for the teeth of Ayukawa no. 2. This apparently represents an adult male *M. carlhubbsi* that had been taken sometime previously by a vessel from the Ayukawa whaling station, probably from the same general area as Ayukawa nos. 1-3.

BCPM 7721. This individual is represented by the skull and mandibles (with teeth) of an animal presumably from a British Columbia stranding for which there are no specific data. The teeth have begun to develop the long root characteristic of males (teeth are 68 mm in height), and the mesorostral ossification has risen above the level of the dorsal margin of the premaxillae, but it has not developed the pachyostosis seen in older males. The condylo-basal length of 815 mm is, however, comparable to that of the adult males in this sample. Accordingly, this individual is interpreted as a subadult male, with a total length on the order of 500 cm. This specimen has not been previously reported.

CAS 9833. An adult male that stranded at Drakes Bay, California. The specimen and data were collected by Orr, who subsequently described this individual (Orr, 1950,

TABLE 3.—Strandings of *Mesoplodon carlhubbsi*, arranged by latitude (specimen condition: 1 = alive, 2 = freshly dead (less than a week), 3 = moderately decomposed (a week or two), 4 = advanced decomposition (several weeks), 5 = indeterminate (skeletal remains, mummies); length in cm; subscript "e" = estimated total length)

Locality	Latitude	Longitude	Date	Sex	Length	Condition	Specimen
Prince Rupert, B.C.	54°17'N	130°22'W	16 Dec 1962	M	472	3	no specimen
Rivers Inlet, B.C.	51°3'-N	127°3'-W	Jul 1965	M		5	UBC 9036
Tofino, B.C.	49°03'N	125°43'W	Jan 1969	F	526	1	UBC 9416
Long Beach, B.C.	49°02'N	125°44'W	3 Jul 1963	M	274	2	UBC 9037
Florencia Bay, B.C.	49°00'N	125°38'W	22 Aug 1967	F	500 _e	1	UBC 9360
Oyhut, Wash.	47°00'N	124°10'W	2 Nov 1944	?		5	USNM 274591
Crescent City, Calif.	41°45'N	124°12'W	18 Mar 1975	F	510	3	HSUZ 1999
Humboldt Bay, Calif.	40°45'N	124°14'W	29 Aug 1975	?		4	HSUZ 2358
Centerville Beach, Calif.	40°34'N	124°21'W	25 Mar 1975	M	496	3	HSUZ 2680
Noyo Canyon, Calif.	39°33'N	123°57'W	22 Jul 1975	F?		5	LACM
Drakes Bay, Calif.	38°01'N	122°58'W	20 Mar 1950	M	509	2	CAS 9833
Drakes Bay, Calif.	37°59'N	122°48'W	22 Jun 1965	?	270 _e	4	CAS 13505
Double Point, Calif.	37°58'N	122°47'W	13 Jun 1974	F	490	4	CAS 16596
Oakland, Calif.	37°49'N	122°20'W	4 May 1952	M	532	2	MVZ 115607
Pajaro River, Calif.	36°51'N	121°49'W	17 Aug 1977	F	247	2	SJSU 2055
Moss Landing, Calif.	36°48'N	121°48'W	23 Jun 1969	F	250 _e	3	SJSU 2834
Del Monte Beach, Calif.	36°36'N	121°53'W	22 Jul 1979	F	258	3	SJSU 2197
Cypress Point, Calif.	36°35'N	121°59'W	5 Oct 1978	M	300	3	SJSU 2972
San Simeon Bay, Calif.	35°38'N	121°12'W	28 Apr 1962	F	440	1	MVZ 130250
Cayucos, Calif.	35°27'N	120°56'W	12 Jun 1972	M	265 _e	2	LACM 54576
Santa Barbara, Calif.	34°25'N	119°40'W	2 May 1972	M	498	1	LACM 52437
La Jolla, Calif.	32°52'N	117°15'W	31 Jul 1945	?	?	1	sighting
La Jolla, Calif.	32°52'N	117°15'W	25 Jul 1945	M	505 _e	1	USNM 278031
Ocean Beach, Calif.	32°45'N	117°15'W	3 Oct 1974	F	532	1	USNM 504128
San Clemente Is., Calif.	32°41'N	118°36'W	25 Jul 1966	M		5	USNM 504883
Ayukawa, Japan	38°--'N	142°--'E		M	500+ _e	5	tooth
Ayukawa, Japan	37°5'-N	142°0'-E	Jun 1960	M	500+ _e	1	jaws
Ayukawa, Japan	37°5'-N	142°0'-E	Jun 1960	F?	500+ _e	1	jaw
Ayukawa, Japan	37°27'N	142°30'E	25 Aug 1958	M	500 _e	1	skeleton
Locality unknown (Canada)				M	500 _e	?	BCPM 7721
Locality unknown (Calif.)				?		?	MVZ 134271

