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MIOCENE MARINE MAMMALS

FROM THE

BAKERSFIELD REGION, CALIFORNIA

BY

LESLIE E. WILSON



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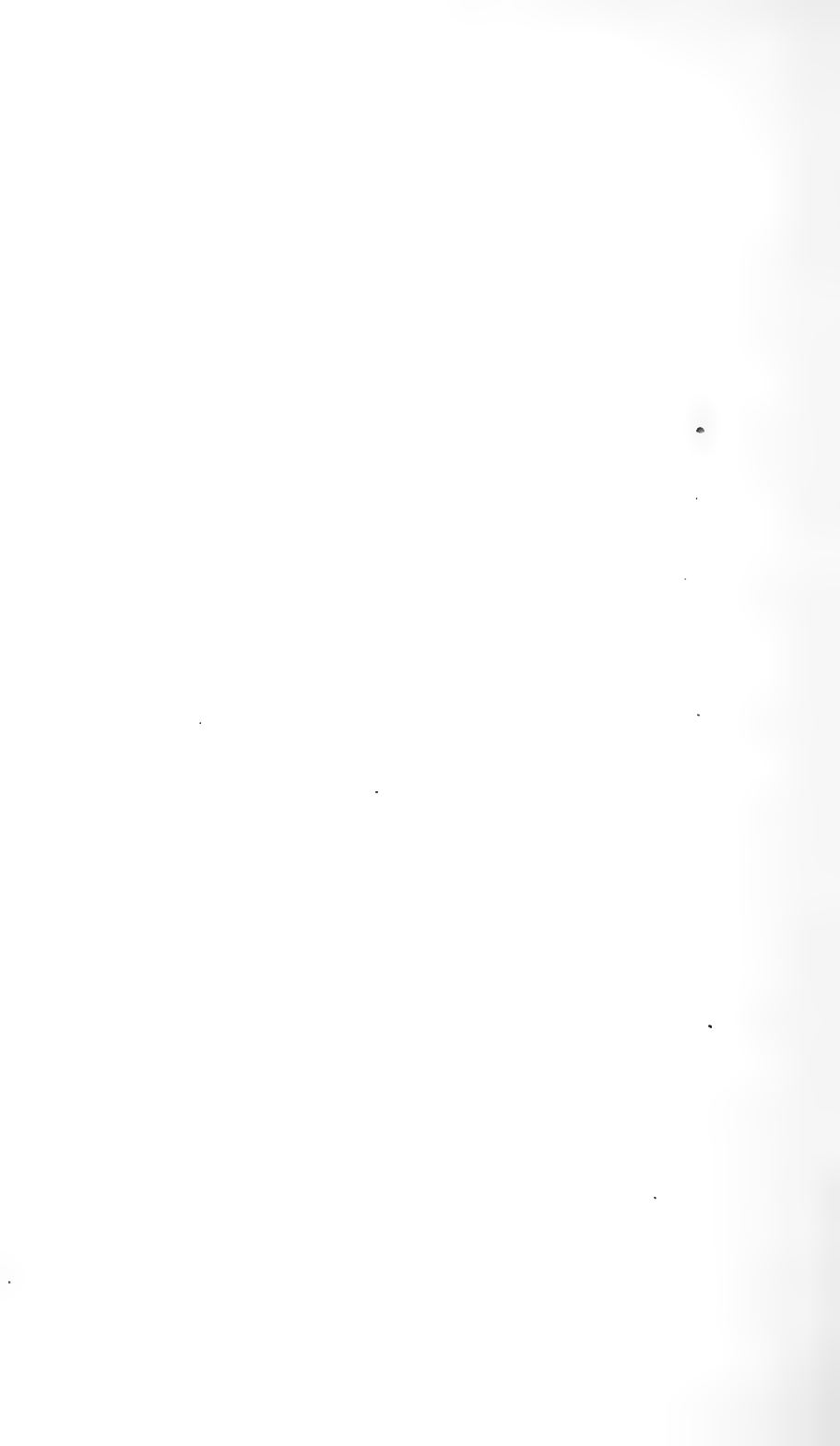


NEW HAVEN
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1935

TO
HUGH GIBB

1860-1932

Chief preparator for O. C. Marsh and the Yale Peabody Museum for fifty years, in tribute to his skill in preparing fossil vertebrates and in gratitude for his kindly aid and instruction in preparation work, this bulletin is dedicated.



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MARINE MAMMALS FROM THE MIOCENE
OF THE BAKERSFIELD REGION,
CALIFORNIA

ACKNOWLEDGMENTS

The most important acknowledgment is to the discoverer of the first fossil which leads to the acquisition of a collection; and, accordingly, first mention in this paper goes to Mr. Charles A. Pratt, a student in the writer's petroleum technology class of 1928-1929 in Bakersfield Junior College, Bakersfield, California, who discovered the skull and vertebrae of *Allodelphis pratti* (n. gen. et sp.) in the autumn of 1928 and brought them to the writer for identification. For the next two years, Mr. Pratt, the writer, Mr. Thurston V. Little of Shafter, California, and others made regular trips to different localities in the southern end of the San Joaquin Valley, discovering new fossil locations and excavating and transporting fossil material. Thanks are due to the members of the writer's classes in petroleum technology, 1928-1930, for excavation work. To the officials of Bakersfield Junior College, Dean Grace Van Dyke Bird and Principal H. A. Spindt, are due thanks for the privilege of storing and displaying the fossils of this collection in Bakersfield. To Mr. H. E. Ireland thanks are due for the careful packing of parts of the collection for shipment to Yale University. The freight on the larger part of the collection, from the shipping points of Palo Alto and Bakersfield, California, to New Haven, Connecticut, was paid by Yale University.

The hardness of the matrix required some new mechanical grinding equipment, for the setting up of which and the making of accessory equipment the writer is indebted to Mr. F. C. Herpich and Mr. William Conway of the Peabody Museum staff. The preparation of this collection has been done entirely by Mrs. L. E. Wilson and the writer. Outline figures were drawn by the writer. The shaded drawings were made by Miss Joy Stilson of the Peabody Museum staff, and financed by the Marsh Publication Fund. Publication of the present paper has been made possible, also, by the Marsh Publication Fund through the good offices of Director Lull. The writer regrets that limitation of

funds prevents the publication, at this time, of sufficient figures to amplify fully the descriptions in this paper.

To Dr. Charles W. Gilmore and Dr. Remington Kellogg of the United States National Museum the writer expresses his gratitude for their assistance and courtesy during the time the comparative work was being done at the National Museum.

LOCATION AND GEOLOGY OF AREA

The area which yielded the fossils described in this report is located at the southern end of the San Joaquin Valley, California, adjacent to the Sierra Nevada Range. Perhaps the first vertebrate fossils collected by scientific men within a dozen miles of this area were the teeth picked up by W. P. Blake¹ and described by Louis Agassiz² as remains of sharks, skates, and mackerel. Professor Agassiz states that this represented the first discovery of shark teeth west of the Rocky Mountains and remarks that their value to science “. . . is further enhanced by the peculiar relations they bear to similar fossils found in the Atlantic states and in Europe . . .” The horizon from which Blake's fossils came is probably the same as that exposed in the “Fullers Earth” mine in Granite Canyon, about four miles north of Poso Creek,³ and exposed, also, at the well-known “Shark Tooth Hill,” Sec. 25, T. 28 S., R. 28 E., Mt. Diablo Base and Meridian, only a few miles east of the Kern River Oil Field. From “Shark Tooth Hill” bones of cetaceans, sea lions, and seals have been excavated.⁴ This locality likewise furnished abundant shark teeth described by the late David Starr Jordan, among them the well-known *Carcharodon temblorensis* Jordan.⁵ The history of discoveries of a geologic and paleontologic nature in this general locality before 1911 is contained in an article by F. M. Anderson.⁶ Long before that date, and since, the great activity in the devel-

1. Pacific R.R. Reports, vol. 5, pp. 164-173, 313-316, 1857.

2. Agassiz, L.—Notice of the fossil fishes found in California by W. P. Blake. *Am. Jr. Sci. and Arts*, 2d ser., vol. XXI, pp. 272-275, 1856.

3. Hanna, G. D.—Miocene marine vertebrates in Kern County, California. *Sci.*, n. s., vol. LXI, pp. 71-72, 1925.

4. Kellogg, R.—Pelagic mammals from the Temblor formation of the Kern River region, California. *Proc. Cal. Acad. Sci.*, 4th ser., vol. XIX, no. 12, pp. 217-397, 1931.

5. Jordan, David Starr.—New sharks from the Temblor group in Kern County, California, collected by Charles Morrice. *Proc. Cal. Acad. Sci.*, 4th ser., vol. XV, no. 8, pp. 257-261, 1926.

6. Anderson, F. M.—The Neocene deposits of Kern River, California. *Proc. Cal. Acad. Sci.*, 4th ser., vol. III, pp. 73-148, 1911.

opment of oil fields in the Kern River region had led to intensive study of the sedimentary formations by geologists of various oil companies; but for economic reasons their information exists only in private reports and maps.

The topography of the east side of the San Joaquin Valley in this locality consists of rolling foothills of the Sierra Nevada and has little relation to the underground structure. The general elevation of the area of this report is about 950-1250 feet (Woody Quadrangle, U. S. G. S.).

The general stratigraphic and structural relations in the Mt. Poso Oil Field, the area nearest the basement complex that, so far, has been described, were clearly set forth by Wilhelm and Saunders in 1927.⁷ The information presented by that report was obtained from a series of well logs and from areal mapping. The surface formations range from the basement complex of Jurassic age along the eastern border of the area, to uppermost Kern River of Pleistocene and Recent age farther away from the mountains.

The dominant structural feature of the area of this report is faulting, a character common to the whole east side of the Valley.⁸ The faults are principally of the normal type, and have been dated by the penetration of the faults by the drill at various horizons and localities during the process of drilling for oil in the area.

7. Wilhelm, V. H., and Saunders, L. W.—Report on the Mt. Poso Oil Field. 12th Ann. Rept. State Oil and Gas Supervisor, Cal. State Min. Bur., vol. 12, no. 7, January, 1927.

8. Fox, L. S.—Structural features of the east side of the San Joaquin Valley, California. Bull. Am. Assn. Pet. Geol., vol. 13, no. 2, pp. 101-108, 1929.

PALEONTOLOGY

This collection of marine mammals includes toothed cetaceans, a cetothere, sea lions, and a seal.

Order CETACEA

The cetaceans described in this report show that the general configuration of the cetacean skull was already attained by the end of Lower Miocene time, and its similarities to the skulls of modern forms show that the only subsequent changes have been those in individual bones.

The characteristic cetacean features of these skulls, namely, the elongation of the maxillaries and premaxillaries, with the posterior broadening of the maxillaries as they overspread the frontals, the shortening of the nasals with their retreat in a posterior direction, the posterior migration and compression of the frontals, the rigidity of the supraoccipital, and the modern aspect of the narial passages, are all represented in the Vaqueros-Temblor transition deposits. The contrast, however, between the characters of the individual bones of these specimens and modern porpoises—for example, the increasing thinness of the maxillaries, the further decrease in size of the nasals, and the assumption of varied shapes in the supraoccipital of recent forms, as contrasted with the comparatively thick maxillaries, longer nasals, and larger frontals of Miocene forms—indicates that the general evolutionary results were established before the beginning of Miocene time, and that later developments have been specialization of parts.

Suborder ODONTOCETI

Family DELPHINIDAE

ALLODELPHIS,⁹ new genus

Genotype.—*Allodelphis pratti*,¹⁰ new species.

9. ἄλλος, strange; δελφίς, dolphin.

10. Named in honor of its discoverer, Mr. Charles A. Pratt of Bakersfield, California.

Diagnosis.—Resembling *Argyroctetus joaquinensis*¹¹ in the presence of elongated nasals, but differing from it in the reduced exposure of the frontals on the vertex, the relatively large occipital condyles, and the conformation of the occiput. Rostrum elongated (distal portion missing), vertex elevated, postero-internal angles of maxillaries rather closely approximated on vertex, nasals long and relatively narrow, premaxillaries narrowed, lambdoidal crests prominent, and occiput flattened.

Allodelphis pratti, new species

Figs. 1-3

Holotype.—Cat. No. 13408 Y. P. M.

The skull is incomplete with the major portion of rostrum missing, the right supraorbital process is destroyed at extremity, the bones inclosing the internal choanae are imperfectly preserved, and the right exoccipital is incomplete. Both tympanic bullae and the left periotic bone are missing. Right periotic is complete. No teeth were preserved with this skull. The skeletal elements consist of the complete right humerus, left half of atlas, thirty incomplete vertebrae, and a few fragments of ribs.

Type locality.—S. W. $\frac{1}{4}$ of Section 12, T. 26 S., R. 28 E., Mt. Diablo Base and Meridian. This locality is on the south slope of a hill shown as elevation $1240 \pm$ feet on the Woody Quadrangle, U. S. Geological Survey. It is about $4\frac{3}{4}$ miles southwest of Woody, Kern County, California.

Horizon.—This fossil bed occurs in a hard, white-to-brown sandstone which reaches a thickness in excess of 60 feet locally, the whole member (Pyramid Hills Sand) attaining a thickness of 160 feet. The Pyramid Hills Sand is the equivalent of the "A" zone of F. M. Anderson.¹² At the outcrop in this locality, the Pyramid Hills Sand is underlain by 50 feet of the mudstone reefs of the "Walker," which, in turn, lies on the Basement Complex. The fossil bed is located in that part of the section which is

11. Kellogg, R.—A Miocene long-beaked porpoise from California. *Smithson. Misc. Coll.*, vol. 87, no. 2, pp. 1-11, pls. 1-4, 1932.

12. Anderson, F. M.—Op. cit.

debatably Temblor or Vaqueros, in what might be called the Temblor-Vaqueros transition zone.

The skull and skeletal parts of this animal were discovered by Mr. Charles A. Pratt of Bakersfield, California, in the autumn of 1928. The excavation of most of the specimen was made by Mr. Pratt; and he transported the specimen to the Junior College in Bakersfield, where it was partially cleaned and put on display by the writer. Subsequent search by Mr. Pratt and the writer led to the accumulation of additional skeletal parts.

Skull

Dorsal view.—The outstanding characters are the flattening of the dorsal surface, the posterior elongation of the narrowed premaxillae, the flaring lateral lambdoidal crests, a conspicuous median crest on the supraoccipital, and the vertical, uncurved narial passages. The premaxillae, anterior to the narial openings, are narrow, with a thin, rounded external edge and a thicker, angular internal edge, and show a broad, deep, longitudinal groove in the center. The premaxillae curve inward behind the narial passages, encroaching upon the nasals laterally and restricting the exposure of the frontals on the vertex. The longitudinal groove in the center of the premaxilla passes to the external edge and disappears 30 mm. in front of the level of the anterior edges of the narial passages. The premaxillae widen somewhat on the internal side at approximately the level of the maxillary notches, and then narrow suddenly to make room for the narial passages. Concurrently, at the level of the narial openings, the position of the premaxillary changes from horizontal to steeply inclined. At the level of the anterior edges of the nasals, the steep inclination is lessened somewhat; and the premaxillae, also, are emarginate at their posterior ends, which lie about 28 mm. behind the anterior edge of the nasals. The maxillae underlie the premaxillae throughout the length of the latter, extend posteriorly to the supraoccipital, overlie the frontals, and lie against the nasals internally. They do not entirely overspread the supraorbital processes of the frontals, but

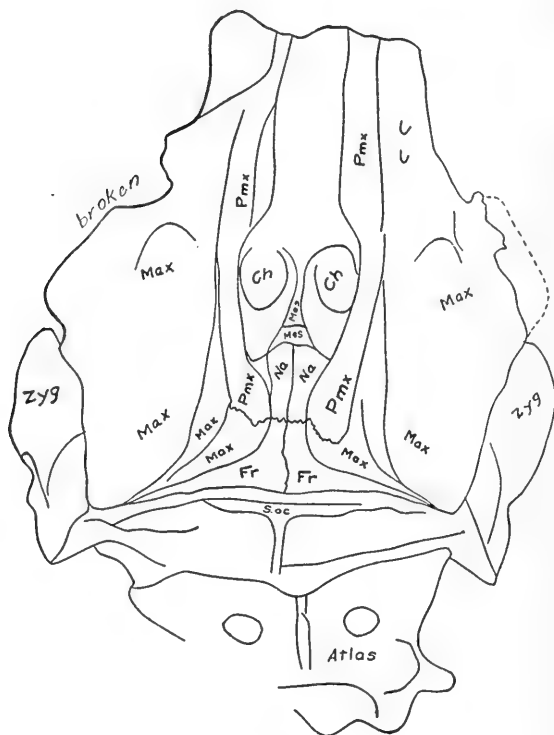


Fig. 1. *Allodelphis pratti* (holotype), dorsal view. x 3/8.

Ant. f.	anterior foramen	Pa	parietal
Ant. no.	anterior notch	Pal. loc.	location of palatine
Ch	choana	Pal. vac.	palatine vacuity
Ex. oc.	exoccipital	Pmx	premaxilla
F. m.	<i>foramen magnum</i>	P. or. pr.	post-orbital process
Fr	frontal	Pr. s	presphenoid
Max	maxilla	Pt.	pterygoid
Mes	mesethmoid	S. oc.	supraoccipital
N	notch for jugular leash	S. or. pr.	supraorbital process
Na	nasal	Sq.	squamosal
O. c.	occipital condyle	Vo.	vomer
Ol. fo.	olfactory foramen	Zyg	zygomatic
Opt. cn.	optic canal		

leave an uncovered portion of more than 13 mm. at the anterior edge. The left maxilla shows three small foramina in the region of the maxillary notch. One lies near the external edge and behind the level of the maxillary notches; and two near the center of the maxilla, separated by a distance of 6.8 mm., just anterior to the level of the maxillary notches.

The frontals are elongated in a lateral direction, and their median suture is indistinct. The nasals are long, narrow bones, considerably wider at the anterior than at the posterior end, elevated at both ends, and supported anteriorly by the mesethmoid. The right nasal is slightly longer than the left, reaching 30 mm. along the median suture. The left nasal, along the same line, is 28.5 mm. The width of the right nasal at the anterior edge is 17.5 mm. and of the left, 14.0 mm. Posteriorly, the right nasal has a transverse width of 8 mm. and the left, the same width. The presphenoid plugs the posterior end of the mesorostral gutter and is, there, a wide spongy bone. In a posterior direction, it becomes more narrow and more elevated. The mesethmoid sheathing the presphenoid reaches well above the premaxillae in a vertical direction and extends posteriorly to the nasals, to form the highest point of the dorsal surface of the skull.

Posterior view.—The supraoccipital is broadly expanded, with flaring exterior edges directed posteriorly. A well-defined carina extends in a dorso-ventral direction from near the top of the supraoccipital toward the occipital condyles. In this specimen, a view of the lower part of this crest is cut off by the presence of the atlas, which has been thrust upward from the occipital condyles and now rests just above them against the supraoccipital. The above-mentioned carina divides near the top and forms, on each side, a smaller crest which extends laterally on the supraoccipital from a median line to near the level of the postero-external angle of the maxillary. Above the junction of these subsidiary crests is a short, transverse crest on the dorsal edge of the supraoccipital. Near the crests, the supraoccipital is rugose and thick but becomes smooth and paper-thin away from them. The occipital condyles are broadest near the base and

taper considerably toward the apex (cf. *Argyroctetus*, Kellogg, p. 6). The high part of the articular surface is near the middle of the condyle. The condyles show sharp, slightly overhanging ridges on the exterior edges, which become rounded on the dorsal side. The necks of the condyles are distinct but short and but little smaller than the exterior edges. The basal intercondylar gap is 22.7 mm. The exoccipitals are heavy bones which descend fanlike from the lower part of the occipital condyles. The exoccipitals are separated from the lateral processes of the basioccipital by the deep notch for jugular leash. The *foramen magnum* is suboval in outline with a greatest width of 40 mm. and a vertical diameter of 24 mm. The internal edges of the condyles overhang the *foramen magnum*.

Lateral view.—The low, flat brain case is a noticeable peculiarity of this skull, as is the sharp backward arching of the lateral portion of the lambdoidal crest and the close approach of the supraorbital process of the frontal to the zygomatic process of the squamosal. The zygoma is stout and moderately curved and has the plane of its external surface practically parallel to the sagittal axis of the skull. Its dorsal aspect shows a steep external slope downward and forward from a broad vertex, and a steeper, inward, posterior slope. The greatest length of the left zygomatic process is 67 mm.; its dorso-ventral diameter anteriorly is 33.1 mm. The orbit is rounded anteriorly and posteriorly, with the posterior slope somewhat steeper. The supraorbital process of the frontal is broken on both anterior and posterior edges on both sides of the skull. The thinnest point is above the center of the orbit, where the process shows a thickness of 3.9 mm. From this point, rapid thickening takes place in both anterior and posterior directions. Its dorsal aspect, while irregular, is noticeably flattened. The superimposed plate of the maxilla does not cover the supraorbital process entirely but leaves a fairly wide border at the exterior edge. The external edge of the frontal underlying this portion of the maxilla is indiscernible. In the lateral view, the backward bowing of the lateral edge of the supraoccipital is conspicuous (similar to *Argyroctetus*). The vertex of the skull

is long and flat, and the descent from it to the rostrum is gradual. The parietal is curved laterally. A deep depression is formed on the squamosal just above the zygoma. The exoccipitals are widened ventrally and become thinner toward their upper limit.

Ventral view.—The vomer is visible from the anterior end of the specimen to its point of contact with the basioccipital. At the anterior end of the specimen, near the base of the rostrum, the ventral surfaces of the maxillae are separated only by the narrow, rounded edge of the vomer, which appears as a ridge

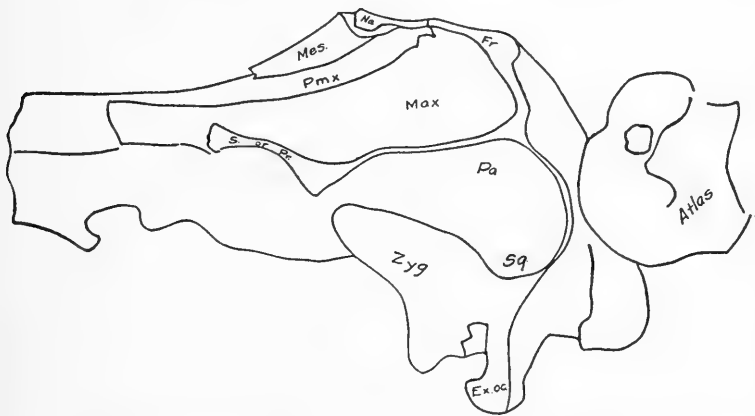


Fig. 2. *Allodelphis pratti* (holotype), lateral view. $\times 3/8$. For explanation of lettering, see Fig. 1.

between the maxillae. In a posterior direction, the vomer shortly appears and is well exposed at the palatine vacuities; it is seen to be triangular in shape, with the apex on the ventral side and the broad base lying dorsal to this. At the anterior edges of the narial openings, the vomer shows lateral compression but becomes wider at the posterior edges of the narial apertures. The palatine vacuities are noticeably large. Interiorly, the narial openings are bounded chiefly by the vomer and partially by the rapidly thinning posterior surfaces of the maxillaries. Exteriorly, they are bounded by the maxillae, and the pterygoids, with their external reduplications. The narial apertures are elliptical

MEASUREMENTS OF SKULL*

Total length of skull as preserved.....	235
Transverse diameter of skull between outer surfaces of zygomatic processes	194
Distance across skull between outer margins of exoccipitals..	171.5
Distance between inner margin of left occipital condyle and outer margin of left exoccipital.....	83
Distance between inner margin of right occipital condyle and outer margin of right exoccipital.....	86
Distance between outer surfaces of descending processes of basioccipital (broken)	80
Distance between outer margins of occipital condyles.....	96
Greatest oblique-vertical diameter of left occipital condyle..	50
Maximum transverse diameter of left occipital condyle.....	37
Maximum transverse diameter of <i>foramen magnum</i>	40
Vertical diameter of <i>foramen magnum</i>	24
Vertical distance from basioccipital to apex of supraoccipital shield	101
Greatest vertical depth of skull at level of anterior borders of narial passages.....	67
Greatest vertical depth of rostrum at broken extremity (70 mm. in front of maxillary notches).....	45
Greatest distance between outside margins of premaxillaries at level of anterior border of narial passage.....	60
Greatest length of left zygomatic process.....	67
Length of right nasal along median sutural line.....	30
Length of left nasal along median sutural line.....	28.5
Width of right nasal at anterior edge.....	17.5
Width of left nasal at anterior edge.....	14
Posterior transverse width of right nasal	8
Posterior transverse width of left nasal	8

*Measurements in this and all subsequent tables are in millimeters.

on the ventral side, more nearly round as they continue dorsally, and almost vertical in direction, a circumstance which contrasts markedly with the usual posterior deflection near the ventral surface of dolphin skulls. The pterygoids are thin, meeting the vomer at the external side of the narial apertures, and pass backward to the lateral process of the basioccipital. The basioccipital is a heavy, well-preserved bone in the shape of a broad U, with

steep but not vertical sides. A groove for the mandibular division of the trigeminal nerve is plainly visible passing from a notch in the alisphenoid to the *foramen ovale*. Slightly behind this notch, and lying just above the basioccipital, is a foramen for the internal carotid. The hypoglossal foramen lies at the base of the notch for the jugular leash. The rugose paroccipital process, to which is attached the stylohyoid, is partly present on the left side of the skull.

Periotic

(Plate 1, figs. a and b)

The right periotic of *Allodelphis pratti* is complete and was attached to a mandibular fragment crushed against the right maxilla and right supraorbital process of the frontal. It is considerably larger than that of *Ædolithax mira* Kellogg¹³ or *Lamprolithax simulans* Kellogg¹⁴ and differs from these types in several other respects. Viewed from the *tympanic side*, the bone presents two major parts separated by the semi-closed canal for the facial nerve and adjoining fossa for the stapedial muscle. The portion above the canal is roughly the shape of a thick crescent, and the part below (*pars cochlearis*) has the appearance of a truncated hemisphere. In the tympanic view, the posterior process is triangular in form and rather stout. On its ventral face, it bears four osseous crests, two large anterior ones and two smaller posterior ones. This process is convex, with a slight twisting in an internal direction. The posterior face is rugose. The anterior edge is bounded by a deep and well-defined groove which extends from the tip of the posterior process to the *fossa incudis*. Near its outer end, this groove divides into two parts, the more posterior one being the larger. This groove ends anteriorly at the small, nearly round depression, the *fossa incudis*, for the *crus brevis* of the incus, which is bounded internally by

13. Kellogg, R.—Pelagic mammals from the Temblor formation of the Kern River region, California. Proc. Cal. Acad. Sci., 4th ser., vol. XIX, no. 12, p. 378, 1931.

14. Kellogg, R.—Op. cit., p. 381.

the external edge of the semi-closed canal for the facial nerve. The *hiatus epitympanicus* is quite broad and bounded posteriorly by a gentle slope of the anterior face of the posterior process, and anteriorly, by the sharp, vertical edge of the tuberosity at the base of the anterior process. This tuberosity on the periotic of *Allodelphis pratti* has a different shape and size from that of *Ædolithax mira* Kellogg. The same observation holds true for *Nannolithax gracilis* Kellogg. The size of this tuberosity is comparable to that of *Schizodelphis bobengi* Case.¹⁵ It differs from *S. bobengi* in that the posterior margin overhangs the anterior portion of the *hiatus epitympanicus*, a feature suggested by the tuberosity of *Ædolithax mira* Kellogg and attained only by *Squalodon errabundus* Kellogg¹⁶ in the U. S. National Museum collection of over fifty fossil periotics of toothed whales of the same approximate size. The depressed surface on which rests the anterior pedicle of the bulla lies on the anterior side of the tuberosity just described. The depression is concave, triangular, and extends anteriorly nearly to the end of the anterior process. It is not at all similar to the corresponding surface in *Ædolithax mira* Kellogg. *Nannolithax gracilis* Kellogg has a corresponding surface generally similar but only about half the size of that of *Allodelphis pratti*. The anterior process itself is large and is directed obliquely inward. It is laterally compressed and rounded at extremity. Lying at the posterior base of the anterior process and just above the *pars cochlearis*, is a narrow curved groove probably marking what was at one time the course of the tensor tympanic muscle. The deep fossa for the head of the malleus is located on the inner portion of the tuberosity described above and is bounded by a nearly complete rim. In this respect, *A. pratti* differs noticeably from *S. bobengi*. The *fenestra ovalis* is located internal to the fossa for the head of the malleus and opposite the epitympanic orifice of Fallopiian

15. Case, E. C.—A specimen of a long-nosed dolphin from the Bone Valley gravels of Polk County, Florida. Contrib. Mus. Pal. Univ. Mich., vol. IV, no. 6, pp. 105-113, 2 pls., 1934.

