ON THE OCCURRENCE OF REMAINS OF FOSSIL PORPOISES OF THE GENUS EURHINODELPHIS IN NORTH AMERICA

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Tertiary porpoises with very long beaks, whose distal extremities are edentulous, have been known to science since 1867. Prof. E. D. Cope described a porpoise of this kind from the Miocene of Charles County, Maryland, under the name of *Rhabdosteus latiradix*.[1]

On December 17, 1867, Viscount DuBus[2] read a paper before the Royal Academy of Sciences of Belgium in which similar porpoises from the Black Crag formation of the Antwerp basin were described and named *Eurhinodelphis*. The skulls of the European forms were subsequently more or less fully described by Van Beneden, Gervais, and others. Finally, in 1901, 1902, and 1905, these forms were studied more thoroughly by Professor Abel,[3] and his monographs were accompanied by satisfactory illustrations. In the spring of 1907 F. W. True discovered a nearly complete skull of one of these long-beaked dolphins in the Miocene clay at Chesapeake Beach, Maryland, and subsequently William Palmer collected three imperfectly preserved skulls in the Calvert Cliffs, at points a few miles below Chesapeake Beach. No vertebrae were found associated with any of the skulls mentioned above. Hence the discovery of a fine skull and lower jaws in association with 16 vertebrae, 10 ribs, a humerus, scapula, and sternum by Norman H. Boss in August, 1918, has supplied some much-needed information regarding the skeleton. The acquisition of this material confirms the occurrence of the genus *Eurhinodelphis* in North American Miocene formations.

[1] Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], pp. 132, 145, Mar. 10, 1868, and Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 91, 1868; True, F. W., Remarks on the fossil cetacean Rhabdosteus latiradix Cope, Proc. Acad. Nat. Sci. Philadelphia, pp. 24–29, text figs. 1–3, pl. 6, Apr. 22, 1908.

[2] DuBus, B., Sur quelques Mammiféres du Crag d'Anvers, Bull. Acad. Roy. Sci. Belgique, ser. 2, vol. 24, p. 569, 1867 (1868).

[3] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers, Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, pt. 1, vol. 1, pp. 1–95, pls. 1–10, text figs. 1–17, 1901; pt. 2, idem, vol. 2, pp. 101–188, pls. 11–18, text figs. 18–20, 1902; Les Odontocètes du Boldérien (Miocène supérieur) d'Anvers, idem, vol. 3, pp. 1–155, text figs. 1–27, 1905.

Besides these skulls, several mandibles and numerous vertebrae, ribs, and limb bones, which are referable with little doubt to this genus have been obtained at this and other points in Maryland and Virginia. As Professor Abel's[4] promised description of the vertebrae, and other parts of the skeleton of the European species of the genus *Eurhinodelphis* has not yet appeared, a full comparison of these parts is not possible at present, but from such figures and records as have been published it is evident that a few of the American forms can be safely referred to the genus *Eurhinodelphis*, including not only those obtained from the Calvert cliffs, but also some of the vertebrae and other parts of skeletons described during the last half of the nineteenth century by Leidy, Cope, and other American writers. From the vertebrae at present available for study, two courses present themselves for the treatment of the material. One can follow Abel and state that there is a wide range of individual variation in corresponding vertebrae or adopt the view of Leidy and Cope that each type represents a different species.

The types of the American species already described by Cope and Leidy, under the names of *Priscodelphinus*, *Ixacanthus*, *Delphinapterus*, *Tretosphys*, and *Belosphys*, the majority of which are in the Academy of Natural Sciences of Philadelphia, necessarily demand attention. Since these latter consist almost exclusively of vertebrae, the question of generic and specific allocation is still an extremely difficult one. Many years ago Du Bus[5] attempted to meet this difficulty by assigning certain European forms to the American genus *Priscodelphinus*, but his material consisted entirely of skulls, while the various American species were described exclusively from vertebrae. This association did not, therefore, remove the difficulty but rather increased it. It is, of course, probable that the same species frequented both the European and the American shores of the Miocene ocean, but this can not be taken for granted, for it is known that certain existing species of porpoises are peculiar to European waters and others to American waters. Until further material is obtained at the type locality for *Priscodelphinus harlini*[6] some uncertainty will exist as to the proper allocation of this genus. An imperfect posterior dorsal vertebra represents all that is definitely known concerning the type species of this genus. Leidy reports that

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[4] Abel, O., Presentation, avec explications justificatives, d'une reconstruction de l'Eurhinodelphis, Dauphin longirostre du Boldérien des environs d'Anvers, Bulletin Société de Belge de Géologie, Paleont., et d'Hydrol, Bruxelles, vol. 20, Proces Verbal, pp. 163–166, 1906; Cetaceenstudien. I. Mitteilung: Das Skelett von Eurhinodelphis Cocheteuxi aus dem Obermiozän von Antwerpen, Sitzungsber. K. Akad. Wiss. mathem.-naturw. Kl., Wien, vol. 118, pt. 1, pp. 241–253, pl., March, 1909.

[5] Du Bus, B., Mammiféres nouveaux du Crag d'Anvers, Bull. Acad. Roy. Soc. Belgique, Bruxelles, ser. 2, vol. 34, p. 492, 1872.

[6] Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, vol. 5, pp. 326–327, 1851 [figured by Harlan, R., Journ. Acad. Nat. Sci. Philadelphia, ser. 1, vol.4, p. 232, pl. 14, fig. 1, 1824.]

this vertebra was discovered in the green sand at Mullica Hill, New Jersey. Other vertebrae from Shiloh, New Jersey, have been assigned to this species.

According to the practice of Cope and others whereby generic and specific names were given to very fragmentary and incomplete remains of fossil cetaceans, the opportunities for setting up new genera and species for variations in structural modifications of vertebrae were practically unlimited. Since many of the genera and species erected by Cope and Leidy were based upon parts other than skulls, it has been very difficult to correlate or allocate the material, save in a few instances. The collection which forms the basis for this study comprises a number of porpoises with skulls and associated vertebrae. In studying this material it became evident that a number of well known genera of fossil cetaceans were present in the Chesapeake embayment during the Miocene epoch, some of which have not been reported previously. A preliminary study of this material in conjunction with the types of the previously described porpoises in the Academy of Natural Sciences of Philadelphia has convinced the writer that many of the Cope and Leidy types can not be allocated until associated skeletons of all the fossil cetaceans for which skulls are known are found.

Since Cope was practically the sole investigator of fossil pelagic mammals in North America at the time of his death, it was unfortunate that no one came forward to carry on this work. Hence interest in the problems involved lapsed. It was not until the Maryland Geological Survey began preparation of a series of reports to illustrate the natural resources of that State that any further interest was shown in the pelagic mammals of the Chesapeake embayment. When this series of reports was planned it was found advisable to secure the services of a number of specialists, and the pelagic mammals were allotted to Prof. E. C. Case. In the section of the report which deals with the Miocene, Case[7] described a fragmentary skull and associated mandibles as *Priscodelphinus* (?) *crassangulum*. A few years later, True[8] concluded that this form belonged in the genus *Schizodelphis*. In 1912[9] True published a detailed account of the skull and associated skeleton of *Delphinodon dividum*. This was the first account of a fairly complete fossil cetacean skeleton obtained from the Calvert formation. Following this publication, renewed interest was taken in the Calvert Miocene, and

[7] Case, E. C., Miocene Text, Maryland Geol. Surv., Baltimore, pp. 12–13, pl. 11, 1904.

[8] True, F. W. Smithson. Misc. Coll. (Quart. Is.). vol. 50, pt. 4, Publ. 1782, pp. 449–460, pls. 69–70, 1908.

[9] True, F. W., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, pp. 165–194, pls. 17–26, 1912.

as a result William Palmer and Norman H. Boss, devoted a considerable portion of their personal time to the exploration of the Calvert exposures on the western shore of the Chesapeake Bay. Mr. Palmer was fortunate enough to collect a number of very interesting skulls. To Mr. Boss should be given credit not only for the discovery of some very valuable specimens, but also for the diligence and skill he has shown in the preparation of the specimens for study and exhibition.

Recent observations have shown that a number of the genera and species erected by Cope are not distinct types and that those forms which occur in the Calvert Miocene do not necessarily belong to different genera from those which are found in some of the Upper Miocene deposits of Europe. While several investigators have adduced much evidence to show that most of those cetaceans which inhabit oceans south of the Equator never enter the waters north of it, no one as yet has been able to satisfactorily explain why certain forms that frequent the European side of the Atlantic Ocean might not also be found on the North American coast as well. On this subject much remains as yet to be investigated, but the occurrence of *Eurhinodelphis*, *Schizodelphis*, *Squalodon*, etc., in the Calvert formation indicates that the same genera and possibly the same species frequented both sides of the Atlantic Ocean. It is possible that actual comparison and acquisition of more complete specimens, especially from deposits in northern Germany and Denmark, may supply some much needed information.

As the distribution of the Cetacea appears to be dependent upon the presence of an adequate food supply and as the organisms which form their food are dependent either directly or indirectly upon temperature, it is evident that those cetaceans which feed upon tropical or subtropical organisms would not be present in waters where temperate or arctic conditions prevailed. Hence in making comparisons between faunas and in attempting to correlate deposits in which pelagic mammals occur some allowance must be made for possible differences in climatic conditions. According to Dr. W. H. Dall [10] the Chesapeake series should be compared with the Miocene of north Germany, Belgium, and Denmark rather than with the more tropical Miocene of southern Europe. The temperature of the Chesapeake embayment, however, was considered to have been warmer than at present. The fauna represented is indicative of a temperate climate, thus differing from the boreal and subtropical faunas now present on the Atlantic coast.

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[10] Dall, W. H., Miocene Text, Maryland Geological Survey, Baltimore, pp. cxlix, cl. 1904.

The sedimentary record of the Calvert formation has been discussed by Shattuck [11] in an article entitled "The Geology of Calvert County," from which the following is quoted:

> The close of the Nanjemoy epoch was marked by an elevation of the region which brought the Eocene deposits above the ocean and exposed them to a prolonged attack of erosion. After the region had suffered extensively from the work of waves and rivers, it was again submerged beneath the ocean and the material composing the Calvert formation were deposited. As the Miocene sea advanced little by little on the sinking surface of the mainland, the waves caught up and reworked the clays and greensands of the various Eocene beds. The more obdurate fossils of the Eocene survived in a great measure the erosive work along the old Miocene shore and were carried out and deposited in deeper water. They may now be seen reworked in the basal member of the Calvert formation. The old shore line of the Miocene sea which was formed during the Calvert epoch of sedimentation has nowhere been preserved in Maryland, but the materials which composed the Calvert formation in this county were deposited in seas of moderate depth in which an abundance of life was present, as is shown by remains of diatoms and the extensive beds of fossil mollusks. The remains of whales and other cetaceans show that these vertebrates abounded in the ocean, and the discovery of a bone belonging to a gannet indicates that birds existed along the near-by shores. This particular form doubtless sought its food in the sea as the modern fishing gannets do at the present time.
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> The Calvert epoch was brought to a close by the elevation of the region once more above the level of the ocean. A period of erosion followed which was probably of short duration and closed with the depression of the region again beneath the sea. Then followed the deposition of the Choptank and St. Mary's formations, in which conditions similar to those just described for the Calvert were repeated.

In spite of the process of erosion that must have been going on for a considerable period, remarkable exposures of the Calvert formation exist to-day along the western shore of the Chesapeake Bay. These cliffs, which extend along the western shore of the Chesapeake Bay from Chesapeake Beach southward to the mouth of the Patuxent River, a distance of about 35 miles, consist mainly of clays belonging to the division of the Maryland Miocene known as the Calvert formation. This area has been very carefully examined and described by the Maryland Geological Survey which has published a full account of the characteristics of the several superimposed strata or zones and of the molluscs contained in each.

It is a comparatively easy matter, therefore, to locate quite exactly the relative position of the various cetacean bones found in the cliffs. The Calvert cliffs have long yielded specimens of different species of toothed and whalebone whales, the former belonging to several different families and genera.

Near the base of zone 10 and in zone 4 oysters are present in large numbers. From this it would appear that a barrier beach had been

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[11] Shattuck, G. B., Calvert County, Maryland Geological Survey, Baltimore, pp. 106–107, 1907.

formed during each of these sedimentation intervals which shut off a portion of the sea bed, and in consequence brackish water conditions prevailed. Aquatic vegetation would thus gain a foothold and afford favorable environmental conditions for sirenians. The occurrence of crocodiles (*Thecachampsa?*) and the soft-shelled turtle (*Trionyx*) would also suggest that extensive lagoons were present in the Chesapeake embayment. Only a few scattered bones of sirenians have been found during the past 15 years, and this in turn suggests that these mammals were far from being plentiful. In time the barrier bars would advance landward and the lagoons would be gradually filled up with sediments. Complete skeletons of the smaller dolphins have been found above and below the zones which contain shells of oysters. This shows that the ocean tides had free access to these areas during such periods of sedimentation, and that the bluish clay in which they were embedded was laid down in quiet water some distance from land. The presence of certain river dolphin types related to *Inia* and *Platanista* tend to confirm the existence of a vast estuary in the present Chesapeake embayment. Almost all of the specimens of the larger cetaceans show either the action of surf waves or the presence of strong currents; the parts of the skeletons are widely scattered and associated vertebrae are of rare occurrence.

After a careful detailed study of the skulls of *Eurhinodelphis* in the National Museum, I am unable to satisfy myself that any one of them is identical specifically with any of the European species, though it is not unlikely that such identity may be established later.

Although there are a few more alveoli in the maxillae, these skulls show a closer agreement with *Eurhinodelphis longirostris*, the smallest species known from the Antwerp Basin, than with any of the others. The shape and relations of the anterior extremities of the palatines, the depth and proportions of the braincase, the width of the raised surface between the longitudinal furrows on the edentulous portion of the rostrum, and the direction of the basicranial axis are very similar. The differences pointed out in the descriptions of these specimens seem to have sufficient weight to justify the application of another specific name to the Calvert Miocene porpoise.

Professor Abel's description [12] of the family Eurhinodelphidae and its single genus *Eurhinodelphis* is as follows:

Family EURHINODELPHIDAE

Rostrum excessively elongated, occupying in one case (*Eurhinodelphis longirostris*) nine-elevenths of the length of the skull; bones of the rostrum very delicate; premaxilla strongly attenuated, form-

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[12] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 3, pp. 117–119, 1905.

ing by itself, in *Eurhinodelphis longirostris*, much more than half of the rostrum; in *Eurhinodelphis cocheteuxi* it is, on the other hand, shorter than the rostral portion of the maxilla. Skull resembling that of the Ziphioids, either slightly convex (*Eurhinodelphis cocheteuxi*, *E. longirostris*) or with a transverse crest (*Eurhinodelphis cristatus*).

Maxilla and mandible, alone, bear teeth; maxilla with 37 to 60 conical teeth, single rooted in each maxilla; premaxilla edentulous, with a rudimentary alveolar gutter, with sharp borders, which extends to the anterior extremity of the rostrum. It is not certain that the lower jaw extends the whole length of the rostrum; perhaps it was shorter (as in *Ichthyosaurus longirostris*); in any case, the symphysis of the lower jaw is very long, and the mandible is furnished with conical teeth, very close together, and single rooted.

Lachrymal free, separated from the jugal by a suture; but with age sometimes ankylosed with it. Olfactory foramina are large. Supraorbital arch convex. Maxillae, above the orbits, especially in *Eurhinodelphis cristatus*, very thick (more in the male than in the female ?). Mesethmoid ossified for a small portion of its length, as in the Delphinoids; vomerine canal broad and closed above by the closely approximated premaxillae. Nasals very small, very variable in form, generally oval. Frontals usually contracted at the vertex, forming a narrow band, but sometimes entirely covered by the supraoccipital, which projects forwards strongly, and the nasals which are deeply embedded posteriorly; parietals always covered on the vertex of the skull.

The form of the different bones of the skull, especially the squamosal, varies greatly in different individuals.

All the cervical vertebrae are free. The atlas with the surfaces for articulation with the occipital condyles sometimes extended into wings on the external borders and having two superimposed transverse processes. Axis with a strong odontoid process and, on each side, a very strong imperforate transverse process. Centra of the succeeding cervical vertebrae, either thin, or very thick (*Eurhinodelphis longirostris*, *Priscodelphinus grandaevus*).

Thoracic vertebrae 10 or 11; the 8 anterior ones bearing bicipital ribs; the last 2 or 3 bearing single-headed ribs. At the eighth dorsal vertebra the rib articulates by the tuberculum to the diapophysis, and by the capitulum to the parapophysis; at the ninth dorsal vertebra the neck of the rib is joined with the parapophysis and the diapophysis becomes rudimentary, or forms, in descending toward the extremity of the rib, a transverse foramen with the neck; the rib articulates with the tuberculum on the neck of the separated rib. The tenth dorsal vertebra bears a very strong transverse process (the neck of the tenth rib, which is joined with the vertebra), and the tenth rib articulates with it there. The thoracic vertebrae are, therefore, formed like those of the Physeteroids and the Ziphioids.

Transverse processes of the lumbar vertebrae remarkably short, slender, and narrow (*Ixacanthus spinosus*, *Eurhinodelphis cristatus*), or long and broad (*Eurhinodelphis cocheteuxi*, *E. longirostris*). Number of lumbar vertebrae probably 11, and of caudal vertebrae 19.

