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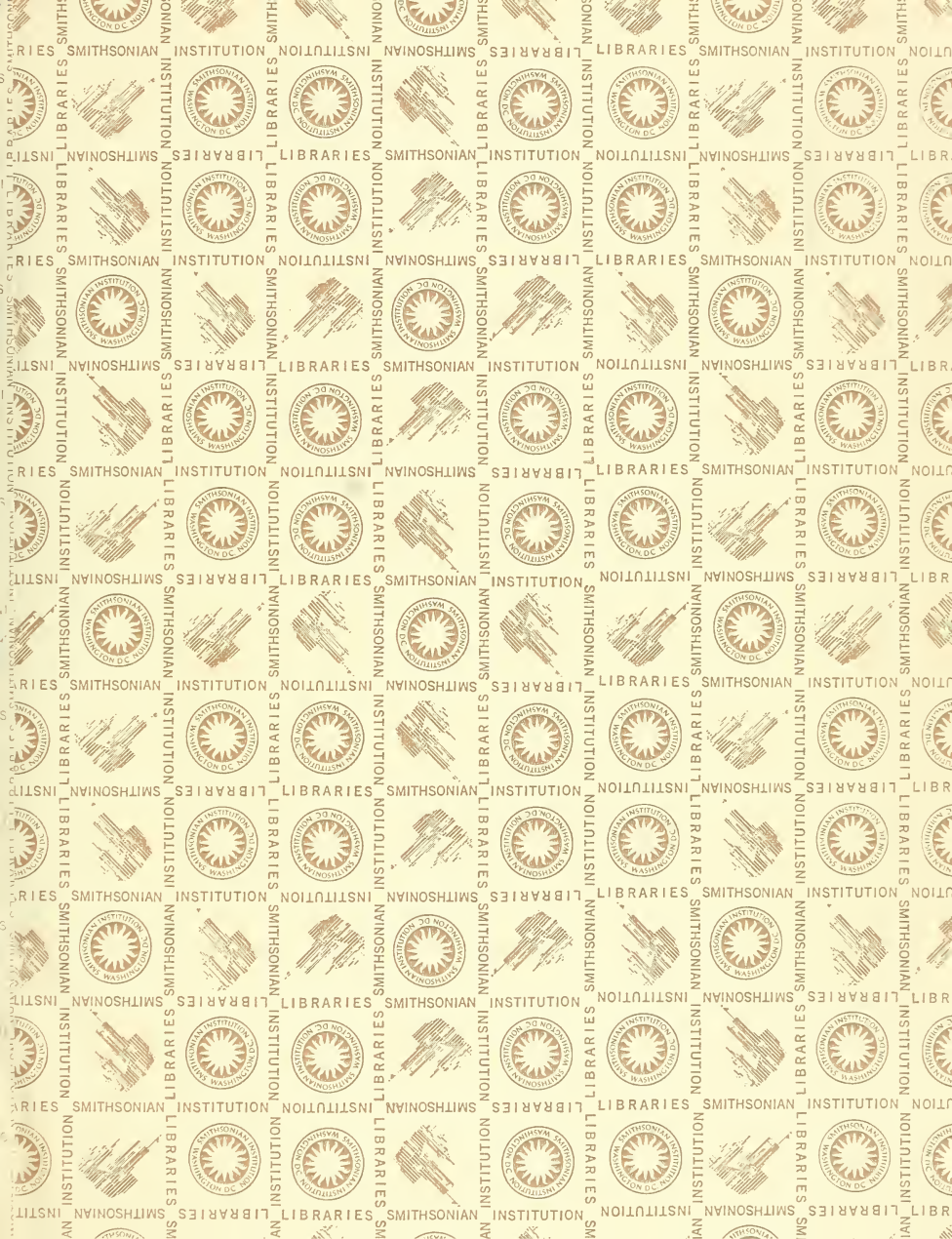
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[*From the* Transactions of the Zoological Society of London, vol. viii. part iii.]

VI. *On the recent Ziphioid Whales, with a Description of the Skeleton of* Berardius arnouxi. *By* William Henry Flower, *F.R.S., V.P.Z.S., Hunterian Professor of Comparative Anatomy, and Conservator of the Museum of the Royal College of Surgeons.*

Read November 7th, 1871.

[Plates XXVII., XXVIII., XXIX.]

The interest which attaches itself to the remarkable division of the Cetacea which forms the subject of the present communication, is in some respects even greater than that which belongs to all the other members of the order.