16. Kellogg, R.—Op. cit., p. 373.

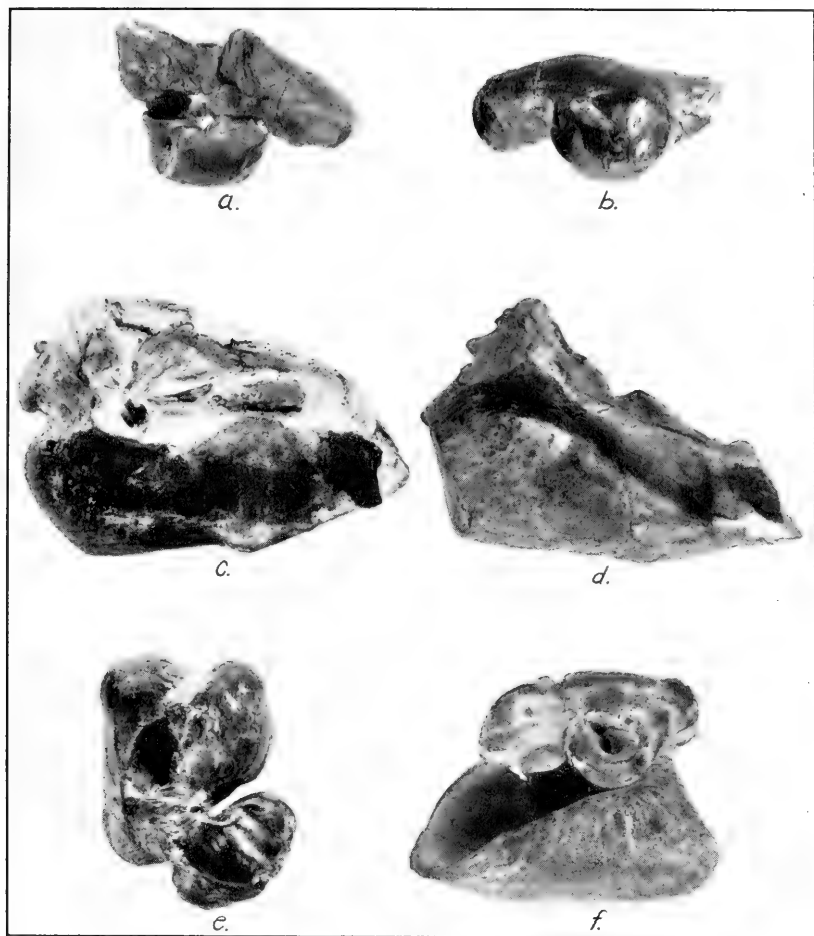


Plate 1. Nat. size

- Fig. a. Right periotic of *Allodelphis pratti* (holotype). Tympanic view.
 Fig. b. Right periotic of *Allodelphis pratti* (holotype). Cerebral view.
 Fig. c. Left tympanic bulla of *Macrodelphinus kelloggi* (holotype). Dorsal view.
 Fig. d. Left tympanic bulla of *Macrodelphinus kelloggi* (holotype). Internal view.
 Fig. e. United right tympanic bulla and periotic. Cat. No. 13413 Y.P.M. Posterior view.
 Fig. f. United right tympanic bulla and periotic. Cat. No. 13413 Y.P.M. Cerebral view.



aqueduct. The *fenestra ovalis*, which held the footplate of the stapes, is small compared to the malleolar fossa but is fairly deep. The semi-closed canal for the facial nerve is large, deep, and,

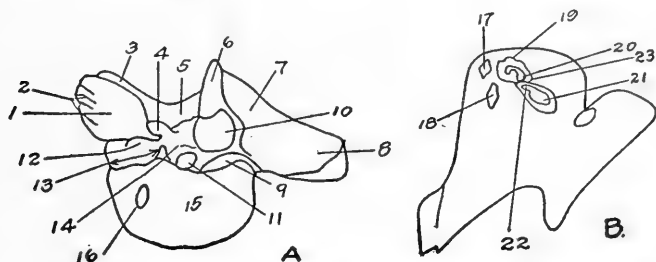


Fig. 3. Right petriotic of *Allodelphis pratti* (holotype). Nat. size.

A. Tympanic view.

B. Cerebral view.

1. posterior process
2. osseous ridges
3. internal posterior groove
4. *fossa incudis* for *crus brevis* of incus
5. *hiatus epitympanicus*
6. tuberosity at base of anterior process
7. triangular depression on which rests anterior pedicle of bulla
8. anterior process
9. groove; probable course of tensor tympani muscle
10. fossa for head of malleus
11. *fenestra ovalis*
12. semi-closed canal for facial nerve
13. fossa for stapedial muscle
14. epitympanic orifice of Fallopian aqueduct
15. *pars cochlearis*
16. *fenestra rotunda*
17. cerebral orifice of *aqueductus cochleae*
18. cerebral orifice of *aqueductus vestibuli*
19. internal acoustic meatus
20. spiral tract ending in *foramen centrale*
21. entrance to aqueduct of Fallopius
22. *foramen singulare*
23. osseous wall

commencing at the epitympanic orifice of Fallopian aqueduct, extends in a posterior direction to the hinder face of the posterior process. Internal to this canal, and extending forward to the level of the *fossa incudis*, is the fossa for the stapedial muscle. This fossa is large, elongate, and extends downward on the

MEASUREMENTS OF RIGHT PERIOTIC

Greatest length of periotic from tip of posterior process to extremity of anterior process.....	36.5
Maximum transverse breadth from exterior tip of tuberosity at base of anterior process to extremity of <i>pars cochlearis</i> at level of fossa for head of malleus.....	24
Greatest dorso-ventral depth from most inflated portion of dorsal face of <i>pars cochlearis</i> to projection on the ventral face at level of cerebral orifice of <i>aqueductus vestibuli</i>	17
Distance between nearest edge of <i>fenestra rotunda</i> and dorsal tip of anterior process.....	25
Distance between dorsal tip of posterior process and nearest edge of <i>fenestra rotunda</i>	17
Distance between center of fossa for head of malleus and nearest edge of <i>fenestra rotunda</i>	10
Distance from nearest edge of internal acoustic meatus to nearest edge of <i>fenestra rotunda</i>	5

external face of the *pars cochlearis*. The lower half of the periotic, the *pars cochlearis*, is large, rounded, and thick and is larger and more robust throughout than that of any of the periotics of long-beaked dolphins available for comparison, including *Schizodelphis bobengi*. The *fenestra rotunda* is the most noticeable feature of the *pars cochlearis* in the tympanic view. It is oval in outline, with the elongation in a dorso-ventral direction. In size, it is nearly equal to the fossa for the head of the malleus. It resembles the *fenestra rotunda* of *S. bobengi* in size and shape but occupies a more anterior position than that of *S. bobengi*.

Cerebral view.—At the posterior edge, in the cerebral view, there appears a short, sharp ridge which marks the posterior edge of the cerebral orifice of the *aqueductus cochleae*. The orifice resembles a longitudinally-sectioned cone with the apex on the exterior edge. Below this orifice and slightly anterior to it, is the eye-shaped cerebral orifice of the *aqueductus vestibuli*, which is much deeper and about twice the size of the orifice of the *aqueductus cochleae* and larger than the corresponding orifice of *Schizodelphis bobengi*. In *Allodelphis pratti*, the ori-

fices are separated only by a thin partition of bone, while in *S. bobengi* the separation amounts to 5 mm. The internal acoustic meatus is the most outstanding feature of this view. Its fundus is deep and its walls vertical. Its anterior edge is bounded by a low osseous partition separating it from the entrance to the aqueduct of Fallopius. The spiral tract ending in the *foramen centrale* is located on the fundus of the internal acoustic meatus. The small *foramen singulare* appears at the posterior end of the entrance to the aqueduct of Fallopius. The anterior process shows in this view as a subconical protuberance. By way of recapitulation, it may be said that this periotic is large and robust, with the tuberosity between posterior and anterior processes well developed, with a deep fossa for the accessory ossicle of the tympanic bulla, and with a narrowed internal acoustic meatus.

Atlas

The imperfect atlas of this specimen is attached to the back of the skull above the occipital condyles. It lacks the posterior facets for the articulation with the axis, the left transverse process, and part of the right transverse process. The cranial aspect of the atlas is not exposed to view; but if it were visible, it would undoubtedly show deeply concave facets for articulation with the occipital condyles, since it is wider above than below. The spinous process is carinate anteriorly and widens posteriorly,

MEASUREMENTS OF ATLAS

Greatest vertical depth from tip of neural spine to inferior face of centrum	70
Maximum width across cranial side of articular surfaces for condyles (outside edges).....	101
Length of atlas, external margin of anterior facet to external margin of posterior facet.....	69

becoming a blunt-edged crest. The neural arch is well elevated. The broad neurapophysis is pierced transversely by small, ovoidal vertebrarterial canals. The base of the right, upper transverse

process (diapophysis) is preserved, and it shows that the process was small and projected obliquely upward and backward. The thick hyapophysial process is partly preserved. There is a wide fossa for articulation with the odontoid process of the axis.

Humerus

The right humerus is well preserved and complete. The head is large, round, and thick, with a distinct neck except at the proximal end, where the head is marked off by a broad groove. The top of the head is on a level with the top of the internal tuberosity. This tuberosity is large and sub-ovoid, and its rugosities indicate a large supraspinatus muscle. The bicipital groove is shallow and short. The external tuberosity is small and rugose and located well below the head. The deltoid crest appears as a sharp ridge near the external tuberosity and widens distally toward the deltoid process, which is large and has a broad, flat surface, oval in outline. The internal border of the humerus is slightly and regularly concave. On the external side of the shaft, just below the head, is a deep, steep-sided, oval fossa for the insertion of the infraspinatus muscle. The capitulum and trochlea are separated by a ridge, and the articular surface for the radius is somewhat broader than the trochlea. The surface of the capitulum is fairly smooth, but the trochlear surface shows a central depression consisting of the union of several small pits. The internal face of the shaft is marked by a flat surface continuing axially from the extension of the trochlea to a point opposite the center of the head, and having an average width of 17 mm.

MEASUREMENTS OF RIGHT HUMERUS

Greatest length	139
Extero-internal diameter of distal end.....	35
Antero-posterior diameter of distal end.....	50
Greatest diameter of head.....	64
Greatest diameter of internal tuberosity.....	40
Least diameter of internal tuberosity.....	28
Thickness of shaft near middle.....	37

MACRODELPHINUS,¹⁷ new genus

Genotype.—*Macrodelphinus kelloggi*,¹⁸ new species.

Diagnosis.—This genus is characterized by the large size of the skull, wide exposure of the frontals on the vertex, short, wide nasals, hinder ends of premaxillaries not extending posteriorly behind nasals, concave supraoccipital, and heavy, elongated rostrum. It differs from *Cetorhynchus christolii*¹⁹ in the size of the teeth. (*C. christolii* has 29 alveoli in a space of 384 mm., while *Macrodelphinus kelloggi* has 6 teeth in a space of 109 mm., the ratio being approximately 3 teeth in *C. christolii* to 2 teeth in *M. kelloggi* in equal distances.) In *C. christolii*, the septa between the alveoli are greatly reduced, and the alveolar groove is narrowed,²⁰ while in *M. kelloggi*, the septa between alveoli average about 5 mm. in thickness, and the alveolar groove is wider. It differs from *Stereodelphis brevidens*²¹ in having teeth of a quite different shape. *M. kelloggi* differs from *Diochotichus vanbenedeni* (Moreno)²² in having a skull with a large, flattened vertex, frontals exposed to a greater extent on the vertex, larger nasals, and a greater number of teeth. The relation between supra-orbital process and maxilla differs in the degree to which the maxilla overspreads the supraorbital process of the frontal, the latter being nearly covered in *D. vanbenedeni* and about two-thirds covered anteriorly in *M. kelloggi*. The rostrum in *M. kelloggi* is much longer than in *D. vanbenedeni*. The dentition is similar as far as the size and spacing of teeth are concerned. *D. vanbenedeni* has 18 alveoli in the right maxilla in a distance

17. μακρός, large, long; δελφίνος, dolphin.

18. Named in honor of Dr. Remington Kellogg, Assistant Curator of Mammals, U. S. National Museum.

19. Van Beneden, P. J., and Gervais, P.—Ostéographie des Cétacés vivants et fossiles. Libraire de la Société de Géographie, Atlas, pl. LVII, fig. 12, 1868-1879.

20. Abel, O.—The genealogical history of the marine mammals. Ann. Rep. Smithsonian Inst., 1907, p. 490.

21. Van Beneden and Gervais.—Op. cit., pl. XXVIII, figs. 14-16.

22. True, F. W.—Description of a skull and some vertebrae of the fossil cetacean *Diochotichus vanbenedeni* from Santa Cruz, Patagonia. Bull. Amer. Mus. Nat. Hist., vol. XXVIII, pp. 19-32, pls. I-V, 1910.

of 291 mm. or 19 in 307 mm., while *M. kelloggi* has 19 alveoli in a space of 317 mm., the latter measurement being taken well out on the rostrum (posterior ones are not preserved), while the count in *D. vanbenedeni* begins with the most posterior alveolus.

Champsodelphis valenciennesii Brandt²³ (based upon "dauphin à longue symphyse" Cuvier²⁴) from the Helvetian shell marl pit at Sort, 2 leagues from Dax, Dept. Landes, France, is based upon a rostral fragment, 168 mm. in length, similar to *M. kelloggi*, but the teeth are larger.

	<i>C. valenciennesii</i>	<i>M. kelloggi</i>
In left maxillary there are 3 alveoli in an interval of	69.5	51.0
A right maxillary tooth <i>in situ</i> :		
Antero-posterior diameter at base of crown	12.2	8.0
Transverse diameter at base of crown..	9.5	9.0
Vertical height of enamel crown.....	15.0	13.4

Cyrtodelphis sulcatus Gervais sp.²⁵ differs from *M. kelloggi* in having an entirely different type of rostrum, hinder ends of premaxillaries extended farther backward, and considerably larger teeth.

Macrodelphinus kelloggi, new species

Fig. 4

Holotype.—Cat. No. 13402 Y. P. M.

This specimen consists of an incomplete skull in which most of the basicranium and lower occipital region are lacking, as are, also, the right supraorbital process of the frontal, the postero-external borders of both maxillae, and part of the rostrum. Several of the rostral parts preserved have teeth, or parts of teeth, *in situ*. This skull is the largest of three discovered in one

23. Brandt, J. F.—Mém. Acad. Imp. Sci. de St. Pétersbourg (7), vol. 20, p. 266, 1873. Also vol. 21, pp. ii, 20-21, 1874.

24. Cuvier, Georges.—Recherches sur les ossemens fossiles, Atlas, 4th ed., Tome II, pl. 224, figs. 9, 10, 11, Paris, 1836.

25. Dal Piaz, G.—Sugli avanzi di *Cyrtodelphis sulcatus* dell'arenaria di Belluno. Paleontographica Italica, vol. IX, pp. 187-219, 1903.

pit by Mr. Charles Pratt in 1929. Excavation of the skulls and skeletal parts from this pit was carried on by Mr. Pratt, Mr. T. V. Little, and the writer at intervals over a period of a few months as time was available. The skull was prepared by the writer at the Bakersfield Junior College, and was on display there, with other fossil whale material, for a year and a half.

Type locality.—Southern part of Section 12, T. 26 S., R. 28 E., M. D. B. & M., near the N-S quarter-section line and on the southern slope of hill 1240± feet shown on the Woody Quadrangle, U. S. Geological Survey. This pit is a few hundred feet southwest of that in which *Allodelphis pratti* was discovered.

Horizon.—The Pyramid Hills Sand as described for *Allodelphis pratti* and fifty feet lower in the section.

Skull

Dorsal view.—The inner portion of the premaxilla is flat over the mesorostral gutter. The lateral portion is slightly convex and narrows posteriorly as it approaches the premaxillary foramen. A narrow groove runs posteriorly from the premaxillary foramen to a forward, lateral projection of the frontal on the vertex of the skull. From the frontal, the premaxilla descends abruptly laterally to its contact with the maxilla. The premaxilla extends for 34.8 mm. behind the anterior edges of the nasals. The inner part of the premaxilla ascends rather steeply along the outer border of the narial opening and is emarginate posteriorly. It is bounded behind by the frontal and on the inside by the nasal. The right premaxilla contains two foramina, one directly behind the other in a line slightly oblique to the lateral contact between the maxilla and premaxilla. The anterior edges of the foramina are separated by a distance of 19.5 mm. The anterior edge of the posterior foramen lies 118 mm. obliquely from a point on the median line of the anterior edge of the nasals. The left premaxilla contains a single foramen which lies at the level of the right premaxillary foramen. The left premaxillary foramen is slightly larger than either of the right premaxillary foramina. The maxilla is broad at the base of the rostrum; and

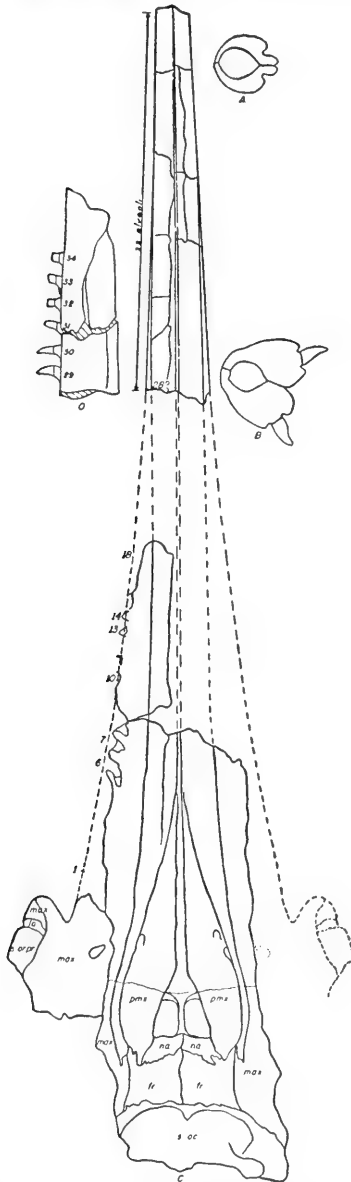


Fig. 4. *Macrodelfinus kelloggi* (holotype).

A, B. Cross sections. x 1/4.

C. Dorsal view. x 1/6.

O. External lateral detail. x 1/5.

For explanation of other lettering, see Fig. 1.

at the anterior extremity, as preserved, it descends abruptly laterally from the premaxilla. At its posterior extremity, the right maxilla rises abruptly to the vertex of the skull, where it bounds the exposed portion of the frontal, and is concave laterally below the vertex. The posterior extremity of the maxilla is irregular in outline where it meets the supraoccipital. The maxillary notch is deep and narrow. Its ventral border is formed by an extension of the jugal, which reaches 6 mm. beyond the border of the maxilla. Two foramina occur in the rostral portion of the right maxilla, one, a rather small one, obliquely anterior to the anterior premaxillary foramen; the other, a large one, at the level of the anterior premaxillary foramen. This maxillary foramen lies 17.6 mm. from the outer border of the premaxilla and 41 mm. obliquely posterior to the center of the maxillary notch. Two small foramina occur, also, in this region. One is at the level of the maxillary notch, with its inner edge 24 mm. from the outer edge of the maxilla; the other occurs 45 mm. obliquely posterior to the maxillary foramen and 40 mm. from the exterior edge of the maxilla. The two are in a line antero-posteriorly. The maxilla projects beyond the lacrimal anteriorly and almost completely covers it laterally. A small part of the lacrimal can be seen in dorsal view below and between the anterior angle of the supraorbital process of the frontal and the anterior angle of the frontal plate of the maxilla. The anterior angle of the supraorbital process of the frontal is exposed for 25.5 mm. beyond the maxilla. The posterior parts of the frontal plate of the maxilla and of the supraoccipital are broken away. The exposed portions of the frontals on the vertex of the skull are large and form the greater part of the vertex. They are very irregular along their anterior borders, forming sharp interfingering sutural lines with the nasals and premaxillae. The right frontal is noticeably broader than the left. The supraoccipital descends abruptly from the vertex of the skull and then flares laterally, forming a concave basin in the center. A blunt, triangular prominence occurs at the top of the supraoccipital a little to the right of the median sutural line of the frontals.

Lateral view.—This view is characterized by the large, deep maxillae, the horizontal plane of the premaxillae extending to the anterior edges of the narial apertures, the flatness of the vertex of the skull, the great thickness of the dorsal cover of the brain case, and the small size of the brain case. The infraorbital foramen shows plainly on the right side where the maxilla is broken away. At the level of the premaxillary foramina, it divides into two branches, one passing interiorly under the premaxilla, the other running in an antero-posterior direction under the maxilla, approximately parallel to the contact line of the premaxilla and maxilla. The optic canal is deep and narrow inferiorly and well displayed, with the side walls complete and only the top removed. Its superior extension is found flaring as a wide shallow groove on the ventral side of the supraorbital process of the frontal. The anterior part of the jugal is large and twisted, with one edge forming a border of the maxillary notch. The base of the styloform process is present at the point of fusion with the lacrimal.

Posterior view.—This view is marked by the deep basin-like depression formed by the supraoccipital, and the large lateral indentations formed by the parietals, a combination of characteristics which gives a constricted appearance to the brain case. The union of the supraoccipital and the frontals forms a smoothly rounded lambdoidal crest. Between the two halves of the interior of the brain case on the dorsal side, is a wide and deep groove reaching a maximum width of 13.8 mm. and a depth approximately as great. This groove extends from the supraoccipital in a ventral direction for a distance of 55 mm. where it quickly becomes narrow and passes into a large fossa near the base of the brain case. This fossa has a diameter of 14 mm., and is nearly circular in outline. The olfactory foramina open into this fossa 20 mm. within the opening.

A right occipital condyle found in the pit with the skull just described is tentatively referred to it. The condyle is complete, strongly convex, broad at the top, and bluntly pointed at its inferior limit. A part of the supraoccipital connecting with the

condyle is present; and from its configuration, the size and shape of the *foramen magnum* can be estimated. A sharp neck, 9 mm. high, sets the condyle apart from the exoccipital. This neck disappears on the dorsal side of the condyle.

MEASUREMENTS OF CONDYLE AND FORAMEN MAGNUM

Maximum dorso-ventral length of condyle.....	63
Maximum transverse width of condyle.....	40
Maximum vertical height of <i>foramen magnum</i>	31±
Maximum transverse width of <i>foramen magnum</i>	44±

Ventral view.—The sutures are plain and open. The rostrum is broad and gently sloping from the median line. The palatine vacuities are long and fairly deep and have the shape of a spherical triangle. They are separated at the median line by an interval of 14 mm. The right vacuity is larger than the left, thus^o agreeing in asymmetry with the larger right frontal. The anterior basal part of the right pterygoid and interior lateral part are preserved. The thickness of these parts is in keeping with the size of the specimen. The preserved lateral part of the pterygoid bounds the anterior part of the narial opening and, on the inner side, sheathes the vomer. The vomer is visible for only a few millimeters, being covered anteriorly by the maxillae and pterygoids. The specimen is broken transversely through the narial passages, permitting an excellent view of the bones at this level. The presphenoid is large and somewhat more compact and rounded than that observed on the other specimens. The narial openings are much larger on the ventral than on the dorsal side. About halfway through the specimen, the narial apertures show the usual posterior recurving. The ventral aspect of the openings shows that they pass backward along the sides of the presphenoid and, at their posterior part, lie nearly horizontally.

Parts which are tentatively referred to *Macrodelfhinus kelloggi* are the following: incomplete left tympanic bulla, right scapula (incomplete), right half of atlas, and fourteen incomplete vertebrae.

MEASUREMENTS OF SKULL

Total straight-line length of skull as preserved (including gap of 150 mm. between rostral fragments).....	1143
Semi-width of skull at level of center of supraorbital process of frontal	175
Greatest depth of rostrum at level of maxillary notches...	145.2
Greatest depth of rostrum at central break	53
Greatest depth of rostrum at most anterior break.....	39
Greatest distance between outside margins of premaxillae at level of anterior border of narial passages.....	127
Greatest breadth of left premaxilla at level of maxillary notch	44+
Greatest breadth of left premaxilla at level of anterior border of narial passages.....	52
Distance between inner margins of premaxillaries at level of anterior margins of nasals.....	30
Semi-breadth of rostrum at level of maxillary notches.....	101
Greatest antero-posterior diameter of nasals along median suture	•54.5
Least transverse diameter of left frontal	45
Least transverse diameter of right frontal	53
Transverse diameter of left frontal at anterior end.....	54
Transverse diameter of right frontal at anterior end.....	54
Transverse diameter of left frontal at posterior end.....	54
Transverse diameter of right frontal at posterior end.....	68
Least distance between inner margins of maxillaries on vertex of skull.....	101
Distance from level of anterior edges of nasals to anterior edge of supraoccipital medially.....	69
Transverse width of combined nasals at anterior edges ...	56
Transverse width of combined nasals at posterior borders.	82.3
Anterior end of left half of rostrum has 22 alveoli in a distance of	372
Anterior end of right half of rostrum has 22 alveoli in distance of	361

Tympanic Bulla

(Plate 1, figs. c and d)

The left tympanic bulla referred to *Macrodelphinus kelloggi* is damaged, the outer lip being broken off in front of the sigmoid

process and crushed into the tympanic cavity. The anterior end is broken off in the region of the tympanic aperture of the eustachian canal. In the ventral view, a deep, wide groove marks the division of the bone into an outer portion consisting of the thin outer lip which overarches the tympanic cavity, and an inner portion, the involucrum. The posterior process is broken off at the base; and the posterior end of the bulla is, likewise, missing, exposing the tympanic cavity. If complete, this posterior end would round into a blunt point. The sigmoid process projects from the lip for a distance of 16 mm. This process is turned nearly at right angles to the central axis of the tympanic cavity. The involucrum is dense, rather wide and is flattened near the posterior end. The dorsal, or periotic view, cannot be described because of the crushing. The fragments of bone which have been forced into the tympanic cavity and are visible in this view represent the marginal border of the outer lip. This tympanic bulla is larger than the corresponding bulla of *Zarhachis flagellator* Cope (as restricted by Kellogg²⁶).

MEASUREMENTS OF TYMPANIC BULLA

	<i>Z. flagellator</i>	<i>M. kelloggi</i>
Anterior tip to posterior end of involucrum	49.5	53.8+
Maximum thickness at level of external end of sigmoid process.....	28.3	35.0

Since the extremities of *Z. flagellator* are more nearly complete than in *M. kelloggi*, the larger dimensions of the latter are not clearly indicated by these measurements. These bullae are readily distinguished by the difference in thickness of the involucrum near its anterior end, that of *M. kelloggi* being easily twice that of *Z. flagellator*, and by the groove on the ventral face of the bulla, which is deep and continuous in *Z. flagellator* and broad, short, and shallow in *M. kelloggi*. In comparison with the tym-

26. Kellogg, R.—A fossil porpoise from the Calvert formation of Maryland. Proc. U. S. Nat. Mus., vol. 63, art. 14, p. 3, p. 38, pl. 7, fig. 2, pl. 8, fig. 4, 1924.

panic of *Eurhinodelphis bossi* (U. S. N. M. specimen collected in June 1924), a resemblance is found in the positions of this groove; but the groove of *M. kelloggi* is shallower and broader than that of *E. bossi*.

Scapula

An incomplete right scapula is referred to this specimen. All of the vertebral border is destroyed, as are, also, parts of the posterior and anterior borders. Both the acromion and coracoid processes are incomplete. The glenoid cavity is subelliptical in outline except for a nearly straight anterior edge, which constricts the anterior width, and its whole border is rugose. The articular surface is strongly concave anteriorly and posteriorly. The neck is quite long. The coracoid process is elliptical in cross section, with diameters of 12 mm. and 18 mm. The acromion process is large, thick, and rather wide, measuring 14 mm. by 40 mm. as preserved. Limits of the supraspinous fossa are not ascertainable. The vertebral border thins to 2 mm. near the hinder angle of the scapula as preserved. The internal surface shows a concave depression extending from the base of the acromion process for a distance of 200 mm., becoming wider and deeper in a vertebral direction.

MEASUREMENTS OF SCAPULA

Antero-posterior diameter of head of scapula.....	67
Extero-internal diameter of head of scapula.....	55
Length as preserved, measured from distal extremity of head to vertebral border	275

Atlas

The right half of the atlas shows the surface for articulation with the occipital condyle to be wider at the top than at the bottom and strongly concave. The vertebrarterial canal is ovoid and of moderate size as compared with that of individual No. 2 of *Macrodelphinus kelloggi*. The superior part of the neural arch is not preserved. The diapophysis is entirely destroyed, but

the fracture shows this process to have been large, projecting backwards at an oblique angle. The facet for articulation with the axis is pear-shaped, with the smaller end on the superior side. The outer edge is sharp, and the facet is set off externally from the rest of the atlas by a well-defined neck about 10 mm. long. Between and anterior to these facets is a depressed fossa for reception of the odontoid process. At the base of the neck for the facet which articulates with the axis, are numerous small vascular foramina as well as two fairly large ones. The lower transverse process is short and blunt and approaches the articular facet more closely than the diapophysis. The ventral portion of the atlas is thick.

MEASUREMENTS OF ATLAS

Greatest vertical depth, as preserved, from point just anterior to vertebrarterial canal to base of surface for articulation with occipital condyle	77
Greatest antero-posterior length at level of lower edge of diapophysis	65
Maximum width of surface for articulation with condyle.....	43
Maximum dorso-ventral height of facet for articulation with axis	56
Maximum width of same.....	41
Distance to posterior edge of vertebrarterial canal measured from edge of facet for articulation with axis.....	39
Width of vertebrarterial canal on internal edge.....	13

Vertebrae

The vertebrae found with this skull include fourteen dorsals (of a size which indicates that they might belong to *M. kelloggi*), all of which are located anterior to the transitional dorsal and belong to two or more individuals. All have anterior and posterior lateral facets for articulation with the heads of the ribs. The centra range in length from 47 mm. to 72 mm. measured along the median line of the superior side of the centrum, the anterior face measuring, for the longest, 55 mm. vertically and 64 mm. transversely, and for the shortest, 54 mm. vertically and 75 mm. transversely.