Number of vertebrae: Cervicals, 7; dorsals, 10 or 11; lumbars, 11; caudals, 19 = 47 or 48. Scapula very large, broad, and triangular, and similar to that of the Delphinoids. Prescapular fossa relatively broad, but the form of the scapula is variable. Humerus similar to that of *Physeter*, with the deltoid crest more or less developed; form of the articular head very variable; head of humerus ordinarily oval, extended over upon the external border of the bone. Radius and ulna large, strong, about as long as the humerus. Olecranon very large, and strongly notched below. Of the carpal bones the following are known: Radial, intermedium, and cubital which are ankylosed (old individual). The phalanges are present. The largest specimens of the largest species (*Eurhinodelphis cocheteuxi*) may have attained a length of 4 or 5 meters.

INDIVIDUAL 1

EURHINODELPHIS BOSSI, new species

Type.—Cat. No. 8842, Section of Vertebrate Paleontology, United States National Museum. This specimen consists of a complete skull with the exception of the ear bones, both lower jaws, sixteen vertebrae, ten ribs, an imperfect scapula, a humerus, and part of the sternum.

Type locality.—The occurrence is as follows: Near latitude 38° 40′ north, and longitude 76° 40′ west, about 2 miles south of Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—The specimen was discovered and excavated by Norman H. Boss in August, 1918. It was dug from the cliff above the oyster shell band. The specimen, apparently, was embedded in Shattuck's zone No. 5 of the Calvert Miocene formation of Maryland.

SKULL

Dorsal view.—Although the outlines and relations of the bones forming the dorsal surface of the skull (pl. 1) at first glance are strongly suggestive of *Schizodelphis*, there appear to be some well-marked differences. In the *Schizodelphis* skull the exposed portions of the frontals on the vertex are considerably larger than the paired nasals, and the teeth are swollen near the base of the crown and rather robust. Conversely, in the *Eurhinodelphis* skull the paired nasals are nearly as large as the exposed portions of the frontals on the vertex, and the enamel-covered crowns of the teeth are anteroposteriorly compressed and rather slender.

This form is best characterized by the exceedingly long attenuate rostrum which comprises four-fifths of the total length of the skull. According to Abel [13] the premaxillae by themselves form more than half of the rostrum of an *Eurhinodelphis* skull. No trace of a suture between the maxilla and the premaxilla in a position corresponding to that shown by Abel could be made out on any of the specimens from the Calvert formation. A shallow groove which probably conveyed some nerve or blood vessel is present in the same relative position on the lateral face of the maxilla. Anterior to the maxillary notches the premaxillae are thick and convex; they decrease in breadth and in height toward the terminal portion of the rostrum. The inner margins become closely appressed to one another at a point 100 mm. in front of the maxillary notches and continue in contact to the extremity of the rostrum. The raised convex portions of the premaxillae do not parallel one another throughout the entire length of the rostrum, but spread apart rather abruptly in front of the maxillary notches. In this region they form the outer margin of the concave and flattened internal portions of the premaxillae, and in consequence of their tapering these elevated convex borders disappear in front of the nasals. The premaxillae commence to expand horizontally in front of the nasal bones and attain their maximum breadth at the level of the anterior margins of the nasal apertures. In front of the nares there is an oval concavity on each premaxilla. The posterior end of each premaxilla is abruptly narrowed along the external margin of the nasal. The premaxillary foramina are moderately large and situated posterior the maxillary ones. Each of these foramina open into two grooves. One of these is broad and deep and extends transversely across the premaxilla to its internal margin; the other, a longitudinal groove, which is continued backward to a point in front of the nasal, lies between the concave internal and the convex external portions of the premaxilla. Anterior to the transverse groove the internal surface of the premaxilla is somewhat flattened; this area narrows rapidly and finally disappears under the raised convex outer strip.

The premaxillae approximate each other so closely anterior to the maxillary notches that the mesorostral gutter is completely roofed over. Distally, the floor of the mesorostral gutter is formed entirely by the premaxillae which meet mesially and ventrally in a linear suture at a point slightly more than half way to the tip of

[13] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers. Mem. Mus. roy. d'hist. nat. de Belgique, vol. 1, p. 65, 1901; vol. 3, p. 117, 1905.

the rostrum; proximally the vomer and the premaxillae contribute to its formation. Skulls of those cetaceans which possess an elongated beak have experienced various modifications in the relations of their component parts, but nevertheless in all forms now known the vomer has been lengthened and so placed as to afford a maximum support for the rostral and cranial portions of the skull. The vomer increases in width posteriorly and takes part in the formation of the lateral walls of the mesorostral gutter. The contact between the vomer and either premaxilla is clearly discernible distally in skulls with damaged beaks although their surfaces are so smoothly mortised into one another proximally that their relations can only be determined by making cross sections of the rostrum. The posterior limit of this contact between the vomer and the premaxilla is near the anterior margin of the presphenoid. On the base of the skull the vomer extends backward upon the basisphenoid.

The mesethmoid does not rise to the level of the premaxillae. It sheathes the dorsal and lateral faces of the presphenoid and thus forms a partition between the nasal passages superiorly, fills in the frontal fontanelle, and provides support for the nasals, and incidentally for the vertex of the skull. No trace of a pair of passages opening between the ectethmoids and the mesethmoid, and leading into the brain case could be found in any of the skulls examined. In skulls of *Diochotichus*, *Ceterhinops*, and *Squalodon* the mesethmoid incompletely fills the frontal fontanelle, and as a result a pair of relatively large foramina are formed, through which the olfactory nerves reached the respiratory passages. Abel[14] states that these foramina are present in a skull of *Eurhinodelphis longirostris*.

A slit-like anterior border for the nasal aperture is formed by the close approximation of the internal margins of the premaxillae. Because of this horizontal expansion of the premaxillae, most of the anterior end of the presphenoid as well as the nasal passages are hidden from view. The presphenoid is a porous bone which forms a plug across the proximal end of the mesorostral gutter, but does not rise to the level of the premaxillae above.

The dorsal surface of the skull is constituted almost entirely by the maxillae and premaxillae; the nasals and frontals form the vertex of the skull. The maxillary notches are shallow and rather broad. From a dorsal view, the maxillae are seen to increase in width from the tip of the rostrum posteriorly. When they reach the maxillary notches they push back over the supraorbital processes of the frontals and expand laterally to form the so-called frontal plates of the maxillae. They attain their greatest width opposite the large concavities on the premaxillae. These plates of the maxil-

[14] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers. Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 2, pp. 171, 172, 1902.

lae and the corresponding underlying lateral extensions of the frontals roof over the temporal fossae, but the former do not come in contact with the supraoccipital posteriorly because of the presence of a narrow intervening strip of the frontal. The outer margins of both maxillae are imperfect above the temporal fossae. The surface of the maxilla is somewhat depressed opposite to the nasals and slightly convex above the supraorbital plates of the frontals. The concavity is most evident above the temporal fossa. Two rather large foramina which connect with the infraorbital canal are present on each maxilla above the temporal fossa, and of these the anterior one is the larger. The internal margin of the maxilla, with the exception of that portion which overlaps the frontals on the vertex, is in contact with the premaxilla for practically its entire length. There are three additional foramina in each maxilla. The most posterior one of these is situated a little behind the notch, and from it there is a deep channel leading in a postero-external direction. The external border of the maxilla is convex in front of the maxillary notch, but this portion of the maxilla is relatively thin. Further forward the thin outer edge gradually disappears with the lateral compression of the rostrum and the maxilla appears to be deeper from a side view, but this is due to the outward and downward curvature of the dorsal surface. In correlation with this tapering, the maxilla decreases in breadth anteriorly and the sides become more nearly vertical. For a distance of about 250 mm. in front of the maxillary notch the inner border of the maxilla fits closely to the outer border of the premaxilla, but at this point a foramen appears between them, succeeded anteriorly by a broad and rather deep groove. This groove does not follow the inner margin of the maxilla, but extends directly forward, finally occupying the side of the maxilla and disappearing before reaching the end of the rostrum.

On comparing the dorsal view of the skull of *Eurhinodelphis cocheteuxi*[15] with this specimen, it was noted that the breadth of the anterior margin of that portion of the maxilla which overlies the supraorbital process of the frontal was proportionately less and that the maxilla sends forward a narrow projection which reduces the maxillary notch to a narrow groove. Although no anterior projection is present on the skull of *Eurhinodelphis longirostris*[16] this portion of the maxilla is even narrower than in *cocheteuxi*. According to the figures used by Abel, the lachrymal is not visible from a dorsal view of the skull in either *longirostris* or *cocheteuxi*. A small portion of the anterior end of the lachrymal projects forward in the left maxillary notch on the skull of

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[14] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs
[16] Abel, O., Idem, vol. 2, p. 11, 1902.

Eurhinodelphis cristatus.[17] In this specimen from the Calvert cliffs the maxilla does not completely sheath the anterior margin of the supraorbital process. The outer margin of the frontal plate of the maxilla is very irregular above the orbit, but on both maxillae there is a deep indenture which sets off a process comparable to that shown on the skull of *E. cocheteuxi.* This portion of the maxilla, however, does not project beyond the anterior edge of the supraorbital process to any appreciable extent, but it may show how a process like that present on the *E. cocheteuxi* skull was formed. In front of and below this process there is a small bone which is continuous ventrally with what was considered by Abel to be the lachrymal. This bone is fused with the jugal and is closely appressed to the maxilla. Differences in respect to the size and position of such bones are to be expected in different genera, but it may appear somewhat unusual that such modifications should be present in different species of the same genus. The anterior end of the jugal is not visible from a dorsal view.

The frontals are limited to a narrow strip on the vertex, being overspread by the premaxillae and maxillae laterally, and by the nasals anteriorly. Posteriorly they abut against the supraoccipital and intervene between the extremities of the maxillae and the latter. Anterolaterally and at a lower level than the vertex each frontal sends out a supraorbital process which forms a complete osseous roof for the orbit. No trace of a small bone described as the interparietal could be found on this skull.

The nasals are small semipyriform bones placed obliquely between the posterior extremities of the premaxillae, with their anterior portions in contact along their inner margins. In position they agree with those of *Eurhinodelphis cocheteuxi*, although in general outlines they are somewhat different. They do not overhang the nasal apertures.

Lateral view.—Aside from the relative small size of the braincase the skull (pl. 2) is characterized by a shallow temporal fossa which is roofed over for the most part by the maxilla and the lateral extension of the frontal, a wide orbit, and a long zygomatic process. The rostrum is exceedingly long and slender, depressed proximally, and compressed from side to side anteriorly. To compensate for strains arising from the length of the rostrum the posterior extremities of the maxillae are expanded horizontally. Additional strength is given to the rostrum by the almost complete ankylosis of the maxilla and premaxilla, as well as by the anterior extension of the vomer.

[17] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 2, p. 15, fig. 1, 1902.

A slight bowed effect is imparted to the rostrum by the curvature of the latero-ventral margin of the maxilla and by the combination of two other features, namely, the upward curvature of the anterior end and proximally by the gradual slope of the dorsal surface to the vertex of the skull. From a lateral view the maxilla appears to be deepest near the distal end of the proximal one-third of the rostrum, but this is due to the curvature of its outer and lower margin. At this point the maxilla is deeper than the premaxilla. Farther forward they are almost equal in depth. Inasmuch as some confusion may arise from differences in interpretation attention should again be directed to the absence in any of the skulls from the Calvert cliffs of any indication of a suture between the maxilla and premaxilla in the position shown by Abel. A shallow, ill-defined groove, however, is present on most of the skulls. If this groove really marked a suture, then the maxilla would taper and end in a sharp point while the premaxilla would increase in depth and finally comprise the extremity of the rostrum.

The orbit is moderately convex, the outer margin of the supraorbital process being thick and the superimposed plate of the maxilla thin and shelving. The preorbital portion of the supraorbital process is rounded, while the postorbital portion is compressed dorsoventrally. The lachrymal is closely appressed to the anterior face of the supraorbital process and is in contact with the maxilla. Below the maxillary notch the jugal fuses with the lachrymal and is attached to the maxilla. The jugal is a very slender bone and extends backward beneath the orbit to the anteroventral angle of the zygomatic process.

The zygomatic process of the squamosal is thickened dorsoventrally and is in contact with the postorbital portion of the supraorbital process. As a whole the zygoma is robust, curved, and rather long; the dorsal outline curves gradually forward and upward. The postglenoid portion of the zygoma curves backward and then forward. The greatest length of the right zygoma along the glenoid face is 98.5 mm. and the greatest depth anteriorly is 24 mm.

In this specimen the crest formed by the contact of the supraoccipital and frontal is the highest point in the dorsal profile. The dorsal outline of the skull slopes forward from the crest and in the region of the nares the declivity is more accentuated, but further forward the slope is more gradual. On each side of the vertex and in front of this crest the frontal plate of the maxilla is depressed, forming a well-marked concavity. The supraorbital process of the frontal and the superimposed maxilla rise above the premaxilla in front of the nares. The temporal fossa is longer than the orbit and its upper border is relatively straight, due in part to the lateral extension of a thin plate of the frontal to underlie the maxilla. In this fossa the parietal is suturally united inferiorly with the squamosal, anteriorly and superiorly with the frontal, and posteriorly with the supraoccipital. Hence the parietals are excluded from the dorsal surface of the skull. When viewed from the side, the condyles are seen to project beyond the plane of the exoccipitals. The basicranial axis is bent downward from the axis of the beak.

Posterior view.—This surface (pl. 4) attains its greatest breadth at the level of the exoccipitals. These exoccipitals are relatively large, coalesced with the supraoccipital above, and project outward and backward like wings. Their external margins are rounded, but are not produced so that they conceal the zygomatic processes from behind. Anteriorly they are in contact with the squamosal and inferiorly they unite with the basioccipital. The junction of the exoccipital with the basioccipital lies internal to the deep jugular incisure and crosses the falcate process of the latter. At the bottom of this incisure and near the posterior margin there is a small condylar foramen. The dorsal border of the exoccipital ascends about half way to the upper limit of the temporal fossa. Externally the upper portion of the exoccipital is produced backward, forming a crest which follows the curvature of the temporal fossa. This crest is continuous with the corresponding border of the supraoccipital and together they form the lambdoid crest. The dorsal contour of the supraoccipital is evenly rounded. Between the upper limits of the temporal fossae the supraoccipital is deeply concave, but becomes somewhat flattened above the foramen magnum. The greatest breadth of the supraoccipital is about equal to twice its depth above the condyles.

Because of crushing the occipital view of this cranium appears slightly unsymmetrical, and the distortion lies in the direction of a plane passing from the upper left-hand angle to the lower right-hand angle. This distortion has affected the contour of the foramen magnum to some extent, but originally it must have been suboval in outline. The occipital condyles are considerably broader near the apex than near the base, and slope outward and forward. The internal margins are concave and sharply defined, converging inferiorly. The external margins are convex and are set off from the exoccipitals by low necks. Below the condyles and internal to the exoccipitals are the descending plates of the basioccipital.

Ventral view.—In contrast to other porpoises with very long beaks there is reason to believe that the distal end of the rostrum of this form did not bear teeth. Of course, there is the possibility that a cartilaginous ligament might have lodged the teeth on this portion of the rostrum, for there is an uninterruped furrow extending from the anterior-most alveolus to the extremity. In that event the teeth would readily become separated from the skull during decay or before the skull was buried by sediments. Sixteen teeth are in place on the right side of the rostrum and 33 teeth on the left. By counting the vacant alveoli and the teeth in place, it appears that originally 59 teeth were present on the right side and 60 on the left side. As by far the greater portion of the rostrum is constituted by the maxillae, they will be discussed first. Near the anterior end of the tooth row the external face of the maxilla is rounded, and in front of the vomer it is nearly vertical, but at a point 190 mm. in front of the maxillary notches the lower outer margin begins to twist upward. This portion of the maxilla becomes progressively thinner as it approaches the maxillary notches. Again it may be noted (pl. 1) that no indication of sutures to mark the presence of the premaxillae on the ventral surface of the rostrum can be traced in this or in any of the skulls mentioned in another part of this paper. Posteriorly the maxillae are separated for a short interval, permitting the keel of the vomer to appear between them. Behind this the maxillae are overlain by the palatines. The thin platelike process of the maxilla that extends backward to the optic canal is applied to the ventral face of the supraorbital process of the frontal. The ventral orifice of the infraorbital canal is bounded by the maxilla alone. In front of this orifice there is a shallow heart-shaped depression which extends over the palatine and the maxilla for a distance of 60 mm. in front of the maxillary notches.

There is nothing peculiar about the position of the palatines. They meet mesially and are closely appressed to the maxillae. Viewed from the side, the palatine extends forward beyond the maxillary notch and above the pterygoid projects backward to the anterior margin of the optic canal. Close to its posterior extremity, but above it, the palatine comes in contact with the orbitosphenoid.

The jugal is a long, slender bone, consisting of a short, triangular, dorso-ventrally expanded anterior portion which is closely joined to the maxilla and lachrymal, and a styliform posterior process. The posterior end of the latter is flattened and extremely thin, being loosely attached to the ventral face of the zygomatic process.

The lachrymal is closely appressed to the anterior face of the supraorbital process of the frontal and is sheathed dorsally by the maxilla, while internally it appears to be fused with the jugal. Inasmuch as no suture can be found it should be stated that these combined bones occupy the lower margin of the maxillary notch.