The Ziphioid Whales form a very compact group, closely united together by the common possession of very definite structural characters, and as distinctly separated from all other groups by equally definite characters.

With the singular exception of *Hyperoodon rostratus* (the structure and habits of which species are as well known perhaps as those of any other Cetacean), no specimen of the group had ever come under the notice of any naturalist up to the commencement of the present century. Since that time, however, at irregular intervals, in various and most distant parts of the world, solitary individuals have been caught or stranded, now amounting to about thirty, which by some naturalists are referred to upwards of a dozen distinct species, and to very nearly as many genera. No case is recorded of more than one of these animals having been observed in one place at a time; and their habits are almost absolutely unknown. Their very presence in the ocean seems to pass unnoticed and unsuspected by voyagers, and even by those whose special occupation is the pursuit and capture of various better known and more abundant cetaceans, until one of the accidental occurrences just alluded to reveals the existence of forms of animal life of considerable magnitude (for they range between fifteen and thirty feet in length), and at least sufficiently numerous to maintain the continuity of the race.

This comparative rarity at the present epoch contrasts greatly with what once obtained on the earth, especially in the period of the deposition of the Crag formations, and leads to the belief that the existing Ziphioids are the survivors of an ancient family which once played a far more important part than now among the Cetacean inhabitants of the ocean, but which have been gradually replaced by other forms, and are themselves probably destined ere long to share the fate of their once numerous allies or progenitors.

These considerations are sufficient to lead to the endeavour to collect all available information with regard to them, and to put it in a convenient form for the guidance of those who may have opportunities to pursue their history further. Doubtless such

opportunities will become more and more frequent as the attention of naturalists in various parts of the world is directed to the importance of never omitting any chance of observing and, if possible, securing the remains of every specimen of the group that may come within his reach.

The Ziphioid[1] Cetaceans belong to the great primary division or suborder of the Odontocetes, or Toothed Whales. The following are their principal common characteristics, as far as they can be defined in the absence of sufficient knowledge of the structural characters of several forms:—

1. No functional teeth in the upper jaw.

2. Teeth of mandible quite rudimentary and concealed in the gum, with the exception of one, or occasionally two, pairs, which may be largely developed, and project like tusks from the mouth, especially in the male sex.

3. Bones of the cranium raised so as to form an elevated prominence or crest behind the nares.

4. Rostrum long and narrow.

5. Pterygoid bones very large and solid, produced backwards, meeting in the middle line, and not involuted but simply hollowed on the outer surface.

6. A distinct bone in the orbit, segmented from the posterior part of the malar, and probably the homologue of the lachrymal.

7. The tympano-periotic bone fixed to the cranium by a posterior, long, wedge-shaped (mastoid?) process lying in a groove between the exoccipital and the squamosal.

8. Number of vertebræ not exceeding 50; ribs not exceeding 10 pairs.

9. Transverse processes of arches of dorsal vertebræ ceasing abruptly near the end of the series, and replaced by processes on the body at a much lower level, and which are in a line (or serially homologous) with the lumbar transverse processes.

10. Spines of dorsal and lumbar vertebræ very long, transverse processes short, bodies of posterior lumbar and anterior caudal vertebræ much elongated.

11. Sternal ribs permanently cartilaginous.

12. Pectoral limbs small, with a rounded extremity. The five digits all moderately well developed.

13. A small subfalcate dorsal fin, situated considerably behind the middle of the back.

14. External respiratory aperture a single, transverse, median, subcrescentic opening.

15. A pair of longitudinal cutaneous furrows on the throat, nearly meeting in the middle line in front, and diverging posteriorly.

By the majority of the above characters, and all the more important ones, as Nos. 1,

[1] According to strict rules of priority, "Hyperoodontoid" would be the more correct term, as *Hyperoodon* was the first genus of the group distinctly characterized; but as the name is erroneous in its signification, and not hitherto used, I have thought it better to keep to the more generally adopted and less objectionable term of "Ziphioid" first applied by Gervais to the animals allied to the Cuvierian genus *Ziphius*. They constitute Eschricht's *Rhynchoceti*.

3, 5, 7, 9, 11, and 12, they differ from the typical Dolphins and agree with the Cachalots; and though they are separated from the latter by certain definite characters, as Nos. 2 and 6, and others of less importance, there is no doubt that the group of which *Physeter* is the type and that which includes *Ziphius* and its immediate allies are closely related, and should be considered subdivisions of one great division which excludes all the other Odontocetes. Perhaps it is most convenient to treat them as subfamilies of a common family *Physeteridæ*, taking its name from the earliest characterized genus *Physeter* (Linn.), and, according to the convenient nomenclature rules of the British Association Committee, to call one *Physeterinæ* and the other *Ziphiinæ*[1]; though some zoologists may prefer to raise both to the rank of families.