Macrodelphinus kelloggi

(Individual 2)

Figs. 5-8

Referred specimen.—Cat. No. 13403 Y. P. M.

This specimen consists of the rostral portion of a skull broken off transversely just behind the maxillary notches and near the anterior end, the preserved part being 560 mm. in length. Associated with the rostrum were a right mandible, atlas, axis, third, fourth, and sixth cervicals, sixth dorsal vertebra, right radius, right ulna, anterior half of the shaft of the left humerus, carpal, one nearly complete sternal plate and part of another, and parts of seven ribs. Since all of these parts are from a single small block of sandstone, and since the adjoining parts articulate properly, all are assumed to have belonged to the same porpoise as the rostrum. This specimen, fortunately, supplies some of the parts of the rostrum that are missing in the type. This skull and associated skeletal parts were discovered by Mr. Charles A. Pratt in 1929.

Locality.—About 200 feet northeast of the pit in which the holotype of *Macrodelphinus kelloggi* was found.

Horizon.—Pyramid Hills Sand, approximately 50 feet higher in the section than the horizon of the holotype.

Skull

Dorsal view.—As in the type specimen, the rostrum is heavy and elongate. The premaxillae, which lie nearly horizontally at the level of the maxillary notches, gradually assume a nearly vertical position concurrently with their anterior extension. The width of the premaxilla is constant, while the maxilla decreases rapidly in width anteriorly. The rostrum shows the maxillae and premaxillae only for a length of 550+ mm. from the maxillary notches. At the anterior end of the rostrum as preserved, the bones are thick and the premaxillae wide. The maxillary notches and the anterior end of the rostrum are higher than the central part, and the maxillae are noticeably concave later-

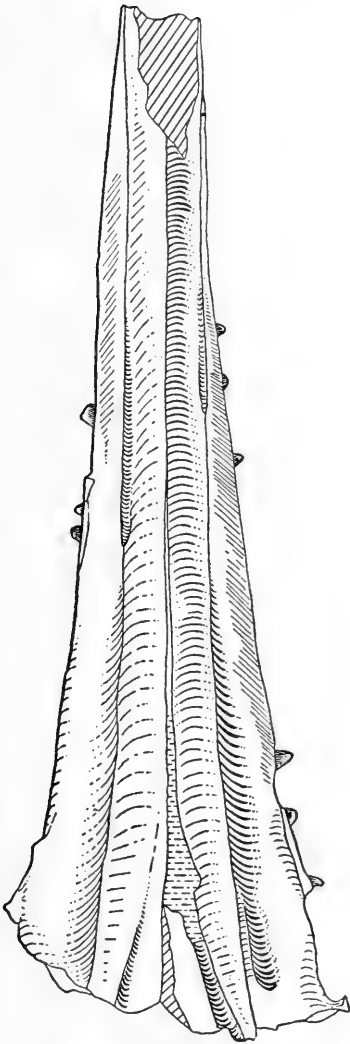


Fig. 5.

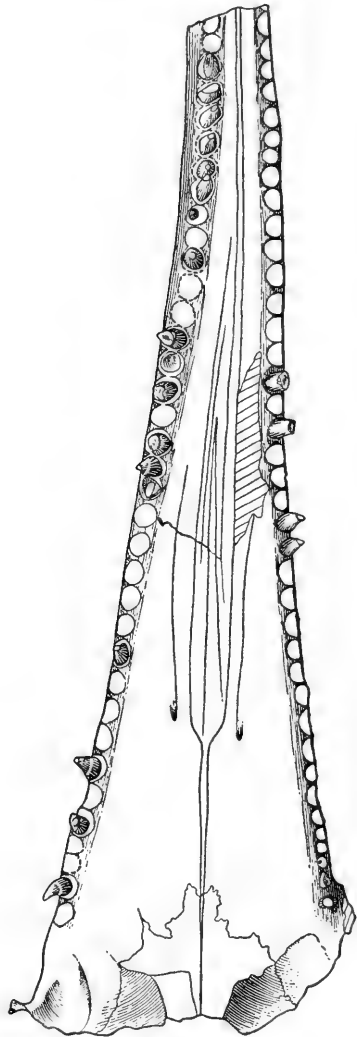


Fig. 6.

Fig. 5. *Macrodelfhinus kelloggi* (individual 2), dorsal view. x 1/4.

Fig. 6. *Macrodelfhinus kelloggi* (individual 2), ventral view. x 1/4.

ally. The right maxilla contains two foramina, the posterior rim of the larger one being on a level with the maxillary notch. The second foramen is located 42 mm. anterior to the first. In the left maxilla, on a level with the anterior foramen of the right maxilla, is a foramen of the same size. Each side of the rostrum has an additional foramen. The foramen of the right side has its posterior border at the contact of the premaxilla and maxilla, at a point 300 mm. in front of the right maxillary notch. This foramen is deep and narrow and measures 67 mm. antero-posteriorly and $2\frac{1}{2}$ mm. transversely at its posterior limit; the width increases anteriorly to 10 mm. The corresponding foramen of the left side lies 39 mm. posterior to the level of the right foramen and is also somewhat wider than the latter. While originating at a point common to both maxilla and premaxilla, each groove is bounded by the premaxilla alone at its anterior end. The maxillae and premaxillae are in contact throughout their length. The right premaxilla has been forced slightly over the left on the mid-line, so that the premaxillae are unequal in height.

Ventral view.—The outstanding characters exhibited in this view are the curvature of the alveolar series, the amount of exposure of the vomer and its width, and the thickness of the palatines. The first alveolus of the right maxilla occurs 49 mm. in front of the maxillary notch. On this side, there are 35 alveoli and teeth in a distance of 491 mm. The teeth occupy the following alveoli, counting forward from the most posterior alveolus: 2, 5, 7, 11, 17, 18, 19, 21, 22, 23, 26, 28 to 34 inclusive. The teeth in alveoli numbered 2 and 7 are complete and in 26 nearly so. The teeth in alveoli numbered 5, 18, 29 to 34, inclusive, lack the crown. A good idea of the dentition, however, can be had from this specimen. The size of the alveoli shows but little variation, the average antero-posterior diameter being about 11 mm. and the transverse diameter approximately the same. The variation in size, and sometimes in shape, is individual rather than directional. In the left alveolar series there are 39 alveoli in a distance of 482 mm. Thus, the left maxilla bears four more teeth

than the right, and the explanation of this numerical difference is found in the small size of the six posterior teeth of the left maxillary. The left side has incomplete teeth in alveoli numbered 1, 2, 3, 17, 18, 20, 21, 22, 24. Only one, that in alveolus numbered 22, has part of the crown remaining. The vomer, beginning at a point 148 mm. in front of the maxillary notch, is exposed between the maxillae for a distance of 160 mm. measured along the median line. At the point of its first appearance, the vomer is only slightly arched but rises anteriorly to a sharp keel, in a space of 30 mm., which continues as far as the vomer is visible. The intermaxillary gap, filled by the vomer, amounts to 20 mm. at its widest place and narrows anteriorly to the point at which the vomer disappears under the maxillae. The anterior ends of the palatines are preserved. They descend gradually from their point of origin to the break which terminates the specimen posteriorly. The palatine vacuities are partly shown. Their anterior ends are separated by a distance of 40 mm.; and at the break on the posterior end of the specimen, the left vacuity is 8 mm. from the median line. The anterior part of the base of the right jugal is preserved, and it is seen to have a long base in an antero-posterior direction and to be narrow transversely. The fragment passing externally to connect with the lacrimal shows no lacrimal suture.

MEASUREMENTS OF SKULL 2

Maximum length of specimen, measured from break just behind maxillary notch to anterior break.....	560
Breadth of rostrum at maxillary notch.....	176
Breadth of left premaxilla at level of maxillary notch.....	40
Breadth of right premaxilla at level of maxillary notch.....	39
Breadth of right maxilla at level of maxillary notch.....	45.2
Breadth of left maxilla at level of maxillary notch.....	44.2
Depth of rostrum at level of maxillary notch.....	86
Depth of rostrum at level of 34th alveolus of left maxilla..	47.5
Breadth of left maxilla at level of 34th alveolus.....	18.4
Breadth of left premaxilla at level of 34th alveolus.....	29

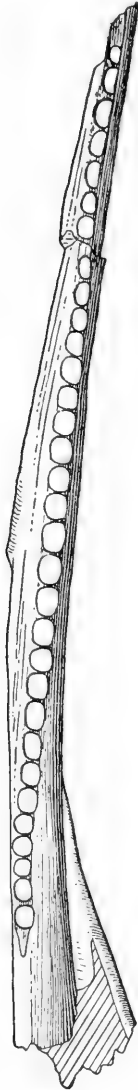


Fig. 7.

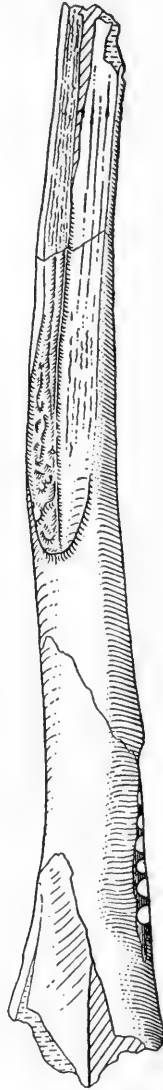


Fig. 8.

Fig. 7. Right mandible of *Macrodelfhinus kelloggi* (individual 2), dorsal view. x 1/4.

Fig. 8. Right mandible of *Macrodelfhinus kelloggi* (individual 2), internal view. x 1/4.

Right Mandible

Part of the anterior end of the right mandible is missing, and the posterior end is broken off 57 mm. behind the posterior border of the first (most posterior) alveolus of the jaw. The most striking character of the mandible is the length of the symphysis (300± mm.; anterior end of jaw missing) and the outward bending of the postero-ventral part of the ramus. The axis of the alveolar series is curved internally from its posterior end to the symphysis, where it becomes practically straight. The mandible contains 32 alveoli in a distance of 484 mm. No teeth are preserved in this series of alveoli. The whole jaw becomes thinner anteriorly both dorso-ventrally and transversely.

MEASUREMENTS OF RIGHT MANDIBLE

Total length of mandible as preserved, measured along the curvature of the alveolar groove.....	580
Depth of mandible at posterior extremity	96
Depth of mandible at posterior alveolus	72
Depth of mandible at ninth alveolus	51
Depth of mandible at posterior end of symphysis.....	47
Depth of mandible at posterior edge of 31st alveolus.....	36
Maximum width at posterior alveolus	21
Maximum width at posterior end of symphysis.....	27
Maximum width at 31st alveolus	13
Length of symphyseal portion.....	300

Teeth (of maxillaries)

The general outline of the teeth is the same for all preserved; and judging by the size of the alveoli and by the eleventh tooth, it appears that the most robust teeth of the right maxilla are those numbered 10 to 16 inclusive, the base of the eleventh tooth measuring 13 mm. The typical tooth has a long root, short crown, and is recurved, with a somewhat flattened posterior side. The seventh tooth of the right maxilla has a height above the septa of 16 mm., of which 8 mm. is crown. The antero-posterior diameter of the tooth at the base of the crown is 7 mm. and at the level of the septa, 11 mm. The transverse diameter at the base of the crown is 7 mm. and at the level of the septa, 9 mm.

Cervical Vertebrae

Atlas, axis, third, fourth, and sixth cervicals are present.

Atlas.—The atlas is complete except for the superior tip of the spinous process. Compared with the atlas assigned to the holotype of *Macrodolphinus kelloggi*, the similarity of general features is at once apparent. The length of the atlas belonging to the holotype is slightly greater, in keeping with the larger size of the animal, the size and positions of the processes are about the same, the neck which sets off the posterior facet for articulation with the axis is the same in both, the shape of the facet is similar, with that belonging to individual 2 being somewhat wider and less elongate, and the surface for condylar articulation is similar, with that belonging to individual 2 being noticeably smaller and more sharply concave. The only apparent difference is in the size of the vertebrarterial canal, which is ovoid in the first-mentioned atlas and strongly elliptical and larger in the second. The maximum breadth of the second atlas is 150 mm. measured from the external edges of the diapophyses, and its length is 60 mm. measured from the facet for the articulation with the axis to the cranial edge of the anterior articular facet. The condylar facets are broader above than below and are separated inferiorly by an interval of 18.5 mm. and superiorly by an interval of 52 mm. The neural arch is well elevated, thin anteriorly and posteriorly, and thicker in the center. It bears a short, stout spine whose base extends the full length of the arch. The anterior edge of the arch is set well back of the anterior edges of the condylar facets.

Two large elliptical vertebrarterial canals pierce the neural arch, with their floors considerably below the superior surfaces of the condylar facets. The posterior border of the canal is a small, sharp ridge which disappears at the level of the diapophysis. The diapophyses are broad and flattened, project backward obliquely, and are united by thick ridges to the lower transverse process. This parapophysis differs markedly from that of *Allodelphis pratti* in its broad, blunt anterior appearance.

The lower transverse process is stout and rounded and does not extend posteriorly to the level of the facet for articulation with the axis. At the axial anterior edge of the diapophysis is a deep groove extending transversely toward the median line and ending on a line with the axial extension of the vertebrarterial canal. The anterior boundary of this groove is a sharp ridge of bone which separates the groove from the vertebrarterial canal. The facets for articulation with the axis are broad and pear-shaped and slope internally and anteriorly into the broad, deep facet for articulation with the odontoid process of the axis. This facet reaches anteriorly into the atlas two-thirds of the length of the atlas and is bounded both anteriorly and superiorly by strong, sharp ridges which pass posteriorly to become the superior borders of the facets for the articulation with the axis. Ventral to the facet for articulation with the odontoid process, is a stout hyapophysial process reaching posteriorly a distance of 18 mm. This arrangement for locking the strongly developed odontoid process of the axis meets the requirement for rigidity in the neck of this animal, eliminating any need for ankylosis of the anterior cervicals. The hyapophysial process is deep and irregularly pitted.

Axis.—The outstanding characters of the axis are the breadth (66 mm.) and thickness of the odontoid process and the height and length of the neural spine. The maximum height of the atlas is approximately equal to its maximum breadth. The neural spine is thin anteriorly and thickens suddenly at the posterior end. Its sides are irregularly furnished with concavities of various sizes for muscle attachment. The whole spine is directed upward and backward, reaching its highest point at its posterior extremity, with an axial length of 99 mm. at its superior limit. The posterior articular processes are carried on the sides of the neural arch approximately half-way between the centrum and the top of the neural canal, and are nearly horizontal in position. These facets measure 16 mm. transversely by 16 mm. longitudinally and are semi-rhomboidal in outline. The posterior face of the spine has a deep, irregularly pitted

groove which extends along nearly the entire posterior face. A moderate-sized vascular foramen appears at the base of this groove and pierces the spine for a distance of 9 mm., emerging in the top of the neural canal. A deep fossa occurs between the external edge of the centrum and the proximal part of the transverse process, but within the fossa, there is no foramen piercing the transverse process. The transverse processes extend obliquely well behind the posterior face of the centrum and are large and rugose.

Third cervical.—This cervical is incomplete, lacking the neural arch and the extremities of the transverse processes. The upper and lower transverse processes are coalesced, with the wall between them very thin and broken adjoining the centrum. The lower, right transverse process is noticeably larger than the left.

Fourth cervical.—The most noticeable character of this cervical is the greater development of the lower part of the right side, the lower right transverse process being larger and longer (67 mm.) than the left (55 mm.). Above the centrum, however, the left side is the stronger, the posterior articular facet measuring 14 mm. dorso-ventrally and the right 12 mm. The pedicle supporting the left articular facet has a transverse width of 18.6 mm., while the corresponding right member shows 17.2 mm., and the axial (longitudinal) diameters of both are the same, 16 mm. Again, the left half of the neural arch has a dorso-ventral thickness of 7 mm. at its middle point, and the right shows 8 mm. at the corresponding point. These measurements are taken to show that the asymmetry of this vertebra is irregular and not directional. It shows, also, that evidence based on vertebrae and used in support of explanations of the problem of asymmetry in whales must be used, if at all, with the greatest caution. The anterior articular facets are large, inset, and ovoid, and each has a vascular foramen at its posterior extremity. The diapophysis has been reduced to a small bar forming the external border for the large canal piercing the combined superior and inferior transverse processes. Below this canal is a flatly expanded bone uniting with both superior and inferior transverse processes; and

judging by the shape of the enlarged extremity of the superior transverse process of the sixth cervical, it probably represents the coalescing of the enlargement with the inferior transverse process.

Sixth cervical.—The sixth cervical is incomplete, lacking the left postarticular process, the left superior transverse process, most of the left inferior transverse process, the distal end of the right inferior transverse process, and the superior tip of the neural spine. This cervical differs considerably from the fourth in that the superior transverse process is no longer united to the inferior transverse process. The inferior boundary of the round canal (transverse foramen) lying between the two processes is indicated by a protuberance on the inferior side of the upper transverse process, and by an elevation on the superior side of the lower transverse process, the two projections so placed that, if joined, they would provide an external boundary for the canal, as in the fourth cervical. The canal of the sixth cervical is considerably larger than that of the fourth, as are the posterior articular facets, the anterior ones remaining in the sixth as in the fourth cervical. The superior process is short, projects downward and outward, and is enlarged at the distal end. The inferior process has become broader and flatter and is deflected more sharply posteriorly.

Dorsal Vertebrae

Sixth dorsal.—The dorsal vertebra found with this specimen is judged to be the sixth by comparison with Abel's²⁷ photographs and descriptions of *Eurhinodelphis cristatus* du Bus and *E. cocheteuxi* du Bus and by comparison with vertebrae of a smaller form, *E. bossi*, in the U. S. National Museum. The neural spine is strongly inclined backward and is broken off posteriorly. The spine is thin on the anterior edge and much thicker posteriorly. The articular face for the tubercle of the rib is strongly concave and nearly circular in outline. Its center lies on a level with the anterior face of the centrum. This face forms the external

27. Abel, Othenio.—Das Skelett der Eurhinodelphiden aus dem oberen Miozän von Antwerpen. Mem. 48, Bruxelles, Musée Royal d'Histoire Naturelle de Belgique, pl. 22, fig. 1, pl. 23, figs. 4a, 4b, 1931.

MEASUREMENTS OF VERTEBRAE

	<i>Cervical</i>					<i>Dorsal</i>
	<i>Atlas</i>	<i>Axis</i>	<i>3d</i>	<i>4th</i>	<i>6th</i>	<i>6th</i>
Greatest vertical depth (tip of neural spine to inferior face of centrum)...	128i	159.6	x	105	100i	134i
Distance between outer extremities of superior transverse processes ...	149	x	x	129	140±	112
Distance across external extremities of inferior transverse processes ...	145	165	x	145	x	x
Length of centrum.....	x	33	31	32	36	67
Vertical height of centrum (anterior face)	x	46	56	57	57	51.5
Vertical height of centrum (posterior face)	x	54	62	59	57	47i
Transverse width of centrum (anterior)	x	x	62	61	61	64
Transverse width of centrum (posterior)	x	66.8	63	64	62.8	73
Anterior height of neural canal	65	29	x	26	33	26
Posterior height of neural canal	39	42	x	26	31.4	28
Anterior width of neural canal	41	53	x	x	x	47
Posterior width of neural canal	63	53	x	x	x	47
Median width of neural canal	53	x	x	56	56	47
Maximum distance between outside margins of anterior articular facets....	117	x	x	89	82	65.5c
Greatest height of articular surface for condyle ...	60	x	x	x	x	x
Greatest breadth of articular surface for condyle..	40	x	x	x	x	x
Greatest length of neuropophysis	42	98s	x	20	25	67
Greatest diameter of vertebrarterial canal	19	x	x	x	x	x
Distance from upper tip of diapophysis to upper tip of parapophysis	47	x	x	x	x	x
Maximum diameter of facet for articulation with axis	49	x	x	x	x	x

i=incomplete. c=condylar. s=neural spine.

margin of a stout transverse process which overreaches the anterior face of the centrum a distance of 20 mm. in a cranial direction. The anterior articular facets are broad and long. The left posterior articular facet is partly eroded. The right exhibits an elliptical shape, with the long diameter directed axially. The centrum is much longer than wide and shows a greater transverse width on the posterior than on the anterior face.

Humerus

All that is preserved of the left humerus referred to individual 2 is the anterior edge with the deltoid ridge and process and part of the internal border. The purpose of referring to this fragment is merely to aid in determining the size of the animal by comparing the fragment with complete humeri of dolphins of known size. The deltoid ridge is short and sharp and terminates distally in the large ovoid deltoid process. This process is wider and more ovoidal than that of *Allodelphis pratti* and somewhat larger and more pronounced than the deltoid process of the modern *Mesoplodon grayi* Haast. The complete humerus was probably about the size of that of *Mesoplodon grayi*. The internal border of the humerus referred to individual 2 of *Macrodelphinus kelloggi* is slightly concave.

MEASUREMENTS OF HUMERUS

Maximum length of fragment.....	150
Maximum transverse width of deltoid process.....	26
Maximum dorso-ventral length of deltoid process (including ovoid portion only).....	34

Radius

The right radius is complete except for a piece of the internal border adjoining the distal articular face. The bone is a simple shaft, concave on the external and posterior sides, convex anteriorly, straight internally, and enlarged at both ends. The radius is wide, as compared with the ulna, and practically constant in

width throughout the length of the shaft. The crown is slightly convex, its supporting shaft rugose (no distinct neck is present), and the tubercle (radial tuberosity) a narrow rugose ridge extending internally from the external face for about two-thirds the width of the neck. The articular surface for the scapholunar has the shape of an elongate ellipse. The anterior edge of the bone is a rounded ridge. The posterior border is gently rounded near the tubercle but becomes a narrow ridge over the distal half and bears, near the distal extremity, a flat surface (facet for ulna) adjoining the ridge on the external side.

MEASUREMENTS OF RADIUS

Maximum length along anterior edge	152
Maximum length along posterior edge	137
Maximum extero-internal diameter of shaft at edge of crown...	37
Maximum antero-posterior diameter of shaft, measured from anterior edge to facet above tubercle.....	46
Maximum antero-posterior diameter of shaft at middle.....	50
Maximum antero-posterior diameter of articular surface for scapholunar	50
Maximum extero-internal diameter of same.....	26

Ulna

The right ulna is incomplete, having a gap in the shaft of about 10 mm. The gap is located 28 mm. above the distal end. The outstanding character of this bone is the great antero-posterior width and dorso-ventral height of the compressed olecranon process. This process shows evidence of erosion at its posterior edge and internal surface. The length of the ulna is about the same as that of *Mesoplodon grayi* (U. S. N. M. No. 49880), but the olecranon process of *Macrodelphinus kelloggi* (specimen 2) is much wider antero-posteriorly. The sigmoid cavity is broad throughout, and its surface is irregular. The radial notch is of moderate depth, rugose, and set into the head of the shaft. The shaft is concave on both anterior and posterior edges just below the radial notch, reaches its narrowest portion at a distance of 38 mm. below the distal edge of the support of the

radial notch, and then increases in size in a distal direction. External and internal borders of the ulna are straight.

MEASUREMENTS OF ULNA

Internal antero-posterior depth of sigmoid cavity.....	33.5
External antero-posterior depth of sigmoid cavity.....	25
Extero-internal diameter of anterior surface of sigmoid cavity..	31
Maximum antero-posterior depth of ulna from vertical face of radial notch to posterior end of olecranon process.....	80
Height of olecranon process above surface for articulation with trochlea	45
Minimum antero-posterior diameter of shaft.....	35.6
Minimum extero-internal diameter of shaft measured at same point as preceding (38 mm. below support of radial notch)	21
Maximum antero-posterior diameter of distal end.....	51
Maximum extero-internal diameter of distal end.....	20

Carpal

The right scaphoid, or radiale, is practically complete and shows considerably more thickness on the posterior than on the anterior side. The articular surfaces are rugose. Because of its shape and since it matches the anterior part of the distal articular surface of the radius, it is designated the scaphoid and allocated to individual 2.

MEASUREMENTS OF SCAPHOID

Antero-posterior diameter of external face.....	22
Dorso-ventral diameter of external face.....	20
Maximum extero-internal diameter of posterior face.....	21
Maximum extero-internal diameter of anterior face.....	11

Sternum

Parts of two sternebrae, which are designated as first and third by comparison with *Orcinus orca* (U. S. N. M. No. 23004), are assigned to individual 2. The third sternebra is nearly complete. The first shows that the left anterior side has about half of the surface for the articulation of the cartilagi-

nous part of the left first rib, and has a posterior extent of 150 mm. The surface for the rib articulation is wide and deeply concave, and the anterior edge bears a projection about 23 mm. long that thins rapidly anteriorly to a sharp edge. The third sternebra is much thicker at the anterior end than at its posterior border, its superior and anterior faces being rugose and the left anterior side showing a surface for articulation with the costal rib. The third sternebra has a median length of 68 mm., an anterior width of 67 mm., a posterior width of 52 mm., an anterior thickness of 16.5 mm., and a posterior thickness of 10 mm.

Ribs

Of the six ribs preserved with this specimen, none is complete. Five have the proximal articulatory processes. By comparisons with *Mesoplodon grayi* (U. S. N. M. No. 49880), a whale with skeletal parts of about the same size as those of individual 2 of *Macrodolphinus kelloggi*, the ribs were placed as follows: first and seventh left, third, fifth, sixth, and tenth right. The first left rib is broad and flat and considerably expanded near the tuberculum. The tuberculum is large, ovoid, and considerably larger than the elliptical capitulum, which is carried on a broad neck. The anterior edge is thick and tapers gradually to about one-third of the anterior thickness, at the posterior edge. The shaft is of constant width and regularly decreasing curvature distally.

The left seventh rib is more rounded and much narrower than the first. The curvature is strong throughout. The shaft is constant in shape and size. The tuberculum is strongly concave and much larger than the capitulum. The capitulum is considerably larger than its supporting neck. Just below the tuberculum, a ridge slightly overhangs the shaft posteriorly and extends for a distance of 65 mm.

The third right rib lacks the tuberculum and capitulum. The rib is preserved for a short distance proximally beyond the angle, and the shaft, as present, is about 100 mm. in length. The

general shape is that of the first, except that the shaft begins to thicken anteriorly and to contract in width distally. On the anterior edge is a sharp angle directed posteriorly.

The fifth right rib lacks the capitulum and the distal half of the shaft. The tuberculum is semi-triangular in shape, with the apex on the vertebral side. A rounded ridge posteriorly overhanging the shaft occurs a short distance below the tuberculum and extends distally a distance of 43 mm. The shaft becomes well rounded distally.

MEASUREMENTS OF RIBS

	<i>Left</i>		<i>Right</i>			
	<i>1st</i>	<i>7th</i>	<i>3d</i>	<i>5th</i>	<i>6th</i>	<i>10th</i>
Greatest length in a straight line (as preserved)	230	280	164	250	139	250
Greatest width of shaft at angle	47.4	25	48	34.5	18.5	41
Distance between external margin of tuberculum and anterior margin of capitulum..	78	36	x	x	60	x
Greatest thickness of shaft near center.	12	13.3	14.5	14	x	14
Greatest diameter of articular facet on head of rib	26	23	x	x	23	inc.
Greatest diameter of articular facet on tubercle of rib.	30	20	x	26	25	x
Least breadth of neck. . .	37	16	x	23	18.6	x

The sixth right rib has only the vertebral end and a short length of the shaft preserved. It is like the fifth except that the tuberculum is irregularly triangular and the posteriorly overhanging ridge of the ventral side continues to the tuberculum.

The tenth rib is flat and has no tuberculum. The capitulum is only partially preserved and is thicker posteriorly than anteriorly. The rib becomes rounder in a distal direction.

? *Macrodelphinus kelloggi*

Fig. 9

Specimen.—Cat. No. 13412 Y. P. M.

This specimen consists of two fragments of the rostrum, presumably from near the distal end, separated from each other by a short interval.

Locality.—N. W. $\frac{1}{4}$ of Section 13, T. 26 S., R. 28 E., M. D. B. & M., at the top of a hill shown in this locality on the Woody Quadrangle, U. S. Geological Survey, about 5 miles southwest of Woody, Kern County, California. This specimen was found by the writer in the spring of 1930.

Horizon.—Near the top of the Pyramid Hills Sand described above.

These two rostral fragments are tentatively referred to *Macrodelphinus kelloggi*, although it is recognized that more complete material may eventually show that the relationships are with the family Iniidae instead. These fragments belong near the terminal end of the rostrum, and both of the specimens heretofore described lack the anterior end of the rostrum. No direct comparisons are, thus, permitted. The alveoli are approximately as large as might be expected to occur on the distal end of the rostrum. The lengths of the alveoli vary from 8 mm. to 11 mm. at the ventral surface of the alveolus. The septa vary in thickness from 1.5 mm. to 4 mm. measured at the ventral surface. The widths of the alveoli average about 9 mm. in the anterior fragment and in the posterior fragment reach as little as 6 mm. as a minimum, with an average of about 7 mm. Although the contours of the mesorostral gutter change rather rapidly in these two fragments, it is still uncertain as to whether or not a continuation of the mesorostral gutter in individuals 1 and 2 of *M. kelloggi* would have assumed the shape here encountered. The differences noted

while examining this specimen are not of sufficient importance to justify the application of a new name.