Some confirmation as to the true relations of the pterygoids with the surrounding bones appears to be found in certain living porpoises. By studying the relations of the various bones involved in this and other skulls hereinafter mentioned it was apparent that the type of structure present was essentially in agreement with that of a young *Delphinapterus*. The two plates of the pterygoid are separated from each other by a narrow interval anteriorly, but posteriorly they are widely separated. Behind the middle the two plates of the pterygoid are divergent, the external plate coming in contact with the squamosal and parietal, and the internal plate overlapping the anterior margin of the basisphenoid behind and the palatine in front. Anteriorly, the internal plate becomes somewhat curved and contributes the lower outer surface for the nasal passage. This portion of the internal plate bends inward and then outward and is continuous anteriorly with the external plate of the pterygoid. On the outside of the pterygoid and in front of the nasal passage there is a lateral concavity. Below this concavity the lateral margin of the pterygoid flares out. The external plate of the pterygoid apparently contributes the horizontal backwardly projecting hamular process which represents a posterior extension of the palatal surface. The opening into the sinus between the two plates of the pterygoid lies internal and anterior to the falciform process of the squamosal. Although this sinus is exposed along the right nasal passage of this skull, it is because the horizontal hamular process of the pterygoid broke off at that level. The anterior margin of the external plate of the pterygoid is united by a S-shaped suture with the palatine. The external plate of the pterygoid articulates with the squamosal, parietal, frontal, and palatine. The posterior half of the external plate is arched over the alisphenoid, and excludes the latter from the temporal fossa and from the outer wall of the cranium. The upper and anterior portion of the internal plate of the pterygoid is applied to the ventral surface of the orbitosphenoid.

On the right side of the skull, the external plate of the pterygoid is imperfect. One is thus permitted to study the relations of the alisphenoid, internal plate of the pterygoid, and orbitosphenoid. Fortunately these bones are essentially perfect in this skull. The alisphenoid is broad, outwardly and upwardly curved, extending to and suturally united above with the squamosal and parietal. Further forward there is a small orbitosphenoid which projects laterally on the ventral surface of the supraorbital process. Both plates of the pterygoids are well preserved on the type skull, but on all the others they have been destroyed in the region of the sphenoidal fissure. By utilizing data obtained from all the specimens, it has been possible to work out most of the details in this region. The conditions observable in the region of the sphenoidal fissure appear to be essentially the same as in the skull of an adult *Delphinapterus*, although in the young of the latter the anterior foramina are not so well defined. As in *Delphinapterus*, the orbitosphenoid forms the lower portion of the anterior wall of the brain case. Between the alisphenoid and the orbitosphenoid there is a sphenoidal fissure, varying in outline and in extent in the different skulls. The alisphenoid is overridden anteriorly by the internal plate of the pterygoid, thus closing the sphenoidal fissure laterally. The optic canal while confluent with the sphenoidal fissure, nevertheless has its course marked by a definite groove, and is bounded anteriorly by the descending portion of the orbitosphenoid. No trace of a posterior partition or taenia metoptica could be found in any of these skulls. As in *Delphinapterus* the foramen rotundum appears to be situated in the angle formed by the anterior margin of the alisphenoid where it comes in contact with the frontal. In some skulls of *Delphinapterus* there is a well-defined anteriorly directed canal leading from this angle for conveying the maxillary branch of the trigeminal nerve. This canal is distinct from a wider channel leading from the sphenoidal fissure, but terminates at the posterior margin of the broad trough for the optic nerve on the ventral face of the supraorbital process of the frontal. A similar canal or groove can be made out on one or two of these fossil skulls, but the interval between this canal and that leading from the spenoidal fissure is much reduced. When the pterygoid is in position the foramen rotundum as well as its canal and the sphenoidal fissure are hidden from view. Near the base of the alisphenoid and partially overlapped by the vaginal process of the pterygoid is the ectal orifice of the canal for the carotid artery. The mandibular branch of the trigeminal nerve issues through a cleft on the posterior margin of the alisphenoid at a point 9 mm. external to the carotid canal and on its outward course occupies a channel on the ventral face of this bone, finally emerging in the temporal fossa through the foramen ovale. The latter is situated between the falciform process of the squamosal and the parietal, immediately behind the posterior extremity of the pterygoid. In front of the carotid canal and the channel for the mandibular branch of the trigeminal nerve, the alisphenoid curves abruptly upward forming with internal plate of the pterygoid a large concavity. This concavity may be further divided into a semicircular internal portion and an elongate external portion. The posterior margin of the internal plate of the pterygoid extends obliquely across this concavity.

In this region the wall of the cranium consists of three layers of bone. These, from the inside outwards, are: First, the alisphenoid, which occupies the interval between the frontal, parietal, and basisphenoid; next, the pterygoid proper, that is, the internal plate which overspreads the sphenoidal fissure, overlaps the lateral margin of the basisphenoid, and contributes the lower outer wall of the nasal passage; and, lastly, the external reduplication of the pterygoid which is in contact posteriorly with the squamosal, anteriorly with the palatine, and superiorly with the parietal and frontal.

By the backward extension of the alisphenoid (pl. 5) and its contact with the underlying process of the basioccipital, a recess is formed which completely excludes the periotic and tympanic from the inner wall of the cranium. Above the descending plate or falcate process of the basioccipital and near its posterior extremity two foramina appear within the recess thus formed. The anterior one of these pierces the bone and probably represents the compartment for the nerves in the *foramen lacerum posterius*. The posterior compartment would then be the passage for the vein in the same foramen. These two compartments are not distinct in the type skull and the intervening bar of bone apparently never formed. The condylar foramen is situated near the posterior margin of the deep incisure between the paroccipital process and the descending plate of the basioccipital. Two condylar foramina are present in each jugular incisure on one of the skulls.

In the type skull the line of union between the basioccipital and the basisphenoid can not be traced with certainty. The ventral surface is concave from side to side. The descending plates or falcate processes of the basioccipital are directed downward, backward, and outward, and anteriorly they become closely united with those portions of the internal plates of the pterygoids which overlap the basisphenoid.

No attempt was made to clean the matrix from the brain case of this skull and hence the position of the sutures between the bones in the basicranium can not be traced. In another skull (Individual 2), however, the anterior surface of the basisphenoid has not united with the presphenoid. The presphenoid is rodlike in the middle to conform with the deep groove of the vomer.

The vomer is horizontally expanded posteriorly, sheathing the basisphenoid and meeting the vaginal plates of the pterygoids along its lateral margins. In front of the basisphenoid and between the nasal passages the vomer becomes noticeably constricted, forming a trough in which the presphenoid rests. It forms the lower portion of the posterior and internal walls for each nasal passage, extending upward to meet the corresponding descending plate of the ectethmoid. Between the nasal passages the vomer presents a keel which anteriorly is interposed between the hamular processes of the pterygoids. In front of these processes the vomer is covered by the palatines and the maxillae, but at a point 92 mm. in front of the maxillary notches, the vomer again makes its appearance as a narrow wedge inserted between the maxillae, and extending forward is visible from a ventral view of a distance of approximately 217 mm.

The distinguishing features of the squamosal are the large size and strength of the zygomatic arch, the short robust postglenoid process, and the slender glenoid process which is directed forward and downward in front of the tympano-periotic recess. A narrow groove for the external auditory meatus traverses the squamosal behind the postglenoid process. To the inside of the postglenoid process and in a position corresponding to the direction of this groove, the periotic was attached to the skull, and it in turn with the tympanic. The posterior border of the squamosal articulates with the exoccipital and between this suture and the transverse groove for the external auditory meatus, a rounded tuberosity is formed. The zygomatic process of this skull is rather large and has a slight outward curve. The lower surface is convex, with a decided upward and forward curve. The articular surface for the condyle of the mandible is an oval concavity, looking forward, inward, and downward. Internal to the glenoid fossa there is a sharply defined longitudinal depression, wide posteriorly and narrow anteriorly, which commences in front of the groove of the external auditory meatus and extends forward to the anterior margin of the squamosal. The lower margin of the squamosal, internal to this last-mentioned fossa, is prolonged downward and inward to form a thin plate.

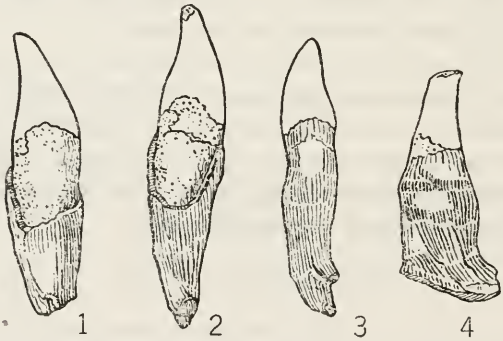
In this skull the line of separation between the exoccipitals and the basioccipital crosses the falcate process of the latter. Posteriorly, the exoccipitals are somewhat concave. The paroccipital process is relatively thick, its anterior aspect is roughened, and internally in conjunction with the descending plates of the basioccipital forms an incisure for the passage of the jugular vein.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	1,066
Length of rostrum (maxillary notches to tip of beak)	859
Breadth of skull across zygomatic processes of squamosal	240
Height of skull (between tip of descending process of basioccipital and nasals)	160
Height of skull (basisphenoid to nasals)	123
Greatest breadth of skull across supraorbital processes	236.5
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	1,000
Greatest distance between outside margins of premaxillae opposite nasal passages	89
Greatest breadth of right premaxilla in front of nasal passages	30
Greatest breadth of left premaxilla at maxillary notch	27.5
Breadth of rostrum at maxillary notches	108
Greatest breadth of rostrum at extremity	14
Length of frontal plate of right maxilla	162
Greatest breadth of right maxilla posterior to nasals	66.5

Measurements of the skull—Continued.

	mm.
Distance between inner margins of maxillae at vertex	65.5
Greatest breadth of supraorbital process of frontal	71
Greatest thickness of frontal and maxilla combined near center of orbit	19.5
Maximum width of exposed portions of combined frontals on vertex	102
Greatest length of exposed portion of left frontal at vertex	27
Anteroposterior diameter of left nasal (along suture)	19
Transverse diameter of left nasal	24.5
Least breadth of cranium between temporal fossae	144.8
Greatest height of temporal fossa	56.5
Distance from vertex to upper margin of foramen magnum	96
Height of foramen magnum (crushed)	23
Width of foramen magnum (crushed)	35.5
Greatest distance between the outer margins of the occipital condyles	80.5
Greatest height of right condyle	49.5
Greatest breadth of right condyle	27.8
Greatest length of right zygomatic process	99.5
Breadth of skull across exoccipitals	186.8
Greatest vertical depth of skull in front of nares	83
Breadth across posterior ends of descending processes of basioccipital	92
Breadth across anterior ends of descending processes of basioccipital	54.4



TEETH

FIGS 1–4.—TEETH OF EURHINODELPHIS BOSSI. CAT. NO. 8842, U.S.N.M. × 3. 1. ANTERIOR VIEW OF TOOTH. 2. POSTERIOR VIEW OF A TOOTH. 3. POSTERIOR VIEW OF AN ANTERIOR TOOTH. 4. LATERAL VIEW OF A POSTERIOR TOOTH, APEX OF CROWN MISSING.

Unfortunately at least 12 of the posterior teeth and all of those in front of the tooth assumed to be the fifty-first on the left side are missing. Those that are present possess some interesting peculiarities. All of these teeth are compressed in an anteroposterior direction and progressively show a slight increase in height and thickness posteriorly. The teeth of *Priscodelphinus productus* as described by Du Bus [18] are apparently flattened in an anteroposterior

[18] Du Bus, B., Bull. Acad. Sci. de Belgique, ser. 2, vol. 34, No. 12, p. 492, 1872.

direction. A short neck or constriction below the enamel crown approximately 1.5 mm. wide accentuates the swollen appearance of the roots of these teeth. The surface of the enamel crown is nearly smooth. The inner and outer margins of the crown are rounded and not strongly carinate. As viewed from in front, the outer margins of the crowns are convex and the inner margins are concave. The apical portions of most of the teeth exhibit a tendency to incline or curve backward. A rudimentary second root is present on some of the teeth.

Measurements of the teeth in the left maxilla, in millimeters.

	Fourteenth	Seventeenth	Forty-ninth	Fifty-first
Height of enamel crown	9.4	9.8	7.3	6.6
Anteroposterior diameter of crown at base	3.4	3.3	2.7	2.6
Transverse diameter of crown at base	4.5	4.5	3.9	3.9

Mandible.—As restored the symphysial portion of each mandible is slightly longer than the free portion. The rami are firmly ankylosed throughout the symphysis and curve upward. This curvature (pl. 2) permits the teeth in the upper and lower jaws to interlock when the mouth is closed. All of the teeth are not located along the symphysis (pl. 3) for at least 14 were present on the ascending portion of the ramus. Judging from the alveoli, there were originally at least 50 teeth on the right ramus and 51 on the left. If the extremity had been preserved the figures given above would be increased. The symphysial portion of the combined lower jaws tapers anteriorly and at the same time the dorsoventral compression becomes more marked. Between the tooth rows the upper surface of the symphysis is relatively smooth. The depth of either mandible at the proximal end of the symphysis is nearly three times that at the extremity. The distance (118 mm.) from the symphysis to the last tooth is greater than the interval (80 mm.) between the opposite rows at the level of this tooth.

Back of the tooth row and on the internal face of the ramus there is an orifice for the large dental canal. Beyond this point the internal wall is incomplete and the ramus consists mainly of a thin shell or bone. A thin inwardly curved plate which extends downward from the superior margin of the coronoid portion of the ramus roofs the concavity above the dental canal. The external surface of the ramus in this region is convex. At a point 110 mm. behind the last tooth on the right ramus and 61 mm. behind the corresponding tooth on the left, the coronoid process and that portion of the jaw which lies above the level of the condyle is missing. Part of the coronoid process has been restored on the left ramus (pl. 3).

The superior margin of the ramus ascends gradually in an even curve, but because of crushing the inferior margin of the left ramus (pl. 2) is continued backward for a distance of 180 mm. in an essentially straight line and then slopes abruptly downward for 120 mm., curving upward beyond this point and terminating below the condyle. Originally the posterior margin of the angle may have been more nearly straight, for it is imperfect on both rami. By making due allowance for crushing and distortion it appears that the greatest depth (estimate 100 mm.) of the ramus at the coronoid was equal to less than one-third of the length of the jaw (341 mm.) posterior to the symphysis. The condyle is sub-quadrate in outline, directed backward and outward.

When viewed from the ventral side it becomes apparent that there is no well-defined longitudinal groove on either ramus. In its place there is a series of small channels which occupy the same relative position. On the right ramus there are at least seven foramina, and from these channels of varying lengths extend forward. Four foramina and their associated channels are present on the left ramus. Between these foramina and their channels the ventral surface of the combined rami is convex. The convexity of this surface is interrupted mesially by the suture following the line of fusion of the two rami.

Measurements of the mandible

	mm.
Length of right mandible as preserved (condyle to tip)	644.5
Length of right mandible, estimated (condyle to tip)	734.5
Length of left mandible as preserved (condyle to tip)	647
Length of left mandible, estimated (condyle to tip)	737.5
Greatest breadth of combined mandibles at extremity	15
Greatest depth of combined mandibles at extremity	10.4
Greatest breadth of combined mandibles at proximal end of symphysis	49.2
Greatest depth of combined mandibles at proximal end of symphysis	27.2
Greatest depth of right mandible at level of proximal alveolus	43.5
Greatest depth of left mandible at level of proximal alveolus	41.7
Breadth of mandible at base of coronoid	20.5
Greatest length of ankylosed symphysial portion of ramus as preserved	319
Greatest length of ankylosed symphysial portion of ramus, estimated	407
Length of right alveolar gutter as preserved	422
Length of left alveolar gutter as preserved	420
Depth of condyle of right mandible	33.2
Breadth of condyle of right mandible	29.5

SCAPULA

In contour and size this scapula corresponds in a general way with that of *Inia geoffrensis*. Posteriorly, most of the bladelike expanded region (pl. 6, fig. 1) above the neck, including the greater portion of the vertebral margin, is missing. The external surface of this bone is slightly concave posterior to the spine, indicating a shallow post-scapular fossa. The prescapular fossa is widest near the medial angle and rapidly narrows as it approaches the acromion process. The inferior margin of the scapula is divided into two deep notches by the long flattened acromion process. This process is relatively wide, expanded and irregularly rounded distally, and slightly twisted. In contrast to *Inia*, there is no distinct metacromial projection, and the coracoid process is relatively long and attenuate. This coracoid process (pl. 6, fig. 4) is inclined inward and directed downward from the head of the scapula. *Orcella* possesses a long coracoid process, but it is expanded distally. The neck of this scapula is rather broad and the glenoid cavity for the head of the humerus is shallow. What remains of the axillary margin shows that it turns abruptly backward near the level of the upper margin of the acromion process.

Measurements of the scapula (in millimeters)

Measurements	*Eurhinodelphis bossi* [1]	*Inia geoffrensis* [2]
Antero-posterior diameter of head of scapula	42.5	46
Extero-internal diameter of head of scapula	35.5	34
Posterior margin of head to tip of coracoid process	64.5	92
Posterior margin of head to tip of acromion	107.2	115
Posterior margin of head to median (anterior) angle	155	155
Distance from anterior (coracoid) margin of scapula to tip of acromion	58	66
Distance from tip of coracoid process to median (anterior) angle of scapula	123	137.5
Maximum thickness of scapula at base of acromion	21	21.5

[1] Cat. No. 8842, U. S. Nat. Mus. [2] Cat. No. 49582, U. S. Nat. Mus.