1953) as *M. stejnegeri*. Moore (1963:399, 1966:56) re-identified it as *M. carlhubbsi*.

CAS 13505. An immature individual that also stranded at Drakes Bay, California, and was collected by R. Bandar. Because it had been dead for sometime, it was not possible to ascertain the sex. The length was given by Mr. Bandar as 8 feet (240 cm), but it is probable that this is somewhat in error, as the condylobasal length (450 mm) is greater than that for both LACM 54576 (446 mm), estimated length 265 cm, and UBC 9037 (440 ± 10 mm), total length 274 cm. We have accordingly used an estimated minimum total length of 270 cm for this individual. This specimen has not been previously reported.

CAS 16596. An adult female stranded near Double Point,

California, and was collected by R. Bandar, R. Jones, and others. The condition of the carcass was such that it was impossible to locate the gonads, but Jones (pers. comm.) indicated that he was relatively certain that it was a female. The vertebral epiphyses were closed, the vomer had filled the mesorostral canal, and the tooth is unerupted, confirming that it was an old adult female. The total length of 490 cm was estimated from composite measurements provided by Jones. While this is small for an adult female, the condylobasal length of 785 mm is also small, suggesting that this may have been an unusually short individual. This specimen has not been previously reported.

HSUZ 1999. An adult female that stranded at Crescent

- City, California, and was collected by Houck. This specimen was reported by Sullivan and Houck (1979), who gave selected external measurements of it.
- HSUZ 2358. Immature individual that stranded 2 1/2 miles north of the entrance to Humboldt Bay and was collected by Houck. The specimen was so decomposed that length and sex could not be determined. This specimen was reported by Sullivan and Houck (1979).
- HSUZ 2680. An adult male that stranded at Centerville Beach, California, and was collected by Houck. The mesorostral ossification is above the level of the dorsal margin of the premaxillae. The vertebral epiphyses are closed, indicating that it was a physically mature individual. The teeth are missing for this specimen, but a photograph of the carcass shows that they were fully erupted. This specimen was reported by Sullivan and Houck (1979), who gave selected external measurements of it.
- LACM 52437. An adult male that stranded at East Beach, Santa Barbara, California, and was collected by Walker. Although the total length (496 cm) is relatively small, the mesorostral ossification is well above the dorsal margin of the premaxillae and has become pachyostotic. The vertebral epiphyses are closed. It appears that this individual, like CAS 16596, is a relatively short adult. The teeth were removed by persons unknown before it was collected. This specimen has not been previously reported.
- LACM 54576. An immature male that was found at Cuyucos, California. The tail had been cut off between the genital and anal slits. External damage to the carcass suggested that it probably had become entangled in a gill net, and that the tail had been cut off in removing the carcass from the net. The total length was estimated at 265 cm by extrapolation, using the snout to anterior insertion of flipper measurement, which ranged from 22 to 23 percent of the total length in the four specimens of *M. carlhubbsi* for which it was available. This specimen has not been previously reported.
- LACM (uncataloged). Partial skeleton brought up by a trawler in 170 fathoms of water, off Noyo Canyon, California, of which the skull and jaws were saved by Augustino Tarantino, the captain of the vessel. This specimen has an unfilled mesorostral canal and a small unerupted tooth, indicating that it is a juvenile of indeterminate sex. This specimen has not been previously reported.