Presumably, these fragments resemble *Saurodelphis acutirostratus* Rovereto²⁸ in a general way. One can not make direct

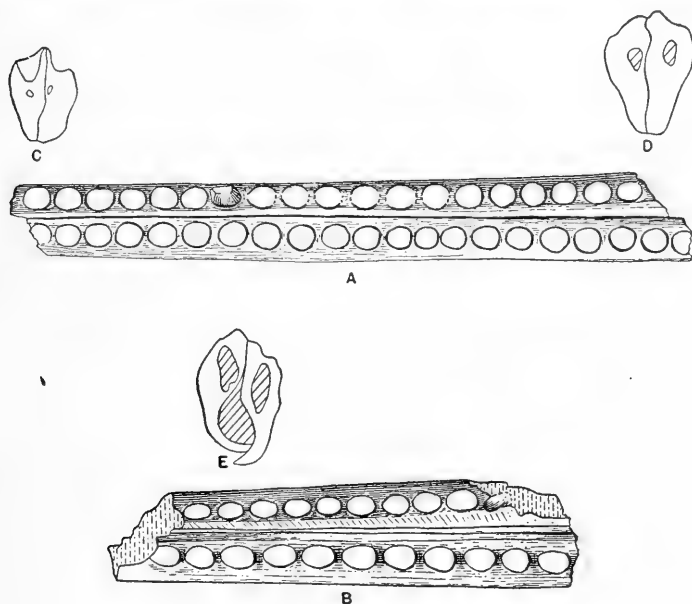


Fig. 9. ? *Macrodelphinus kelloggi*. $\times 2/5$.

A, B. Ventral view.
C-E. Cross sections.

comparisons between the anterior fragments of the mandibles in Rovereto's type and these rostral fragments, which, furthermore, are located farther behind the anterior extremity. The anterior fragment shows 19 alveoli in the left side of the rostrum in a space of 208 mm., an average of 10.9 mm. for an alveolus plus septum; and the right side shows 20 alveoli in a space of 216 mm., an average of 10.8 mm. The greatest diameter of an

28. Rovereto, C.—Nuevas investigaciones sobre los delfines longirrostrados del Mioceno del Paraná (República Argentina). *Anales del Mus. Nat. Hist. Nat. Buenos Aires*, Tomo XXVII, p. 146, pl. 3, figs. 1, 2, 1915.

alveolus alone varies from 8.8 mm. to 10.5 mm. The tendency for the alveolus to assume an elliptical form, mentioned by Rovereto, is seen in this specimen. But this specimen also shows alveoli which are circular adjoining those which are elliptical, and the writer is inclined to believe that this character is of doubtful value as an aid in determining the generic position of the specimen here described. The alveoli and teeth of *Sauroidelphis acutirostratus* are separated by varying intervals at different places on the mandible. The measurements not given in Rovereto's table were computed from the photographs and may not check precisely with the true measurements. The right side shows 14 alveoli in a distance of 302 mm., an average of 21.6 mm. for 1 alveolus plus septum. But the 5 anterior alveoli plus septa occupy a space of 159.5 mm., an average of 32 mm. per alveolus plus septum, the 4 center ones average 17.5 mm., and the 5 posterior ones, 13.4 mm. The depth of the rostrum of No. 13412 at the point of the anterior break is 33 mm., and the anterior break of Rovereto's specimen measures 21.4 mm., as nearly as can be ascertained from the photographs. The writer is not inclined to allocate the rostral fragments here described to *Sauroidelphis acutirostratus*. From the standpoint of regularity of size of tooth socket, the rostral fragment which received the name *Ischyrorhynchus vanbenedeni* Ameghino^{29, 30} more closely resembles No. 13412 than any other description or figure found. But in *I. vanbenedeni* the size of the alveoli vary from 11 mm. to 13 mm. in the short fragment (100 mm.). The width of the septa between alveoli reaches 7.6 mm., while in specimen No. 13412 the maximum width of a septum is 3 mm. It is probable that this South American Pliocene genus and No. 13412 are not the same.

The length of the more distal fragment is 225 mm. and con-

29. Ameghino, F.—Caracteres diagnosticós decincuenta especies nuevas de mamíferos fósiles Argentinos. *Revista Argentina de Hist. Nat.*, Tomo I, pp. 163-165, figs. 71-72, 1891.

30. Cabrera, A.—Cetáceos fósiles del Museo de La Plata. *Revista del Museo de La Plata*, Tomo XXIX (Tercera serie, Tomo V), p. 403, 1926.

tains 19 well-preserved alveoli on the left side and 20 on the right. Counting forward from the posterior end of the fragment, left alveolus number 13 contains a tooth broken off below the crown. No teeth are preserved on the right side. The posterior fragment has a length of 150 mm., consisting of part of the symphysis of the rostrum, the left half of the jaw showing 9 alveoli in a space of 97 mm. and the right, 11 in a space of 139 mm. An interesting character of both fragments is the occurrence of well-defined vascular grooves running lengthwise of the rostrum in a position which seems to correspond, on the posterior fragment, with the contact of the premaxilla and maxilla. The proximal end of the more posterior fragment shows a deep, narrow groove, in the position of the superior borders of the maxillae, which appears to separate the lateral part of the rostrum into two divisions believed to be the maxilla and premaxilla, as was the situation in *Macrodolphinus kelloggi* (individual 2). Toward the anterior end the separation is not visible, and the groove

MEASUREMENTS OF ROSTRAL FRAGMENTS

Anterior fragment

Maximum length of anterior fragment.....	225
Left side has 19 alveoli in space of.....	208
Right side has 20 alveoli in space of.....	216
Maximum diameter of tooth root in 13th socket of left side (counting forward from the most posterior one).....	9.7
Minimum (transverse) diameter of same tooth root.....	6.0
Vertical depth of rostrum at anterior break.....	33
Vertical depth of rostrum at posterior break.....	42
Maximum width of rostrum at anterior break.....	21
Maximum width of rostrum at posterior break.....	28.5

Posterior fragment

Length of posterior fragment.....	150
Left side has 9 alveoli in space of.....	97
Right side has 11 alveoli in space of.....	139
Maximum depth of right side of rostrum at anterior break....	43
Maximum depth of right side of rostrum at posterior break....	45.5

becomes wide and shallow, showing no visible trace of separation into two parts. The grooves continue, with some irregularities of direction, to the anterior end of the distal fragment. The groove on the right side shows two foramina in the anterior fragment, with their posterior edges separated by an interval of 58 mm. At the level of the anterior one of these on the right side of the rostrum, is a slight swelling carrying a small oblique ridge which may represent an injury or some pathologic condition. Judging by the cross sections of the breaks, the interval between these two fragments is about 100 mm. on the left side.

Genus ACRODELPHIS Abel

Acrodelphis bakersfieldensis,³¹ new species

Figs. 10-11

Holotype.—Cat. No. 13406 Y. P. M.

The skull is incomplete, lacking the distal portion of the rostrum, part of the left supraorbital process of the frontal, the right zygoma, right exoccipital, right occipital condyle, and most of the supraoccipital.

Type locality and horizon.—The same as for the holotype of *Macrodelphinus kelloggi*.

Skull

Dorsal view.—The dorsal surface of the skull consists principally of the maxillaries, premaxillaries, frontals, and nasals. The vertex of the skull, formed by the frontals and nasals, is flat and somewhat wider than long. The nasals rise abruptly from the frontals to form a sharp crest at their anterior edge. The premaxillaries are extended back to a level with the anterior edge of the nasals, in which they differ from *Argyroctetus joaquinensis* (Kellogg, R., footnote 11). The line of demarcation separating the lacrimal, the maxillary, and the supraorbital process of the frontal, ventrally, is a shallow but broad furrow. On the rostrum

31. Named for Bakersfield, California.

the anterior part of the maxillary descends to a straight, sharp edge. In the central portion of the maxillary a ridge begins its development 90 mm. in front of the maxillary notch and becomes fairly prominent and somewhat rounded as it approaches the maxillary notch. A large maxillary foramen occurs at the level of the maxillary notch, and a second, smaller one occurs 20 mm. behind the maxillary notch and in line with it. The maxillary gives the appearance of having overspread the supraorbital process of the frontal irregularly, reaching nearly to the outside edge posteriorly and about half that distance at the suture of the lacrimal and supraorbital process. At the posterior end of the maxillary, a sharp ridge is formed at the junction of the maxillary with the nasals and frontals. This ridge disappears at the posterior end of the frontal but is recurved on itself slightly, forming a concavity, throughout the length of the nasal. Anteriorly, the premaxillaries are rounded and thick on the outer edges. The inner edge becomes thinner posteriorly, particularly so at its contact with the mesethmoid. Two small grooves arise on the inner half of the premaxillary 45 mm. in front of the maxillary notch. The outer one deepens posteriorly and extends into the premaxillary foramen, the anterior edge of which is located just behind a transverse line from the maxillary notch, and continues posteriorly, to give the impression of separating the premaxillary into two parts, one of which, a broad, slightly concave, inner part, is raised increasingly above a narrowing outer edge. Just behind the premaxillary foramina, the premaxillaries ascend quite sharply, become broad where they form the outer borders of the nares, and reach back to touch the outer anterior edges of the nasals. The inner edges of the premaxillaries are in contact at a distance of 120 mm. in front of the maxillary notch. From this point of contact they diverge posteriorly for a distance of 94 mm. and then converge gradually. The nasals, which are in their natural positions, rise abruptly from the anterior edges of the frontals, overriding the dorsal end of the mesethmoid. On both sides there appears to be clear separation of the nasals from the maxillaries and premaxillaries; but stylolite-like sutures unite

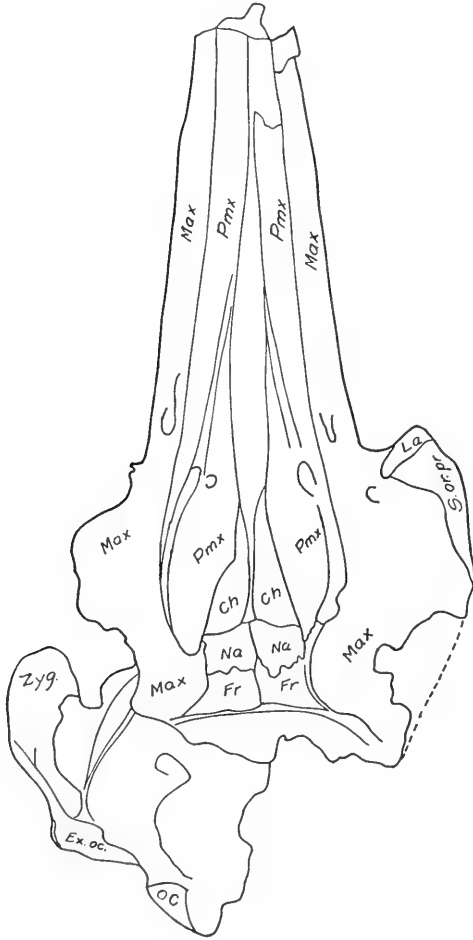


Fig. 10. *Acrodelfis bakersfeldensis* (holotype), dorsal view. $\times 2/5$. For explanation of lettering, see Fig. 1.

the nasals with the frontals. The frontals are flat and have their greatest length on the outside edges adjoining the maxillae. The posterior part of the left frontal is raised into a ridge just anterior to its junction with the supraorbital process. The right frontal is flat throughout. In both frontals, the greatest lateral extensions occur at the anterior and posterior edges. The supraoccipital is preserved only along its anterior edge. Along its medial line there is an abrupt descent from the union with the frontals, and a basin-like depression of small proportions is formed. The whole supraoccipital drops away from its anterior margin posteriorly in a sudden descent, forming ridges where the maxillae meet the supraoccipital. The left premaxilla shows two foramina instead of one as on the right, separated by a ridge some 3 mm. in width. The shape of each narial passage is that of a high, narrow triangle with an arc as base. The well-developed mesethmoid separates the narial passages. The internal edge of each premaxilla is notched near the anterior limit of the choanae with an apparently natural and abrupt posterior widening (about 3 mm.) of the narial area. All the bones of the dorsal part of the skull are relatively heavy as compared with the modern dolphin.

Lateral view.—This view is marked by the stoutness of the bones forming the rostrum, the evenness of the rostral thickness and the gradual changes in deflection, the backward projection of the pterygoids, and the stoutness of the supraoccipital. The nasals form the highest part of the skull. The maxilla loses its rounded outline and becomes depressed about 75 mm. in front of the maxillary notches and, at the position of the palatine, widens and becomes thinner. Only the antero-superior end of the jugal is preserved, and its separation from the lacrimal is not plain. The separation of the lacrimal from the supraorbital and the maxillary is indicated by closed sutures; this condition differs from that of *Argyroctetus* in having a much wider part of the supraorbital and the lacrimal exposed instead of being covered by the overreaching of the maxillary. It appears that the maxillary crowding came from a posterior direction, since the posterior

end of the supraorbital is much more widely covered than is the anterior part. The extreme posterior end of the right maxillary is broken and lacking, and the posterior tip of the supraorbital is broken away. The supraorbital shows only a slight curvature in a vertical direction, with the heaviest portions at the anterior and posterior edges and with the middle part comparatively thin. The optic canal is deep, rounded, and fairly well preserved for a distance of 32 mm. from the base of the supraorbital process. The palatines are lacking, but their shape and size may be judged from the vacuities which remain. The anterior edge of the pala-

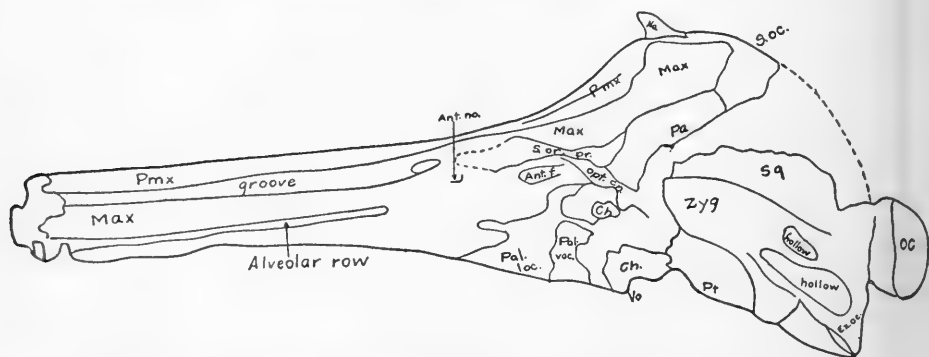


Fig. 11. *Acrodelphis bakersfieldensis* (holotype), lateral view. $\times 2/5$. For explanation of lettering, see Fig. 1.

tine vacuities begins almost opposite the maxillary notch as a rounded point and extends in a posterior direction for a distance of 27 mm., where it attains a width of 27 mm., thus being represented in the lateral view as an equilateral, triangular depression. If the palatines were not of a diverging type but followed the suture-like depressions in the maxillaries, they extended a distance of 50 mm. in front of the notches at the anterior edges of the pterygoids. The lacrimal is rounded anteriorly and fits against the maxillary notch and is drawn out and thinned where it attaches to the jugal. The posterior edge is in the shape of a ridge, slightly rounded and higher at its outside edge; and its attachment to the supraorbital process seems to be a straight

suture. The basal anterior part of the jugal has a ridge-like shape, and its styliform process is partially preserved as a thin, sharp-edged bone. The posterior parts of the pterygoids are partially preserved, but the hamular processes are lacking. The pterygoids are separated from the posterior edges of the palatine depressions by a distance of 10 mm. The left zygomatic process of the squamosal has considerable dorso-ventral thickness internally and gradually tapers to a thin external edge. The process is strongly curved, short, and straight transversely at the posterior edge. The whole curves upward on the dorsal side. This process is much shorter and thinner than that of *Allodelphis pratti*. Between the posterior end of the zygoma and the exoccipital are two large depressions in the joining bone.

Posterior view.—The left occipital condyle is wider dorsally than ventrally and has its maximum width slightly above the transverse center line. The neck is continuous around the condyle and shallower on the dorsal side than elsewhere. The dorsal edge of the exoccipital forms a sinuous crest.

Ventral view.—The anterior ends of the maxillaries are rounded on the outside portions but on the interior edges descend in almost a straight line to meet the vomer, which projects into the space between the maxillaries to a height of 4 mm. over a distance of 47 mm. The sharp ridge of the vomer becomes rounded and flattened in a posterior direction 100 mm. in front of the maxillary notches. The maxillaries meet 50 mm. in front of the anterior end of the palatine depressions. These palatine depressions extend a few millimeters in front of a transverse line from the maxillary notch. The left narial opening is somewhat larger than the right. The pterygoids extend down from the crest to the optic canal, where they are turned at a reëntrant angle. The posterior extremities are broken away. The internal dorsal aspect of the brain case is visible on the right side. The brain case is somewhat narrower anteriorly than posteriorly. The olfactory foramina are noticeably large, the right one being about twice as large as the left. A strong medial crest, having a height of 13 mm., descends from the roof of the brain case and continues forward as far as the

MEASUREMENTS OF SKULL

Total length as preserved.....	260
Transverse semi-diameter of skull at level of posterior edges of premaxillary foramina across supraorbital processes of frontals (right half).....	71.3
Greatest vertical depth of skull at level of anterior borders of narial passages	60.8
Greatest vertical depth of rostrum at level of maxillary notches	46.2
Greatest vertical depth of rostrum at broken extremity (141 mm, in front of maxillary notches).....	29.5
Greatest distance between outside margins of premaxillaries at level of anterior border of narial passages.....	64.7
Greatest breadth of left premaxillary at level of anterior border of narial passages.....	26.6
Greatest breadth of left premaxillary at level of maxillary notch	20.8
Distance between inner margins of premaxillaries at level of anterior margins of nasals.....	31
Maximum transverse diameter of right premaxillary at level of narial passages.....	25
Breadth of rostrum at level of maxillary notches.....	75.8
Greatest antero-posterior diameter of left nasal along suture..	12
Greatest antero-posterior diameter of right supraorbital process of frontal.....	60
Transverse diameter of left nasal at anterior end.....	17.2
Width of brain case at level of olfactory foramina.....	60
Least distance between inner margins of maxillaries on vertex of skull	34.6
Distance from level of anterior edges of nasals to anterior edge of supraoccipital medially.....	30.5
Maximum transverse diameter of combined nasals.....	33.8
Maximum transverse diameter of right nasal.....	17
Maximum antero-posterior diameter of right nasal.....	19
Maximum antero-posterior diameter of frontal along median sutural line	16
Transverse width across pterygoids at level of post-orbital process of frontal.....	43
Maximum width of right supraorbital process of frontal at level of premaxillary foramen.....	24.6
The left maxilla has 20 alveoli in a distance of 109 mm, counting forward from the posterior edge of the posterior alveolus to the anterior edge of last alveolus measured.	

The right maxilla has 20 alveoli in a distance of 108 mm. counting forward from the posterior edge of the posterior alveolus to the anterior edge of the last anterior alveolus measured.

Maximum antero-posterior length of zygoma (left).....	60
Maximum transverse width of zygoma (left).....	29
Maximum dorso-ventral diameter of left occipital condyle....	35
Maximum transverse width of condyle.....	23.6
Transverse diameter of skull between outer surfaces of zygomatic processes	174±

olfactory foramina, where it descends abruptly to them. The left half of the basioccipital is preserved for its full length. The posterior extension of the vomer is considerably thicker, where it overlaps the basioccipital, than in the modern dolphins. The side of the basioccipital is steep and descends to the limit of the exoccipital. The ventral, internal curvature of the zygomatic process is clearly observed in this view. The lower, anterior division of the squamosal (falciform process) is much wider than in the modern *Tursiops truncatus*. The exoccipital is stout. Between it and the posterior wall of the basioccipital is the wide notch for the jugular leash, and at the top of the notch appears the hypoglossal foramen. The tympano-periotic recess is longer than wide, straight internally, and rounded externally. The internal carotid foramen may be seen emerging on the dorsal side of the basioccipital. Its ventral point of entrance is on the external side of the basioccipital. The foramen for the mandibular branch of the trigeminal nerve is irregular in outline, being wider anteriorly than posteriorly.

Teeth.—The right maxilla shows 20 alveoli in a length of 108 mm. The tenth one, counting forward from the posterior alveolus, has, in place, a broken tooth whose width is 3 mm. The left maxilla has 20 alveoli in a length of 109 mm. The alveoli are quite distinct on the left maxilla but are somewhat worn on the right one. The tooth which is present is not sufficiently complete to describe.

Remarks.—Although the diagnostic generic characters are

found in the mandibles, the identification of the skull of *A. scheynensis* by Abel³² has made some of the cranial peculiarities available for comparison. The mutual relations of the bones of the skull, as brought about by the process of telescoping, are similar to *Acrodelphis*, especially the relations of frontals to nasals and maxillae, the relatively large size of the nasals and their shape, the degree of lateral compression of the vertex of the skull, and the posterior prolongation of the premaxillae. These characters are common to *A. bakersfieldensis* and *A. scheynensis* du Bus (Abel, O., p. 137). In specific characters the skull of *A. bakersfieldensis* differs from *A. scheynensis* in that the premaxillaries of the former attain a greater height, the rostrum is wider at the level of the maxillary notches, and the supraoccipital is concave at its superior border while that of the latter is rounded as in *Phocaena*. The mesethmoid is more elevated in *A. bakersfieldensis* than in *A. scheynensis*. Longhi³³ gives the measurements of the teeth of *A. ombonii*. In *A. bakersfieldensis* only the roots of two teeth are preserved, and diameters of alveoli and roots of teeth are generally different. However, it would seem that the teeth of *A. ombonii* are slightly larger than those of *A. bakersfieldensis*, judging by the size of the alveoli, which vary in *A. ombonii* from 10 mm., the diameter in the anterior alveoli, to 4 mm., the diameter in the posterior alveoli. Of the twenty alveoli of the left maxillary of *A. bakersfieldensis*, the hindmost one is 3 mm., the twentieth is 4 mm., and the largest of the twenty is 5 mm. in diameter. Longhi, unfortunately, fails to give the degree of enlargement of his photographs. The two teeth of *A. bakersfieldensis* are incomplete, and the specimen can not, therefore, be compared with *A. denticulatus*,³⁴ founded on three teeth. *A. bakersfieldensis* is the first species of *Acrodelphis* which

32. Abel, O.—Les odontocètes du Boldérien (Miocène Supérieur) d'Anvers. Mém. Mus. Roy. d'Hist. Nat. Belgique, Tome III, pp. 130-139, 1905.

33. Longhi, P.—Sopra i resti di un cranio di *Champsodelphis* fossile scoperto nella molassa Miocenica del Bellunese. Atti. Soc. Veneto-Trent. Sci., 2d ser., vol. iii, pp. 323-381, pls. i-iii, 1897.

34. Probst, J., 1886, see Abel, O. Op. cit., p. 135.

has been recorded from the Pacific Coast of the Americas. True³⁵ says, “. . . it is probable that some of the American species [of Odontoceti] are referable to the European genera . . . *Acrodelphis* . . .,” and states that he has found in Maryland vertebrae belonging to *Acrodelphis*.

Skeletal parts found with this skull and referred to it tentatively are the fourth and sixth cervical vertebrae and the left humerus. The skull and skeletal parts were discovered by Mr. Charles A. Pratt and excavated by Mr. Pratt, Mr. T. V. Little, and the writer.

Cervical Vertebrae

Two cervical vertebrae, the fourth and sixth, found with this specimen are referred to it. Neither is complete. The outstanding character is the thinness of the centra.

Fourth cervical.—This cervical lacks the top of the neural arch, the right posterior articular process, and most of the right lower transverse process. The centrum has the outline of an upright shield with top, bottom, and sides deeply concave within the facial ridges, probably resulting from the process of shortening. The left posterior articular facet is sub-rectangular in outline, elongated posteriorly, nearly horizontal in position, and large compared with its supporting pedicle. The left upper transverse process descends from the side of the neural arch to unite with the lower transverse process, forming a broad, thin sheet of bone between the processes and entirely enclosing a large, ovoid arterial canal. The left lower transverse process is well developed, with a wide flange on its ventral border. It is directed obliquely backward. The process is moderately long.

Sixth cervical.—The centrum of this cervical is noticeably thicker than that of the fourth, less shield-like, and more nearly rectangular in outline. The right lower transverse process is lacking, as are, also, the left pedicle and superior parts of the

35. True, F. W.—On the correlation of North American and European genera of fossil cetaceans. Proc. Internat. Zool. Cong., vol. VII, p. 781, Boston, 1907.

neural arch. The left lower transverse process is directed obliquely backward at a much lower angle than that of the fourth. The process is blunt anteriorly and thin posteriorly. Near the centrum, it bears a projection which marks the external boundary of the arterial canal. This canal is much larger than that of the fourth and probably was not enclosed on the external border. The right posterior articular facet is curved internally at its posterior border and is wider anteriorly than posteriorly.

MEASUREMENTS OF CERVICAL VERTEBRÆ

	4th	6th
Greatest breadth of neural canal.....	33.2	21±
Median height of anterior face of centrum.....	31	31.5
Maximum breadth of anterior face of centrum....	39	35
Length of centrum minus facial discs.....	10	x
Length of centrum with one facial disc.....	x	13.5
Distance across vertebra between exterior edges of posterior articular facets.....	54±	62.8±
Width of posterior articular facet (left, 4th; right, 6th)	10	10.3
Length of posterior articular facet (left, 4th; right, 6th)	11	13
Greatest diameter of arterial canal.....	12.3	20
Minimum diameter of left rudiment of upper trans- verse process	3.9	x
Length of left lower transverse process.....	33	34.5

Left Humerus

The humerus is complete and well preserved. The internal border is concave, but less strongly so than that of *Eurhinodelphis bossi*. The anterior edge is blunt and strongly convex for the greater part of its length, reaching its maximum thickness at the level of the infrapinnous fossa, where the deltoid process is not clearly delimited from the deltoid ridge. The oval head is set off from the shaft by an unconstricted neck which disappears on the dorsal side. The posterior tuberosity is sharply separated from the anterior by a steep face, less clearly sepa-

rated from the head, slightly convex, and pitted with small pits. The anterior tuberosity is set below the posterior. The bicipital groove is shallow except at the posterior extremity. Posteriorly, the whole bone is broad and flattened, including the head. The capitulum bears an antero-posterior groove into which the internal and external faces slope. This groove passes into the trochlea, which continues in a dorsal direction along the posterior edge of the humerus to form a flat facet, over the full width of the bone, for the articulation of the proximal part of the olecranon process of the ulna. A transverse ridge separates the capitulum and trochlea.

MEASUREMENTS OF LEFT HUMERUS

Greatest length, proximal end of greater tuberosity to ridge on distal end, along internal border.....	94.4
Maximum extero-internal diameter of distal end.....	24
Maximum antero-posterior diameter of distal end.....	35
Greatest length of deltoid fossa.....	24
Greatest width of deltoid fossa.....	14
Greatest diameter of head.....	34
Least diameter of head.....	30

Acrodelphis bakersfieldensis, new species

(Individual 2)

Fig. 12

Referred specimen.—Cat. No. 13410 Y. P. M.

This specimen consists of the incomplete facial portion of a skull in which the distal part of the rostrum is lacking; the supraorbital processes of the frontals, with their overlapping maxillaries, are broken off approximately at the maxillary notches; the internal edges of the premaxillae are broken; the posterior edges of the maxillae and premaxillae have suffered erosion, as have all the bones of the vertex of the skull; and the entire occipital region is lacking.

This specimen was discovered and collected by the writer in the spring of 1930.

Locality.—N.W. $\frac{1}{4}$ of Section 4, T. 28 S., R. 29 E., M. D. B. & M., near the N-S center line of the section.

Horizon.—Near the contact between the Pyramid Hills Sand and the "Walker" formation.

Skull

Dorsal view.—The premaxillae, at the anterior, broken end of the rostrum, are thick and rounded dorsally and lie quite close against and on top of the inner edges of the maxillae. The premaxillae are rapidly converging. The mesorostral gutter is deep

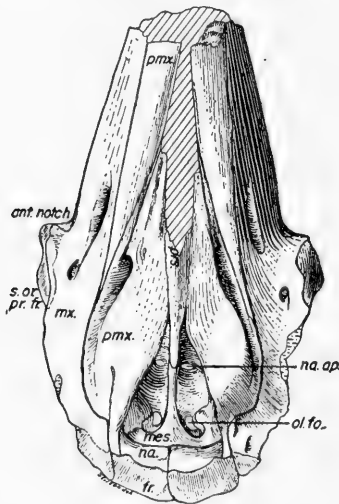


Fig. 12. *Acrodelphis bakersfieldensis* (individual 2), dorsal view. $\times 2/5$.
For explanation of lettering, see Fig. 1.

and large. A small, narrow groove originates 25 mm. in front of the anterior edge of the premaxillary foramen and runs directly back into the foramen, then continues in a posterior direction, sharply differentiating the premaxilla into two parts, a broad, raised, interior face and a narrow, outer border. The premaxillae are heavy throughout and reach posteriorly to a point approximately 8 mm. in front of the anterior edges of the

nasals. At the premaxillary foramina, the premaxillae slope transversely upward to the mesethmoid, which is thick wherever preserved. At a distance of about 24 mm. behind the maxillary notches, the premaxillae rapidly diverge, until at their most posterior extension, they are separated by an interval of 33 mm. The maxillae, at the anterior end of the specimen, slope steeply away from the medial line. A large maxillary foramen has its posterior edge on a level with the maxillary notches and is located in the center of the maxilla. A second maxillary foramen lies posterior to the first one on an oblique line. The distance between the two foramina is 10 mm. on the left premaxilla and 13 mm. on the right one. It is plain that the maxilla did not reach to the outside border of the right supraorbital process. The maxilla appears to be much thicker at the posterior end of the supraorbital process than at the anterior end, a circumstance which may be evidence that the thrust which caused the spreading of the maxilla came from behind. The nasals are short in an antero-posterior direction and may be partially eroded at their anterior edges. The right one is slightly larger than the left. The frontals slope away from the medial line, giving the apex of the skull a slightly rounded appearance. The frontals slope gradually upward from their posterior edges, and no abrupt change of slope is noticeable until the anterior edges of the nasals are reached. The mesethmoid is pierced by two large, crescent-shaped olfactory foramina.