HUMERUS

The humerus is irregularly concave on the internal border, convex on the external, and except for a slight swelling near the lower margin of the lesser tuberosity the outline of the anterior border (pl. 12, fig. 4) is rather evenly concave. The broadly oval head is set off from the shaft by a well-marked neck, which, however, does not extend around upon the proximal surface. The head is large and projects slightly beyond the internal margin. It is barely visible when the humerus is viewed from in front, and when viewed from the side it is seen to lie below the lesser tuberosity, being separated from it laterally by a narrow groove. The deltoid crest is represented by a low swelling on the external face of the shaft. About halfway between the head and the inner trochlea there is a smaller but more evident protuberance on the angle formed by the internal and posterior faces. On the anterior face of the shaft there are two short elongate depressions that are almost continuous with one another, which commence near the upper margin of the inner trochlea and extend obliquely upward to a point about 10 mm. below the center of the lower margin of the greater tuberosity. These depressions may mark the position of the *M. teres major* and the *MM. pectoralis and latissimus dorsi.* The posterior surface (pl. 12, fig. 5) is marked by a deep pit near the center of the shaft and below the head. In this pit the short head of the *M. triceps* probably had its origin. The inner trochlea is continued upward on the internal face of the shaft to correspond with the shape of the greater sigmoid cavity of the ulna. From an inferior view the capitulum or articular facet for the radius is seen to be parabolic in outline and to follow closely the contour of the lower end of the shaft. There is a distinct crest or ridge between the capitulum and the inner trochlea. Both of these articular facets are characterized by a transverse depression formed by a series of small foramina.

Measurements of left humerus

	mm.
Greatest length (greater tuberosity to lower margin)	104
Exterointernal diameter of shaft near middle	47
Anteroposterior diameter of shaft near middle	29.5
Exterointernal diameter of distal extremity of shaft	49.5
Anteroposterior diameter of proximal face of greater tuberosity	28
Dorsoventral diameter of head of humerus	49.5
Exterointernal diameter of head of humerus	41
Anteroposterior diameter of humerus through head	58

CERVICAL VERTEBRA

Only one of the cervical vertebrae was found and it (pl. 6, fig. 3) lacks the distal extremities of the lower transverse processes. For this reason it is difficult to determine which one of the posterior cervicals it actually represents. On making comparisons with the cervical series of other living and fossil porpoises there appears to be some grounds for believing that this vertebra is the fifth. The centrum is broadly oval in outline and relatively thin. The anterior epiphysis is complete, but a portion of the posterior one (pl. 6, fig. 6) is missing. The articular facets on the prezygapophyses are elongate, flattened, and slope obliquely inward. The neural arch is slender and bears a short spine. Only a rudiment of the upper transverse process persists, but the lower process is developed to an extraordinary degree. The lower transverse process is thin, broadly expanded, and unless it differed radically from other known porpoises was rather long. This process is directed obliquely backward and is perforated at the base by a large arterial canal. The postzygapophysial articular facets are obliquely situated on the lateral faces of backwardly projecting portions of the neural arch.

Measurements of fifth cervical vertebra

	mm.
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	73.6
Greatest breadth of neural canal posteriorly	36.8
Height of anterior face of centrum	42.4
Breadth of anterior face of centrum	50.2
Height of posterior face of centrum	43.2
Breadth of posterior face of centrum	48.7
Length of centrum	25.6
Distance across vertebra between tips of the diapophyses	67.2
Distance across vertebra between tips of the transverse processes (parapophyses)	103.2+
Distance across vertebra between tips of prezygapophyses	47.6
Distance across vertebra between outside margins of the postzygapophysial facets	54.3
Distance between tip of left postzygapophysis and tip of left prezygapophysis	37.1
Minimum length of neurapophysis	11.1
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	10
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	11.5
Maximum thickness of posterior epiphysis	5

DORSAL VERTEBRAE

Isolated vertebrae of fossil cetaceans are usually difficult to allocate when the full complement of the skeleton is unknown. Abel [19] has indicated the vertebral formula for *Eurhinodelphis* and has published a restoration of the entire skeleton. It is not known whether his observations were based on an associated skeleton, or whether a composite skeleton was constructed out of miscellaneous vertebrae from deposits in the vicinity of Antwerp. This formula in conjunction with the ribs found with the skull have been used in allocating these vertebrae.

From a study of recent types it might be argued that these seven dorsals are sufficiently characteristic for definite allocation. This is true so far as certain vertebrae are unquestionably anterior and others posterior. The prezygapophysial facets on the anterior dorsal of this porpoise are separated by a greater interval than any of the succeeding ones. Hence the postzygapophysial articular facets on each of the following dorsals tend to approximate one another to a greater degree in accordance with their position in the column. The centra of the dorsal and lumbar vertebrae increase

[19] Abel, O., Cetaceenstudien. I. Mitteilung: Das Skelett von Eurhinodelphis Cocheteuxi aus dem Obermiozan von Antwerpen. Sitz.-ber. kais. Akad. Wiss., Wien, Mathem.-naturw. Kl., vol. 118, Abt. 1, pp. 241–253, mit 1 pl., 1909.

in length from the first to the last. In view of the above, all allocations given below will remain tentative until a skeleton with associated vertebrae is found. Inasmuch as the first six ribs on the right side were preserved, it has been possible to determine definitely the position in the column of at least three of these dorsals.

The first and second dorsals are missing, but the third (pl. 8, fig. 1) is characterized by a rather long diapophysis, large oval prezygapóphysial facets which lie in a slightly oblique plane, and a narrow neural spine. The neural arch (pl. 7, fig. 3) is low, relatively long, and on each side gives rise to a lateral process, the diapophysis. The articular facet for the tuberculum of the third rib is situated on the lower two-thirds of the outer face of the diapophysis. The neck of the diapophysis is constricted dorsoventrally between the facet and the neural arch. The postzygapophysial facets (pl. 7, fig. 6) are large, elongate, and slope obliquely inward. Both epiphyses are missing.

The neurapophyses of the fifth dorsal (pl. 7, fig. 2) are not as highly arched as the third, the diapophyses are shorter, and the neural spine is longer. No posterior epiphysis (pl. 7, fig. 5) is present and at least two-thirds of the anterior one is missing. The prezygapophysial facets are large and elongate, but they are nearer together than those of the third, and the inward slope is more oblique. The facet for the tuberculum of the rib (pl. 8, fig. 2) has shifted very slightly in position from that of the third, but it is somewhat broader. The postzygapophysial facets are nearly vertical in position. There is a trace of a median keel on this vertebra.

Unless the vertebra assumed to be the sixth (pl. 7, fig. 1) is abnormal, it will be difficult to explain certain features possessed by it. The centrum (pl. 8, fig. 3) is too short to follow after the fifth vertebra, but the neural spine is too high and long, and the prezygapophysial facets are too close together to assign a more anterior position to it. This vertebra may not belong to this porpoise. The diapophyses (pl. 7, fig. 4) are much shorter than those of either the fifth or the third, and the mesial dorsoventral constriction has largely disappeared.

The neural spine of the seventh dorsal is broken off near the base and the posterior epiphysis is missing. The prezygapophysial facets (pl. 7, fig. 7) are strongly concave, oblique in position, with thin raised inferior margins. The neural canal is more nearly circular than in any of the preceding vertebrae and the neurapophyses are slightly thinner. The diapophyses are short and their extremities are occupied by kidney-shaped facets for the tubercula. In the anterior dorsals the basal portions of the neural arches extend practically the entire length of the centrum, but in the ninth dorsal as well as in the more posterior ones they have receded from the posterior epiphyses. As will be noted from an examination of the figures, the backward projecting mesial portion of the neural arch becomes progressively shorter toward the posterior end of the series. The principal differences to be noted between this dorsal and the anterior ones are the length of the neural spine, the length of the centrum, the position and length of the diapophysis, and the close approximation of the postzygapophysial facets.

On account of the contact between the diapophysis and the parapophysis it appears probable that this vertebra (pl. 9, fig. 3) is the ninth dorsal. At least it is the last one in the dorsal series that retains a diapophysis. The most apparent differences between this vertebra and the preceding are the more noticeable constriction of the mesial portion of the centrum, the increase in length of the neural spine, and the narrowness of the neural canal. On the first two or three dorsals the diapophyses arise high up on the neural arch and when followed backward along the series they are seen to gradually shift their position until on the ninth dorsal they project from the base of the arch. In the third dorsal the distance from the inside margin of the neural arch to the tip of the diapophysis is 46.5 mm. The same measurement for the ninth dorsal is 18.5 mm.

On each side of the centrum of the third, fifth, and sixth dorsals, below the level of the neural arches and in front of the posterior epiphysis, there is a circular depression for the accommodation of the capitulum of the following rib. On the seventh dorsal there is a corresponding articular surface behind the anterior epiphysis and below the base of the neural arch.

The tenth dorsal (pl. 7, fig. 9) is characterized by a short broad parapophysis, high and narrow neural canal, long neural arch, and the small size of the postzygapophysial facets. The prezygapophysial facets of the third, fifth, and sixth dorsals are more nearly horizontal in position than are those of the ninth, tenth, and eleventh. The metapophyses project beyond the epiphyses in all of these dorsals, but the postzygapophyses do not. The anterior margin of the parapophysis on the tenth dorsal (pl. 9, fig. 2) is nearer to the anterior epiphysis than is the posterior margin with the other epiphysis, while in case of the eleventh dorsal (pl. 9, fig. 1) both margins near the base are almost equally distant from their corresponding epiphyses. Furthermore, the parapophyses of the eleventh dorsal tend to incline backward. On these last mentioned dorsals, the articular facets for the tubercula of the ribs are elongate and shallowly concave. These vertebrae differ among themselves in the size of the neural canal in accordance with their position in the column. Anteriorly the neural canal is wider than high, but posteriorly (pl. 7, fig. 8) the reverse is true. The centra of all these dorsals are very slightly flattened dorsally and constricted mesially. The centra of the posterior dorsals are deeper and more rounded in cross section. There is a thin-edged longitudinal ridge or carina on the dorsal faces of the centra of the third, fifth, ninth, tenth, and eleventh dorsals.

Measurements of dorsal vertebrae (in millimeters)

	Third	Fifth	Sixth	Seventh	Ninth	Tenth	Eleventh
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	130+	131+	110.2+	97+	129.7	143.2	132.7
Greatest depth of neural canal anteriorly	29.5	27	23.7	27.6	28	32.7	29.5
Greatest breadth of neural canal posteriorly	37.2	34.5	30.2	27.2	20.5	20.5	20.7
Height of anterior face of centrum	39	38.2	33.5+	41.4	45.2	47.5	48
Breadth of anterior face of centrum	42	43.4	46.4	46.7	53.6	54	53.6
Height of posterior face of centrum	38+	35.5	35+	41.7+	47	46.6	48+
Breadth of posterior face of centrum	53+	51.7	56.2	48.8+	50.2	52.8	54.2+
Length of centrum	[2] 36	[1] 44.2	[2] 35+	[1] 48.7	57.5	61.8	[1] 60.6
Distance across vertebra between tips of the diapophyses	114	96.8	84.5	83.3	57.2	--------	--------
Distance across vertebra between tips of transverse processes (parapophyses)	--------	--------	--------	--------	66	97	128.2
Distance across vertebra between tips of prezygapophyses	68	51.2	--------	45.7	29.4	28.3	--------
Distance across vertebra between outside margins of the postzygapophysial facets	53.7	33.4	28.6	18.5	16.5	14.3	11.7
Distance between tip of left postzygapophysis and tip of left prezygapophysis	58.7	65	49.5	73.2	66+	73.5+	82.2
Minimum length of neurapophysis	20.2	22.1	20.4	26	35.8	40.7	42.3
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	30.5	36	36	41	45.5	45	49.2
Anteroposterior diameter of right diapophysis at extremity	21.4	32.7	25.5	21	15.4	--------	--------
Anteroposterior diameter of right parapophysis at extremity	--------	--------	--------	--------	--------	34.3	33.3
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	61+	62.1	49.7	--------	52	66.8	55.5

[1] One epiphysis missing. [2] Both epiphyses missing.

LUMBAR VERTEBRAE

Before taking up in detail the characteristics of the three lumbars found with the skull, mention should be made that on the basis of Abel's restoration they appear to represent the sixth, eighth, and tenth in the series. The right parapophysis of the sixth lumbar (pl. 8, fig. 5) is broken off near the base. Beyond the lengthening of the neural spine and a slight narrowing of the neural canal, there is no marked difference between the eighth (pl. 8, fig. 4) and sixth lumbars. The sixth (pl. 9, fig. 5) lacks the posterior epiphysis and the eighth (pl. 9, fig. 4) lacks both epiphyses. The prezygapophyses of both lumbars are damaged, but those of the eighth are the best preserved. The right parapophysis, the posterior epiphysis, the neural arch and its associated structures are missing on the tenth lumbar (pl. 9, fig. 6). On the sixth and eighth lumbars the neural arches are not as long anteroposteriorly as those of the eleventh dorsal and are characterized by curved anterior and posterior margins. The neural canals of these lumbars are narrow, high, and roughly triangular in outline. In cross section the centra of all three lumbars are roughly pentagonal in outline. The transverse processes or parapophyses are thin, relatively narrow, long, and incline downward. The neural spines appear to rake backward to a more noticeable degree than those of the posterior dorsals. The prezygapophysial facets are situated on the internal faces of the obliquely directed laminae which arise from the anterior margins of the neural arches. The postzygapophysial facets are small and are situated on the lateral faces of the neural spine at the posteroinferior angle. There is a well-defined ventral carina on the eighth and tenth lumbars.

Measurements of lumbar vertebrae (in millimeters)

	Sixth	Eighth	Tenth
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	180.2	157.5+	----------
Greatest depth of neural canal anteriorly	33.8	33.7	----------
Greatest breadth of neural canal posteriorly	18.7	19.5	11.2
Height of anterior face of centrum	52.5+	50.7	----------
Breadth of anterior face of centrum	56.8+	55	58
Height of posterior face of centrum	52.3+	48.5	[1] 56.5
Breadth of posterior face of centrum	55.3+	54.7+	[1] 60
Length of centrum	[1] 66	[1] 65.5	[2] 73.5
Distance across vertebra between tips of parapophyses	193.3	[2] 194	[2] 194
Distance across vertebra between tips of prezygapophyses	27.7+	----------	----------
Distance across vertebra between outside margins of postzygapophysial facets	6.2	8.4	----------
Distance between tip of right postzygapophysis and tip of right prezygapophysis	84	80.2	----------
Minimum length of neurapophysis	40	40.5	----------
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	44.5	50	----------
Anteroposterior diameter of left parapophysis at extremity	23.5	24	24.2
Vertical height of neural spine (distance between superior margin of spinal canal and tip of spine)	95.2	80.5+	----------

[1] Epiphysis missing. [2] Estimate.

CAUDAL VERTEBRAE

It may seem unusual that these five caudal vertebrae are so widely separated from each other in the column, but on the basis of Abel's figure they will have to be assigned somewhere near the following positions. The epiphyses of three of these caudals are nearly circular, even though the centra are irregularly pentagonal. Although the transverse processes of the fifth caudal (pl. 12, fig. 1) are broken off near the base, it is evident that these processes were somewhat shorter than those of the tenth lumbar. The lateral faces of the centrum (pl. 11, fig. 1) both above and below these processes are concave. The neural arches are high and long anteroposteriorly. The neural spine is short and its posterior margin curves forward. The neural canal is very narrow in proportion to its height. Large protruding postero-inferior facets for the chevrons (pl. 13, fig. 1) are present in front of the posterior epiphysis, but the anteroinferior ones are somewhat smaller. Between these facets the inferior surface of the centrum is grooved.

The neural arches of the eighth caudal (pl. 10, fig. 2) are rather low and the neural canal is small and ovoidal. Short transverse processes (pl. 12, fig. 2) are present; their extremities are obliquely truncated. Both pairs of inferior facets for the chevrons (pl. 13, fig. 2) are situated on prominent protuberances. These articular surfaces are obliquely placed on the protuberances and slope upward and outward. The depression between these facets is deeper than that on the fifth caudal. On this caudal and on the tenth the prominence of these protuberances in conjunction with the outward curvature of the rudimentary neural arches emphasize the concavities above and below the transverse processes.

The tenth caudal (pl. 10, fig. 3) is characterized by a lower neural arch, smaller neural canal, and rudimentary transverse processes. In cross section this vertebra would appear almost pentagonal. Behind the transverse process (pl. 11, fig. 3) there is a well-defined groove which curves downward and reaches the ventral face through the depression between the anterior and posterior facets for the chevron bones. Between these facets (pl. 13, fig. 3) there is a broad elongate concavity. This vertebra is noticeably broader anteriorly than posteriorly. Both epiphyses are missing.

As compared with the tenth caudal, the fourteenth (pl. 10, fig. 4) is somewhat shorter, more rounded, and lacks a complete neural arch. Near the middle and inside of the low ridges which represent the rudiments of the neural arch, there is an orifice for each vertebrarterial canal. No trace of the transverse process is retained on either lateral face of the centrum. In its place there is a mesial depression which corresponds in function with the more evident groove on the tenth caudal. No facets for the chevrons are present.

The eighteenth caudal is strongly flattened dorsoventrally. The anterior epiphysis is thick with a convex articular face. The posterior epiphysis is missing. Near the middle of the dorsal face there are a pair of orifices for vertebrarterial canals which pierce the centrum in a dorsoventral direction and emerge ventrally. There is an oval longitudinal depression between their orifices on the ventral face. The centrum is irregular in outline and is more noticeably porous than any of the preceding caudals. The lateral faces of this caudal are nearly vertical in contrast to the rounded appearance of the centra of the anterior caudals. The anterior and posterior faces of the centrum swell out and consequently the epiphyses of this caudal acquire a slightly different shape from the others.