- MVZ 115607. An adult male that stranded adjacent to the toll plaza of the Oakland Bay Bridge, Oakland, California, and was collected by Seth Benson and L. Richards. Roest (1964:135) mentioned this specimen, which he regarded as *M. stejnegeri* (in the sense of Orr, 1953). Moore (1963:399) mentioned the specimen, which he had not been able to examine, and suggested that it was likely to be *M. carlhubbsi*, based on geographic considerations. An excellent photograph of the head appeared in the *San Francisco Chronicle*, 6 May 1952, page 15. The characteristic pigmentation of the head (Figure 1) readily identifies this as *M. carlhubbsi*. Benson's notes gave a length of 535 cm, measured to the tip of the lower jaw. We have estimated the projection of the lower jaw in this individual to be 3 cm, based on the head photos, and have accordingly used an estimated standard total length of 532 cm.
- MVZ 130250. A subadult female that stranded alive in San Simeon Bay, California, and was collected by Aryan Roest. The specimen was described by Roest (1964) as *M. stejnegeri*, following Orr's (1953) inclusion of *M. carlhubbsi* in this species. Moore (1963:300, 1966:56) subsequently recognized it as *M. carlhubbsi*.
- MVZ 134271. The skull of an adult found in the vertebrate paleontology collections at the University of California, Berkeley, by Edward Mitchell in 1965. There were no data associated with the skull, which is missing the distal portion of the rostrum and mandibles. The mesorostral ossification is level with the dorsal margin of the premaxillae. This specimen has not been previously reported.
- SJSU 2055, 2197, 2834, and 2972. These were all fresh calves collected from the beaches of Monterey Bay by Victor Morejohn and his students at the Moss Landing Marine Laboratories. None of us has seen the specimens. The identifications were confirmed by John Heyning, who used our criteria.
- UBC 9036. A subadult male from Skull Cove, Rivers Inlet, British Columbia. Neither the collector nor the circumstances of collection of this specimen are recorded. Material consists of a mandible and both teeth. The sex and age class are deduced from the relatively large teeth (120 mm high) with an open pulp cavity and poorly ossified cementum at the base. This specimen was identified as *M. carlhubbsi* by Pike and MacAskie (1969:11). We were unable to locate a Skull Cove in Rivers Inlet, although there is one about 30 miles south of there. The latitude and longitude given in Table 3 are arbitrary coordinates for the general area of Rivers Inlet.
- UBC 9037. A juvenile male that washed ashore on Long Beach, Vancouver Island, British Columbia, and was collected by Ian MacAskie. Pike and MacAskie (1969:10) gave the total length of "9 feet (274 cm)" in their description of the specimen but gave 10.8 feet in a summary table (1969:53). The former is more consistent with the external measurements and condylobasal length. The illustration of this specimen (1969, fig. 4) is captioned *Mesoplodon* sp., but the text indicates that it was identified as *M. carlhubbsi*. The text (1969:10) states that the complete skeleton was sent to the University of British Columbia, whereas the table (1969:53) indicates that the specimen is a skull, which is all that could be located in the collection.

TABLE 4.—Measurements of *Mesoplodon carlhubbsi* specimens (first number = absolute measurement in cm, second (in parentheses) = percentage of total length, subscript "e" = estimate; MVZ 115607 from Seth Benson's field notes, preserved at the Museum of Vertebrate Zoology, Berkeley; CAS 9833 from Orr, 1953; USNM 278031 from Hubbs, 1946; LACM 52347 measured by W. Walker; UBC 9037 from Pike and MacAskie, 1969; LACM 54576 measured by Aryan Roest; USNM 504128 measured by J. Mead; UBC 9360 measured by R. Campbell; UBC 9416 measured by D. Hatler; MVZ 130250 from Roest, 1964)