Ventral view.—The alveoli have been eroded. The alveolar gutter begins 24 mm. in front of the maxillary notch. The ventral side of the dorsal edge of the maxilla projects well beyond its inferior portion. The anterior end of the ventral side of the maxilla is narrow but widens rapidly in a posterior direction, and the two maxillae meet in a median line slightly in front of the palatine vacuities. The parts of the lacrimal, as preserved, are very small and can not be described. The infraorbital foramina are large. The right one is rounded; the left one, partly broken. Judging by the palatine sutures on the maxillaries and the medial suture, the palatines were closely appressed. The pterygoids are

preserved only on the interior of the narial openings. The brain case presents a circular appearance, with two large concave depressions on the sides. The olfactory foramina occupy a position nearly central in the preserved portion of the brain case. Above the olfactory foramina is a blunt, triangular prominence,

MEASUREMENTS OF SKULL

Total length as preserved.....	158.5
Transverse diameter of skull across preorbital angles of supra-orbital processes of frontals as preserved.....	88
Greatest vertical depth of skull at level of anterior borders of narial passages	52
Greatest vertical depth of rostrum at level of maxillary notch..	44.5
Greatest vertical depth of rostrum at broken extremity (70 mm. in front of maxillary notches).....	26.5
Greatest distance between outside margins of premaxillaries at level of anterior border of narial passages.....	57
Greatest breadth of left premaxillary at level of anterior border of narial passages.....	21.5
Greatest breadth of left premaxillary at level of maxillary notches	18.3
Distance between inner margins of premaxillaries at level of anterior margins of nasals.....	32.7
Maximum transverse diameter of right premaxillary at level of narial passages	20
Least distance between inner margins of maxillaries on vertex of skull	41
Width of right premaxilla 60 mm. in front of maxillary notch	12.5
Breadth of rostrum at level of maxillary notches.....	70
Antero-posterior diameter of left nasal along medial suture...	10
Transverse diameter of left nasal, anteriorly.....	18
Width of brain case across olfactory foramina.....	56
Distance from level of anterior edges of nasals to anterior edge of supraoccipital medially.....	22.5
Maximum transverse diameter of right nasal.....	18.6
Maximum transverse diameter of combined nasals.....	35
Maximum antero-posterior diameter of right nasal.....	10.5
Maximum antero-posterior diameter of frontal along median sutural line	12.6
Width of posterior opening of left olfactory foramen.....	5
Length of posterior opening of left olfactory foramen.....	7

apparently formed by an inferior posterior projection of the frontals. The nasal apertures are large and nearly circular. The large size of the olfactory foramina is an outstanding character within the brain case.

Remarks.—This skull is tentatively referred to *Acrodelphis* on the basis of the similarity of the general relations of the bones of the dorsal side of the skull to those of *Acrodelphis scheynensis*. The absence of teeth, mandibles, and skeletal parts makes a definite allocation impossible. The large size of the nasals, posterior position of the premaxillaries, gradual slope of the facial region, and small size of the skull are the chief characters relating this specimen to *Acrodelphis*. This skull differs from *Acrodelphis scheynensis* du Bus (a fragmentary specimen) in the length of the external border of the nasals, that of *A. scheynensis* measuring 13.5 mm., while that of *A. bakersfieldensis* (individual 2) measures only 9 mm. Also, the anterior border of the left nasal of *A. scheynensis* measures 22.8 mm., and that of *A. bakersfieldensis* (individual 2) reaches only 19 mm. This apparent difference in the nasals may be the result of the erosion of the apex of the skull of *A. bakersfieldensis* (individual 2). Other apparent differences between the bones of the skulls, such as the width of the maxilla at the maxillary notch, may be accounted for by the position of the skull of *A. scheynensis* when photographed. These several apparent differences between the holotype and individual 2 of *A. bakersfieldensis* are of less importance than the following, namely: in individual 2 the posterior extremities of the premaxillae end in front of the anterior border of the nasals, and in the holotype they end at the anterior edge of the nasals. In view of the similarities of the skulls, this one point of difference is not now considered sufficient to remove individual 2 from the specific designation. The greater height of the presphenoid in individual 2, with its consequent elevation of the internal edges of the premaxillae, is an age variation, as is shown by a study of a series of modern dolphins, the high presphenoid being a character of maturity. The holotype is a somewhat larger specimen than individual 2.

Acrodelphis bakersfieldensis

(Individual 3)

Figs. 13-14

Referred specimen.—Cat. No. 13411 Y. P. M.

This specimen consists of the portion of the rostrum lying just anterior to the narial openings and made up of the premaxillae and maxillae. The right maxillary has split, the palatal portion being forced inward, exposing the alveolar gutter. The left maxillary has been pushed out of position, exposing the ventral surface of the vomer. The left half of the rostral fragment is, thus, apparently normal, while the right half is certainly distorted.

Locality and horizon.—Southern part of Section 12, T. 26 S., R. 28 E., M. D. B. & M., from the pit which yielded the holotype of *Macrodelphinus kelloggi*.

Rostral Fragment

Dorsal view.—The premaxillae meet on the mid-line, 107 mm. in front of the premaxillary foramen. The shape of the premaxilla, in cross section, at the anterior end of this rostral fragment is that of a half crescent, with the thin extension on the interior side. The outside edge rounds over gradually to its point of contact with the maxilla and then becomes nearly vertical. The whole premaxilla fits into a groove of the maxilla. In a posterior direction, the shelf-like inner portion of the premaxilla becomes wider, and the main outer portion becomes narrower and thinner until, at the premaxillary foramen, the latter constitutes only a narrow depressed border to the raised and widened, concave, inner portion. A shallow, irregular groove runs anteriorly from the premaxillary foramen to the hinder broken edge of the premaxilla, a distance of 37 mm. On the anterior portion of this rostral fragment, the maxillae show a gradual slope in a transverse direction from the outer margin of the premaxilla. A groove has its origin a distance of 77 mm. in front of the posterior edge of the maxillary foramen and becomes gradually

deeper and slightly narrower as it passes into the maxillary foramen. The minimum oblique distance between the premaxillary and maxillary foramina is 13 mm. The exterior edge of the maxilla forms a shield above the alveolar gutter. The distance from the posterior end of the maxillary foramen to a transverse line drawn from the posterior end of the alveolar gutter is 21 mm.

Ventral view.—The shelf of the maxillary overhanging the alveolar gutter is well shown on the right side in this view. Except

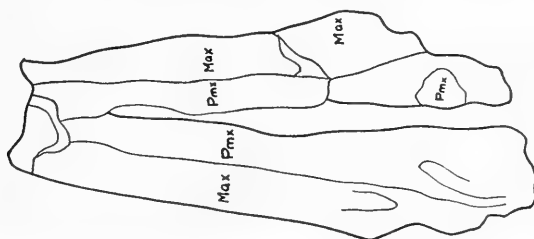


Fig. 13. *Acrodelphis bakersfieldensis* (individual 3), dorsal view. $\times 2/5$.

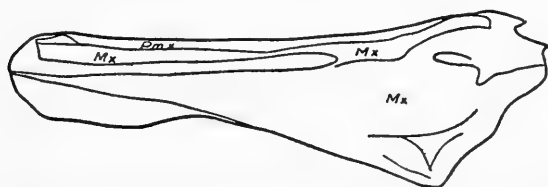


Fig. 14. *Acrodelphis bakersfieldensis* (individual 3), lateral view. $\times 2/5$.

at the posterior end, the alveoli are eroded. Where preserved, the alveoli are seen to curve downward and inward posteriorly. An alveolus shows a length of 8 mm. It appears that there are 4 alveoli on the right maxilla in a distance of 18 mm. near the posterior end of the alveolar groove. Other septa of the alveoli are too much eroded to be counted with accuracy. The maxilla rounds underneath as it enlarges and unites with its counterpart from the opposite side to furnish the floor of the mesorostral gutter, which is wide, open, and rounded and rapidly tapers to a small opening at the anterior end of the specimen. The anterior

extent of the palatines can be determined by the positions of their sutures, which are marked on the maxillaries. At the posterior end of each palatine vacuity is a nearly vertical groove which was walled by the palatine and roofed by the outer pterygoid, when these bones were present.

MEASUREMENTS OF ROSTRAL FRAGMENT

Length of rostrum as preserved.....	180
Width of rostrum at level of left premaxillary foramen.....	79
Depth of rostrum at level of posterior end of palatine depression	55
Posterior end of left alveolar groove has 6 alveoli in a distance of	27.3
Transverse width of left maxilla at level of maxillary foramen	20
Transverse width of left premaxilla at same level.....	19

MIODELPHIS,³⁶ new genus

Genotype.—*Miodelphis californicus*, new species.

Diagnosis.—The skull of this dolphin is characterized by the close approximation of the maxillae at their posterior extremities, the oblique truncation of the maxilla above the temporal fossa, the large, rectangular exposures of the frontals on the vertex, and the small size of the occipital condyles.

Miodelphis californicus, new species

Figs. 15-16

Holotype.—Cat. No. 13407 Y. P. M.

The skull is incomplete, lacking the rostrum from the maxillary notches forward, the nasals, the right supraorbital process of the frontal, most of the left zygomatic process of the squamosal, and most of the pterygoids. This specimen was discovered by the writer in the spring of 1930. Two hyoid bones and two vertebrae found with this specimen are tentatively referred to it.

36. Mio(cene) + δελφίς, dolphin.

Type locality.—S. W. $\frac{1}{4}$ of Section 12, T. 26 S., R. 28 E., M. D. B. & M., about 100 yards northeast of the location of *Macrodelphinus kelloggi* (holotype).

Horizon.—Pyramid Hills Sand at approximately the same level as *M. kelloggi* (holotype).

Skull

Dorsal view.—The premaxillae end, posteriorly, opposite the nasals at a point 10 mm. in front of the anterior edge of the frontals. The external border of the premaxilla is smooth and

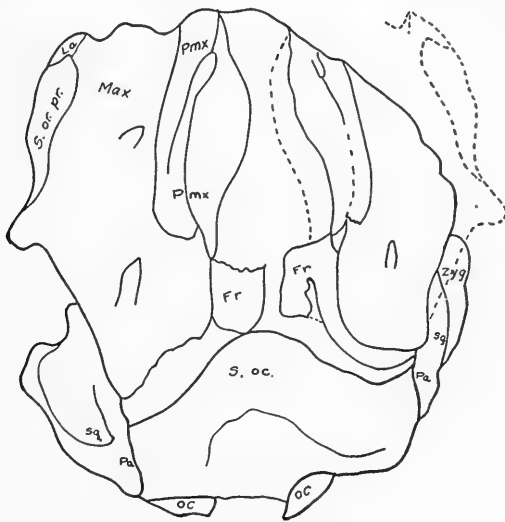


Fig. 15. *Miodelphis californicus* (holotype), dorsal view. $\times 2/5$. For explanation of lettering, see Fig. 1.

flat, measuring 8.5 mm. in width on a level with the maxillary notch. The border quickly disappears in a posterior direction, and accordingly, the maxilla is then undifferentiated between external and internal parts (cf. *Allodelphis*, *Macrodelphinus*, *Doliodelphis*, and *Acrodelphis bakersfieldensis*). The internal edges of the premaxillae are not in contact in this specimen. Their expansion horizontally on a level with the narial passages is less than that shown by other fossil dolphins from this region.

On a level with the maxillary notch is a small premaxillary foramen lying at the junction of the two parts of the premaxilla. The maxillae are unusually broad and closely approximated at the vertex. The posterior external border, from the frontal to the supraorbital process, is a straight edge which gives the appearance of oblique truncation of both maxilla and frontal. The maxilla does not overspread the supraorbital process completely but leaves a border of several millimeters in width throughout the length of this process. The maxilla is thicker at

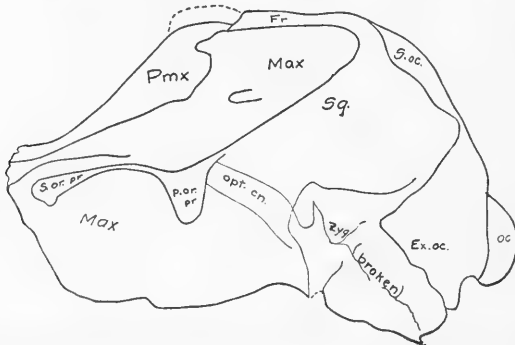


Fig. 16. *Miodelphis californicus* (holotype), lateral view. x25. For explanation of lettering, see Fig. 1.

the anterior than at the posterior border of the supraorbital process of the frontal. Two foramina occur in the maxilla. One is on a level with the center of the supraorbital process and 6 mm. from the premaxillary boundary; the other occurs 44.5 mm. behind the first one. The left maxilla shows erosion at its posterior extremity, where it overlaps the frontal. The nasals are lacking in this specimen but will be discussed with individual 2. The frontals are large and rectangular in outline, as exposed on the vertex of the skull, with posterior, oblique extensions between the maxillae and supraoccipital. The exterior edge of the frontal shows a smooth and barely perceptible union with the maxillary. The frontal slopes slightly externally and posteriorly. The supraoccipital reaches forward to the frontals in a high sharp arc which differs considerably from individual 2.

Lateral view.—The maxilla and underlying frontal have a common external edge, in the vertical plane, which overhangs the parietal as far forward as the posterior process of the supra-orbital process of the frontal. The zygomatic process is long and directed upward in an anterior direction, and the close approximation of the zygoma to the common edge of the maxilla and frontal shows that contact was almost established in these three bones at the anterior point of the zygoma. As a result of this meeting of these bones, the parietal has been constricted anteriorly and recurved; and the internal part of the squamosal has been compressed and thickened. The posterior process of the supraorbital has the same shape and position as in *Tursiops*. It furnishes the posterior dorsal border of the orbit and defines the anterior border of the temporal fossa. The supraorbital process is quite thin posteriorly but thickens at its anterior edge. Its dorso-external margin is not covered by the maxilla for a width of 11 mm., a character common to *Tursiops*. Also, the maxilla is thickened at its point of union with the lacrimal, another feature common to *Tursiops*. The lacrimal is fairly large for a dolphin of this size and unites with both maxilla and supraorbital. No suture is shown between lacrimal and jugal. The styliiform process of the jugal is preserved for a few millimeters. It is thin and narrow, as in the modern dolphins.

Posterior view.—The outstanding character of this view is the almost modern cast of the whole posterior part of the skull. With the exception of the size of the occipital condyles, which in *Miodelphis* are quite small, the occipital portion of the skull of this Miocene form, notwithstanding its much smaller dimensions, resembles that of the modern *Tursiops*. The lambdoidal crest of *M. californicus* is a smoothly rounded, slightly raised ridge from its anterior limit to the junction of the parietal and supra-occipital, where a slight backward projection occurs, which is very suggestive of the corresponding crest in the modern *Tursiops*. The *foramen magnum* is nearly round and of moderate size. The condyles show a distinct neck, laterally, which is dis-

MEASUREMENTS OF SKULL

Total length of specimen, as preserved, from tip of left premaxilla, on a level with the maxillary notch, to posterior surface of left occipital condyle.....	174
Maximum transverse semi-width from median line of frontals to external edge of zygomatic process.....	80
Maximum transverse semi-width from mid-line of presphenoid to external edge of posterior process of supraorbital.....	78
Maximum width between posterior external edges of premaxillae	72
Closest approach of premaxillae near vertex of skull.....	40
Width across premaxillae at level of maxillary notches.....	53
Distance between external edges of maxillae at level of posterior process of supraorbital.....	138
Transverse diameter of left maxilla at level of anterior borders of choanae.....	37
Transverse width of left maxilla from external border to point of contact between premaxilla and frontal, measured normal to external border.....	53.5
Length of nasals along median suture.....	20.6
Anterior width of left nasal.....	19
Width of supraoccipital near posterior edges of maxillae.....	90.5
Maximum distance between external edges of occipital condyles	63.5
Maximum transverse width of left occipital condyle.....	19.5
Maximum dorso-ventral height of left occipital condyle.....	29
Vertical height of <i>foramen magnum</i>	30
Maximum width of <i>foramen magnum</i>	31
Maximum length of right zygoma (as preserved).....	57.5
Distance from superior internal border of left occipital condyle to farthest extremity of left exoccipital.....	64
Maximum length of supraorbital process of left frontal.....	71
Length of posterior process of left supraorbital.....	21
Width of posterior process of left supraorbital at base.....	19.4
Depth of skull from inferior surface of basioccipital to a line from superior side of supraoccipital.....	91
Depth of rostrum at level of maxillary notches.....	52

continuous dorsally and ventrally. The condyles reach well down on the ventral side. The exoccipitals are thick bones situated close to the condyles instead of far forward as in *Tursiops*.

Ventral view.—The basioccipital forms a narrow but deep U-shaped trough with steep sides converging somewhat anteriorly. The notch for the jugular leash is deeply inset against the exoccipital. The large hypoglossal foramen is found below this notch a distance equal to the depth of the notch. A fracture follows the external, posterior edge of the basioccipital, passes internally around the left occipital condyle and extends a short distance into the supraoccipital. The left side is depressed two or three millimeters along the fracture. The left, triangular falcate process is fairly well preserved and becomes narrow and thick in its ventral extremity.

While the above comparisons have been made with *Tursiops*, it is realized that the features compared are similar, also, to those in *Sotalia*, *Steno*, and *Cephalorhynchus*. In other words, *Miodelphis californicus* represents a generalized type of dolphin from the lower middle Miocene.

Hyoid Bones

Thyrohyal.—The right thyrohyal is complete except for the superior tip. Its broad, dorso-ventrally flattened end which articulates with the basihyal is rugose; and although there are some indications of exostosis on the ventral margin, the probability is that these elements were separate. The superior surface is strongly concave, with thin, upturned edges. The widest part of the thyrohyal is near the middle where a short, broad protuberance projects anteriorly. Toward the superior end the edges disappear and the bone becomes circular in cross section.

A second hyoid bone referred to *Miodelphis californicus* is incomplete. It lacks both ends and, accordingly, can not be determined accurately.

MEASUREMENTS OF THYROHYAL

Greatest length (as preserved).....	88
Greatest width	20
Thickness of base.....	8.4
Thickness of tip.....	7.6

Vertebrae

Cervical.—The fifth cervical is incomplete, lacking the right post-zygapophysis and both transverse processes on the left side. The neural arch is narrow, gently sloping, and bears a short neural spine. The spatula-like anterior articular facets slope obliquely forward and slightly downward. The pedicles are robust and, at the base, extend nearly the full length of the centrum. The right arterial canal is very large and almost round. The diapophysis is short and bent forward, while the elongated parapophysis is curved backwards. The centrum is long in comparison with its height and width and has large depressions, two on the dorsal, two on the ventral, and one on each lateral surface.

Dorsal.—The second dorsal vertebra agrees well in size and shape with the fifth cervical, except that it is somewhat longer. The right transverse process, the right anterior articular process, and the tip of the neural spine are lacking. The neural arch is broad, gently sloping, and bears a stout spine. The anterior articular processes are inclined obliquely and have a steep, internal slope. The postzygapophysial facets are slightly concave, with raised external edges, and are spatula-like in shape. The left transverse process reaches in front of the anterior edge of the centrum and bears a large, rounded, concave facet for articulation with the tubercle of a rib. On each side of the centrum anteriorly is a half facet for articulation with the head of a rib. A similar facet is located on the hinder border. The neural canal is roughly heart-shaped and wider than high. The transverse diameter of the centrum exceeds the vertical height.

? Miodelphis californicus

Fig. 17

Referred specimen.—Cat. No. 13431 Y. P. M.

In the pit with the type skull of *Miodelphis californicus* were found the hinder portions of the right and left mandibles, as well as the third, fourth, and fifth cervical vertebrae, a middle lumbar, the left scapula, the left ulna, the proximal part of the left radius,

MEASUREMENTS OF VERTEBRAE

	5th Cervical	2d Dorsal
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum).....	67	85p
Greatest depth of neural canal anteriorly.....	21.6	19
Greatest breadth of neural canal posteriorly.....	39	35.7
Height, anterior face of centrum.....	33.4	33
Breadth, anterior face of centrum (including facet)..	40±	49.5
Height, posterior face of centrum.....	34.2	31.7
Breadth, posterior face of centrum (including facet)	41±	50
Greatest length of centrum.....	21.5	29
Maximum distance across vertebra between external edges of prezygapophyses.....	66	69±
Maximum distance across vertebra between external edges of postzygapophyses.....	63.5±	58
Distance between tip of left prezygapophysis and left postzygapophysis	33	44
Antero-posterior breadth of spine at neural arch....	11	19.3

p = as preserved

two carpals, one phalanx, and three ribs. The relative dimensions of all these elements indicate they belong together. These specimens are tentatively allocated to *Miodelphis californicus*.

Mandible

The rami are the same size and shape as those of *Steno* (U. S. N. M. No. 21169) except that this specimen (Y. P. M. No. 13431) has a larger coronoid process, and its alveoli are smaller and approach nearer the condyle in a posterior direction. These rami also resemble *Priscodelphinus atropius* (U. S. N. M. No. 10770) in size and shape.

The left ramus, from the seventh alveolus to the condyle, is only slightly damaged. Excepting the coronoid and condyle, the bone is thin and fragile. This part of the ramus is straight internally and strongly convex externally. The degree of convexity gradually increases in a posterior direction until just before the condyle is reached, where the central part of the ramus is nearly round, with more flattened dorsal and ventral portions.

The condyle is small and eroded on its superior edge and extends externally beyond the rest of the ramus. The coronoid is a long, gradually sloping, internally concave elevation of heavy bone, beginning about 28 mm. behind the alveolar groove and extending in a posterior direction a distance of 75 mm. to its posterior break. Its posterior part has been damaged. On the internal face of the ramus, near the anterior end of the coronoid, is the large inferior dental canal. The entrance to the dental canal is extremely wide and infundibuliform, occupying practically the entire internal side of the ramus. Its floor is furnished by a short, internally curved portion of the ramus; the roof is sup-

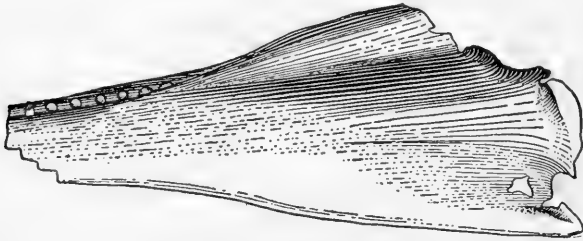


Fig. 17. Left ramus of *Myiodes californicus?*, external view. $\times 3/8$.

plied by a thin layer of bone descending from the coronoid process. The canal is open posteriorly. Extending in an anterior direction from the anterior limit of the inferior dental canal, is a broad, shallow, gently curved groove, which disappears at about the level of the posterior edge of the alveolar groove. The coronoid process passes anteriorly into the flat, narrow, superior margin of the ramus, which in turn passes quickly into the alveolar groove. The alveoli are nearly round and are regularly spaced. There are 7 alveoli in a space of 48 mm. In the seventh alveolus, counting forward from the most posterior alveolus, is an incomplete tooth, the antero-posterior diameter of which is 4.4 mm. at the level of the septa. The transverse diameter is 4 mm. The tooth is broken off unevenly at the base of the crown. The base of the crown is round and has a diameter of

3.5 mm. The internal border of the alveolar groove is noticeably higher than the external.

The right ramus differs from the left in the absence of the condyle, teeth, and coronoid process. The alveolar groove is eroded so that no count of alveoli can be made.

MEASUREMENTS OF MANDIBLES

	<i>Left</i>	<i>Right</i>
Total length as preserved.....	205	167
Maximum width at level of anterior edge of inferior dental canal	14.5	19
Maximum depth at level of top of coronoid to base of ramus	78	x
Maximum dorso-ventral diameter of condyle.....	36.7	x
Maximum transverse diameter of condyle.....	16	x
Length of entrance to dental canal, condyle to closed portion	96	x
Height of entrance to dental canal at level of top of coronoid	50	x

Vertebrae

Cervical.—Three cervical vertebrae, the third, fourth, and fifth, are tentatively placed with this specimen. The thickness of the centra of these vertebrae agrees fairly well with corresponding vertebrae of *Eurhinodelphis* sp. (U. S. N. M. No. 10479). These cervicals differ from *Eurhinodelphis* in their rapid transition from thin to thick centra. Since the fourth and fifth are in contact, there seems to be no doubt about their position; yet they differ considerably in thickness. The third cervical lacks the neural arch and transverse processes. The fourth lacks the processes. The right pedicle of the neural arch and the right prezygapophysis are present. The anterior articular facet is concave, axially long, and nearly horizontal in position. Its length is approximately twice its width. The arterial canal is fairly small, deep, and well rounded. The fifth cervical lacks the right side and transverse processes. The left pedicle is present with its anterior articular facet and a small piece of the neural arch attached to it.

MEASUREMENTS OF CERVICALS

	3d	4th	5th
Maximum length of centrum.....	21	22	23
Maximum width of centrum.....	49.5	52	51±
Height of centrum.....	40.5	41	42

Note: one epiphysis not included in measurements on No. 3, two in No. 4, one in No. 5.

Lumbar.—An incomplete lumbar vertebra is tentatively assigned to this animal. The terminal ends of the transverse processes and the neural spine above the neural arch are missing. Judging by the position of the pedicles, the size and shape of the neural arch, the positions of the transverse processes, and the length of the centrum, this vertebra is the seventh lumbar.

MEASUREMENTS OF LUMBAR VERTEBRA

Greatest depth of neural canal posteriorly.....	25
Greatest breadth of neural canal posteriorly.....	13
Height of anterior face of centrum.....	47.5
Breadth of anterior face of centrum.....	55
Length of centrum.....	67
Length of right transverse process as preserved.....	48.2
Antero-posterior diameter of right transverse process at base..	40
Antero-posterior diameter of left transverse process at base....	40
Antero-posterior diameter of left transverse process near break	33

Ribs

The second left rib lacks the capitulum and a short part of the distal end of the shaft. The tubercle has a greater external than internal width. A rounded ridge extends externally from the base of the tubercle a distance of 45 mm., becoming higher and more rounded at its external end. It projects posteriorly, overhanging the shaft. The shaft is strongly curved throughout.

A second rib lacks both ends. It is tentatively assigned as the third or fourth left rib, by comparison with several mounted skeletons of recent odontocetes, on the basis of its degree of curva-

ture, difference in thickness of the anterior and posterior edges, and shape.

A rib lacking the capitulum and distal extremity, assigned as the fourth right, is more rounded than the preceding and shows a distinct neck between the capitulum and the tuberculum. There is, likewise, a constriction below the tuberculum. The curvature is regular and less sharp than that of the second left rib.

MEASUREMENTS OF RIBS

	—Left—		Right
	2d	3d	4th
Total length in a straight line across ends	233	252	225
Greatest breadth of shaft at angle.....	22.4	x	14
Distance between external margin of tuberculum and external margin of capitulum	29	x	x
Greatest thickness of shaft near middle..	10	8	11
Greatest diameter of tubercle.....	20	x	15
Least breadth of neck.....	17.2	x	11.7

Scapula

The left scapula is nearly complete, with the exception of the greater part of the acromion and all of the coracoid process. The vertebral border forms a broad, elliptical curve. The greater diameter is the antero-posterior one. The axial margin slopes forward and downward to the neck more steeply than the cranial margin. The external surface is strongly concave, the deepest part of the concavity being directly above the glenoid cavity in the center of the scapula. There are two well-defined ridges on the cranial half; the more anterior one is the sharper. The glenoid cavity has a small break on its anterior edge. The cavity is of moderate depth and expansion. The whole scapula gradually becomes thin toward the vertebral border. Internally the scapula is smooth, convex at the central part, with smaller concavities at the cranial and axial vertebral limits.