Measurements of caudal vertebrae (in millimeters)

Measurements	Fifth	Eighth	Tenth	Four-teenth	Eigh-teenth
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	142	93	82	54.6	30
Greatest depth of neural canal anteriorly	28	--------	8	--------	--------
Greatest breadth of neural canal posteriorly	8.5	8.7	7.2	--------	--------
Height of anterior face of centrum	60.5	61.7	63	61.2	29
Breadth of anterior face of centrum	67.7	64.7	61.5	53	35.7
Height of posterior face of centrum	66	64	65	47	--------
Breadth of posterior face of centrum	67	58.6	52.6	44.3	--------
Length of centrum	87.5	86.5	[1] 69	61.6	[1] 45
Distance across vertebra between tips of the parapophyses	--------	92.2	66	--------	--------
Distance across vertebra between tips of the prezygapophyses	35	38.2	30.5	--------	--------
Minimum length of neurapophysis	41	46	51	--------	--------
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	31.2	--------	--------	--------	--------
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	53	--------	--------	--------	--------
Maximum thickness of posterior epiphysis	9.3	--------	--------	--------	--------

[1] Epiphysis missing.

RIBS

All the ribs found with this specimen are imperfect. The proximal portions of 10 ribs are sufficiently well preserved to permit accurate description. The extremities only of two other ribs were found. This fossil porpoise probably possessed 11 pairs of ribs of which the first pair are the shortest. When these ribs are arranged in what appears to be their normal position, the external curvature of the anterior ribs is seen to be less pronounced than that for those near the posterior end of the series.

The neck of the first rib (pl. 14, fig. 1) is flattened, relatively deep, and bears a short quadrangular-shaped capitulum at the extremity. The tuberculum is subovoidal, concave, with a noticeable mesial depression. The shaft is also flattened.

Only the neck of the second rib (pl. 14, fig. 2) was found and it is also deep and rather short, but the capitulum is larger and more ovoidal than that of the first rib. The tuberculum is also ovoidal, but is not so noticeably depressed mesially. There is a concavity on the posterior face of the neck.

The neck of the third rib (pl. 14, fig. 3) is narrower than that of the second, with an evident constriction. The capitulum is trapezoidal in outline. The tuberculum is elongate, nearly subtriangular in outline, and somewhat depressed mesially. Between the tuberculum and the angle the external face of this rib is flattened, with a flaring posterior margin.

In depth the neck of the fourth rib (pl. 14, fig. 4) is about equal to the breadth. The increase in length of the neck corresponds to the change in relative position of the facets on the corresponding vertebrae for the capitulum and tuberculum. These facets are roughly triangular in outline. The external face of this rib is flattened with projecting anterior and posterior margins. This flattened area commences 23.5 mm. below tuberculum and extends downward for a distance of 38 mm.

The neck of the fifth rib (pl. 14, fig. 5) is also narrow, with its depth greater than its breadth. The tuberculum is sub-triangular in outline and about equally as long as broad. The internal margin of this articular facet rolls over upon the shaft and the external face of the shaft is not so noticeably flattened as on the fourth rib.

The neck of the sixth rib (pl. 14, fig. 6) is even narrower, but the depth and breadth are about equal. The capitulum and tuberculum are about equal in area. As in case of the fifth rib, the internal margin of the tuberculum likewise rolls over upon the shaft, and the external face is more rounded.

On the ninth rib (pl. 14, fig. 7) the facets for articulation with the rudimentary diapophysis and parapophysis are combined into a single articular head. The tenth rib (pl. 14, fig. 8) is characterized by having a long narrow articular head for the parapophysis. Near the middle the width and depth of the shaft are about equal. All the ribs thin out near their lower extremities.

Measurements of ribs in millimeters

Measurements	First rib right	Second rib right	Third rib right	Fourth rib right	Fifth rib right	Sixth rib right	Ninth rib right	Tenth rib left	Third rib left	Fifth rib left
Total length in a straight line	[2] 149.5	--------	[1] 186.3	[2] 265.7	[1] 174.3	[2] 283.5	[1] 248.5	[2] 293.6	[1] 112.2	[1] 120
Greatest breadth of shaft at angle	25.7	--------	24.3	18.2	17	18.3	14.8	16.3	19.3	16.8
Distance between external margin of tuberculum and anterior margin of capitulum	50.6	--------	47.5	46.8	--------	43.2	25.1	--------	46.1	43.2
Greatest thickness of shaft near the middle	10.2	--------	9.5	10.8	10.6	10.8	11.7	10.2	10.1	11.7
Greatest diameter of articular facet on head of rib	13.8	18.7	16.7	14.3	--------	16.3	[3] 25.2	--------	13.7	14.5
Greatest diameter of articular facet on tubercle of rib	30.2	--------	21.9	21	17.6	17.7	--------	--------	20.7	17.6
Least breadth of neck	21.4	20.2	12.7	11.1	10.6	9.9	--------	--------	10.8	10

[1] Capitulum to extremity.
[2] Tuberculum to extremity.
[3] Combined facets for diapophysis and parapophyses.

INDIVIDUAL 2

Skull, Cat. No. 10714, Section of Vertebrate Paleontology, United States National Museum.

Some difficulty was encountered while excavating around this skull in preparation for its removal from the cliff, and unfortunately it was fractured in several places. The top of the cranium (pl. 15, fig. 1) and most of the rostrum was removed in good condition.

All of the material that could be found was brought to Washington, and thanks to the skillful manner in which the fragments have been fitted together by Norman H. Boss, a fair skull was made available for study. In its present condition the loss of the extremity of the rostrum is the most noticeable defect. Fortunately the external margins of the maxillae above the temporal fossae are perfect and supplement the skull of individual 1 (Cat. No. 8842, U. S. Nat. Mus.). The premaxillae were damaged in the region of the nasal passages and the missing portions have been restored. There is an unusually deep external groove leading backward from the premaxillary foramen. The nasal bones are in contact mesially for a distance of 25 mm. The exposed portions of the frontals on the vertex are relatively narrow and are not noticeably longer than the nasals. The dorsal surface of the vertex (pl. 16, fig. 1) is higher than the adjoining upper margin of the supraoccipital. On the left side the posterior half of the supraorbital process is missing. The left zygoma lacks the postglenoid process and a portion of its anterior extremity. Except for the anterior end, the right zygoma is lost. In addition the lower half of the left exoccipital and the adjoining portion of the descending plate of the basioccipital are missing. In the region of the temporal fossae, both parietals are absent. The pterygoids (pl. 15, fig. 2) are completely destroyed on the left side. On the right side, a small portion of the internal plate of the pterygoid which abuts against the basisphenoid is present; the remainder of this plate and its external reduplication are missing. In consequence of the loss of the external plate of the pterygoid, the optic canal is exposed near its origin. Because of the absence of the mesethmoid and the loss of the internal plates of the pterygoids, the nasal passages do not appear as small as they do in better preserved skulls. The foramina (pl. 5) in the right tympano-periotic recess are well preserved; those on the left side are more or less mutilated. A broad strip of the supraoccipital extending from side to side immediately above the foramen magnum is also missing. The posterior styliform processes of the jugals are missing on both sides, but their anterior extremities are present. For the most part the septa between the alveoli are obliterated.

Occurrence.—Near latitude 38° 40′ north, and longitude 76° 41′ west, South Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—This skull came from Shattuck's zone No. 3 of the Calvert Miocene formation of Maryland. It was discovered and excavated by William Palmer in September, 1920.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	794
Length of rostrum (maxillary notches to tip of beak)	587
Breadth of skull across zygomatic processes of squamosal	239
Height of skull (between tip of descending process of basioccipital and nasals	179
Height of skull (basisphenoid to nasals)	140
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	743
Greatest breadth of skull across supraorbital processes	224
Greatest distance between external margins of premaxillae at level of nasal passages	108
Greatest breadth of left premaxilla in front of nares	47.5
Greatest breadth of left premaxilla at maxillary notch	46.5
Breadth of rostrum at maxillary notches	126.5
Greatest length of frontal plate of right maxilla	164
Greatest breadth of right maxilla posterior to nasals	87.5
Distance between inner margins of maxillae at vertex	66
Greatest antero-posterior length of supraorbital process of right frontal	68.5
Greatest thickness of frontal, lachrymal, and maxilla combined in front of right orbit	30
Maximum width of exposed portions of combined frontals on vertex	98
Greatest length of exposed portion of left frontal at vertex	32.5
Anteroposterior diameter of left nasal (along suture)	25.5
Transverse diameter of left nasal	26
Distance from vertex to upper margin of foramen magnum	102.5
Height of foramen magnum	39
Breadth of foramen magnum	36
Greatest distance between outer margins of occipital condyles	89.8
Greatest height of right condyle	51.2
Greatest breadth of right condyle	32.7
Greatest length of left zygomatic process (as preserved)	78.8
Breadth of skull across exoccipitals	201
Greatest vertical depth of skull in front of nares	94
Breadth across posterior ends of descending processes of basioccipital	107
Breadth across anterior ends of descending processes of basioccipital	61
Breadth of skull across zygomatic processes of squamosals	237

INDIVIDUAL 3

Skull, Cat. No. 10464, Section of Vertebrate Paleontology, United States National Museum.

Although the skull from a dorsal view (pl. 16, fig. 2) appears to be in a fair state of preservation, this condition unfortunately does not extend to structures not visible from this view. The extremity of the rostrum, the teeth, and the ear bones are missing. On the left side of the rostrum in the groove between the maxilla and the premaxilla and at a point 248 mm. in front of the maxillary notch, there is a large foramen. Notwithstanding the fracture across the base of the rostrum, the premaxillae were little damaged by that accident. The mesethmoid is present, and although there is a well-defined pit on each side of it below the nasals the frontal fontanelle was completely closed and no trace can be found of foramina which would afford passage for the olfactory nerves through the ectethmoids. To make certain that these foramina were not hidden by matrix, that portion of the bone which incloses the pit on the left side was removed and carefully examined. The jugals and their long styliform processes are missing. Both lachrymals are preserved even though the forward projecting processes of the horizontal plates of the maxillae which normally overlie them are broken off near the anterior margin of the supraorbital processes of the frontals. The right and left supraorbital processes are essentially complete except for the loss of their postorbital projections. The outer margin of the maxilla above the right temporal fossa is imperfect. The nasals are more rounded than those of the other skulls. On each side above the foramen magnum there is a vacuity in the supraoccipital approximately 38 mm. wide which has resulted from some accident, probably from the dislodgment of the exoccipitals. Between these vacuities there is a median strip of the supraoccipital averaging 31 mm. in width which maintains the correct relations between the base and the top of the skull. Both exoccipitals are lost. All of the right and left squamosal bones, including their zygomatic processes, are missing. The extremities of the alisphenoids are damaged. The descending plates of the basioccipital are not complete. No remnants of the pterygoids can be found on either side. Both parietals are lost.

Occurrence.—Near latitude 38° 40′ north, and longitude 76° 41′ west, South Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Pateuxent Folio, No. 152, United States Geological Survey.

Horizon.—The skull was found by F. W. True on March 30, 1907, in clay on the shore at a point immediately north of the Sunset Hotel, Chesapeake Beach. It lay in bluish clay about a foot above the beach. The skull was turned upside down, and the right frontal bone was exposed. The long axis of the skull was at an angle to the face of the bank. The skull belongs to Shattuck's zone No. 5.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of the rostrum)	842
Length of rostrum (maxillary notches to tip of beak)	649
Height of skull (basisphenoid to nasals)	118
Greatest breadth of skull across supraorbital processes of frontals (anteriorly)	196.5
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	803
Greatest distance between outside margins of premaxillae opposite nasal passages	95

Measurements of the skull—Continued

	mm.
Greatest breadth of left premaxilla in front of nares	41
Greatest breadth of left premaxilla at maxillary notch	29. 2
Breadth of rostrum at maxillary notches	118
Breadth of rostrum at extremity	19. 2
Length of frontal plate of left maxilla	152. 3
Greatest breadth of left maxilla posterior to nasals	66
Distance between inner margins of maxillae at vertex	56. 8
Greatest thickness of frontal and maxilla combined near center of orbit	17. 3
Maximum width of exposed portions of combined frontals on vertex	75
Greatest length of exposed portion of left frontal at vertex	25
Anteroposterior diameter of left nasal (along suture)	21. 5
Greatest anteroposterior diameter of right nasal	28. 3
Transverse diameter of right nasal	21. 2
Distance from vertex to upper margin of foramen magnum	102. 7
Greatest height of left condyle	41
Greatest breadth of left condyle	26

INDIVIDUAL 4

Skull, Cat. No. 10711, Section of Vertebrate Paleontology, United States National Museum.

From time to time large masses of clay are dislodged from the cliffs by the undercutting action of the tides. Whenever remains of fossil cetaceans are thrown down in this manner they are usually broken up either by the fall or by being rolled about in the water. It is not known whether this skull was broken in this way or at the time of excavation. At any event the skull was fractured in many places and was restored to its present condition before it was purchased by the museum. It is listed here on account of the large size of the braincase. On the basis of comparative measurements taken from the other skulls it is apparent that only the proximal one-third of the rostrum is preserved. As will be noted from an examination of plate 17, the outer margins of the maxillae anterior to the maxillary foramina have been broken off along the external margins of the premaxillae. The thin horizontal plate of the left maxilla is fairly well preserved above the temporal fossa and retains most of its original external margin, but on the right side posterior to the supraorbital process a large section of the maxilla is missing, exposing the temporal fossa.

A section of the right premaxilla, 46 mm. in length, is missing above the nasal passage and the inner margin of the left is imperfect in the corresponding region. Both nasal bones are lost. A very narrow strip of the combined frontals is exposed on the vertex. Part of the thin horizontal plate of the maxilla which overlies the right supraorbital process is missing. The slender process of the maxilla which projects forward and overlies the left lachrymal was broken off near its origin. The anterior half of the outer border of the right supraorbital process is missing.

The right zygoma is nearly perfect, but the left one is fractured behind the postglenoid process. In the right temporal fossa a small fragment of the parietal remains. The alisphenoid is considerably damaged on both sides, so much so that most of the foramina are obliterated. The outer and lower extremities of both exoccipitals are damaged. The supraoccipital is lost except for a small piece attached to the right frontal. From a ventral view the vomer is seen to be greatly constricted between the nasal passages, forming a narrow trough. The internal plate of the pterygoid and its external reduplication are completely missing on both sides. The lachrymals and jugals are missing. The palatines are damaged along their external margins. The mesethmoid is lost. No septa between the alveoli are preserved.

Occurrence.—No definite information regarding the place of discovery of this specimen can be found in any of the notes left by William Palmer. All that is known is that it was obtained from the Calvert cliffs, on the western shore of Chesapeake Bay, at some point between Dare's wharf and Chesapeake Beach. The clay matrix and mollusca within the brain cavity show that the specimen came from the Calvert formation.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	497.5
Length of rostrum (maxillary notches to extremity)	287.5
Breadth of skull across zygomatic processes of squamosals	245
Height of skull (between tip of descending process of basioccipital and frontals)	177
Height of skull (basisphenoid to frontals)	131
Greatest breadth of skull across supraorbital processes	250
Greatest distance between outside margins of premaxillae opposite nasal passages	111
Greatest breadth of left premaxilla in front of nasal passages	44
Breadth of rostrum at maxillary notches	126.4
Length of frontal plate of left maxilla	169
Greatest breadth of left maxilla at level of posterior margin of supraorbital process of frontal	100
Distance between inner margins of maxillae at vertex	55
Greatest anteroposterior length of left supraorbital process of frontal	76.2
Maximum width of exposed portions of combined frontals on vertex	92
Greatest length of exposed portion of left frontal on vertex	25
Distance from vertex to lower margin of foramen magnum	
Breadth of foramen magnum	40.5
Greatest distance between outer margins of occipital condyles	92.2
Greatest breadth of right condyle	35
Greatest length of left zygomatic process, as preserved	86.4
Breadth of skull across exoccipitals	203.5
Breadth of skull across zygomatic processes of squamosals	245

EXPLANATION OF PLATES

Eurhinodelphis bossi, new species. Type, Cat. No. 8842, Section of Vertebrate Paleontology, United States National Museum. Calvert formation, western shore of Chesapeake Bay, about 2 miles south of Chesapeake Beach, Calvert County, Maryland. Collected by Norman H. Boss, August, 1918.

PLATE 1

Type skull of *Eurhinodelphis bossi*, new species. About one-sixth natural size. Fig. 1. Dorsal view. Fig. 2. Ventral view. Abbreviations: *Bo.*, basioccipital; *C.*, condyle; *Ex. O.*, exoccipital; *Fo. c.*, condyloid foramen; *Fo. inf.*, infraorbital foramen; *Fo. l. p.*, foramen lacerum posterius; *Fo. max.*, maxillary foramen; *Fr.*, frontal; *Ha.*, hamular process of pterygoid; *Ju.*, jugal; *La.*, lachrymal; *Max.*, maxilla; *Mes.*, mesethmoid; *Na.*, nasal; *Op. c.*, optic canal; *Pal.*, palatine; *Pmx.*, premaxilla; *Pt.*, pterygoid; *So.*, supraoccipital; *S. or. pr.*, supraorbital process of frontal; *St. pr.*, styliform process of jugal; *V.*, vomer; *Zyg.*, zygomatic process of squamosal.