Character	Males						Females					
	MVZ 115607	CAS 9833	USNM 278031	LACM 52437	UBC 9037	LACM 54576	USNM 504128	UBC 9360	UBC 9416	MVZ 130250		
Total length	532	509	505	498	274	265	532	530.	526	440		
Snout to eye		64 (13)	63 (13)	63 (13)	36 (13)	26 (9.8)	70 (13)	69 (13)	68 (13)	54 (12)		
Snout to angle of mouth	32 (6.0)		49 (9.7)		21 (7.7)	16 (5.8)	50 (9.3)	38 (7.2)	33 (6.3)	24 (5.5)		
Snout to blowhole		60 (12)		61 (12)	45 (16)	33 (12)	66 (12)	64 (12)	65 (12)	53 (12)		
Snout to flipper		112 (22)		115 (23)	63 (23)	61 (23)				97 (22)		
Snout to dorsal fin tip				357 (72)		176 (66)	349 (66)			297 (68)		
Snout to genital slit				389 (78)		167 (63)	363 (68)			304 (69)		
Snout to anus	368 (69)	370 73		412 (83)			379 (71)					
Girth at axilla	280 (52)			258 (52)	132 (48)		226 (42)	274 (52)				
Maximum girth		254 (50)		272 (55)			264 (50)					
Blowhole width	16 (3.0)	15 (2.8)										
Anterior length flipper	60 (11)		54 (11)	55 (11)	7 (2.6)	7 (2.6)	12.7 (2.4)					
Posterior length flipper				44 (8.8)	29 (11)		55 (10)		48 (9.1)	47 (11)		
Flipper width	18.5 (3.5)	16.3 (3.2)		16.5 (3.3)	23 (8.4)	21 (7.9)	35 (6.6)		34 (6.5)	33 (7.5)		
Height dorsal fin	23 (4.3)	22 (4.3)		23 (4.6)	9 (3.3)		15.4 (2.9)			13 (3.0)		
Fluke width	152 (28)	129 (25)		138 (28)	59 (22)	25 (5.7)	23 (4.3)		127 (24)	107 (24)		

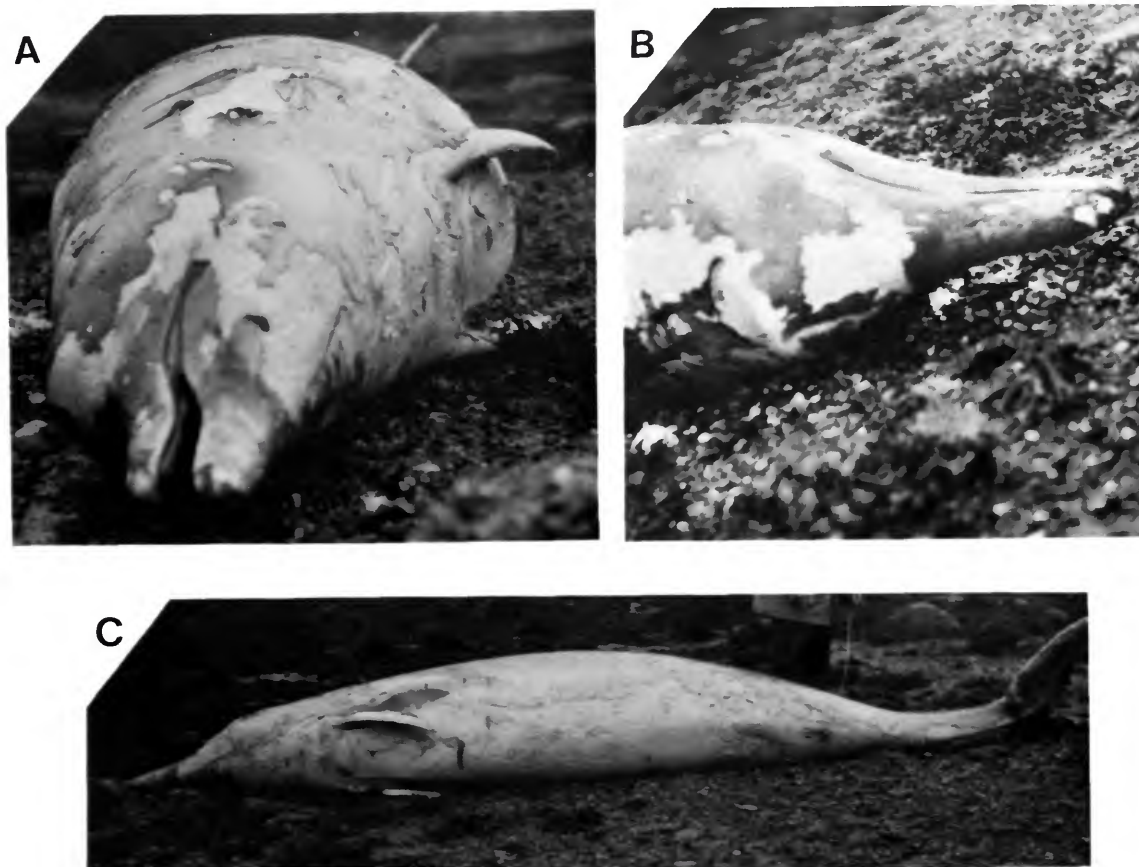


FIGURE 11.—Young male *Mesoplodon* cf. *M. carlhubbsi* stranded at Prince Rupert, British Columbia: A, anterior view; B, dorsal view; C, ventral view.