MEASUREMENTS OF SCAPULA

Maximum crano-axillary length of blade.....	253
Maximum dorso-ventral height from vertebral edge to distal extremity of head.....	175
Antero-posterior diameter of head.....	41
Extero-internal diameter of head.....	31.3
Dorso-ventral diameter of acromion process at break.....	46
Maximum thickness of acromion process at break.....	8.4
Antero-posterior diameter of neck at base of acromion process.....	44.2±
Extero-internal diameter of neck at same level.....	18.6
Posterior margin of head to base of acromion process.....	23

Ulna

The left ulna is complete except for a broken anterior border along the distal half. The epiphysis is thick and shows a broken anterior border. One carpal, the pisiform, is attached. The shaft is nearly straight on the anterior border and less strongly concave posteriorly than other ulnas described in this paper. The olecranon process is well developed and concave on the exterior border. Its postero-superior border is thin and rugose, becoming thicker as it approaches the sigmoid cavity. The shape of the olecranon process is similar to that of *Macrodelphinus kelloggi* (individual 2) but much smaller. The lower portion of the greater sigmoid cavity is approximately twice the width of its superior portion. The lower surface rounds into the anterior border. The radial notch is broader and less rugose than any of the radial notches described below. The narrowest portion of the shaft lies just below this notch. The shaft is wider, antero-posteriorly, at the distal end than elsewhere. The epiphysis is thick and shows, on its distal face, articular surfaces for the reception of the carpals. On the internal border of the epiphysis and situated on the anterior half, is a slight elevation about 15 mm. in length, having within it a smooth groove. This feature has not been observed on other ulnas of this collection. Posteriorly the epiphysis is obliquely truncated and shows internally

a suture between the truncated edge and the pisiform; but on the external border of the radius, the two bones appear to be fused. The maximum dorso-ventral diameter of the pisiform is 27 mm., and the antero-posterior diameter is 17 mm. This bone is the same thickness as the epiphysis, at its anterior border, but rapidly thins in a posterior direction, becoming but a few millimeters thick at its posterior limit.

MEASUREMENTS OF ULNA

Maximum length (superior edge of olecranon process to distal face of epiphysis).....	140
Length of anterior border.....	107
Height of olecranon process above anterior edge of sigmoid cavity	37
Greatest oblique length of olecranon process.....	52
Anterior extero-internal diameter of sigmoid cavity.....	22
Antero-posterior diameter of shaft just below radial notch....	28.5
Maximum extero-internal diameter at same place.....	20.5
Antero-posterior diameter of shaft at place of articulation with epiphysis	40
Maximum extero-internal diameter at same place.....	17.7
Maximum dorso-ventral diameter of pisiform.....	27
Maximum antero-posterior diameter of pisiform.....	17

Radius

Only the proximal half of the left radius is present. Its size and articular surfaces match the ulna. Its head is concave and pitted. The anterior limit of the head is elevated into a sharp ridge a few millimeters higher than the rest of the head. The facet for articulation with the ulna is broad, and rugose on its internal limit. The shaft is about the same width as the head, concave and flat posteriorly, and convex and sharply rounded anteriorly. The distal break shows that the walls of the shaft are thick and enclose a large hollow extending the length of the shaft.

MEASUREMENTS OF RADIUS

Length of anterior border as preserved.....	72
Length of posterior border as preserved.....	79
Maximum antero-posterior diameter of head.....	32.6
Maximum extero-internal diameter of head.....	27.7
Antero-posterior diameter of shaft near center.....	35.5
Extero-internal diameter at same place.....	22

Carpal and Phalanx

The isolated carpal is tentatively identified as the centrale (intermedium) by comparison with the carpal bones of several recent dolphins in the collection of the U. S. National Museum. The long, narrow phalanx is believed to be the second phalanx of the second digit of the left manus.

MEASUREMENTS OF CARPALS AND PHALANX

	<i>Pisiform</i>	<i>Centrale</i>	<i>Phalanx</i>
Maximum dorso-ventral diameter	27	19	27.5
Maximum antero-posterior diameter	17	30	16
Minimum antero-posterior diameter	x	x	13

Unallocated Lumbar Vertebra

Specimen.—Cat. No. 13432 Y. P. M.

A lumbar vertebra found with the above skeletal parts is too large to belong to the genotype of *Miodelphis* and is described without allocation.

Both transverse processes are broken off. The right one is entirely lacking and the left one, nearly so. The neural spine is broken along part of the posterior border, and the posterior ventral part of the centrum has a broken edge. Comparisons with the vertebrae of *Eurhinodelphis bossi* and with the vertebrae of several recent porpoises in the collection of the U. S. National Museum have been made. Considering the lateral constriction and size and height of the neural canal, the nearly vertical position and height of the neural spine, the straightness of the left transverse process, and the length of the centrum, the vertebra is tentatively designated as the eighth lumbar.

MEASUREMENTS OF LUMBAR VERTEBRA

Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum).....	181
Greatest depth of neural canal anteriorly.....	32
Greatest breadth of neural canal posteriorly.....	17
Height of anterior face of centrum.....	63.7
Breadth of anterior face of centrum.....	65.5
Length of centrum.....	70
Minimum antero-posterior breadth of left transverse process..	35
Distance across external edges of prezygapophyses.....	28.3
Antero-posterior width of neural spine at level of prezygapophysis and including prezygapophysis.....	71
Vertical height of neural spine (from superior limit of neural canal to tip of spine on posterior side).....	88
Antero-posterior width of spine at superior extremity.....	47

Miodelphis californicus

(Individual 2)

Figs. 18-19

Referred specimen.—Cat. No. 13405 Y. P. M.

This specimen consists of an incomplete skull in which the rostrum is broken off at the level of the maxillary notches, the supraoccipital is broken away 35 mm. to the rear of its anterior edge, and all the posterior portion of the skull behind this is lacking. The left maxilla and premaxilla are complete as far forward as the maxillary notch, with the attached supraorbital process, lacrimal, and part of the jugal. The supraorbital process is lacking on the right side, as is part of the maxilla.

On the dorsal side, this specimen exhibits the same features as the type except that the nasals, lacking in the type, are practically complete. The supraoccipital of this skull has a wide, shallow arc at the lambdoidal edge and a gradual postero-ventral slope, while that of the type shows a much steeper slope and a wide longitudinal depression. Individual 2 is a larger dolphin than the type and, fortunately, gives additional information.

Location.—N. W. $\frac{1}{4}$ of Section 13, T. 26 S., R. 28 E., M. D.

B. & M., at the top of a hill shown in this locality on Woody Quadrangle, U. S. Geological Survey, near the main road to Woody, Kern County, California.

Horizon.—Near the top of the Pyramid Hills Sand described above.

Skull

This skull is characterized by a very wide maxilla, large frontals, gently-sloping supraoccipital, and long nasals.

Dorsal view.—The preserved parts of the premaxillae are quite

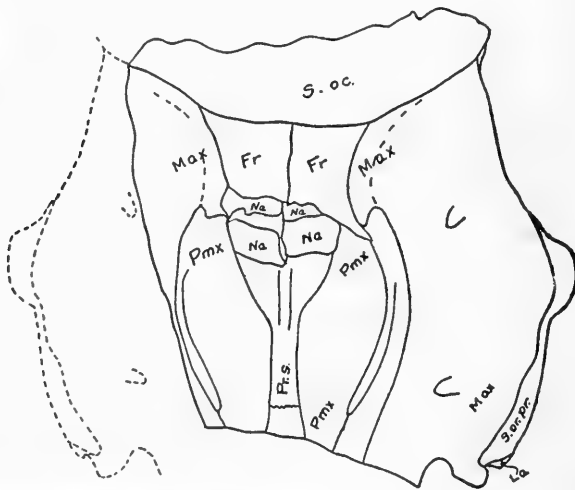


Fig. 18. *Miodelphis californicus* (individual 2), dorsal view. $\times 2/5$. For explanation of lettering, see Fig. 1.

definitely separated into two distinct portions by a narrow groove that passes through the premaxillary foramen and continues to the posterior extremity of the premaxilla. The premaxillary foramen is located $1\frac{1}{4}$ mm. behind a transverse line from the maxillary notch. At the level of the maxillary notches, the outside part has a width of 11 mm. and the inside part, 10 mm. The outside part of the premaxilla rapidly narrows in a posterior direction to a point on a line with the anterior part of the nares, where it

thins to a width of 2 mm. and then gradually flares out to a width of 12 mm. The premaxilla is carried back to the posterior edge of the nasals. At its widest place, the complete premaxilla is 35.5 mm., the broad, superior part representing 30 mm. of this width. The maxillae, like the premaxillae, are thick at the point opposite the maxillary notch. The maxilla fails to overspread the supraorbital process at both ends but along the middle portion almost reaches the external edge. The external anterior surface of the supraorbital process is uncovered for a width of 13 mm. (maximum). The posterior surface is uncovered for a width of 20 mm. The maximum width of the maxilla, just above the posterior downward projection of the supraorbital process, is 50 mm. The anterior maxillary foramen is 25.5 mm. behind a transverse line from the maxillary notch, and the anterior edge of the foramen is 23.9 mm. from the external edge of the maxilla. A posterior maxillary foramen is located on a line with the anterior edges of the nasals, and its anterior edge is 25.5 mm. from the external edge of the maxilla, measured along this transverse line. The union of the maxilla with the supraoccipital forms a ridge, sharp at the exterior edge, then rounded, and finally flattened at its junction with the exterior edge of the left frontal. The supraorbital process of the frontal is sharply curved on the infero-posterior side, forming a rounded triangular portion with a base 31 mm. wide where it adjoins the maxilla. This projection is not covered by the overspreading of the maxilla. The curve of the orbit flattens at the top quite suddenly and then descends in an anterior direction in a gentle curve and slope. The highest part of the orbit is marked by the maximum thinness (2.1 mm.) of the supraorbital process. From this place, it thickens rapidly in both posterior and anterior directions. The frontals are noticeably large and rectangular in shape, except for the extension into serrated peaks at each exterior corner. The posterior peaks extend between the supraoccipital and maxillaries. Each anterior extension is bounded by the nasal, the maxilla, and the premaxilla. Otherwise, the

frontals are rectangular in form. The length of the frontals is noticeably greater than the width. They meet in a well-marked medial suture, which extends unbroken between the nasals. The general appearance of the frontals is flat, with a gentle arching toward the center; and their considerable breadth gives a transversely-expanded effect to this part of the skull. The nasals are long and overhang the narial openings. The slope from the anterior edge of the frontals to the supero-anterior edge of the nasals is gradual. The nasals are thick and stout at their junction with the frontals but gradually become thinner in an anterior direction and, at the anterior external edge, are less than 2 mm. in thickness but are

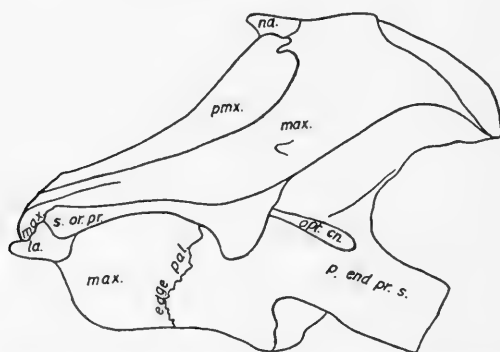


Fig. 19. *Miodelphis californicus* (individual 2), lateral view. $\times 2/5$. For explanation of lettering, see Fig. 1.

somewhat heavier on the medial edge. Both nasals are cracked near the base, the right having been somewhat displaced in an anterior direction. The left one is in place. The mesethmoid extends under the projection of the nasals. It is much less robust than in the *Acrodelphis* species described above. The supra-occipital rounds off gradually from its apex and is smooth and regular in the part that is preserved, except on the exterior edges, where there are small semi-lateral ridges for muscle attachment. A groove begins 23 mm. behind the low lambdoidal crest and

extends in a postero-inferior direction to the broken edge of the supraoccipital.

Ventral view.—The lines of division between the lacrimal and the supraorbital process and maxilla are distinct, but no suggestion of a suture can be observed between the lacrimal and the anterior basal portion of the jugal. The lacrimal has a wide and heavy superior portion at its union with the supraorbital and maxilla, where it is morticed to both these bones. It contracts considerably over most of its middle distance and thins in the direction of the maxillary notch. The basal portion of the jugal is of moderate thickness, covers the entire inferior portion below the maxillary notch, and then is attenuated to form the small stem-like styliiform process that extends backward. The palatine vacuities are separated by a distance of 12 mm. instead of meeting in the medial line as in *Acrodelphis bakersfieldensis*. Just posterior to the palatine vacuities are two grooves extending from the medial line to the optic canal. At the internal limits of these grooves are the internal parts of the pterygoids, the anterior parts of which are made of thin bone. The heavy, pillar-like walls of the basioccipital have a maximum lateral thickness of 15 mm. each. Between these two elevated portions is a U-shaped depression which forms the floor of the basioccipital and has a minimum vertical thickness of 3.7 mm., and a transverse width of 18 mm. An indistinct line within the major depression probably represents a fused suture where the posterior part of the pterygoids and the vomer adjoin the basioccipital. From this suture, the vomer extends in an anterior direction, sheathing the presphenoid. The basioccipital is broken away just behind the union with the pterygoids. The brain case is much narrower in front than behind, and the rostral, or anterior wall, shows either a division and pairing or else a worn break of a medial ridge. The superior portion of the brain case is irregular and indented. The two cerebral hemispheres were separated by a wide rounded depression. The ventral wall of the brain case has many small depressions in addition to the two principal ones.

SKULL MEASUREMENTS

Total length of specimen, as preserved, from broken left maxilla adjoining maxillary notch in a direct line to broken edge of supraoccipital.....	167
Maximum transverse semi-width of skull from posterior extension of supraorbital process to the medial line.....	100
Maximum distance across premaxillae on same line as above measurement	78.4
Greatest distance between outside margins of premaxillaries at level of anterior border of narial passages.....	78
Greatest breadth of left premaxillary at level of anterior border of narial passages.....	35.5
Greatest breadth of left premaxillary at level of maxillary notch	21
Distance between inner margins of premaxillaries at level of anterior margins of nasals.....	33
Maximum transverse diameter of right premaxillary at level of narial passages	32
Greatest vertical depth of skull at level of anterior borders of narial passages	83
Greatest vertical depth of rostrum at level of maxillary notches	51
Least distance between inner margins of maxillaries on vertex of skull	43
Maximum transverse diameter of combined nasals.....	38
Maximum transverse diameter of left nasal.....	19.4
Maximum antero-posterior diameter of left nasal.....	18.1
Distance from level of anterior edges of nasals to anterior edge of supraoccipital medially.....	45
Maximum antero-posterior diameter of frontals along median sutural line	26
Least transverse width of left frontal.....	20.6
Least transverse width of right frontal.....	22
Maximum oblique diameter of left frontal.....	43.1
Greatest antero-posterior diameter of left supraorbital process of frontal	78
Greatest antero-posterior length of superior part of lacrimal..	20.6

Family INIIDAE

DOLIODELPHIS,³⁷ new genus

Genotype.—*Doliodelphis littlei*,³⁸ new species.

Diagnosis.—Resembling porpoises belonging to the family Iniidae in the great thickness of frontal on the vertex of the skull, the deeply indented maxillary notches at the base of the rostrum, and the strong tapering of the slender preorbital apophysis of the maxilla.

Doliodelphis littlei, new species

Figs. 20-21

Holotype.—Cat. No. 13404 Y. P. M.

The skull is in two pieces, having been split longitudinally approximately through the center, thus exposing the choanae and surrounding bones in an excellent manner. The skull is incomplete, lacking the distal part of the rostrum, the right frontal, right nasal, the premaxillae and dorsal surface of the maxillae in front of the maxillary notches, left supraorbital process of frontal, postero-external portions of maxillae, and occipital portion of the skull. It differs from recent Iniidae in the dentition and also in several other respects.

Type locality.—N. W. $\frac{1}{4}$ of Section 13, T. 26 S., R. 28 E., M. D. B. & M., on the west slope of a round hill and just east of the main road to Woody, Kern County, California. This skull was found by Mr. T. V. Little and the writer in the spring of 1930.

Horizon.—Pyramid Hills Sand, about 100 feet below ? *Macrodelphinus kelloggi*, No. 13412.

Skull

The general configuration of this cetacean skull leads one to believe that if the lateral compression by the maxillaries against

37. δόλιος, deceptive; δελφίς, porpoise.

38. Named in honor of one of its discoverers, Mr. Thurston V. Little, of Shafter, California.

the vertex of the skull and the forward thrusting against the premaxillae were to continue along the lines of development indicated by this specimen, a condition like that in the modern *Lipotes* (U. S. N. M. No. 218293) or *Inia* (U. S. N. M. No. 49582) would probably result. But the structural condition in *Doliodelphis littlei* shows that these modern forms have undergone considerable remodeling, particularly in the maxillae, which have been modified from a horizontal plate to an elevated and concavely curved surface, in the premaxillae, which have moved anteriorly from the apex, and in the frontals, which have been greatly elevated. While the skull of *Doliodelphis littlei* appears to have started in this direction, it can not be classed with modern Iniidae on account of the differences just mentioned and also the differences in dentition. No teeth of this specimen are preserved, but the left maxilla has 22 alveoli in a distance of 157 mm., counting from the hindmost alveolus forward. *Inia geoffrensis* Blainville³⁹ shows 22 teeth in 199.5 mm., much too large a ratio for *Doliodelphis littlei*. *Stenodelphis blainvillei* P. Gervais⁴⁰ shows 22 teeth in a distance of 88 mm., much too small a ratio. The structural peculiarities of these two recent porpoises (Winge⁴¹) indicate that the fossil specimen herein described probably lies between these two extremes and may possibly be ancestral to one or to both. *Hesperocetus californicus*⁴² is much too large to possess any near affinity to this form. Nor can *Eoplatanista italica* Dal Piaz⁴³ be closely related, since, in the middle portion of the left rostrum, it possesses 8 teeth in a distance of 83 mm., or 1 in 10.4 mm., while *Doliodelphis littlei* has 1 in 7 mm. Nor are any

39. Abel, O.—Op. cit., vol. I, fig. 5, 1901.

40. Ibid., fig. 4.

41. Winge, H., and Miller, G. S.—A review of the interrelationships of the Cetacea. *Smithson. Misc. Coll.*, vol. 72, no. 8, pp. 228-235, 1921.

42. True, F. W.—A fossil toothed cetacean from California, representing a new genus and species. *Smithson. Misc. Coll.*, vol. 60, no. 11, pp. 1-7, 2 pls. 1912.

43. Dal Piaz, G.—Gli Odontoceti del Miocene Bellunese. Parte Quarta, *Eoplatanista italica*. *Mem. dell'Istituto Geologico della R. Università di Padova*, vol. 5, tav. II, 1916.

of the species of Abel's⁴⁴ Platanistidae sufficiently like the one under discussion to necessitate any detailed comment.

Dorsal view.—The premaxillae are largely destroyed anterior to the premaxillary foramina; and hence the distinguishing features of their dorsal surfaces are lacking. The premaxillary foramen is deep, and a groove runs from it posteriorly, dividing the premaxilla into two distinct parts, a broad, slightly concave portion which rises above the groove on the internal side, rising rather sharply as it approaches the nasal, and a narrow portion which slopes away from the groove laterally and posteriorly and flares widely at its posterior limit. At its posterior extremity, the lower portion of the premaxilla rests on the maxillary, and the upper portion is bifurcated, one point meeting the extreme anterior edge of the frontal, and the other point being wedged in between the extreme anterior projection of the frontal and the lateral face of the nasal. Although part of the inner portion of the right premaxillary is eroded, it is apparent that the two premaxillae did not approach each other closely posterior to the premaxillary foramina. The mesorostral gutter is, accordingly, completely open at the top and exposed from the anterior tip of the specimen to the presphenoid. The left maxillary is mostly lacking posterior to the maxillary notch. The dorsal surface of the right maxillary is almost all eroded, and part of the posterior portion of this bone is broken away. The maxillary is broad and high behind the maxillary notch and overlaps the supraorbital process of the frontal. This overlapping of the supraorbital process is nearly complete at its apex, covering all but 3.3 mm. But near the anterior edge, there is an exposed surface of 13 mm.; and at the extreme anterior edge, the maxilla extends in a blunt point slightly beyond the lacrimal. The maxillary notch is broadly curved, the anterior edge ascending gradually to the point where the maxillary overrides the lacrimal. The maxillary foramen is deeply incised, with a broad, deep groove extending a

44. Abel, O.—Untersuchungen über die fossilen Platanistiden des Wiener Beckens. Denks. Akad. Wiss., Wien, Math.-naturw. Classe, Bd. LXVIII, 1900.

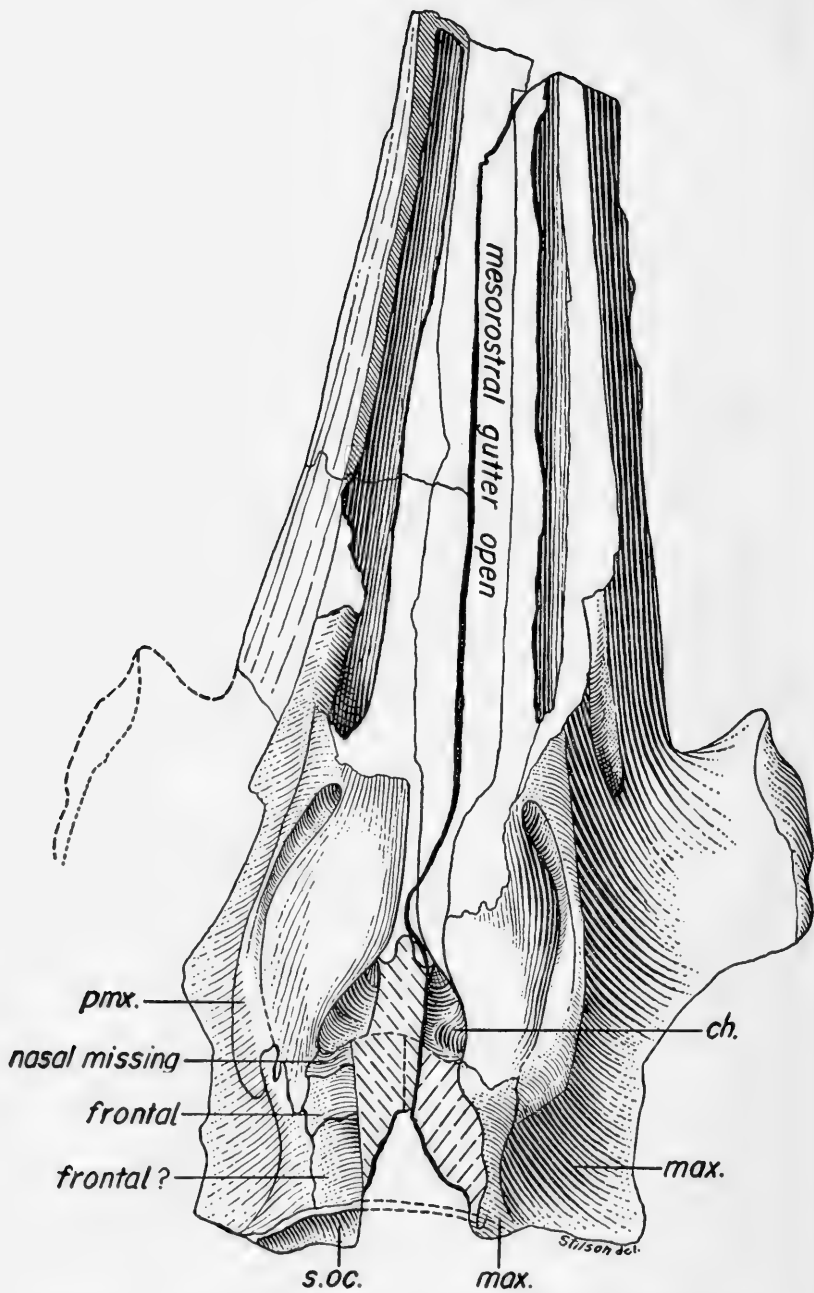


Fig. 20. *Doliodelphis littlei* (holotype), dorsal view. $\times \frac{1}{2}$. For explanation of lettering, see Fig. 1.

short distance from it both anteriorly and posteriorly. The right nasal is lacking, and the left one is incomplete, with the inner half destroyed. A projection from the ventral anterior part of the nasal forms a shelf on which an extension of the mesethmoid may have rested. The right frontal is broken off. The exposed surface of the left frontal is rather irregular in outline and emarginate. The posterior portion is prolonged into a point that extends laterally along the anterior edge of the supraoccipital crest. A V-shaped suture is formed at the anterior border of the frontal. The lateral arm of the V is long and sharp-pointed and is bordered by the maxilla on one side and the premaxilla

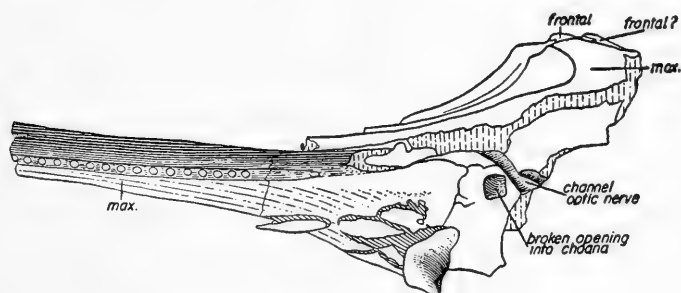


Fig. 21. *Doliodelphis littlei* (holotype), lateral view. $\times 1/4$.

and nasal on the other side. The medial line of the V is less sharp, and its end is posterior to the end of the lateral arm. If the right frontal were present, the line forming the anterior border of the combined frontals would form the letter W. The narial openings slant forward and downward at a slight angle in the dorsal view and curve posteriorly as they approach the ventral side of the skull. The posterior portion of the skull is lacking. A high, narrow but rounded lambdoidal crest on the supraoccipital is visible along the posterior border of the left frontal. The supraoccipital seemingly descends abruptly from this crest. The frontals are thick, at least 23.2 mm., at the level of the occipital crest. This thickness rapidly diminishes in a

posterior direction, because of the steep descent of the supra-occipital.

Ventral view.—The outstanding features of this view are the height of the presphenoid between the pterygoids, the preservation of the posterior part of the mandible collapsed against the skull, and the height and position of the pterygoids.

The left maxilla shows 22 alveoli in a distance of 157 mm. counting forward from the most posterior alveolus. The maxillaries are rounded at the anterior end of the specimen, being much more steep on the interior edge where it descends abruptly to meet the vomer. In a posterior direction, the maxillary becomes more broad and flat, descending very gradually on the external edge to the alveolar groove. The posterior part of the alveolar groove is eroded so that the alveoli can not be counted. The vomer is visible from the anterior end of the specimen for a distance of 105 mm., where it passes under the internal edges of the maxillaries. It is next seen as a high crest between the pterygoids and is then broken away just at the posterior edges of the narial openings. The palatine vacuities are covered by the pieces of the mandible which have been collapsed on the ventral side of the skull. The left infraorbital foramen appears as a wide groove passing from the exterior edge of the broken maxilla to the under surface of the premaxilla. The optic canal is of moderate width and depth on its interior side and opens to a broad, shallow depression as it passes to the under side of the frontal plate. The pterygoids are well preserved laterally and anteriorly but broken posteriorly. The anterior edges are thin and the posterior parts, thick. The crest of the vomer extends above the tops of the pterygoids a distance of 16 mm. The lacrimal is separated clearly from the supraorbital process of the frontal and from the maxillary at the exterior edge but shows no suture on the interior edge. Evidence of separation of the lacrimal from the base of the jugal can not be seen. Only the base of the jugal is preserved, and it is thin and narrow. The brain case is rugose and shows the olfactory foramina, which are small but set in

fairly large depressions. The anterior part of the brain case is considerably narrower than the posterior part.

MEASUREMENTS OF SKULL

Total length of specimen as preserved, measured from anterior edge of left maxilla to posterior edge of the supraoccipital, as preserved	330
Maximum semi-width from median line to exterior edge of supraorbital process of right frontal at level of the premaxillary foramen	99.2
Maximum distance across premaxillaries at level of anterior edges of posterior premaxillary foramina.....	72.2
Greatest distance between outside margins of premaxillaries at level of anterior edges of narial passages.....	89.5
Maximum width of left premaxillary at level of anterior edges of dorsal narial openings.....	40.2
Distance between inner margins of premaxillaries at level of anterior edges of narial passages.....	14.3
Greatest vertical depth of skull at level of anterior margins of narial passages	116.3
Minimum distance between premaxillaries at anterior edges of nasals	42.3
Minimum distance between maxillae at vertex of skull.....	56.7
Maximum width of right maxilla at level of anterior edges of narial openings	58.2
Maximum transverse diameter of left nasal.....	15.9
Maximum antero-posterior diameter of left nasal along line near its center.....	22.3
Maximum transverse diameter of left frontal.....	22.4
Antero-posterior length of left frontal along median line.....	19.3
Maximum oblique diameter of left frontal.....	39
Distance across maxillary notch from anterior base of jugal to anterior margin of lacrimal.....	37

Family EURHINODELPHIDAE

Genus EURHINODELPHIS du Bus

Eurhinodelphis extensus,⁴⁵ new species

Figs. 22-23

Holotype.—Cat. No. 13409 Y. P. M.

The skull is incomplete, and the greater part of the rostrum is lacking. The supraorbital processes of both frontals and the overlying maxillae are broken off at the level of the maxillary notches; and on the left side, part of the premaxilla also is broken off at this level. The inferior part of the supraoccipital, the remainder of the hinder surface, and the whole basicranium are lacking.

Type Locality.—Near the southern boundary of Section 12, T. 26 S., R. 28 E., M. D. B. & M., in a deep pit on the east side of a branch road which leaves the main road to Woody, Kern County, California, near the center of Section 13, and within a few hundred feet of the pit which yielded *Macrodelphinus kelloggi* (holotype).

