THE
AMERICAN JOURNAL OF SCIENCE

[FOURTH SERIES.]

ART. XV.—*Fossil Dolphin from California*; by RICHARD SWANN LULL. With Plate VIII.

[Contributions from the Paleontological Laboratory, Peabody Museum, Yale University, New Haven, Conn., U. S. A.]

Introduction.
Extent and preservation of the specimen.
Dedication of the specimen.
Morphology.
 The axial skeleton.
 Skull.
 Jaw.
 Dentition.
 Vertebral column.
 Ribs.
 Sternum.
 The appendicular skeleton.
 Scapula.
 Humerus.
 Forearm.
 Hand.
Summary.

Introduction.

THERE has recently been presented to the Peabody Museum at Yale University a slab of sandstone containing the impression of a small fossil whale, apparently one of the Delphinidæ, but otherwise new to science. It was found by Mr. Edwin White Newhall, Jr., of the Newhall Land and Farming Company, San Francisco, and presented by him to the Peabody Museum through the intermediation of the writer. In view of the scarcity of cetacean remains from the Tertiary rocks of the Pacific coast, and of the perfection of the relic, the specimen is eminently worthy of consideration.

AM. JOUR. SCI.—FOURTH SERIES, VOL. XXXVII, No. 219.—MARCH, 1914.

Photograph of entire fossil. $\frac{1}{6}$ nat. size. Viewed from above, showing the left aspect of the skull and jaws, with the right paddle pointing toward the upper edge.

The slab was found on the Suey ranch, owned by the Newhall Land and Farming Company, in San Louis Obispo county, California, in what is called "Sulphur Creek" canyon, about 700 feet above sea-level and 30 miles in a direct line from the ocean. According to the company's maps, the place is in the southeast corner of Section 17, Range 32, West Township 11, north San Bernardino Base and Meridian. Sulphur creek empties into the Santa Maria river at about the southern extremities of Sections 16 and 17, and Mr. Newhall found the specimen about a quarter of a mile up the creek.

The fossil is presumed to be of Miocene age, judging from the Geologic Map of North America published in 1911. The precise level, however, has not been determined, but is at present under investigation through the courtesy of Professor John C. Merriam, of the University of California.

Extent and preservation of the specimen.

The specimen, which bears the catalogue number 10040, Yale Museum fossil vertebrate collection, consists of a single slab of sandstone, upon the surface of which the articulated skeleton of the dolphin was impressed (see Plate VIII). Most of the bones have been eroded away, so that their imprints alone remain, with but little of the osseous material clinging to their depths. Of the skull, however, a great deal was preserved, for, while the exposed surface had suffered from weathering, removal of the matrix from the reverse side displayed most of the right aspect of the cranium and jaws.

There remains of the animal, therefore, the entire skull and jaws with many of the teeth, some entire, some having but the root embedded in the alveolus, and others represented only by their imprint in the matrix. The vertebral column is indicated as far as the twelfth dorsal, though each bone cannot be clearly distinguished. There are twelve pairs of ribs and the impression of the sternum is distinct. Of the limbs, the left scapula, the humerus, and the ulna are represented, and at least four phalanges of the second or third digit, while of the right paddle, impressions of all the elements remain except the distal ends of the several digits. There is unfortunately no trace of lumbar or caudal vertebræ, nor have I recognized any portion of the pelvis, which would be of great interest in so old a form. I should judge the animal to be fully adult despite its rather small size, as the bones show scarcely a trace of the epiphyses.

The only preparation for study necessary was the removal of the matrix from the right aspect of the skull, and, after a careful preliminary examination, it was deemed expedient to

eliminate the bone fragments clinging to the depths of certain of the impressions, especially those of the cervical series and of the right paddle, in order to secure by means of casts and otherwise the more exact contour of the bones themselves. One should fully realize that while the imprints are often deep, certain outlines become very vague and the extent of the various processes very difficult to determine.