PLATE 2

Lateral view of type skull of *Eurhinodelphis bossi*, new species. About one-sixth natural size.

PLATE 3

Dorsal view of type mandible of *Eurhinodelphis bossi*, new species. About three-tenths natural size.

PLATE 4

Posterior view of type skull of *Eurhinodelphis bossi*, new species. About one-half natural size.

PLATE 5

Ventral view of skull of *Eurhinodelphis bossi*. Individual 2, Cat. No. 10714, United States National Museum. About five-sevenths natural size. View showing foramina within the tympano-periotic recess and the relations of the various elements composing the ventral face of the skull. The external reduplication of the pterygoid and the orbitosphenoid are missing. Hence the outer wall of the nasal passage is also missing. Abbreviations: *Al.*, alisphenoid; *Bo.*, basioccipital; *Bo. pl.*, descending plate or falcate process of the basioccipital; *C.*, condyle; *Ex. o.*, exoccipital; *Fo. inf.*, infraorbital foramen; *Fr.*, frontal; *Ju.*, jugal; *La.*, lachrymal; *Max.*, maxilla; *Op. c.*, optic canal; *Pal.*, palatine; *Pt.*, pterygoid; *S. or pr.*, supraorbital process of frontal; *Sq*, squamosal; *V.*, vomer; *Zyg.*, zygomatic process of squamosal; 1, carotid canal; 2, passage for mandibular branch of trigeminal nerve; 3, furrow for mandibular branch of trigeminal nerve; 4, foramen lacerum medius; 5, jugular foramen or foramen lacerum posterius, compartment for nerves; 6, jugular foramen or foramen lacerum posterius, compartment for vein; 7, condyloid foramen or hypoglossal canal in jugular incisure.

PLATE 6

Views of scapula and vertebrae of *Eurhinodelphis bossi*. Fig. 1, dorsal or external view of left scapula (about three-sevenths natural size); Fig. 2, posterior epiphysis of fifth caudal (about two-fifths natural size); Fig. 3, anterior view of fifth cervical (about one-half natural size); Fig. 4, ventral or internal view of left scapula (about three-sevenths natural size); Fig. 5, internal surface of epiphysis of an anterior caudal (about two-fifths natural size); Fig. 6, posterior view of fifth cervical (about one-half natural size).

PLATE 7

Views of dorsal vertebrae of *Eurhinodelphis bossi.* About three-tenths natural size. Fig. 1, anterior view of sixth dorsal vetebra; Fig. 2, anterior view of fifth dorsal vertebra; Fig. 3, anterior view of third dorsal vertebra; Fig. 4, posterior view of sixth dorsal vertebra; Fig. 5, posterior view of fifth dorsal vertebra; Fig. 6, posterior view of third dorsal vertebra; Fig. 7, anterior view of seventh dorsal vertebra; Fig. 8, anterior view of eleventh dorsal vertebra; Fig. 9, anterior view of tenth dorsal vertebra.

PLATE 8

Views of dorsal and lumbar vertebrae of *Eurhinodelphis bossi.* Figs. 1–3, about three-sevenths natural size; Figs. 4–5, about one-third natural size. Fig. 1, lateral view of third dorsal vertebra; Fig. 2, lateral view of fifth dorsal vertebra; Fig. 3, lateral view of sixth dorsal vertebra; Fig. 4, anterior view of eighth lumbar vertebra; Fig. 5, posterior view of sixth lumbar vertebra.

PLATE 9

Lateral views of posterior dorsal and lumbar vertebrae of *Eurhinodelphis bossi.* About two-fifths natural size. Fig. 1, eleventh dorsal vertebra; Fig. 2, tenth dorsal vertebra; Fig. 3, ninth dorsal vertebra; Fig. 4, eighth lumbar vertebra; Fig. 5, sixth lumbar vertebra; Fig. 6, tenth lumbar vertebra.

PLATE 10

Views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, anterior view of fifth caudal vertebra; Fig. 2, anterior view of eighth caudal vertebra; Fig. 3, anterior view of tenth caudal vertebra; Fig. 4, dorsal view of fourteenth caudal vertebra; Fig. 5, anterior view of fourteenth caudal vertebra.

PLATE 11

Lateral views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, fifth caudal vertebra; Fig. 2, eighth caudal vertebra; Fig. 3, tenth caudal vertebra.

PLATE 12

Views of caudal vertebrae and left humerus of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, dorsal view of fifth caudal vertebra; Fig. 2, dorsal view of eighth caudal vertebra; Fig. 3, dorsal view of tenth caudal vertebra; Fig. 4, internal view of left humerus; Fig. 5, posterior view of left humerus.

PLATE 13

Ventral views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, fifth caudal vertebra; Fig. 2, eighth caudal vertebra; Fig. 3, tenth caudal vertebra.

PLATE 14

Lateral views of ribs of *Eurhinodelphis bossi.* About nine-twentieths natural size. Fig. 1, first rib, right side; Fig. 2, second rib, right side; Fig. 3, third rib, right side; Fig. 4, fourth rib, right side; Fig. 5, fifth rib, right side; Fig. 6, sixth rib, right side; Fig. 7, ninth rib, right side; Fig. 8, tenth rib, right side; Fig. 9, third rib, left side; Fig. 10, fifth rib, left side.

PLATE 15

Skull of *Eurhinodelphis bossi.* Individual 2, Cat. No. 10714, United States National Museum. About one-fifth natural size. Fig. 1, dorsal view; Fig. 2, ventral view.

PLATE 16

Fig. 1. Lateral view of skull of *Eurhinodelphis bossi.* Individual 2, Cat. No. 10714, United States National Museum. About one-fifth natural size.

Fig. 2. Dorsal view of skull of *Eurhinodelphis bossi.* Individual 3, Cat. No. 10464, United States National Museum. About one-fifth natural size.

PLATE 17

Lateral view of skull of *Eurhinodelphis bossi.* Individual 4, Cat. No. 10711, United States National Museum. About one-third natural size.

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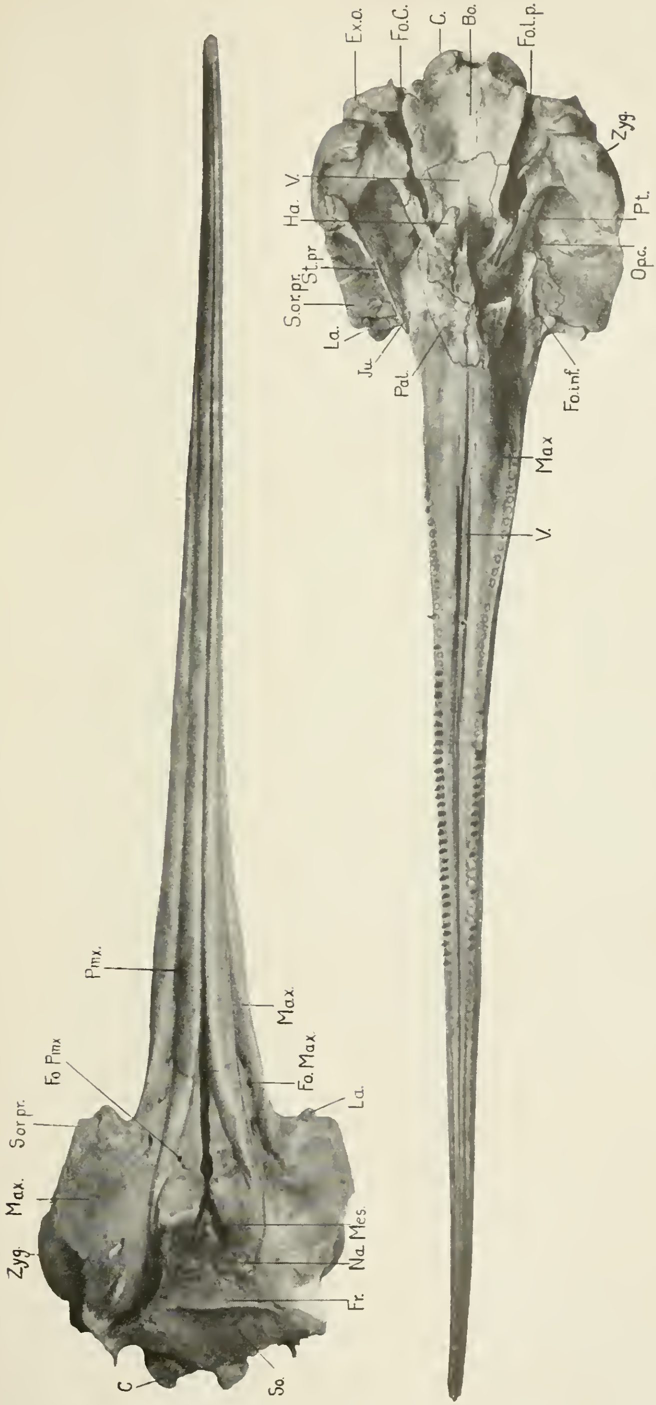
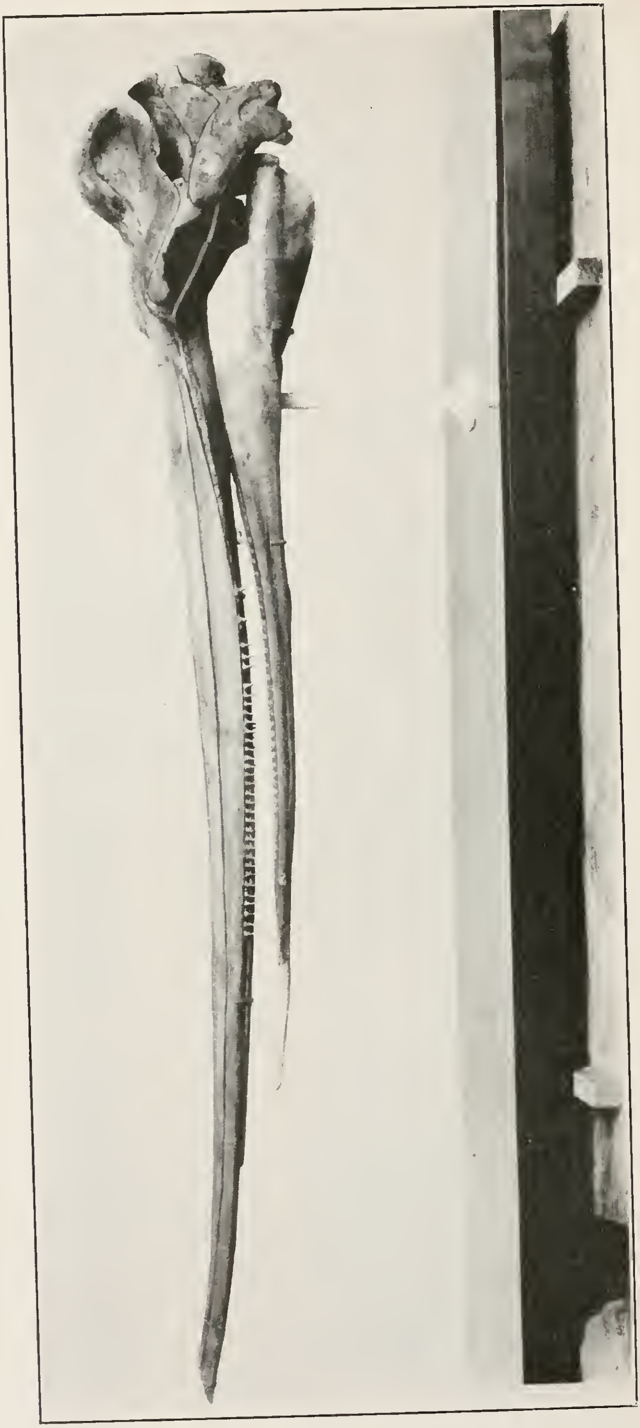


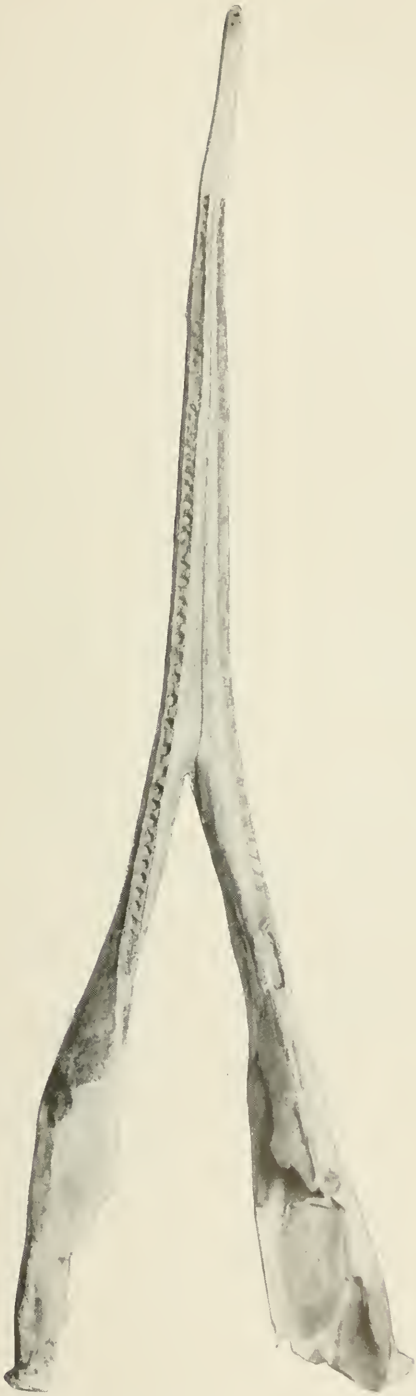
DORSAL AND VENTRAL VIEWS OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



LATERAL VIEW OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38

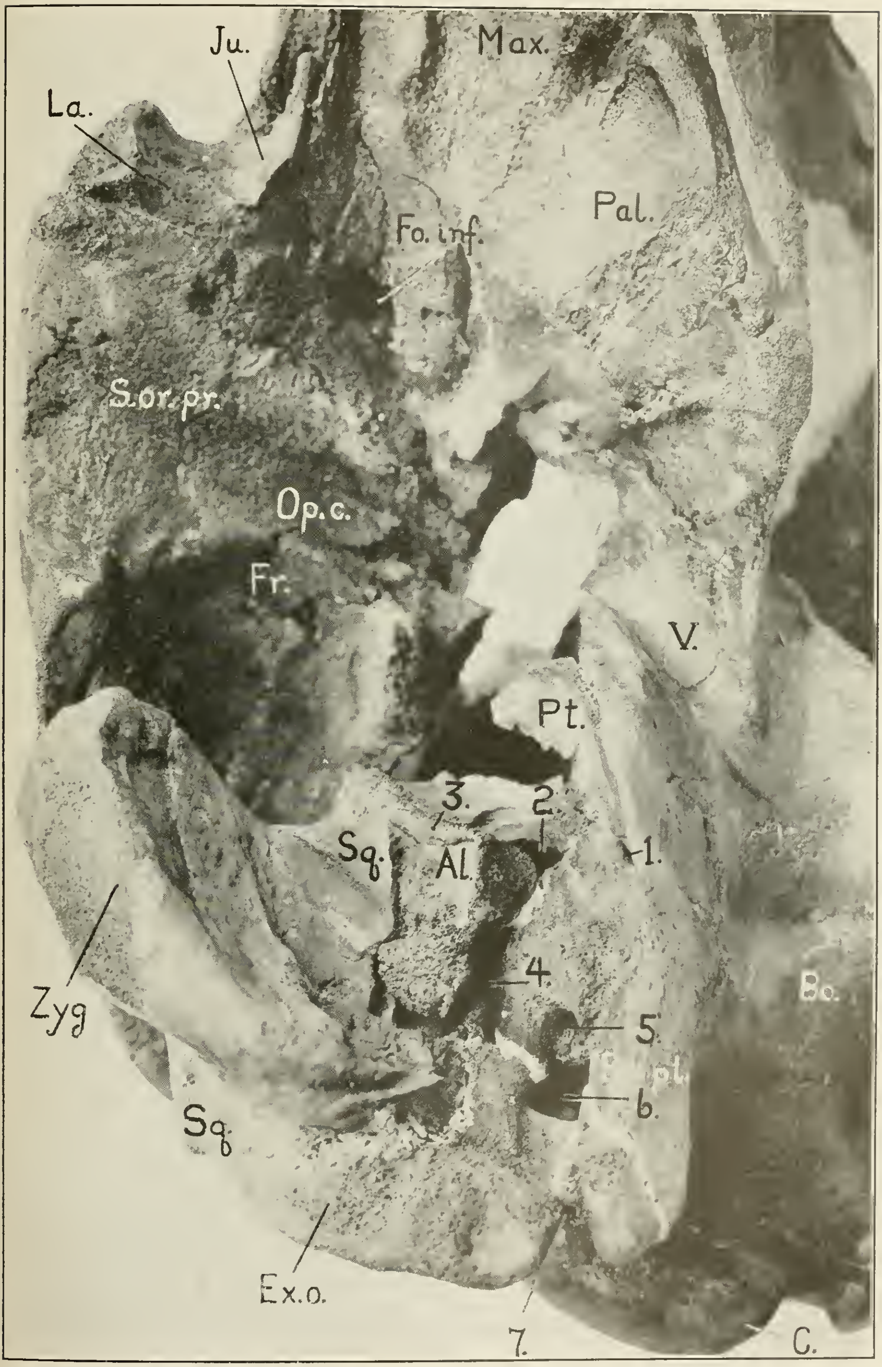


DORSAL VIEW OF TYPE MANDIBLE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38