Horizon.—Pyramid Hills Sand, approximately 30 feet lower in the section than *M. kelloggi*. Not in place and may have been washed down from a higher horizon than that in which it was found but not higher than that of *M. kelloggi*.

This skull was found by the writer in the autumn of 1928. No skeletal parts were found associated with the skull. The skull was cleaned by the writer during the course of the next few months and put on display with other cetacean material at Bakersfield Junior College.

The *diagnostic characters* are the marked posterior prolongation of the premaxillae behind the posterior margins of the nasals, the height and development of the presphenoid, and the anterior elevation of the nasals.

45. The specific name refers to the posterior extension of the premaxilla behind the nasal.

This specimen is referred to the *Eurhinodelphidae* of Abel^{46, 47} and placed in the genus *Eurhinodelphis* by reason of the occurrence in it of the following characters: The premaxillae are thickened behind the maxillary notch, their internal portions are elevated and form a roof over the mesorostral gutter for some distance just anterior to the maxillary notch, reaching their maximum width at the anterior margins of the narial apertures. Their external margins posterior to the maxillary notches form a narrow ridge. The maxillaries are thick above the orbits and at their posterior edges descend with a steep, external slope from the premaxillae and frontals. The supraoccipital is concave. The frontals are constricted laterally at the vertex. The nasals are of moderate size and deeply imbedded posteriorly. The vomer helps to floor the mesorostral gutter. *Eurhinodelphis extensus* differs from the type of the genus, *E. cocheteuxi* du Bus,⁴⁸ in lacking the interparietal, in having differently shaped nasals (those of *E. extensus* being narrower at the posterior than at the anterior border, and those of *E. cocheteuxi* being much wider at the posterior than at the anterior border), and in having comparatively shorter frontals.

Of the numerous specimens of *Eurhinodelphis* in the U. S. National Museum, this specimen more closely resembles the type of *E. bossi* (U. S. N. M. No. 8842)⁴⁹ than any other. It has in common with the type most of the facial and apical features of the skull. (The face in the members of this family may or may not be elongated.⁵⁰) This specimen and *E. bossi* both show anterior curvature of the supraoccipital in its sudden descent

46. Abel, O.—Les dauphins longirostres du Boldérien (Miocène Supérieur) des environs d'Anvers. Mem. Mus. Roy. d'Hist. Nat. Belgique, Tome I, p. 60, 1901.

47. True, F. W.—On the classification of the Cetacea. Proc. Amer. Philos. Soc., vol. XLVII, p. 388, 1908.

48. Abel, O.—Op. cit., pl. I, fig. 8.

49. Kellogg, R.—On the occurrence of remains of fossil porpoises of the genus *Eurhinodelphis* in North America. Proc. U. S. Nat. Mus., vol. 66, art. 26, pp. 1-40, pls. 1-17, 1925.

50. Winge, H., and Miller, G. S.—A review of the interrelationships of the Cetacea. Smithson. Misc. Coll., vol. 72, no. 8, p. 35, 1921.

from the lambdoidal crest. The distance over which the anterior curvature takes place is greater in *E. bossi* than in *E. extensus*. The posterior extension of the premaxillae is greater in *E. extensus* than in *E. bossi* or in any other specimen of *Eurhinodelphis* studied. *E. extensus* differs from *E. bossi* (specimen No. 10464) in having smaller and less ovoid nasals. In specimen No. 10464, as in the type, the premaxillae reach posteriorly to the posterior ends of the nasals. It differs from *E. bossi* (specimen No. 10714) in having anteriorly elevated nasals, while those of the U. S. N. M. specimen are anteriorly depressed. In No. 10714 the lateral posterior extensions of the frontals are much smaller than in *E. extensus*. The frontals of specimen No. 10714 also show a posterior bulge at the point where the median line of the frontals meets the supraoccipital. Also, the posterior ends of the maxillae of No. 10714 drop away from the frontals in a nearly vertical slope, while those of *E. extensus* have a more gradual descent to the external edge. The lambdoidal crest of No. 10714 is much more prominently developed and sharper than in *E. extensus*.

Skull

Dorsal view.—The outstanding features of this skull are two, namely: the extension, in a posterior direction, of the premaxilla far beyond the posterior border of the nasals, and the overhanging lambdoidal crest at the apex of the supraoccipital. The gradual approach of the premaxillae toward each other shows that the porpoise is a member of a long-beaked family. The rostrum is broken off at a distance of 132 mm. in front of the anterior edge of the narial openings. The rostral portion preserved is somewhat rugose and has been cracked through and slightly distorted at a distance of 37.5 mm. in front of the anterior edge of the narial openings. The posterior edge of the maxillary foramen lies nearly opposite the maxillary notch, and a groove runs from it in an anterior direction for a distance of 62 mm. The outer portion of the maxilla from the maxillary

notch to the posterior extremity is largely broken away. The inner portion of the maxilla is in contact with the premaxilla throughout. The external rounded portion of the premaxilla is convex on the rostrum, with a much steeper angle on the internal than on the external side. A groove runs in an anterior direction along the inner edge of the convex portion from the premaxillary

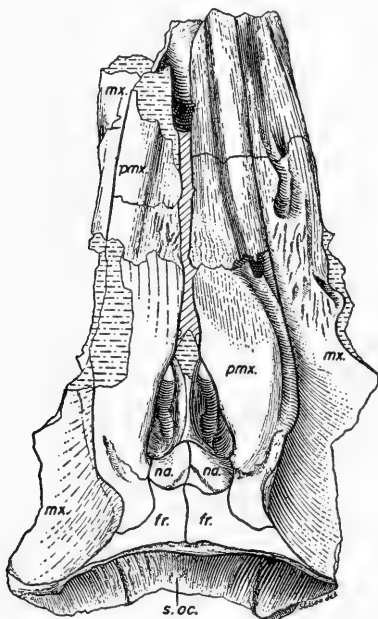


Fig. 22. *Eurhinodelphis extensus* (holotype), dorsal view. $\times 1/3$. For explanation of lettering, see Fig. 1.

foramen to the end of the preserved portion of the rostrum. Also, a groove extends posteriorly from the premaxillary foramen, disappearing toward the posterior extremity of the premaxilla. Behind the premaxillary foramen, the premaxilla rises gradually to the anterior edge of the narial opening and then rises steeply to form part of the vertex of the skull at the posterior extremity of the premaxillary. The premaxilla extends posteriorly far behind the nasals.

The vertex of the skull is flat except for the portion formed by the nasals. The nasals rise slightly above the narial openings but do not overreach them (as in *Acrodelphis bakersfieldensis*). The narial openings are long and narrow, and somewhat elliptical in outline at the dorsal side, and approximately the same size. Each opening really consists of two parts, the narial passage itself, which is round and anterior in position, and the posterior part, which is an irregularly shaped depression lying behind the rounded anterior opening and having a floor lying a distance of 49 mm. below the top of the medial line of the nasals. Near the

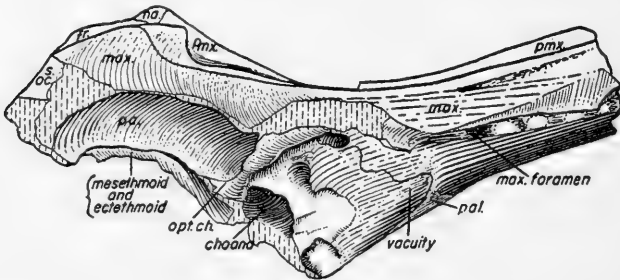


Fig. 23. *Eurhinodelphis extensus* (holotype), lateral view. x 1/3. For explanation of lettering, see Fig. 1.

bottom of the posterior part, two vascular foramina appear as small holes. The distance from the posterior edge of the rounded anterior part to the rear of the irregular platform, measured in an antero-posterior direction, is 14.5 mm. This platform, or floor, is formed by the mesethmoid. Only the upper portion of the supraoccipital is present. At its contact with the frontals, it forms a ridge which overhangs the supraoccipital posteriorly. Beneath this overhanging ridge, the supraoccipital descends nearly vertically for approximately 7 mm. and then slopes more gradually. The central portion of the supraoccipital is depressed and bordered laterally by ridges which extend to join the overhanging ridge at the vertex. Several rugosities running dorso-ventrally occur in this depression, and one of them forms a ridge

running from the overhanging crest medially for a distance of 17 mm. The frontals show a combined anterior breadth of 31.5 mm. and a posterior breadth of 80 mm. at the maximum. The antero-posterior length of the frontals along the medial line is 22 mm. The longitudinal suture is not clearly defined; and hence, the frontals can not be described separately. The nasals extend forward only to the posterior edges of the narial openings. Each nasal is roughly rectangular in shape. The maximum antero-posterior length of the left nasal through its approximate center is 15 mm., with the right nasal the same size. It is interesting to find that there is no apparent asymmetry in this part of the specimen.

Ventral view.—The two rounded narial openings appear clearly in this view, widely separated by the deep, robust presphenoid. The transverse diameter of each narial opening is 18.5 mm. The palatine vacuities show a maximum length of 32 mm. (left) and 37 mm. (right). At the medial line, the vacuities are separated by a minimum width of 13 mm. The indentation of these vacuities and the associated posterior depressions is deep. The optic canals, with the walls partially preserved, are deep and somewhat rugose dorsally and lie quite close to the narial openings (3.5 mm.). The maxillae are gently rounded in this view except at the inner, anterior edges, where an abrupt, steep slope is observed. The infraorbital foramen is quite large and preserved only on the right side. Its anterior edge lies 22 mm. behind a transverse line drawn from the maxillary notch. This foramen flares out widely at its posterior end. Only the base of the anterior part of the jugal is present. It is broadened in an oblique, antero-posterior direction, thinned at right angles to this direction, and stronger than the corresponding part of the jugal in *Acrodelphis bakersfieldensis*. Not enough of the dental groove is preserved to obtain information on the teeth. This groove ends just 18 mm. in front of the maxillary notch. The dorsal part of the brain case is well preserved, and parts of the bounding sides are present. Vascular

foramina lie at the edge of the presphenoid and anterior frontal plate. A strong sagittal ridge at the line of union between the opposite frontals projects downward into the cranial cavity, dividing the roof into two well-marked halves. The anterior part is narrower than the posterior part, and the whole is rugose.

MEASUREMENTS OF SKULL

Total length of specimen, as preserved, from projection on right supraoccipital to dorsal edge of right premaxilla...	240.3
Depth of skull at level of infraorbital foramen.....	81.6
Depth of rostrum at level of maxillary notches.....	60
Depth of rostrum at anterior break (89 mm. in front of maxillary notch)	43.6
Maximum width of right premaxilla at anterior edge of narial opening	39.5
Interval between premaxillae at anterior edges of narial openings	11
Closest approach of premaxillae at their posterior ends.....	33
Minimum distance between maxillae at vertex of skull.....	56.4
Distance from posterior edge of right maxilla to posterior edge of maxillary foramen.....	140
Anterior width of combined frontals.....	31.5
Length of frontals along medial line.....	22
Maximum posterior width of combined frontals.....	80
Maximum transverse width of combined nasals.....	35.3
Central length of left nasal antero-posteriorly (also right)...	15
Maximum breadth of left nasal (also right).....	18
Maximum length of narial opening, dorsal view.....	43
Maximum transverse width of left narial opening, dorsal side	14.2
Maximum transverse width of right narial opening, dorsal side	13.1

UNALLOCATED RIGHT TYMPANIC BULLA
AND PERIOTIC

Plate 1, figs. e and f

Specimen.—Cat. No. 13413 Y. P. M.

A complete right tympanic bulla and periotic united in their natural relations were found in the pit with *Macrodelphinus kelloggi* (individual 2). These ear bones are not to be allocated to *M. kelloggi*, since the bulla is quite unlike that associated with the type of *M. kelloggi*, and since it is too small for as large a dolphin as *M. kelloggi* (individual 2).

The periotic resembles that of *Allodelphis pratti* in general size and shape but differs from it in several respects, such as the size and shape of the *pars cochlearis*, the locations of the *fenestra rotunda*, cerebral orifice of *aqueductus cochleae*, and cerebral orifice of *aqueductus vestibuli*, the size and shape of the internal acoustic meatus, and the configuration of the dorsal surface of the posterior process. The tympanic bulla does not resemble at all closely any of the tympanic bullae in the U. S. National Museum collection.

Periotic: Tympanic view.—The posterior process is short and nearly flat. The extero-anterior face of this process is partially covered by the posterior pedicle of the tympanic bulla, and the internal border of the posterior process furnishes the exterior wall of the canal for the facial nerve. The width and flatness of the posterior process are in marked contrast to the posterior process of the periotic of *Allodelphis pratti*. The dorsal face of the process does not overhang the substructure as in the periotic of *A. pratti*. The *hiatus epitympanicus* is deep and narrow. The tuberosity at the base of the anterior process is large and bulbous and separated from the anterior process by a deep, regular groove which continues dorsally across the superior side of the periotic. The surface on which rests the anterior pedicle of the bulla is more rounded than triangular (cf. *Allodelphis pratti*) and set deeply into the periotic. The anterior process is much deeper

than wide, and smooth throughout. On the anterior side of the periotic, between the anterior process and *pars cochlearis*, are two small grooves leading along the ventral surface in a posterior direction. The fossa for the head of the malleus appears in the center of the ventral surface just above and anterior to the end of the sigmoid process of the bulla. It is ovoid, deep, and surrounded by a faint rim on the dorsal border. The *fenestra ovalis* and the fossa for the stapedial muscle are hidden by the attached tympanic bulla. The semi-closed canal for the facial nerve is smaller and more nearly closed than that of *Allodelphis pratti* or *Schizodelphis bobengi*. It is bordered ventrally by the posterior pedicle of the posterior process of the tympanic bulla.

Cerebral view.—The *fenestra rotunda* is elliptical in outline. The cerebral orifice of *aqueductus cochleae* is oval in outline and almost as large as the *fenestra rotunda*. A character of the cerebral orifice of *aqueductus vestibuli* worthy of notice is that the fossa enclosing it is quite shallow, being no more than a pit, whereas in the periotic of *Allodelphis pratti* it is about twice the size of the orifice of *aqueductus cochleae*. It is located midway between the *aqueductus cochleae* and the dorsal side of the periotic. In the periotic of *A. pratti* its location is near the dorsal margin of the bone. The internal acoustic meatus is round and deep, and shows clearly that the spiral tract ending in the *foramen centrale* makes two whorls. The entrance to aqueduct of Fallopius and the *foramen singulare* are separated from the spiral tract by a low, osseous wall extending upward about one-third of the distance from the bottom of the internal acoustic meatus to the rim. The entrance to the *aqueductus Fallopius* is much larger than the *foramen singulare*.

Tympanic bulla: Cerebral or internal view.—On the dorsal surface, the heavy involucrem shows numerous osseous ridges, which cross it in a spiral series toward the anterior apex. The dorsal side slopes rapidly toward the anterior apex. The dorsal edge of the anterior part of the outer lip can be seen in this view at a much higher elevation than the dorsal side of the involucrem. It is seen, also, to be curved inward and slightly ventrally. The

MEASUREMENTS OF PERIOTIC

Greatest length of periotic from tip of posterior process to extremity of anterior process.....	32.5
Maximum transverse breadth from exterior tip of tuberosity at base of anterior process to extremity of <i>pars cochlearis</i> at level of internal acoustic meatus.....	19.2
Greatest dorso-ventral depth from most inflated portion of dorsal face of <i>pars cochlearis</i> to projection on ventral face at level of cerebral orifice of <i>aqueductus vestibuli</i>	13.5
Distance between nearest edge of <i>fenestra rotunda</i> and dorsal tip of anterior process.....	23
Distance between dorsal tip of posterior process and nearest edge of <i>fenestra rotunda</i>	16.6
Distance from nearest edge of internal acoustic meatus to nearest edge of <i>fenestra rotunda</i>	4.5
Greatest diameter of <i>fenestra rotunda</i>	3
Greatest diameter of cerebral orifice of <i>aqueductus cochleae</i> ..	3
Distance between <i>fenestra rotunda</i> and cerebral orifice of <i>aqueductus cochleae</i> at nearest surficial approach.....	2.1

anterior eustachian outlet, which separates the outer lip from the involucrem, is about one-half the maximum width of the involucrem.

Ventral view.—A deep groove runs longitudinally for two-thirds the length of the bulla, reflecting the division into involucrem and outer lip. The groove is much deeper at the posterior end than anteriorly and much deeper throughout, narrower, and longer than the corresponding groove on the bulla of *Macrodelphinus kelloggi* (holotype). The width of the involucrem is greater than that of the outer lip at the posterior end.

Posterior view.—At the dorsal border the two pedicles of the posterior process of the periotic are separated by the elongate opening that connected with a sinus. The above-described groove on the ventral surface lies just below this aperture.

External view.—The sigmoid process stands well above the outer lip, is broad on its anterior slope, and rounded dorsally and posteriorly. It reaches nearly as high as the posterior process of the periotic and then descends in a sigmoid curve to almost touch the epitympanic face of the periotic. The posterior

conical apophysis lies between the sigmoid process and the postero-external pedicle; it is a slightly-raised, rounded prominence. The small, flattened accessory ossicle (uncinate process) on the anterior process of the outer lip of the bulla rests on the anterior process of the periotic.

MEASUREMENTS OF TYMPANIC BULLA

Greatest length of bulla.....	44.8
Greatest depth of bulla on cerebral side (dorsal surface of involucrem to ventral surface of same).....	16
Greatest depth of bulla on external side (anterior face of posterior conical apophysis to ventral face of bulla).....	23.3
Depth from dorsal surface of sigmoid process to ventral surface of bulla	29
Interval between posterior edge of sigmoid process and ventral edge of posterior process of periotic.....	4.6
Greatest posterior width (involucrem and bulla).....	22.2
Dorso-ventral length of opening into sinus.....	8

UNALLOCATED SPECIMENS FOUND WITH
MACRODELPHINUS KELLOGGI (holotype)

Not infrequently in excavating fossil cetacean bones, many skeletal parts are obtained which can not be allocated to the skulls with which they are found associated. These bones form a part of the record of marine mammals of the horizons represented and are here described without any attempt to place them in any new or old genera. It is to be hoped that, in the future, discoveries of additional material will make feasible the allocation of these bones.

Articulated Limb Bones

Specimen.—Cat. No. 13414 Y. P. M. Left radius, distal end of shaft of left ulna and its epiphysis, scaphoid, lunar, trapezoid, unciform, cuneiform, and a metacarpal.

The radius is nearly complete, except for a small piece of the internal border near the distal end and the entire distal epiphysis. The proximal angle of the anterior end is eroded. The shaft is convex anteriorly and slightly bowed outward; the anterior edge

is narrower than the posterior. The proximal ulnar facet slopes steeply downward, has a projecting lower border, and is widest on the external half of the shaft. The facet for articulation with the capitulum of the humerus is slightly concave and pitted.

MEASUREMENTS OF RADIUS AND ULNA

	<i>Radius</i>	<i>Ulna</i>
Length along posterior border.....	100	x
Length along anterior border.....	120	x
Antero-posterior diameter of proximal end.....	29	x
Extero-internal diameter of proximal end.....	25.5	x
Antero-posterior diameter of distal end.....	41	48.6
Extero-internal diameter of distal end.....	20	21

The distal end of the shaft of the ulna and its epiphysis are preserved. The shaft of the ulna is wider than that of the radius. It is about twice as thick on its anterior as on its posterior edge. The distal epiphysis has been moved posteriorly. Its facets for the articulation of the carpals have been sufficiently uncovered to reveal their shapes and sizes, thus assisting in placing the carpals.

Four carpals were attached to the radius and ulna, and one was free. By comparison with *Delphinus* (U.S.N.M. No. 20162) and with *Steno* (U.S.N.M. No. 49628) the carpals present are believed to be the following: scaphoid, lunar, trapezoid, unciform, and cuneiform. An unattached metacarpal which might belong to this individual was present also.

MEASUREMENTS OF CARPALS

	<i>Scaphoid</i>	<i>Lunar</i>	<i>Unciform</i>	<i>Trapezoid</i>	<i>Cuneiform</i>	<i>Metacarpal</i>	<i>Ulnar epiphysis</i>
Antero-posterior length	31	15	23.5	23	26	35	46
Dorso-ventral width ..	21	15	18.3	15	15	26	10.5
Extero-internal thickness	17	17.5	15.2	14.2	14	19	19

Ulna

Specimen.—Cat. No. 13415 Y. P. M. Proximal portion of left ulna.

The articular surfaces and general proportions of this ulna do not agree with any of the bones found with it, and accordingly it is given a separate number. The proximal part of the olecranon process is broken off. The sigmoid cavity reaches its widest part at its anterior edge where it slightly overhangs the facet for articulation with the radius. The sigmoid cavity is convex and pitted. The shaft is nearly straight, wide at the anterior edge, and narrower posteriorly.

MEASUREMENTS OF ULNA

Length of specimen as preserved.....	70
Antero-posterior width of shaft below sigmoid cavity.....	41
Antero-posterior width of olecranon process at proximal break (25 mm. above anterior margin of face of sigmoid cavity)..	34
Extero-internal diameter of anterior border of shaft.....	15
Extero-internal diameter of posterior border of shaft.....	8

Atlas

Specimen.—Cat. No. 13416 Y. P. M. Left half of an atlas which lacks most of the lower transverse process.

Its great length is its outstanding character. The articular facet for the occipital condyle is sharply concave and deep, and its outer edge is thin. The vertebrarterial canal is slightly oblique where it pierces the neural arch, which was thin and, probably, steeply arched. The slender upper transverse process extends obliquely backward and curves downward at its posterior end. It is thick at the base but thins in a posterior direction. Its posterior end is on a level with the facet for articulation with the axis. The upper transverse process is notched anteriorly at the base. The lower transverse process is broken off on a level with the posterior end of the upper one and, evidently, extended beyond it when it was complete. Its direction of extension is approximately that of the upper transverse process. The facet

for the articulation with the axis bears a sharp, thin external border, is slightly concave, and, internally, forms a wide facet for the articulation of the odontoid process.

Atlas

Specimen.—Cat. No. 13417 Y. P. M. Left half of atlas, damaged.

This atlas resembles that allocated to *Macrodelphinus kelloggi* (holotype). The lower transverse process in this specimen is short, reaching posteriorly only to the facet for articulation with the axis. The broad base of this process is pierced by a tiny foramen. The facet for articulation with the axis is not set off by a neck as in the atlas of *M. kelloggi*. Otherwise, the shape of the facet is like that in the latter. This atlas is slightly smaller than that of *M. kelloggi*. The position of the lower transverse process of *M. kelloggi* lies much below that of this specimen.

Atlas and Axis

Specimen.—Cat. No. 13418 Y. P. M. Axis and left half of atlas.

This atlas is much too small to belong with the large skull of *M. kelloggi* and too large to belong with either of the *Acrodelphis bakersfieldensis* skulls from this pit. Since the axis and atlas articulate properly, they are assigned together.

The condylar articular surface of the atlas is deeply concave and drawn to a sharp anterior edge. The whole atlas is short. The vertebrarterial canal runs transversely into the neural arch. The upper and lower transverse processes are separated. The upper is broken off; the lower is very small and vestigial, its posterior extension reaching only to the anterior edge of the neck of the facet for articulation with the axis. This facet, shaped like those previously described, is well set off by a neck.

The axis lacks the neural arch and both inferior transverse processes. Judging by the inflection of the partly preserved right pedicle, it appears that the neural canal was low and

broader than high. The anterior facets for articulation with the atlas are roughly heart-shaped and higher than wide. The odontoid process is short and blunt and has a rounded ridge, on its superior side, extending the full length of the axis. Just anterior to the level of these facets are two vascular foramina, one on each side of the ridge.

MEASUREMENTS OF ATLASES AND AXIS

	<i>Atlases</i>			<i>Axis</i>
	13416	13417	13418	13418
Greatest length of anterior articular facet	56p	68.4p	50.2	39
Greatest transverse width of anterior articular facet.....	37.3	38.5	31	30
Maximum length of centrum.....	75	58	51	57
Maximum vertical height of posterior face of centrum.....	x	x	x	45
Maximum width of posterior face of centrum	x	x	x	58
Maximum vertical height of facet for articulation with axis.....	36.5	57	39	x
Length of upper transverse process (anterior edge on centrum to posterior tip)	43.2	x	x	x
Length of lower transverse process on posterior side.....	x	20	6	x
Width of axis across exterior edges of anterior articular facets....	x	x	x	95

p = as preserved

Radius

Specimen.—Cat. No. 13419 Y. P. M. Left radius.

This left radius is imperfect, lacking a part of the internal border near the distal end. Its size and shape are practically the same as in left radius No. 13414. It differs from the latter in having a smaller ulnar notch and a narrower anterior border.

MEASUREMENTS OF RADIUS

Length along posterior border	95.5
Length along anterior border	126
Antero-posterior diameter of proximal end.....	37
Extero-internal diameter of proximal end.....	25
Antero-posterior diameter of distal end.....	38
Extero-internal diameter of distal end.....	21

Humeri

One of the most commonly preserved bones of cetaceans is the humerus.

Specimen.—Cat. No. 13420 Y. P. M. Left humerus.

This humerus is complete. The head is the same size as the unconstricted neck, and its superior profile is on a level with the superior surface of the greater tuberosity. The lesser tuberosity can be differentiated from the greater only with difficulty, and no trace of the bicipital groove is found. The deltoid process is large, subelliptical, strongly convex, and set at an angle to the deltoid ridge. The fossa for the attachment of the infraspinatus muscle is deep and eye-shaped. The posterior surface of the shaft is but little thinner than the anterior surface. The shaft is strongly concave on the internal border. The trochlea is somewhat smaller than the capitulum, occupying the full width of the shaft, extending along its posterior surface a distance of 32 mm., and terminating in an ovoid articular surface which is separated superiorly from the rest of the shaft by a deep, narrow groove. The ridge separating the trochlea from the capitulum is steep on the posterior side and fades gradually into the capitulum anteriorly.

Specimen.—Cat. No. 13421 Y. P. M. Left humerus.

This left humerus is incomplete. It differs from No. 13420 in having the head well set off from the shaft by a high, constricted neck, a more strongly concave internal border, a larger and flatter deltoid process, a more distinct lesser tuberosity, and a shallower and broader fossa for the attachment of the infraspinatus muscle. The posterior part of the shaft appears thicker than the anterior

part. The ridge separating the capitulum from the trochlea is much the same as in No. 13420, and the trochlea extends along the posterior edge to the same height as in No. 13420.

Specimen.—Cat. No. 13422 Y. P. M. Left humerus.

This left humerus is nearly complete. The internal border is concave, more concave than in No. 13420, less than in No. 13421 but similar to it. The head is on a high but unconstricted neck which slopes gently away from the head ventrally. The deltoid process is larger than that of either No. 13420 or No. 13421. It is subelliptical in outline and very thick extero-internally near the fossa for the attachment of the infraspinatus muscle. The lesser tuberosity is clearly separated from the greater by the bicipital groove. The head extends to a greater height than either tuberosity. The fossa for the attachment of the infraspinatus muscle is oval and deep. On the posterior border of the shaft, just above the superior extension of the trochlea, is a strong, slightly oblique ridge at the distal side of which is a groove separating the ridge from the trochlea. The ridge separating the capitulum from the trochlea is higher and sharper than in No. 13420 or No. 13421.

Specimen.—Cat. No. 13423 Y. P. M. Distal and posterior part of right humerus.

Only the posterior part of the head is preserved. It appears to have been set off on this side by a distinct neck, which is less distinct externally. The fossa for the attachment of the infraspinatus muscle is large and round. The trochlea is continued along the posterior edge of the shaft in a broad, smooth face, above which is an oblique groove. A prominent, oblique ridge lies parallel to the groove on the superior side.

Specimen.—Cat. No. 13424 Y. P. M. Distal part of left humerus.

This humerus is broken off above the fossa for the attachment of the infraspinatus muscle. It is open proximally, in contrast with the other humeri from this pit. The fossa has steep boundaries on the distal and posterior edges. The deltoid process is large, and its limits are not clearly defined. A wide, shallow groove

MEASUREMENTS OF HUMERI

	13420	13421	13422	13423	13424
Maximum overall length from head (or from greater tuberosity) to ridge on distal face	140	139t	131	136p	97p
Maximum antero-posterior width of shaft at level of deltoid process	60	61	58	x	46
Maximum extero-internal thickness of shaft at distal end	31	32.5	34	37.5	33.6
Greatest diameter of head..	45	50	47	x	x
Least diameter of head.....	39	46	41.5	x	x
Greatest diameter of deltoid process	32	38	34.5	x	27
Least diameter of deltoid process	17	18	23	x	13
Maximum diameter of fossa for attachment of infraspinatus muscle	26	22	21	27±	unc.
Least diameter of fossa for attachment of infraspinatus muscle	14.2	21	15	27±	12
Maximum diameter of posterior tuberosity	28	x	34.5	x	x
Least diameter of posterior tuberosity	24	x	22.5	x	x
Antero-posterior length of capitulum	26	23.5	22	32±	24
Extero-internal width of capitulum	27	27	28.2	34.5	26
Antero-posterior length of trochlea on distal end....	23±	22.5±	22.5	25.5	23
Extero-internal width of trochlea on distal end....	26	26.6	28.4	32.5	24.4
Extension of trochlea on posterior side of shaft.....	29	30	32	42	25.6

t = measurement from posterior tuberosity.
unc. = uncertain.

p = as preserved.

occurs above the proximal facet for the articulation of the ulna. Just above the groove is a short protuberance, the result of the union of two, small, nearly vertical ridges. The capitulum has a central, deeply-pitted depression which occupies about half of the capitulum. The ridge separating the capitulum from the trochlea is high and steep on both anterior and posterior sides. The trochlea forms a continuous groove from the ridge to its superior extremity. The shaft appears to be straight on both internal and external borders and has approximately the same thickness on anterior and posterior edges.