The entire specimen is in a sense comparable to the deeply incised but partially effaced inscriptions on an Egyptian obelisk, and the interpretation of such an ancient hieroglyph is necessarily halting.

Dedication.

I propose for this form the name *Delphinavus newhalli*, n. gen., n. sp., the generic distinctions in contrast with *Delphinus* being outlined below. The species is dedicated to the family of Newhall, twice a contributor to the Yale collections, first through the late Henry G. Newhall of the class of 1874, Sheffield Scientific School, who accompanied Professor Marsh upon the Yale Expedition of 1873, and again through his nephew, Edwin White Newhall, Jr., Massachusetts Agricultural College 1906, the discoverer and giver of this important specimen.

Morphology.

For the purpose of comparison, I have, through the courtesy of Doctor George F. Eaton, used a mounted skeleton of *Delphinus delphis*, catalogue number 265, Peabody Museum osteological collection. This specimen is not quite mature, as the vertebral epiphyses are still free from their respective centra. The skeleton measures 5 feet 10 inches from tip of rostrum to that of the caudal series. The fossil, which as I have said, seems to have been fully grown, would have an estimated length of perhaps 5 feet, though the proportions of the various regions which serve to make up the total length differ in the two forms, as I shall show.

THE AXIAL SKELETON.

Skull.—In the proportions of cranium to rostrum the form under consideration agrees most nearly with the modern dolphin, *Delphinus*, in contrast with those proportions seen in *Phocæna*. The most apparent cranial contrast with *Delphinus* is the higher, more nearly vertical occiput which in the fossil makes a sharp angle with the roof of the skull at the vertex, instead of rounding forward as in the modern form. The precise limits of the various bones are not to be determined with assurance in many cases, but they agree in general with those

of *Delphinus*, with the following exceptions. The exoccipital bones in the fossil have a much less lateral extent in proportion to their height. The squamosal bone is very robust and broadly expanded antero-posteriorly so as to be both actually and relatively larger and heavier. The orbit is large and well rounded and the superior limiting bones, frontal and jugal, are compar-

FIG. 1.

FIG. 1. Skull seen from the right, about $\frac{1}{2}$ nat. size.

atively heavy. The frontal plate of the maxilla does not appear to have the full lateral or posterior expanse which is characteristic of the modern type, as its presence cannot be detected in the antorbital or orbital regions viewed laterally. What appear to be fragments of the zygomatic process of the jugal are at least twice the diameter of that of *Delphinus*. In the sharp-edged posterior limitation of the temporal fossa, the fossil agrees with *Delphinus* in contrast to *Phocaena*.

Jaw.—The two forms may be contrasted in the proportions of this bone, for whereas the entire length of the mandible is 278^{mm} in the fossil to 370^{mm} in the recent form, their vertical expanse at the posterior end is essentially the same. This

coupled with a more robust angle in the fossil implies a greater proportionate jaw power in the older form. In the latter the symphysis is apparently longer, though the distal two-thirds of each jaw is about equal in slenderness.

Dentition.—The dental formula of *Delphinus* is $\frac{40}{42}$. In the fossil the number of teeth in the upper jaw is exactly the same,

FIG. 2.

FIG. 2. Right lateral aspect of skull and jaws. $\frac{1}{3}$ nat. size. Bo, basi-occipital; C, condyle of jaw; D, dentary; Exo, exoccipital; Fr, frontal; J, jugal; Max, maxillary; Nas, nasal; Oc, occipital condyle; Pa, parietal; Pmx, premaxillary; Pn, ?posterior nares; Sq, squamosal; So, supraoccipital.

but the imperfection of the mandible renders a count of the lower dentition impossible. There is no reason, however, to suppose that the number here was not also essentially similar. In each instance the premaxillary bone is toothless.

The teeth themselves are also alike, being simple, slightly re-curved cones without carinae, and with smooth, polished enamel. They contrast sharply with the spatulate crowned teeth of *Phocaena*.