UBC 9360. A nearly adult female that came ashore alive at Florencia Bay (north end of Wreck Bay), Vancouver Island, British Columbia, and was collected by Wayne Campbell (Campbell and Stirling 1971:220, fig. 4). The mesorostral canal is filled to the level of the dorsal margin of the premaxillae in its posterior portion, but is only partially filled anteriorly. The vertebral epiphyses are not closed. This suggests an animal nearing adulthood. The total length was given in Campbell's notes as 20 feet \pm 6 inches (600 cm). This was estimated, as the tail had been cut off, and is certainly an overestimate, probably as a result of the deceptively short caudal region in ziphiids. All external measurements in Campbell's notes are comparable to similar measurements from USNM 504128 (532 cm) and UBC 9416 (526 cm) (Table 4). The condylobasal length of 80 cm would suggest a slightly shorter length, on the order of 500 cm. This length is in agreement

with the physical immaturity of the specimen. Photographs of this specimen are on file at British Columbia Provincial Museum (PDF 56).

UBC 9416. An adult female that stranded alive at Long Beach, near Lovekin Rock, Vancouver Island, British Columbia. External measurements were taken by David Hatler and are included in Table 4. The extent of the mesorostral ossification is very similar to that of UBC 9360. A single photograph on file at the British Columbia Provincial Museum (PDF 142) is reproduced as Figure 7. This record was briefly mentioned by Campbell and Stirling (1971:220).

USNM 274591. A fragmental cranium from Oyhut, Washington. This is the earliest record of this species and was first mentioned (as *M. stejnegeri*) by Scheffer and Slipp (1948:267). It was subsequently reported as *M. carlhubbsi* by Moore (1963:399, 1966:55). The mesorostral canal is

substantially filled but not pachyostotic, suggesting that this is a female or a subadult male.

USNM 278031. An adult male that stranded alive just south of the Scripps pier at La Jolla, California. This was the first specimen of this species to be described and was identified by Remington Kellogg as *M. bowdoini* (Hubbs, 1946). The total length of this specimen was measured as 17 feet, 4 inches (528 cm) along the curve of the body and reduced to an estimated straight line length of 505 cm by Hubbs (1946:246). In our experience the difference between curvilinear and straight line measurements in cetaceans is somewhat less than this, so this estimate probably represents a minimum value. This specimen was described by Orr (1953) as *M. stejnegeri*. It was designated the type specimen of *M. carlhubbsi* by Moore (1963:422).

USNM 504128. An adult female that stranded alive at Ocean Beach, San Diego, California, and was collected by Mead. The weight of this specimen was 3150 ± 40 lbs (1430 ± 20 kg). Vedvick and Itano (1976) did a study on the hemoglobin; Arnason, Benirschke, et al. (1977) karyotyped both the specimen and its fetus ($2n = 42$); and Arnason, Lima-de-Faria, et al. (1977) did an analysis of the DNA.

USNM 504883. The rostrum of an old male, recovered from 395 fathoms, off San Clemente Island, California, by the DSRV *Deepstar*. This specimen exhibits extreme me-

sorostral ossification but is otherwise indistinguishable from adult male specimens of this species. This specimen has not been previously reported.

No number. A young male *Mesoplodon* (472 cm) that stranded at Prince Rupert, British Columbia, on 16 December 1962. Pike and MacAskie (1969) included the measurements of this animal as *Mesoplodon* sp. but did not publish the photographs of it. Since there is no specimen, we have reproduced three of the photographs herein (Figure 11). The shape of the head precludes *M. densirostris*, and the faint countershading visible on the carcass suggests it is not *M. ginkgodens*. The only choices that are left are *M. carlhubbsi* and *M. stejnegeri*. In the dorsal view of the rostrum there can be seen evidences of lighter pigmentation, and it is on this basis that we would refer it to *M. carlhubbsi*. Unfortunately, the measurements do not help, since *M. ginkgodens*, *M. carlhubbsi*, and *M. stejnegeri* are virtually identical. If it was a specimen of *M. carlhubbsi*, it is the northernmost record of that species.