Skull Fragment

Specimen.—Cat. No. 13425 Y. P. M. Part of left half of posterior part of skull.

This specimen resembles the corresponding part of the skull of *Acrodelphis bakersfieldensis* (holotype) and might possibly belong to individual 3 of this species. The superior internal edge is broken away. Most of the zygomatic process is lacking. The specimen differs from *A. bakersfieldensis* (holotype) in having a long, wide opening extending for a length of 34 mm. between the external superior edge of the basioccipital and the internal edge of the squamosal in the tympano-periotic recess. In place of this opening, *A. bakersfieldensis* has two openings separated by a wide transverse ridge. The longer of the two openings is 12 mm.

Ulna and Radius

Specimen.—Cat. No. 13426 Y. P. M. Right ulna and proximal end of left radius.

This ulna and radius can not be definitely assigned to any skull from the same pit. They are too small to be associated with *Macrodelphinus kelloggi* (holotype) and too large to belong with either of the skulls of *Acrodelphis bakersfieldensis*.

The right ulna is nearly complete, lacking the distal epiphysis and the proximal part of the olecranon process. The anterior border of the shaft is straight and the posterior, concave, making

the central portion of the shaft the smallest. The wide olecranon process curves internally and posteriorly and has a series of ridges on its internal, posterior border. The distal end is enlarged and elliptical in outline. The sigmoid cavity is proximally covered by a bone which is probably part of the adjoining humerus that had fused with the radius, a character of old age.

The head of the left radius is concave and pitted. No variation in the size of the shaft is observable in the short part preserved.

MEASUREMENTS OF ULNA

Maximum length	170
Antero-posterior width, posterior end of olecranon process to notch for articulation with radius.....	74
Antero-posterior diameter of smallest part of shaft.....	38
Extero-internal diameter of shaft at same place.....	25
Antero-posterior diameter of distal end.....	46
Extero-internal diameter of distal end.....	30

MEASUREMENTS OF RADIUS

Length of preserved proximal part.....	70
Antero-posterior diameter of head.....	44
Extero-internal diameter of head.....	36

Ulna and Radius

Specimen.—Cat. No. 13427 Y. P. M. Right radius and ulna.

The radius is incomplete, lacking the anterior part of the head and the posterior part of the distal end. It resembles the radius of *Macrodelphinus kelloggi* (individual 2) and is only a little smaller.

The ulna lacks the olecranon process and has a break 23 mm. in length on the posterior side of the distal end. The shaft has its narrowest part just below the olecranon process. The distal end is considerably wider.

Radius

Specimen.—Cat. No. 13428 Y. P. M. Proximal portion of left radius.

This radius differs from other radii described in its greater size and in having an elevation at the anterior border of the proximal end. This elevation is separated from the rest of the head by a broad groove.

Ulna

Specimen.—Cat. No. 13429 Y. P. M. Left ulna.

This ulna lacks the lower posterior border of the olecranon process and the distal half of the shaft. The surface of the sigmoid cavity is fused to the adjoining part of a humerus, as not infrequently happens in fossil whales.

MEASUREMENTS OF RADII, ULNAS, AND HUMERUS

	<i>Radius</i>		<i>Ulna</i>		<i>Hu- merus</i>
	13427	13428	13427	13429	13430
Greatest length along median longitudinal line (as preserved)	143	76	129	114	82
Antero-posterior diameter of shaft near central portion	47	56	34	33.5	62
Extero-internal diameter of head	34	40	x	x	x
Antero-posterior diameter of distal end	26	x	25	x	x
Extero-internal diameter of distal end	x	x	x	x	36
Antero-posterior diameter of head	x	52	x	x	x
Antero-posterior length of capitulum	x	x	x	x	39
Extero-internal diameter of capitulum	x	x	x	x	36
Extero-internal diameter of shaft near central portion	24	23	x	21	38.5

Humerus

Specimen.—Cat. No. 13430 Y. P. M. Right humerus.

The distal end of this humerus is fused with the olecranon process of the corresponding ulna. Both distal articular surfaces are long, and the ridge separating them is sharp, narrow, and steep on the posterior side.

Suborder MYSTICETI

Family CETOTHERIIDAE

Genus and species indeterminate

Humerus

Specimen.—Cat. No. 13437 Y. P. M. Left humerus.

Locality and horizon.—This humerus was found in the same pit as the type specimen of *Miodelphis californicus*.

The humerus of cetaceans is not a diagnostic bone; and, in fact, in both the Mysticeti and Odontoceti such a wide range of variation occurs, that it is by no means certain that even a suborder allocation can be made on this bone alone. In many instances in odontocetes, the fossa for the insertion of the infraspinatus muscle occurs in a more proximal and more nearly central position than in the mysticetes. However, this collection of humeri shows that this is not invariably true, for the fossa occurs in relatively different positions in these humeri. The size of this specimen suggests that it may have belonged to a mysticete. It is characterized by a strongly concave internal border, in contrast with the nearly straight border of the modern mysticetes; but it is probable that this change marks further specialization since lower Miocene.

The humerus is complete except for a small piece broken away from the shaft just above the trochlea. The head is large and fairly well separated from the posterior tuberosity, though less clearly separated from the anterior one. The shaft is fairly con-

stant in its extero-internal thickness and is concave on the internal border. The anterior tuberosity is separated from the posterior by a wide, shallow groove, whose wall adjoining the anterior tuberosity rises steeply. The deltoid process is an irregularly-shaped prominence of no definite limits, which attains its greatest extent at about the middle of the shaft, on a level with the fossa for the insertion of the infraspinatus muscle. The distal terminations of the shaft are normal, and the trochlea extends along the posterior border of the shaft somewhat higher than normal. The superior articular surface of the trochlea is a large, subrectangular prominence limited proximally by an oblique groove and truncated distally by an irregular depression, which lies between the superior and inferior (distal) parts of the trochlea.

MEASUREMENTS OF HUMERUS

Greatest length of humerus, head of lesser tuberosity to central ridge between capitulum and trochlea	177
Greatest diameter of head	73
Least diameter of head	67
Greatest diameter of lesser tuberosity	51.2
Least diameter of lesser tuberosity	43.4
Greatest diameter of greater tuberosity	34.3
Least diameter of greater tuberosity	22.4
Extero-internal diameter of distal end of shaft	41.5
Antero-posterior diameter of distal end of shaft (along internal border)	63

Order CARNIVORA

Suborder PINNIPEDIA

Family PHOCIDAE

In 1850 there appeared a notice by Wyman⁵¹ telling of the discovery by Dr. M. Burton of a few fragmentary bones of fossil seals at Richmond, Virginia. This is, perhaps, the earliest recorded discovery of fossil seals in the United States. About

51. Wyman, J.—Notice of remains of vertebrated animals found at Richmond, Virginia. Amer. Jr. Sci., 2d ser., vol. 10, pp. 228-235, 1850.

thirty years ago True⁵² discovered a humerus of a seal in the Miocene of Maryland. Specimens of fossil seals from the Pacific Coast have been summarized and several new genera and species described by Kellogg.⁵³ The remains of seals described in the present paper were found at the same locality and horizon as *Macrodelphinus kelloggi* (holotype).

Humerus, Femur, and Vertebrae

Specimen.—Cat. No. 13433 Y. P. M. Left humerus, complete except the proximal portion of the deltoid ridge, distal part of left femur, and the first and fifth lumbar vertebrae.

As is always the case with fragmentary material, the correct allocation is difficult and uncertain. The fossil humerus here described has features common to both the Otariidae and the Phocidae. It is tentatively placed in the Phocidae on the basis of its resemblance to the humerus of phocids in what are believed to be the more significant characters, such as the height of the tuberosities in relation to the height of the head, and the general configuration of the bone, especially the posterior side. In several respects the humerus resembles that of the recent *Callorhinus alascanus* (No. 12740, No. 14226, No. 14225 U. S. N. M.) more closely than other otariids in the U. S. National Museum collection with which it was compared, but differs from it in a number of details. The male and female of this species show differences other than that of size. The fossil humerus has a thinner shaft than that of *Callorhinus*, its major and minor tuberosities both lie well below the level of the top of the head and are not so distinctly set off from the head, and the head is less sharply set apart from the shaft. The trochlea of the fossil humerus is shorter and narrower than in *Callorhinus*, the distal continuation of its deltoid ridge is much longer, the groove for the reception of the bra-

52. True, F. W.—Description of a new genus and species of fossil seal from the Miocene of Maryland. Proc. U. S. Nat. Mus., vol. XXX, pp. 835-840, 2 pls., 1906.

53. Kellogg, R.—New pinnipeds from the Miocene diatomaceous earth near Lompoc, California. Carnegie Inst. Wash., pub. 348, no. IV, pp. 71-95, no. V, pp. 97-116, 1925.

chialis muscle is much narrower, and the distal end is less clearly divided into the radial and ulnar articular protuberances. The fossil humerus resembles that of *Callorhinus* in the lack of an entepicondylar foramen, in the shape and size of the supinator ridge, and in the general external shape of the distal end. The fossil humerus resembles *Phoca groenlandica* in the similar position of the greater and lesser tuberosities, the similarity of the groove for the brachialis muscle, and in its similarly shaped deltoid crest proper. It differs in its longer continuation of the deltoid crest, in the lack of separation of the lesser tuberosity from the head, in its greater width of groove between the condyles at the distal end, and in lacking an entepicondylar foramen. The lack of this foramen, however, may not be diagnostic; for while it is usually present in the Phocidae, it is not always so, since Thomson⁵⁴ found it absent in a number of skeletons of seven species and genera of phocids. This humerus differs from *Pithanotaria starri*⁵⁵ (Stanford Univ. Cat. No. 11; U. S. N. M. cast No. 11055) in the size and shape of the minor tuberosity. In *P. starri* the minor tuberosity is separated from the head by a deep narrow groove; the humerus herein described has no corresponding groove. Both greater and lesser tuberosities rise above the head in the humerus of *P. starri*, and the whole bone is stouter, especially at the distal end. The general configuration of the humerus (No. 13433 Y. P. M.) shows that this seal had already attained a high degree of specialization at the time when the Vaqueros-Temblor transition zone was being deposited. It is probable that the ancestor of this seal must be sought long before the beginning of the middle Miocene, probably as far back as early Eocene.

On the dorso-internal side the head overhangs the shaft and, for a short distance, shows a steep neck; but laterally the major and minor tuberosities grade into the head. The deltoid ridge continues into the greater tuberosity. This tuberosity is small

54. Thomson, R. B.—Osteology of the Antarctic seals. Scot. Nat. Antarc. Exped., 8, Trans. Roy. Soc. Edinburgh, vol. 47, pp. 187-201, 1909.

55. Kellogg, R.—Op. cit., p. 74.

and, apparently, narrow, although the anterior edge is broken away, and has on its external face a plain, nearly round depression for the insertion of the tendon of the infraspinatus muscle. A wide groove separates the greater and lesser tuberosities. The lesser is much larger than the greater and rises to the same height as the head. In this respect it differs markedly from the living *Callorhinus*, in which the lesser tuberosity is located well down on the shaft below the head. In *Phoca hispida* the lesser tuberosity is “. . . phenomenally developed . . . , and higher than either the head or the ‘greater’ tuberosity.”⁵⁶ Thus, it is similar to the fossil humerus (No. 13433 Y. P. M.) in development but is different in height. The large lesser tuberosity has a long, strong, rounded, supporting ridge, which grades gradually into the shaft, terminating near the middle of the shaft. The corresponding ridge of *Leptophoca lenis* is much shorter. The humerus of *Leptophoca lenis*, while about the same length as the one here described, is much more slender throughout. In *L. lenis* the groove separating the articular surfaces for radius and ulna is much deeper and narrower and more nearly like the recent forms than like the one herein described, in which the separating groove is wide and shallow. The supinator crest is much larger than in True’s form. After comparing the two humeri side by side, it appears that *L. lenis* has the more modern aspect of the two. The excellent comparative sketches of humeri of Toula⁵⁷ have been helpful to the writer in making comparisons.

The size of the distal portion of the left femur indicates that it probably belongs with the humerus just described. The shaft above the condyles is preserved for a distance of only 27 mm. The external condyle is the larger, and the two are separated by a deep groove with nearly vertical sides. The surface for the articulation of the patella is about the same relative size as that

56. Howell, A. B.—Contribution to the comparative anatomy of the eared and earless seals (genera *Zalophus* and *Phoca*). Proc. U. S. Nat. Mus., vol. 73, art. 15, p. 29, 1928.

57. Toula, F.—*Phoca vindobonensis* n. sp. von Nussdorf in Wien. Beitr. zur Paleon. und Geol. Österreich-Ungarns und des Orients, Band XI, Heft II, pp. 1-88, 3 pls., 1897.

MEASUREMENTS OF HUMERI

	<i>Phocidae</i> gen. and sp. indet. Lower M. Miocene Y. P. M. 13433	<i>Leptophoca</i> <i>lenis</i> U. S. N. M. 5359 k U. Miocene	<i>Pithanotaria</i> <i>starri</i> Lompoc, Calif. U. Miocene U. C. 26784 k	<i>Callorhinus</i> <i>alascanus</i> U. S. N. M. 14225
Head to capitulum.....	127.5	124	123+	132.2
Greater tuberosity to crest of inner trochlea	116	116	114	144.5
Breadth of humerus (lesser tuberosity to head)	43.4	38.1e	x	51
Breadth of humerus (inner condyle to ex- ternal condyle)	47.6	37	x	55.5
Greatest depth of hu- merus at deltoid crest	41	37e	38	39
Least breadth of humerus near middle	15	17	x	22.1
Length of deltoid crest	98	75±e	x	86
Maximum width of groove for insertion of bra- chialis	10.6	19.3	x	22
Least diameter of shaft, antero-posteriorly on external side	28	27	x	30

e = Measured on an eroded surface.

k = From Kellogg, R.—1925a, p. 79.

of *Phoca vindobonensis*⁵⁸ but is small compared with the femur next described (Y. P. M. No. 13434).

None of the vertebrae is complete, and the lack of apophyses and processes makes exact assignment difficult. After comparison with several specimens of comparable size in the collection of the U. S. National Museum, the vertebrae are tentatively assigned as

58. Toulou, F.—Op. cit., pl. X, fig. 2a.

follows: first and fifth lumbar of one animal, and fourth cervical and first lumbar of a second individual.

The first lumbar vertebra lacks the transverse processes, the zygapophyses, and the neural spine. It resembles the corresponding vertebra in the recent *Phoca groenlandica* (U. S. N. M. No. 3517), of comparable size, in having the anterior edges of the pedicles nearly flush with the anterior face of the centrum. It resembles this species also in the following ways: the centrum is much longer than high, the ventral surface has two, long, deep concavities, the transverse processes project forward at small acute angles, the pedicle occupies three-fourths of the length of the centrum, the neural arch is flat, and small anapophyses are developed. The anterior edge of the neural arch is located well behind the anterior face of the centrum. The inferior anterior edge has secondary ridges lying below the superior borders, forming small shelf-like projections from the walls of the pedicles. The transverse processes are located much lower on the centrum than in *Phoca groenlandica*.

The fifth lumbar resembles that of *P. groenlandica* in the length of the centrum, the forward extension of the prezygapophyses to the line of the anterior face of the centrum, and the distance between the anterior edge of the neural arch and anterior limit of the centrum. It differs from the recent species in having the transverse processes high on the centrum, as in an anterior lumbar, and in the length of the pedicle, which is nearly equal to the length of the centrum. It is considerably larger than the posterior lumbar of *Leptophoca lenis*.⁵⁹ No anapophyses are developed.

Femur and Vertebrae

Specimen.—Cat. No. 13434 Y. P. M. Eroded distal end of a left femur and two vertebrae.

The shaft above the condyles is preserved for only a few millimeters, and the dorsal edges of the condyles are partly eroded. This femur is larger than femur No. 13433 and is placed with

59. True, F. W.—Op. cit., p. 839.

the larger vertebrae. Its outstanding feature is the great width of the surface for articulation with the patella.

MEASUREMENTS OF FEMORA

	13433	13434
Greatest length, as preserved.....	58	42
Length of shaft, as preserved (ventral side).....	27.	18
Maximum width across condyles.....	52.4	56.5
Maximum antero-posterior length of external condyle	21.5	21.9
Maximum extero-interior width of external condyle	23.4	22
Maximum antero-posterior length of internal condyle	18.6	21.8
Maximum extero-interior length of internal condyle	15±	19
Maximum width of groove between condyles....	16	16.6
Maximum depth of groove between condyles....	16	18.6
Maximum antero-posterior length of surface for patella	25	23
Maximum extero-internal width of surface for patella	21±	32
Maximum dorso-ventral thickness of femur at distal end	28.2	35

Two incomplete vertebrae, too large to be allocated with No. 13433, are placed tentatively with the larger femur and are assigned as fourth cervical and first lumbar.

The fourth cervical has only the left half of the centrum, part of the base of the left transverse process, and the base of the left pedicle of the neural arch. These boundaries of the arterial canal show its approximate size and shape and, accordingly, the position of the vertebra in the vertebral column. The outstanding character of the vertebra is the thickness of the pedicle, in contrast with the thin pedicle of the living seals. The size of this cervical is considerably larger than the corresponding one of recent seals. It is probable that the cervicals of seals of lower and middle Miocene were less specialized and larger than those of a recent animal of comparable size.

The other vertebra is designated as the first lumbar on the basis of the short length and position of the transverse process, the increase of the neural canal in posterior width, and the size and position of the prezygapophysis. The posterior face of the centrum is divided into three parts, two supero-external elevated portions, and the remainder of the face depressed. All parts are rugose and suggest that erosion is the cause of this peculiarity. This vertebra is poorly preserved, part of it being filled with sand. It differs from the first lumbar of recent forms in the size of the prezygapophyses, which are wing-like and larger than in the living seal.

MEASUREMENTS OF VERTEBRAE

	13433		13434	
	<i>1st lumbar</i>	<i>5th lumbar</i>	<i>1st lumbar</i>	<i>4th cervical</i>
Maximum length of centrum...	46	44.5	45	47.4
Maximum height of anterior face of centrum.....	27	28.6	31	x
Maximum width of anterior face of centrum.....	31	37	38.8	x
Anterior height of neural canal	13	15	x	x
Maximum posterior width of neural canal	22	29	34	x
Antero-posterior diameter of pedicle at junction with centrum	31.2	30.2	34	24
Distance from superior side of centrum to superior tip of prezygapophysis	x	26.8	38.4	x
Oblique antero-posterior diameter of prezygapophysis.....	x	22	30.2	x
Oblique dorso-ventral diameter of prezygapophysis	x	16.5	21±	x

Family OTARIIDAE

Genus and species indeterminate

Vertebrae

Specimen.—Cat. No. 13435 Y. P. M. Two incomplete vertebrae are assigned as the fourth and fifth (or sixth) cervicals after comparison with the recent *Eumetopias jubata*.

Location and horizon.—Same as *Miodelphis californicus* (holotype).

The fourth cervical lacks the neural arch and nearly all of each parapophysis. The centrum is noticeably smaller at the anterior than at the posterior end and is nearly equal in its three dimensions. The pedicle supporting the neural arch occupies about three-fourths of the centrum. The arterial canal has the shape of a rounded wedge with the wide end down. It is small and entirely closed. The preserved base of the parapophysis shows a basal antero-posterior diameter nearly as long as the centrum, and at its anterior half is sharply deflected in a ventral direction. The ventral view of the centrum shows a high medial ridge running its full length and extending below the lower limit of the centrum at its posterior face. Deep depressions on each side border this ridge and adjoin the internal borders of the parapophyses.

The fifth (or sixth) cervical vertebra has the same characters as the fourth and is even less complete, having only the centrum, right pedicle, and basal boundaries of the arterial canals preserved. It differs from the fourth in having the pedicle shorter and thinner, the bases of the transverse processes longer and thicker, and the ventral depressions shallower.

Vertebrae

Specimen.—Cat. No. 13436 Y. P. M. Two incomplete cervical vertebrae assigned as the third and fifth (or sixth). These vertebrae represent a larger animal than those of specimen No. 13435.

The third cervical vertebra lacks the neural arch, left pedicle, and left transverse process. Its shape and dimensions are similar to the corresponding vertebra of No. 13435 except that the transverse process is narrower and thinner. The right side shows the diapophysis and parapophysis complete, enclosing the ovoid arterial canal and uniting to form a broad, posteriorly-directed, wing-like process with a broad distal end. On this vertebra the parapophysis is a small, thin process, and the diapophysis is thick and large, a condition just the reverse of the corresponding vertebra of specimen No. 13435.

This fifth (or sixth) cervical, which may possibly belong to still a different individual but is tentatively allocated with the preceding vertebra, lacks the neural arch, the parapophyses, and the right pedicle for the support of the neural arch. The left diapophysis is broken near its external extremity. This vertebra

MEASUREMENTS OF CERVICAL VERTEBRAE

	13435		13436	
	4th	5th	3d	6th
Maximum length of centrum.....	55	56	59	57.3
Maximum height of anterior face of centrum	53	50	55	48.8
Maximum width of anterior face of centrum	57.8	58.2	62.4	52.6
Maximum height of posterior face of centrum	54.2	52.6	51.8	50.2
Maximum width of posterior face of centrum	61.3	62.4	63.7	57.2
Greatest diameter of arterial canal	12.8	x	15.5	22.2
Least diameter of arterial canal....	7	x	11	17
Width of internal border of arterial canal	x	12	x	x

differs from the third in having a much larger arterial canal, as it should, and in having the parapophysis very long and thick,

whereas the corresponding process of the preceding vertebra was small and thin. The left prezygapophysis is long and narrow and nearly constant in transverse width. The base of the left pedicle occupies about half of the length of the centrum and is set at a slightly oblique angle. The arterial canal was, evidently, nearly or entirely enclosed. It is bounded superiorly by the thin diapophysis.

Sternal Plate

Specimen.—Cat. No. 13439 Y. P. M.

This incomplete sternal plate appears to be the presternum of a large otariid and may possibly belong with No. 13436. The dorsal surface is slightly concave. The plate becomes narrow anteriorly and has a blunt, constricted termination. At the posterior end, the plate is broken through the deeply indented surfaces for articulation of the costal ribs. The presternum is unsymmetrical.

MEASUREMENTS OF PRESTERNUM

Total length as preserved.....	120
Maximum width	69.2
Maximum width, anterior end.....	25
Maximum thickness, anterior end.....	18.5
Maximum thickness at posterior break.....	39
Closest approach of articulatory surfaces for costal ribs.....	22

Calcanea

Specimen.—Cat. No. 13441 Y. P. M. Right calcaneum. The proximal end of this calcaneum has been worn and hollowed by erosion, but otherwise it is complete.

Locality and horizon.—This calcaneum is from the same block of sandstone as *Miodelphis californicus* (holotype).

The distinguishing characters of this calcaneum are the breadth of its large, deeply-concave surface for the support of the sustentacular facet of the astragalus and the size and height of the ectal facet. The general configuration of the bone differs from

the calcaneum of the recent *Zalophus californicus* (No. 49425 U. S. N. M.) and the Miocene *Neotherium mirum* (No. 11542 U. S. N. M.) with which it was compared, since it is much stouter than either of these. The expansion of the distal end is proportionately greater than in the calcanea of either of the above but is more like *Z. californicus*. The internal and caudal borders of the shaft are slightly concave. The plantar face for articulation with the navicular is concave and ovoid in outline. The groove for the interosseous ligament follows the external border of the ectal facet and is much like that of *Z. californicus*. The shaft of the fossil calcaneum herein described lacks the distal external groove, that is well developed on *Z. californicus*.

Specimen.—Cat. No. 13442 Y. P. M. Left calcaneum. The external proximal end of the shaft has been eroded from this specimen.

Locality and horizon.—The same as for No. 13441.

MEASUREMENTS OF CALCANEA

	<i>Z. californicus</i> 49425 U.S.N.M.	13441 Y.P.M.	13442 Y.P.M.	<i>N. mirum</i> 11542 U.S.N.M.
Greatest length of shaft..	53	52p	42.2	52.8
Greatest dorso-plantar diameter of distal end. . . .	20.5	18	12	16.8
Greatest oblique tibio-fibular diameter of distal end	34	38.2	27	28.2
Greatest diameter of ectal facet	24	29	16.6	21

p = as preserved

This left calcaneum is much smaller than No. 13441 and more like that of *N. mirum* in outline. It is shorter than that of *N. mirum*, and the ectal facet is shorter and more elevated but about the same shape. The shaft is more strongly concave than in *Monachus monachus* (No. 219059 U. S. N. M.), *N. mirum*, or

No. 13441 (Y. P. M.). The peroneal tubercle is the same shape as that of *N. mirum* and is but slightly smaller. The groove for the interosseous ligament is short, and its floor is irregularly pitted. The distal termination is much like that of *N. mirum* in size, shape, and slight degree of concavity. The ectal facet is only slightly oblique to the vertical axis of the shaft, while in *M. monachus* it is nearly transverse in its distal half.

Family ALLODESMIDAE

Genus ALLODESMUS Kellogg

Allodesmus (cf. *A. kernensis*)

Specimen.—Cat. No. 13440 Y. P. M. This specimen consists of the axis and the third, fourth, and fifth cervical vertebrae of a large seal. All the vertebrae are united. The animal was about three-fourths the size of *Eumetopias jubata* (No. 7140 U. S. N. M.).

Location and horizon.—About 100 feet southeast of the pit in which the *Miodelphis californicus* type was found and about 20 feet lower in the section. Not in place.

The series of articulated cervical vertebrae are tentatively referred to *Allodesmus* on the basis of the relative dimensions (cervicals referred to this form by Kellogg⁶⁰ are smaller), the geographic location and geologic position, and the general configuration of the processes of the vertebrae. A series of skeletons belonging to the recent *Eumetopias jubata* in the U. S. National Museum shows that a considerable variation in size exists, not only between the sexes, but also between individuals of different ages. Furthermore, no differentiatory diagnostic peculiarities were found in this series of cervicals.

The axis is incomplete, lacking the odontoid process, the

60. Kellogg, R.—Pelagic mammals from the Temblor formation of the Kern River region, California. Proc. Cal. Acad. Sci., 4th ser., vol. XIX, no. 12, p. 244, 1931.

anterior part of the right transverse process, and the posterior tip of the neural spine. The axis differs from *Eumetopias jubata* (No. 7140 U. S. N. M.) in having less rounded facets for articulation with the atlas. The facets of *E. jubata* are convex, while those of the fossil form (Y. P. M. No. 13440) are slightly concave. The transverse process is short, reaching only to the level of the posterior face of the centrum (a length of 47 mm. from posterior tip of transverse process to anterior edge of axial facet), is not pierced by an arterial canal as in *E. jubata*, and has a much thicker base than has *E. jubata*. The spine is long, extending as far forward as the level of the facets for articulation with the atlas, and reaching 26+ mm. behind the posterior face of the centrum. Its superior edge is a sharp ridge extending the full length of the spine. The postzygapophyses are small in comparison with *E. jubata*, are very little expanded laterally, and are subrectangular in shape.

The third cervical has developed a long, wide, wing-like transverse process, which reaches nearly to the center of the fourth cervical vertebra. The postzygapophyses are about the same width but are longer than those of the second cervical. The neural arch is broad and low and bears a short rounded spine.

In the fourth cervical the neural arch and postzygapophyses are absent. The diapophyses become much thinner in an extero-internal direction than in the preceding vertebra, the arterial canal is distinct, and the distal end of the transverse process is more widely expanded and more strongly concave.

The neural arch and postzygapophyses of the fifth cervical are absent. The prezygapophyses have become much longer than in the preceding vertebrae and have assumed a spatula-like shape. The diapophyses are wider above the arterial canal than are those of the preceding vertebra (fourth cervical), are less expanded distally, have lost the flattened appearance of the superior part, and have become more rounded. The inferior portion of the transverse process is thin and curved upward at its distal extremity.

MEASUREMENTS OF CERVICALS

	<i>2d</i>	<i>3d</i>	<i>4th</i>	<i>5th</i>
Greatest depth (vertically) from tip of neural spine to inferior face of centrum.....	98	85	x	x
Length of spine of axis.....	74.2+	x	x	x
Distance across vertebra between tips of transverse processes	116±	117	116.5	133±
Distance between outside edges of axial articular facets.....	94±	x	x	x
Distance across vertebra between outside margins of prezygapophyses	x	x	63.5	67.2
Distance across vertebra between outside margins of postzygapophyses	49	51.8	x	x
Length of centrum.....	52a	55	57	57.4
Height of centrum.....	x	55.5	52	51.7
Width of centrum.....	68±	52.4	54	58
Distance anterior tip of prezygapophysis to posterior tip of postzygapophysis	x	69	x	x
Median length of transverse process, measured along groove on external side.....	38	58	49	40.6

a = Ventral anterior face of axial facets to posterior face of centrum

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