In so far as I am able to judge, the skull and dentition of the fossil agree essentially with those of *Delphinus*, the exceptions being all in the direction of greater cetacean specialization on the part of the latter, such as the character of the occiput, the reduction of the zygomatic arch, and the lessened jaw power.

Measurements of the skull.

	<i>Delphinurus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Length, including rostrum	290 ^{mm}	440 ^{mm}
“ anterior end of jugal to tip of rostrum	181	265
Height, vertex to lower margin of exoccipitals	117	150
Antero-posterior diameter of orbit	35	49
Length of mandible	278	370
Height of mandible at posterior end	64	66.5
Space for 10 alveoli in rear of maxillary	43	47
Maximum length of crown of tooth	06	08
Squamosal, height	40	41.5
“ exposed breadth	36	21
Tympanic bone, greatest diameter	30	---
Height of mandible at mid-length	17.5	26.5
Length of symphysis	32.4	37
Vertical diameter of mandibular condyle ...	20.5	23

Vertebral column.—Cervical vertebræ. The cervicals are recorded only as deep impressions in the matrix, so that their

FIG. 3.

FIG. 3. Impressions of cervical vertebræ. $\frac{1}{2}$ nat. size. I, atlas; fac, posterior facet of atlas; z, postzygapophysis of axis; dI, first dorsal; VII, seventh cervical.

interpretation is accompanied with great difficulty and the apparent results may not be in harmony with the actual facts. The vertebræ seem to be entirely free, the atlas presenting its posterior aspect, with well-developed, slightly convex facets for articulation with the axis, such as *Delphinus* might well exhibit were the bones not coalesced in their lower half. The right diapophysis is indicated. The axis seems to have been a rather

massive bone, and exhibits again the posterior face of the centrum, which is concave with well-rounded margins. The axial arch and spine, the former exhibiting a well-developed postzygapophysis upon the left side, are well preserved but apparently entirely detached from the centrum.

I can discern with fair assurance the impressions of five or six cervicals in proper sequence, but what is apparently the sixth shows a diapophysis comparable in development to that of the seventh in *Delphinus*, while just beyond it there lies an impression very suggestive of the diapophysis which in the modern form articulates with the tuberculum of the first rib; one cervical is therefore either missing or too obscurely defined to be recognized.

In comparison, then, with *Delphinus*, the fossil again exhibits more generalized traits in the free cervicals, in their actually greater length in the smaller specimen, and their much greater relative size. They seem to represent more nearly the degree of evolution shown by *Inia*, but display no feature which would debar the older type from direct ancestry to *Delphinus*.

Measurements of the cervical series.

	<i>Delphinavus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Length of entire series	74 ^{mm} *	47 ^{mm}
Width of atlas	62.5	119
Height of axial spine measured from base of postzygapophysis	46	40

Dorsal vertebrae.—At least twelve rib-bearing vertebrae are preserved, comparable in number to those of *Phocæna*, and three fewer than in *Delphinus delphis*. However, this is of little moment, as the remainder of the body is lacking in the fossil so that the number of dorsals and ribs may readily have been greater.

The vertebrae differ markedly from those of either of the above mentioned genera in the much greater length of centrum and in the low neurapophysis in contrast with the very high spine of an approximately equivalent vertebra of the recent form. The proportions of the vertebral centra are more nearly those of *Inia* again, though in that genus the neural spine is much higher.

FIG. 4. ?Ninth dorsal vertebra, left aspect. $\frac{1}{2}$ nat. size. Imp., impression.

*This is not a just measurement, for the vertebrae are slightly displaced.

Measurements of dorsal ? IX.

	<i>Delphinavus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Length of centrum	38 mm	23 mm
Height of centrum, posterior end....	21.8	29.5
Total height, including neural spine..	44.1	110

Ribs.—Twelve pairs of ribs are preserved in the specimen, of which at least four pairs were double-headed, in comparison

FIG. 5.