In addition to the above specimen records, Hubbs (1946:253) reported the sighting of a small whale, which may have been this species, off the end of the Scripps pier, La Jolla, California, six days after USNM 278031 stranded in that same area. This is the only sighting of a live animal we have encountered that is referable to this species.

Literature Cited

- Arnason, U., K. Benirschke, J. G. Mead, and W. W. Nichols
1977. Banded Karyotypes of Three Whales: *Mesoplodon europaeus*, *M. carlhubbsi*, and *Balaenoptera acutorostrata*. *Hereditas*, 87:189-200.
- Arnason, U., A. Lima-de-Faria, H. Granstrom, and M. Isaksson
1977. Analysis of Cetacean DNA, II: Localization of 18S and 28S Ribosomal RNA Cistrons in a Heavy DNA Component. *Hereditas*, 87:67-76.
- Besharse, J. C.
1971. Maturity and Sexual Dimorphism in the Skull, Mandible, and Teeth of the Beaked Whale *Mesoplodon densirostris*. *Journal of Mammalogy*, 52: 297-315.
- Campbell, R. W., and D. Stirling
1971. A Photoduplicate File for British Columbia Vertebrate Records. *Syesis*, 4:217-222.
- Clarke, M. R.
1962. The Identification of Cephalopod "Beaks" and the Relationship between Beak Size and Total Body Weight. *Bulletin of the British Museum (Natural History)*, Zoology, 8:421-480, plates 13-22.
1980. Cephalopoda in the Diet of Sperm Whales of the Southern Hemisphere and Their Bearing on Sperm Whale Biology. *Discovery Reports*, 38: 324 pages.
- Favorite, F., A. J. Dodimeade, and K. Nasu
1976. Oceanography of the Subarctic Pacific Region. *International North Pacific Fisheries Commission Bulletin*, 33: 187 pages.
- Galbreath, E. C.
1963. Three Beaked Whales Stranded on the Midway Islands, Central Pacific Ocean. *Journal of Mammalogy*, 44:422, 423.
- Hubbs, C. L.
1946. First Records of Two Beaked Whales, *Mesoplodon bowdoini* and *Ziphius cavirostris*, from the Pacific Coast of the United States. *Journal of Mammalogy*, 27:242-255.
- Ivashin, M. V., and Yu. P. Golubovsky
1978. On the Cause of Appearance of White Scars on the Body of Whales. *International Whaling Commission Report*, 28:199.
- Kasuya, T., and M. Nishiwaki
1971. First Record of *Mesoplodon densirostris* from Formosa. *Scientific Reports of the Whales Research Institute*, 23:129-137.
- Leatherwood, J. S., D. K. Caldwell, and H. E. Winn
1976. Whales, Dolphins, and Porpoises of the Western North Atlantic. *National Marine Fisheries Service Circular*, 396: 176 pages.
- McCann, C.
1964. A Coincidental Distribution Pattern of Some of the Larger Marine Animals. *Tuatara*, 12:119-124.
1974. Body Scarring on Cetacea-Odontocetes. *Scientific Reports of the Whales Research Institute*, 26:145-155.
1976. Note of the Foetal Skull of *Mesoplodon stejnegeri*. *Scientific Reports of the Whales Research Institute*, 28: 107-117.
- Mead, J. G.
1981. First Records of *Mesoplodon hectori* (Cetacea, Ziphiidae) from the Northern Hemisphere and a Description of the Adult Male. *Journal of Mammalogy*, 62(2):430-432.
- Mitchell, E. D., and V. M. Kozicki
1975. Autumn Stranding of a Northern Bottlenose Whale (*Hyperoodon ampullatus*) in the Bay of Fundy, Nova Scotia. *Journal of the Fisheries Research Board of Canada*, 32(7):1019-1040.
- Moore, J. C.
1963. Recognizing Certain Species of Beaked Whales of the Pacific Ocean. *American Midland Naturalist*, 70: 396-428.
1966. Diagnoses and Distribution of Beaked Whales of the Genus *Mesoplodon* Known from North American Waters. In K. S. Norris, editor, *Whales, Dolphins, and Porpoises*, pages 32-61. Berkeley and Los Angeles: University of California Press.
- Moore, J. C., and R. M. Gilmore
1965. A Beaked Whale New to the Western Hemisphere. *Nature*, 205:1239, 1240.
- Newman, W. A., and A. Ross
1976. Revision of the Balanomorph Barnacles; Including a Catalog of the Species. *San Diego Museum of Natural History Memoir*, 9: 108 pages.
- Nishimura, S., and M. Nishiwaki
1964. Records of the Beaked Whales *Mesoplodon* from the Japan Sea. *Publications of the Seto Marine Biological Laboratory*, 12:323-334.
- Nishiwaki, M.
1962a. *Mesoplodon bowdoini* Stranded at Akita Beach, Sea of Japan. *Scientific Reports of the Whales Research Institute*, 16:61-77.
1962b. Observation on Two Mandibles of *Mesoplodon*.