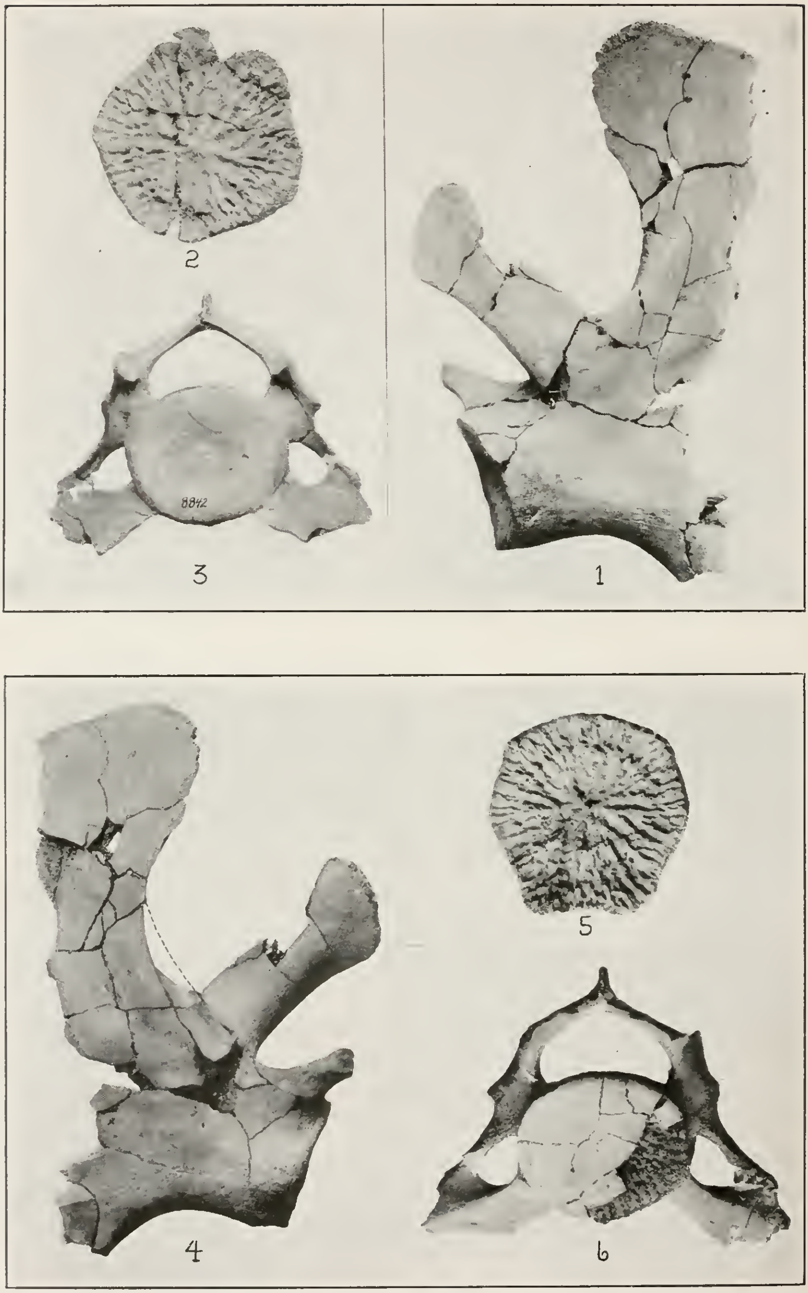
POSTERIOR VIEW OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



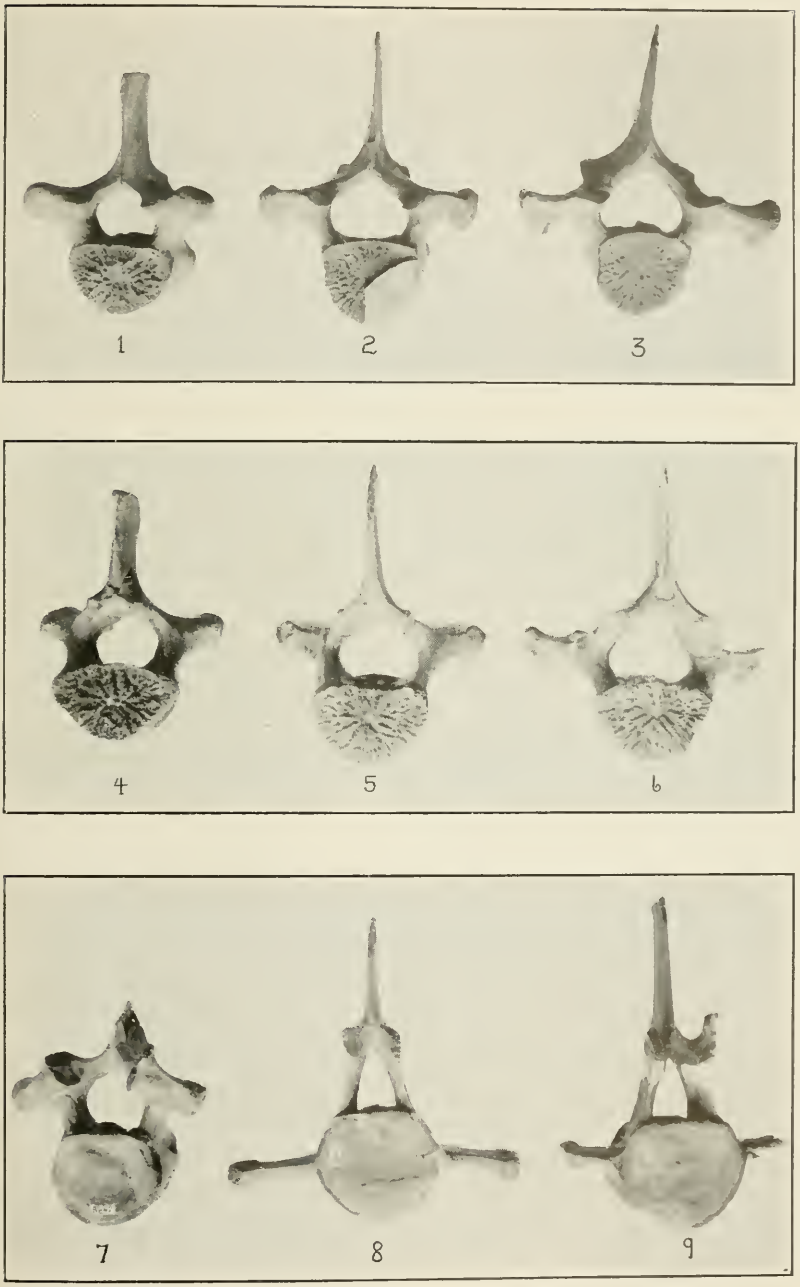
VENTRAL VIEW OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