FIG. 6.

FIG. 5. Fourth rib. $\frac{1}{3}$ nat. size.FIG. 6. Sternal impressions. $\frac{1}{3}$ nat. size.

with five in *Didelphis* and six in *Phocaena*. It seems hardly possible that in this regard the ancient type is more specialized than *Delphinus*, while in every other respect in which they do not agree the reverse is true. The ribs are quite comparable to those of *Delphinus* in proportions and general curvature.

Measurements of the ribs.

	<i>Delphinavus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Length of first rib, measured along the chord	99mm	120mm
Length of fourth rib	200	225

The torso of the fossil form was evidently fully as long and deep as that of the dolphin used for comparison, though the skull of the latter is materially larger.

Sternum.—There are two impressions not far removed from their normal position which I take to be those of two coalesced and one isolated sternobræ. The outlines are very vague in each instance but the anterior one seems to differ very markedly from that of *Delphinus* and to resemble more nearly that

FIG. 7.

FIG. 7. Right pectoral limb. $\frac{1}{3}$ nat. size. ac, acromion process; cor, coracoid process; cun, cuneiform; h, humerus, anterior aspect; ha, humerus, internal aspect; l, lunar; m, magnum; mcp, metacarpal; p, phalanx; r, radius; s, scapula; sc?, ?scaphoid; t?, ?trapezoid; u, ulna; unc, unciform. Drawn from the impression.

of *Platanista*. The difference is mainly in the greater size of the element in the fossil and in its simplicity of outline. The anterior margin has a simple semicircular notch about one-third the width of the entire bone, whereas in *Delphinus* the notch

has become converted into a foramen through the closing together of the anterior margins. In *Delphinus* the lateral edges of the anterior sternal are prolonged into outward and backward projecting cornua, while in the other there are simple rounded angles in their place and the width of the sternal posterior to them is relatively much greater.

Measurements of the sternum.

	<i>Delphinavus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Length of sternals 1 and 2	120 ^{mm}	124 ^{mm}
Greatest breadth	70	84

I cannot positively identify sternal ribs in the fossil.

THE APPENDICULAR SKELETON.

Both paddles are preserved, that of the right side almost entire, the left more or less occluded by the skull but supplying certain details lacking in the other due to the orientation of certain of the bones, notably the humerus.

The limb is essentially delphinoid, showing apparently the same reduction of digits, but differing mainly in the more primitive character of the individual elements. In so far as it is preserved, the limb is of approximately the same size in both modern and fossil forms.

Scapula.—The scapula is less widely expanded than that of *Delphinus*, otherwise the two are very suggestive of one another. In the fossil the horizontal extent of both coracoid and acromion processes cannot be ascertained; they are, however, similar in the extent of their origin to those of *Delphinus*. The prescapular fossa seems to have been relatively greater in the ancient type.

Humerus.—The ratio of humerus to radius is much greater in the fossil, as one would be led to infer in the case of the more primitive form. The humerus is also relatively more slender, but has much the same general outline as in *Delphinus*, except that the tuberosity projects slightly above the head and has a lesser transverse extent. A faint indication of the capitular epiphysis may be seen in the fossil, practically the only indication of one in the entire skeleton. The right humerus presents the impression of its posterior aspect, while the left is viewed from without. The latter shows the character of the distal facets, each of which is planoconcave, the curved axis lying in the transverse plane. The radial facet is the greater, as in *Delphinus*.

Forearm.—The forearm presents perhaps the greatest divergence in the two forms of any part of the limb, for instead of

being nearly parallel as in *Delphinus*, the two bones are separated by a wide lenticular space, the curved line of the radius being particularly noticeable. In the ulna the olecranon is better developed but simple in outline.