- Scientific Reports of the Whales Research Institute*, 16: 79-82.
- Nishiwaki, M., and T. Kamiya
 1958. A Beaked Whale *Mesoplodon* Stranded on Oiso Beach, Japan. *Scientific Reports of the Whales Research Institute*, 13:53-83.
 1959. *Mesoplodon stejnegeri* from the Coast of Japan. *Scientific Reports of the Whales Research Institute*, 14:35-48.
- Norris, K. S. (editor)
 1961. Standardized Methods for Measuring and Recording Data on the Smaller Cetaceans. *Journal of Mammalogy*, 42:471-476.
- Orr, R. T.
 1950. Rarity of the Deep. *Pacific Discovery*, 3(6):13-15.
 1953. Beaked Whale (*Mesoplodon*) from California, with Comments on Taxonomy. *Journal of Mammalogy*, 34:239-249.
- Perrin, W. F., R. R. Warner, C. H. Fiscus, and D. B. Holts
 1973. Stomach Contents of Porpoise, *Stenella* Spp., and Yellowfin Tuna, *Thunnus albacares*, in Mixed-Species Aggregations. *Fishery Bulletin* (U.S.), 71(4): 1077-1092.
- Pike, G. C., and I. B. MacAskie
 1969. Marine Mammals of British Columbia. *Fisheries Research Board of Canada Bulletin*, 171: 54 pages.
- Pringle, J. A.
 1963. Two Specimens of the Beaked Whale *Mesoplodon densirostris* (Blainville) Washed Ashore near Port Elizabeth, South Africa. *Annals of the Cape Provincial Museums*, 3:61-63.
- Rice, D. W., and D. K. Caldwell
 1961. Observations on the Habits of the Whalesucker (*Remelegia australis*). *Norske Hvalfangstidende*, 1961: 181-189.
- Roest, A. I.
 1964. *Physeter* and *Mesoplodon* Strandings on the Central California Coast. *Journal of Mammalogy*, 45:129-146.
- Scheffer, V. B., and J. W. Slipp
 1948. The Whales and Dolphins of Washington State with a Key to the Cetaceans of the West Coast of North America. *American Midland Naturalist*, 39: 257-337.
- Schonewald, J.
 1978. Academically Speaking: A Beaked Whale. *Pacific Discovery*, 31(6):28-31.
- Strahan, R.
 1963. The Behavior of *Myxine* and Other Myxinoids. In A. Brodal, editor, *The Biology of Myxine*, 588 pages. Oslo: Universitetsforlaget.
- Sullivan, R. M., and W. J. Houck
 1979. Sightings and Strandings of Cetaceans from Northern California. *Journal of Mammalogy*, 60(4): 828-833.
- Tomilin, A. G.
 1967. Cetacea. In V. G. Hepter, editor, *Mammals of the U.S.S.R. and Adjacent Countries*, 9: 717 pages. [Academy of Science, U.S.S.R., 1957; translated from Russian into English by Israel program for Scientific Translations, Jerusalem, 1967.]
- True, F. W.
 1910. An Account of the Beaked Whales of the Family Ziphiidae in the Collection of the United States National Museum, with Remarks on Some Specimens in Other American Museums. *United States National Museum Bulletin*, 73: 89 pages, 42 plates.
- Vedvick, T. S., and H. A. Itano
 1976. Partial Characterization of the Hemoglobin from Hubb's Beaked Whale (*Mesoplodon carlhubbsi*). *Comparative Biochemistry and Physiology*, 55B:65-68.

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