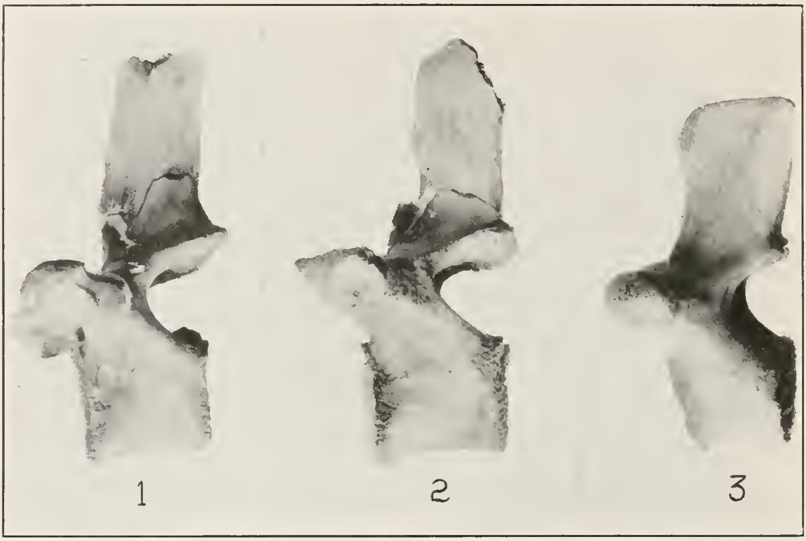
VIEWS OF SCAPULA, CERVICAL, AND EPIPHYSIS OF EURHINODELPHIS BOSSI

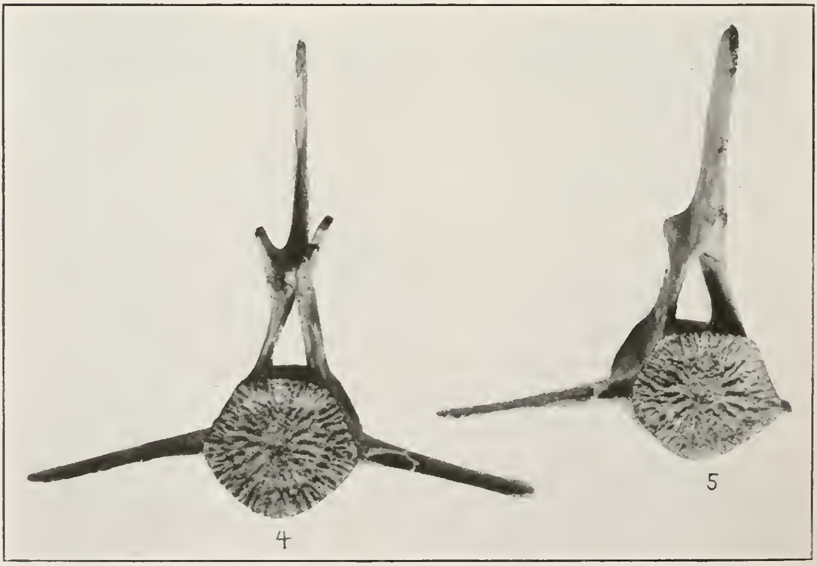
FOR EXPLANATION OF PLATE SEE PAGE 38



VIEWS OF DORSAL VERTEBRAE OF EURHINODELPHIS BOSSI

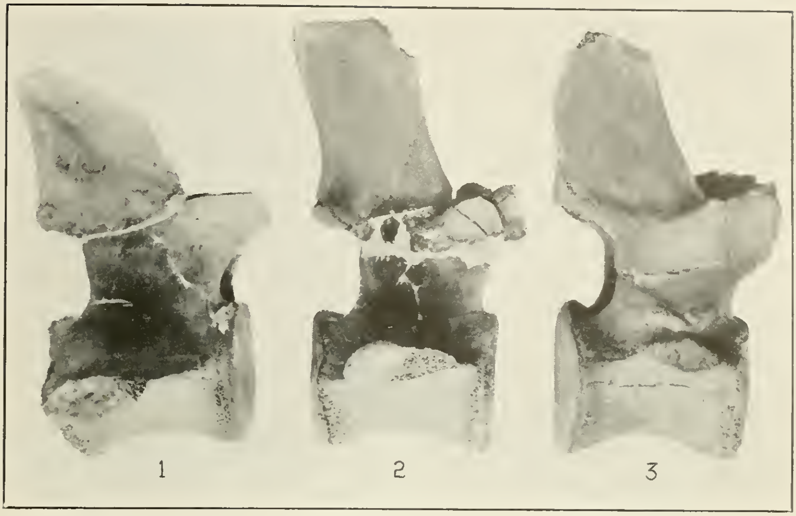
FOR EXPLANATION OF PLATE SEE PAGE 39

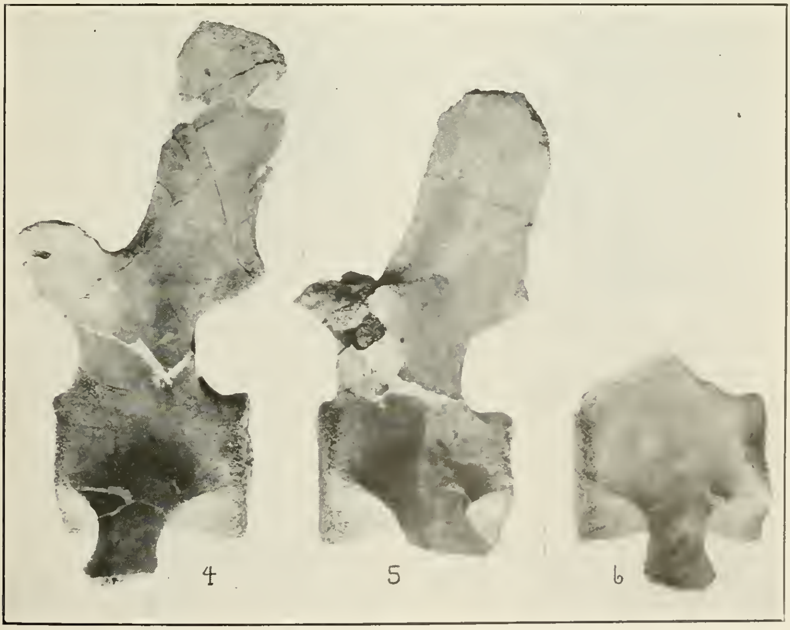




VIEWS OF DORSAL AND LUMBAR VERTEBRAE OF EURHINODELPHIS BOSSI

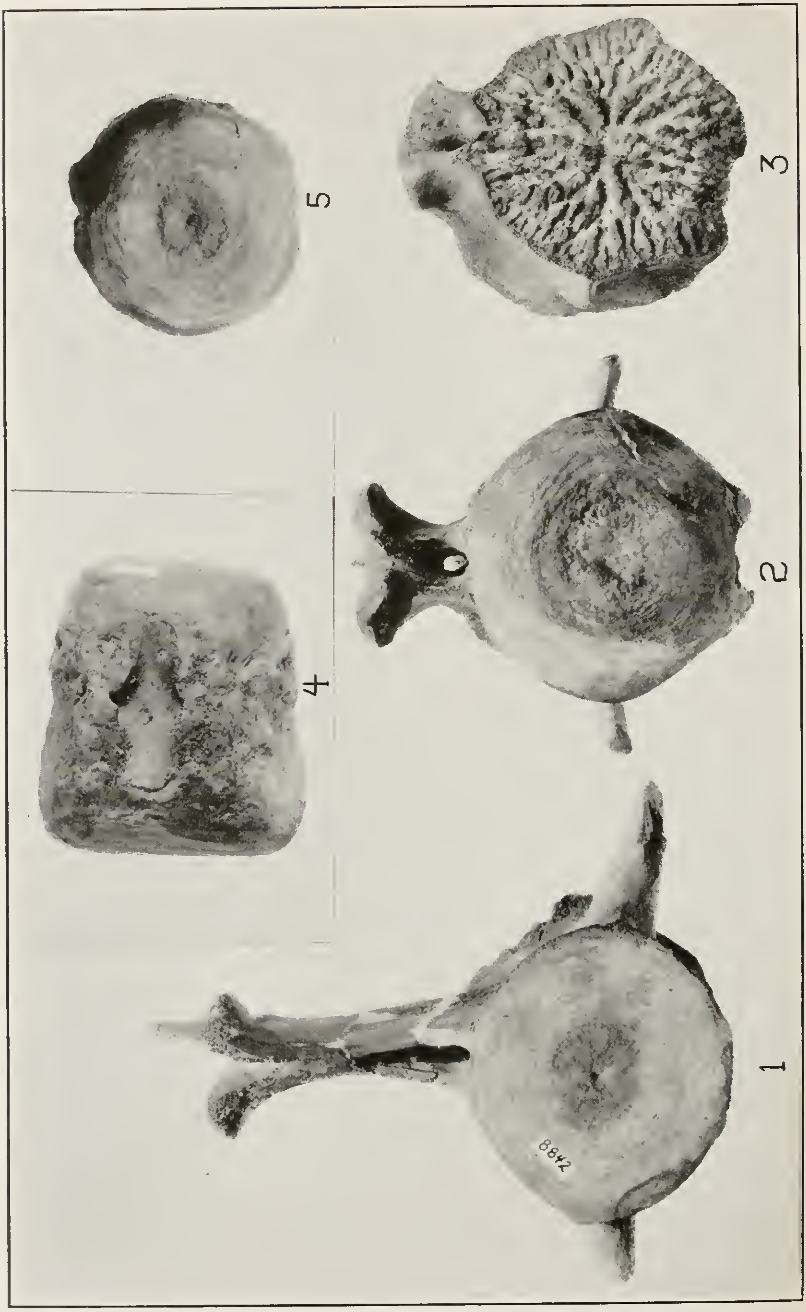
FOR EXPLANATION OF PLATE SEE PAGE 39





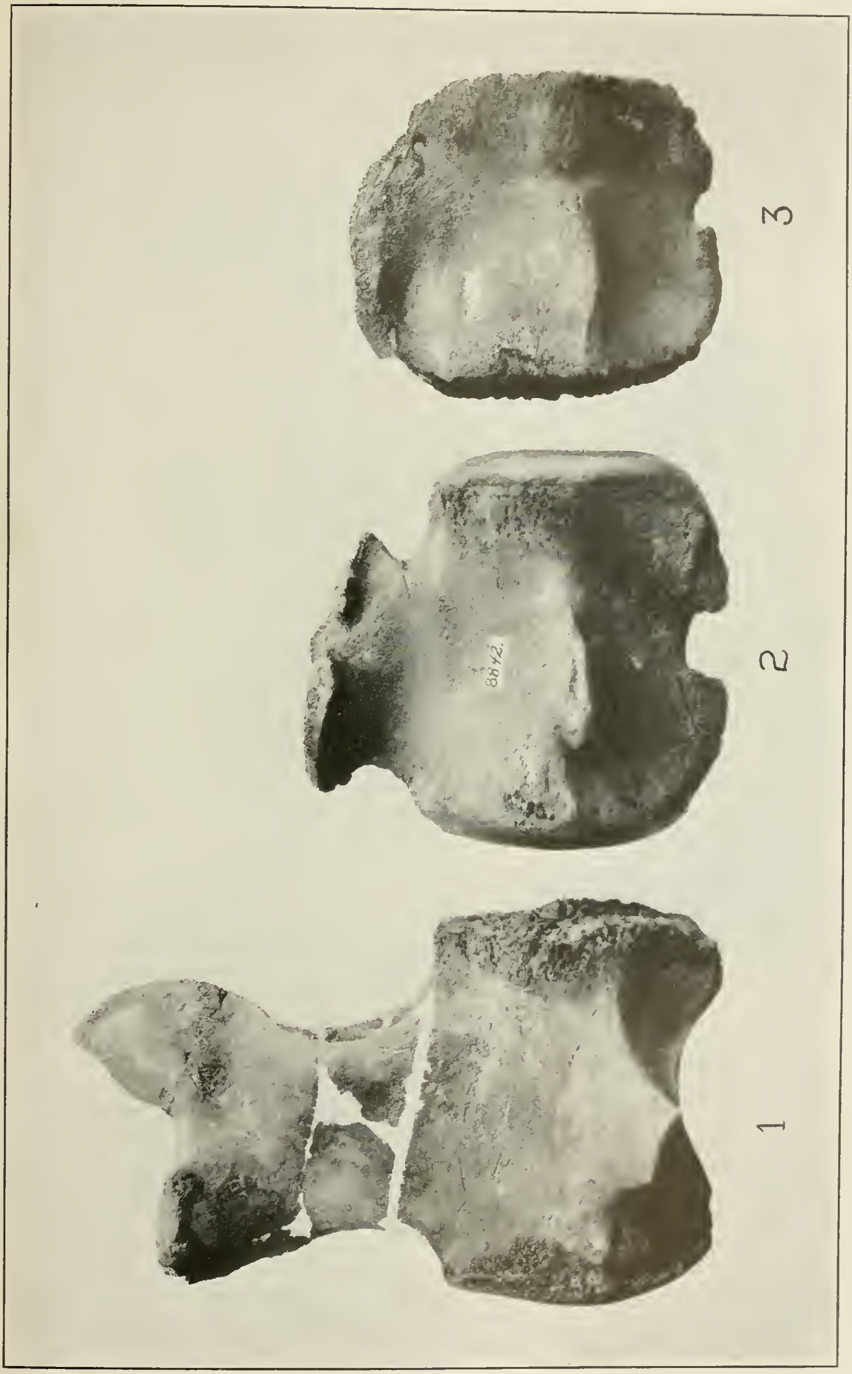
VIEWS OF DORSAL AND LUMBAR VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



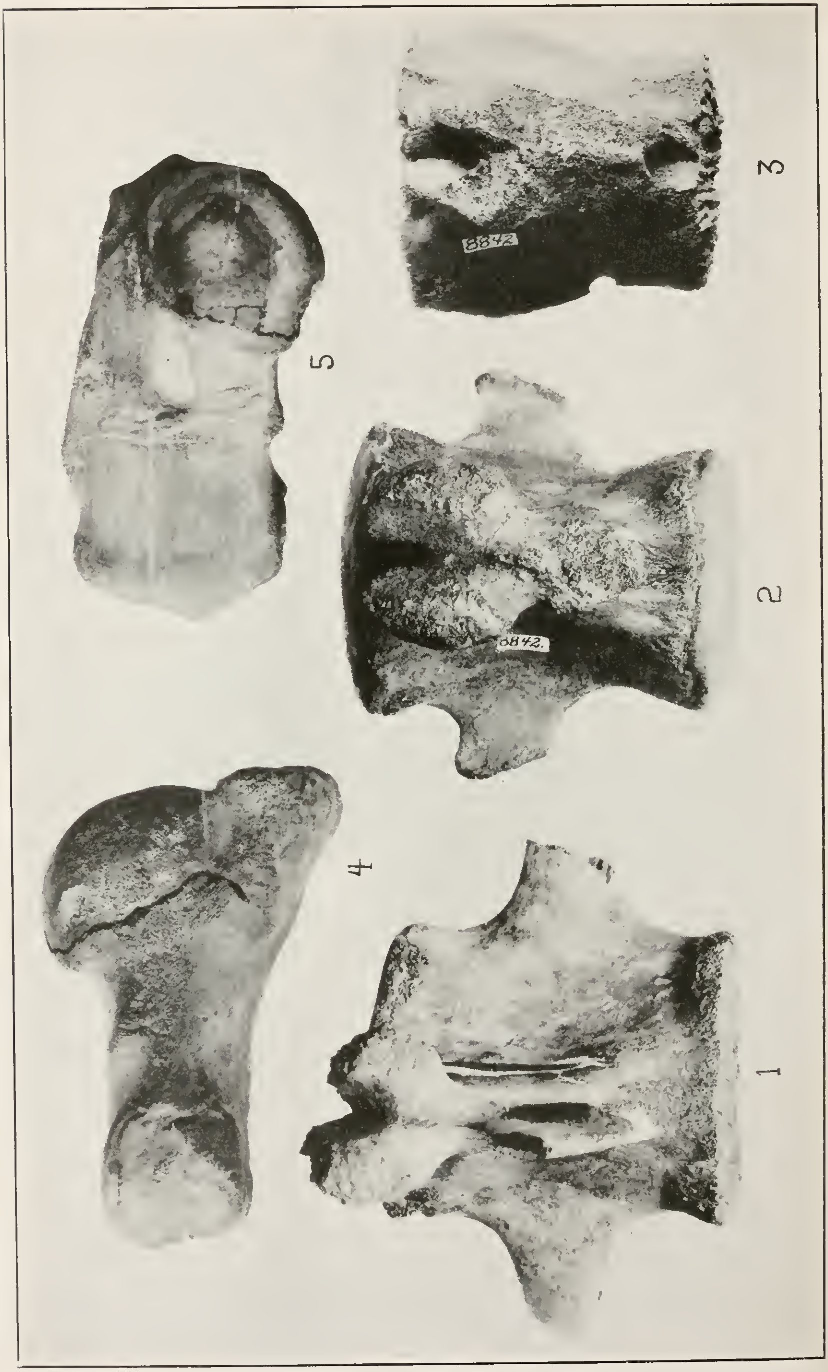
VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



LATERAL VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



VIEWS OF CAUDAL VERTEBRAE AND HUMERUS OF EURHINODELPHIS BOSSI

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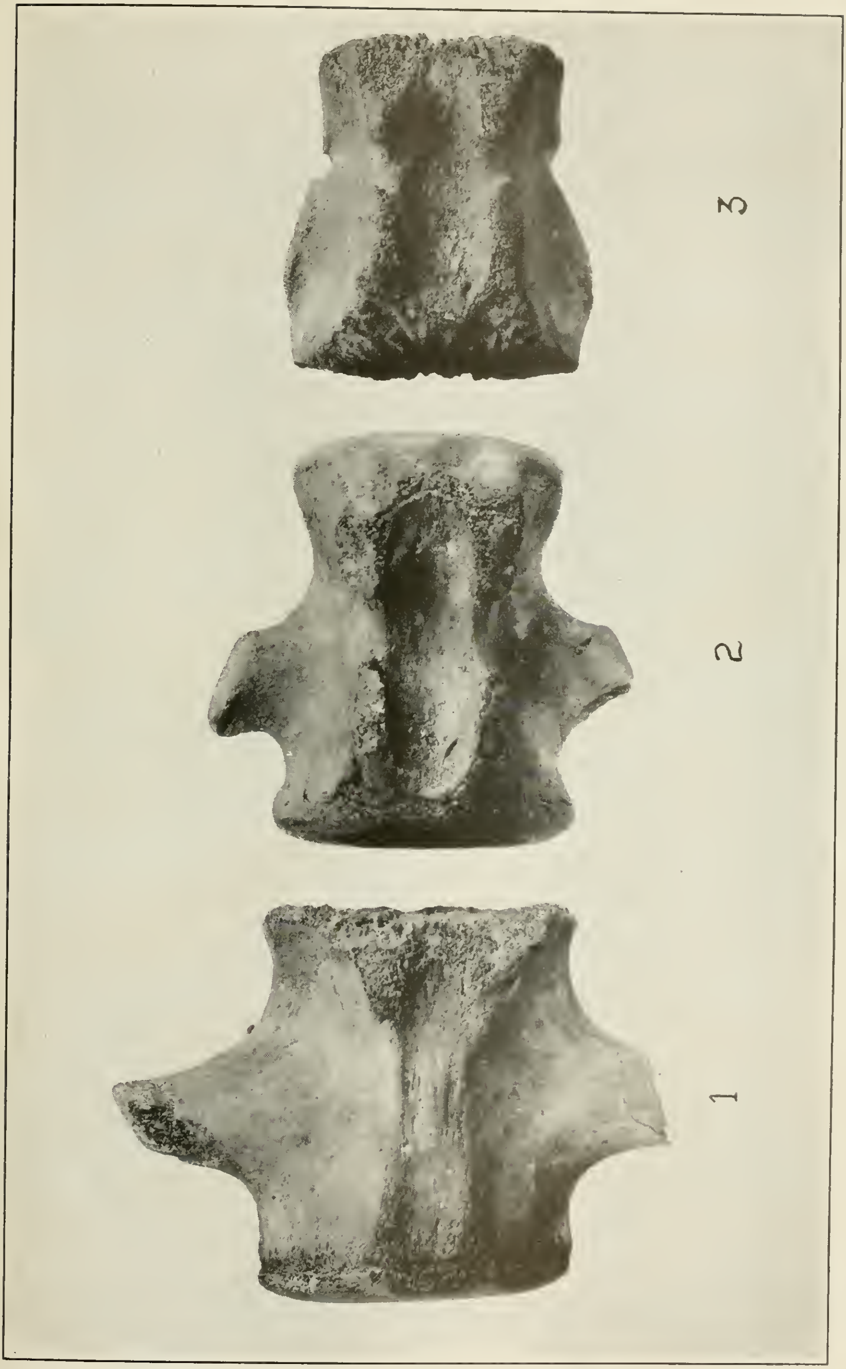
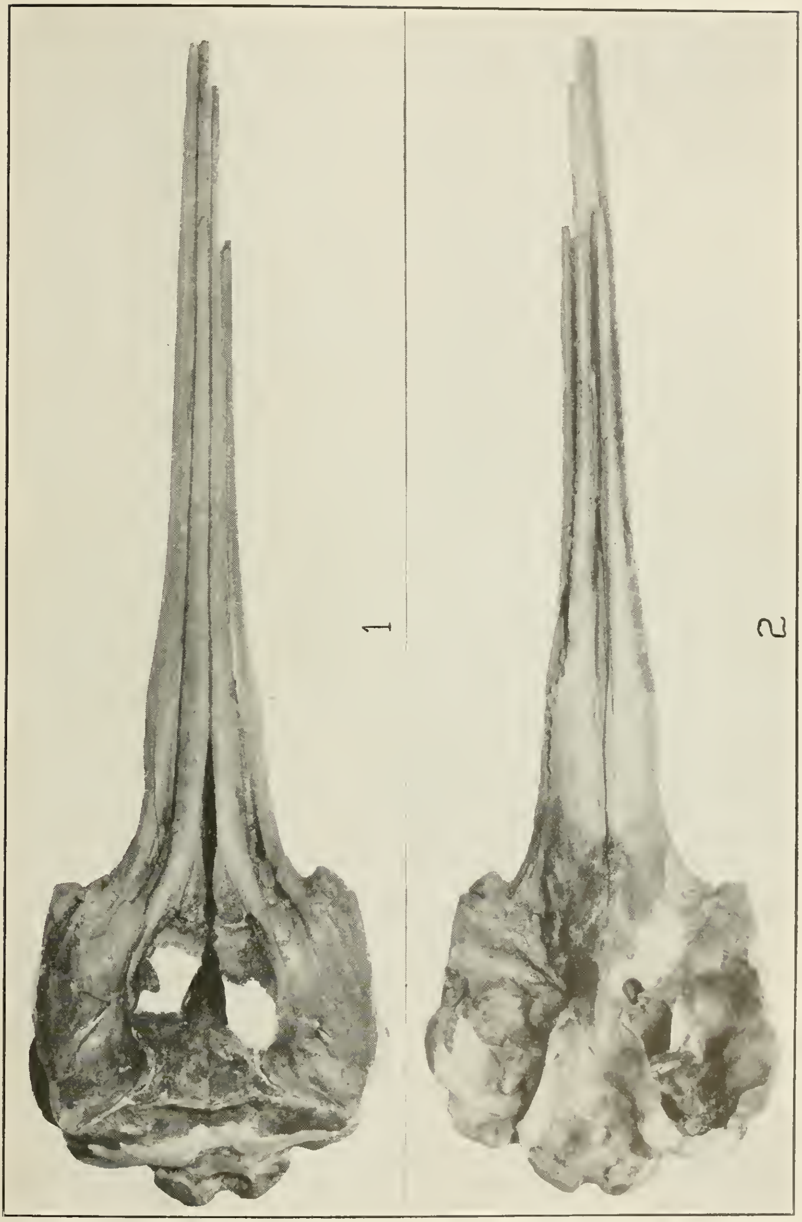


VENTRAL VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39

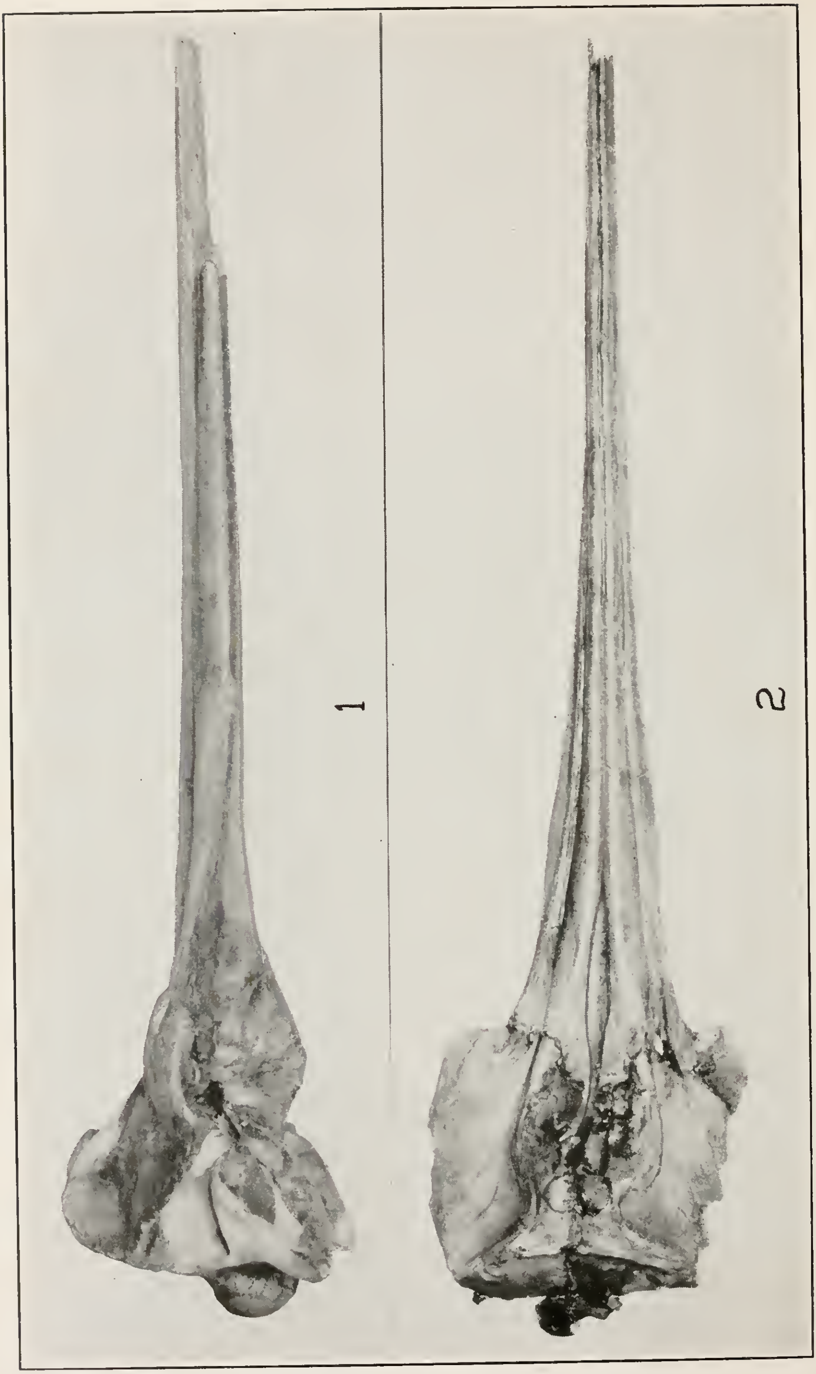
Lateral Views of Ribs of Eurhinodelphis bossi

For explanation of plate see page 39



DORSAL AND VENTRAL VIEWS OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40



VIEWS OF TWO SKULLS OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40

LATERAL VIEW OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40