Hand.—The carpus is essentially alike in both genera, but here again the fossil is the more primitive in that the magnum is represented by a well-defined lenticular bone lying at the proximal end of metacarpal III; whereas in the specimen of *Delphinus* used for comparison, it is reduced to a tiny nodule closely adpressed against the unciform and visible only from the inner aspect of the wrist. Its position, however, is exactly the same in each form. In the fossil the bones of the anterior side of the carpus have been displaced, but their identity seems fairly certain.

The metacarpals show much the same proportions in each genus, but the preserved phalanges are relatively longer and more slender in the fossil, no separate phalangeal epiphyses being discernible. The digital reduction has gone further in the modern type, as evidenced by the proximal phalanx of digit IV, which is a much better developed bone in the fossil.

Measurements of the pectoral limb.

	<i>Delphinavus</i> Cat. No. 10040	<i>Delphinus</i> Cat. No. 265
Scapula, height	105 ^{mm}	104 ^{mm}
“ breadth	146	160
Humerus, length	60	60
“ proximal breadth	37	49
“ ant.-post. diameter, distal end	31.5	38.5
“ transverse “ mid shaft	19.5	24
Radius, length	67.3	84
“ diameter, proximal end	25	28.5
“ “ distal end	33	37.5
Ulna, length	71.5	72
“ diameter, proximal end	26.5	30
“ “ distal end	26	27
Metacarpal III, length	20	32
“ “ breadth of shaft	11	14
Digit III, 1st phalanx, length	19.5*	21.5†
“ “ 2d “ “	11.5	17
“ “ 3d “ “	08	13
Length of digit, inc. metacarpals, estimated	80	100
“ “ entire limb, inc. scapula, “	320	360

Summary.

The specimen under consideration is clearly a dolphin allied to *Delphinus* and hence of the family Delphinidae. It com-

* No epiphyses nor articular cartilages indicated, but bones are spaced.

† Including epiphyses, bones in contact.

pares favorably with the dolphins of this genus in point of size, proportion of rostrum to cranium, in dental formula, character of the dentition, in having approximately the same number of double-headed ribs, and in the general character of the pectoral limb, more especially of the manus.

The contrasts are in practically every instance due to the more primitive character of the fossil, and I fail to recognize one which would debar the more ancient type from a direct ancestry to *Delphinus delphis* itself. To sum up these contrasts, they are: In the skull, the straighter, more nearly vertical occiput, the minor proportions of the individual cranial elements, the more robust zygomatic arch, the less expanded maxillary plate, and the more broadly expanded and powerful rear portion of the lower jaw. The cervical vertebræ, in so far as may be learned, differ mainly in the lack of fusion of atlas and axis in the fossil and the somewhat greater collective length of the entire series. The dorsals are much longer in centrum and lower in the height of the neural spine, while the number of double-headed ribs in the two specimens is apparently four for the fossil and five for the recent type, the only instance wherein the former seems to be more specialized, and this may be due to lack of perfection of the fossil.

The sternum of the older form is simpler and more generalized, but easily modified into the modern type. In the limbs, the contrasts lie in the less widely expanded scapula, relatively longer humerus, wide lenticular space separating the radius and ulna, and in the simpler form of the olecranon in the fossil. In the carpus the magnum is relatively large, while in the recent type it is vestigial. The phalanges are relatively longer in the ancient type.

The degree of evolution of the two dolphins is doubly interesting when compared with the advance manifest in the same length of time in certain terrestrial families, notably the horses. It points to the early adaptation of the Cetacea to their aquatic habitat and their slow subsequent evolution, which amounts, in this instance, merely to the adjustment of certain minor details, some, as in the jaw power, along the line of degeneracy, others mainly for the perfection of speed.

This evolution shows the impelling force of topographical changes on the land, which not only directly modify the animal form and motor organs, but also, through influencing climate and thereby vegetative life, necessitate new adaptations on the part of terrestrial animals or the elimination of those forms which cannot thus change. All of this passes harmlessly over the head of the cetacean, which can migrate when the waters become too cold, and upon which none of the other influences can make themselves felt.