Among the restricted Delphinidæ no genus is known which appears to form any true transition towards the Physeteridæ; but the strange and aberrant genera *Platanista*, *Inia*, and *Pontoporia*, which cannot be placed in either of the two principal families of the Odontocetes, and yet have scarcely sufficient common characters to constitute a group apart, do in some few respects fill up the otherwise wide intermediate space[2].

The excessively confused synonymy of the genera and species of the Ziphiinæ, as thus defined, is a cause of great difficulty in writing about this group, and makes one almost hesitate to enter upon the subject, lest in endeavouring to clear up the confusion the perplexity should be inadvertently increased, either by adding new synonyms or by adopting and perpetuating ill-chosen and incorrect terms.

In a recent memoir on the group by Professor Owen[3], the difficulty is disposed of in a very summary manner by uniting all the known forms, both living and extinct (with the exception of *Hyperoodon*), under the generic name of *Ziphius*. This proceeding at all events has the merit of running no risk of adding to the confusion of nomenclature which has been caused by hasty or ill-defined generic subdivisions, often founded on imperfect or fragmentary knowledge of the animal described. But, however great our admiration may be for this strong-handed resistance to the system of name-coining, which is fast rendering the study of zoology almost an impossibility, it must not lead us to overlook well-marked structural characteristics by which certain small groups of species are allied together and differentiated from others, whether we call them genera or by any other term. The question now is, can the genus *Ziphius*, as understood by Owen, be divided into any such groups?

[1] This is the arrangement adopted in the sketch of the classification of the Cetacea given in Trans. Zool. Soc. vol. vi. p. 113.

[2] In the attempt at a natural classification of the Cetacea just referred to, I had provisionally grouped these genera into a single family, between the Physeteridæ and the Delphinidæ; but the details of the anatomy of *Pontoporia*, first made known in the valuable monograph of Dr. Burmeister, published in the 'Anales del Museo Publico de Buenos Aires,' vol. i. pp. 389–442 (1869), show that this family can scarcely be retained, without at least considerable modification of the characters assigned to it. The only alternative seems to be to make of each of these three genera a distinct family.

[3] "British Fossil Cetacea from the Red Crag," Palæontographical Society's vol. xxiii. (1870).

It must be premised that as far as is at present known, putting aside the peculiar rounded form of the head in *Hyperoodon*, the external characters of the various known Ziphiinæ afford no grounds for generic subdivision. It is to the skeleton and the teeth that we must look in examining whether the group is truly homogeneous or not; and it is only very recently that complete skeletons of a sufficient number of individuals have been known, to attempt a comparison between them. The teeth have been relied upon almost entirely; and I agree with Professor Owen that the trifling differences in the situation of the developed teeth are not such as, unless accompanied by other more important and constant characters, are sufficient for generic distinction; but, at the same time, if such differences are constantly associated with others, they may be useful guides to classification.

Hyperoodon (Lacépède) appears to differ from all the other Ziphiinæ in the characters of the cervical vertebræ, especially in their great antero-posterior compression, the constant ankylosis of all seven, and the absence of inferior transverse processes in the third, fourth, fifth, and sixth[1]; it has also only nine pairs of ribs, and but forty-five vertebræ in all[2]. In the more essential characters of the cranium it resembles one of the other sections to be spoken of presently (*Mesoplodon*), with the superaddition of the great maxillary crests; and in the dentition it resembles more nearly another section (*Ziphius*).

Having separated *Hyperoodon*, the remaining known members of the subfamily agree in having a comparatively well-developed cervical region, with certain of the posterior vertebræ (one, or usually more) permanently detached, and with distinct inferior transverse processes as far as the sixth, in having almost always ten pairs of ribs[3] and at least forty-six vertebræ, usually forty-eight or forty-nine. There are, however, in the conformation of the skull and the form and situation of the teeth considerable differences, by which they may be divided into three distinct sections, which appear to me to be natural, and which are not, as far as is yet known, united by intermediate forms; so I think that they may well be considered generic, though of course this is a subject upon which the judgment of zoologists may differ. I can see no grounds at present for any further subdivision.

These sections may be characterized as follows—though the distinctive peculiarities are more readily appreciated by an inspection of a specimen than they can be expressed in words.

[1] The great differences between the cervical vertebræ of *Hyperoodon* and *Ziphius cavirostris* (erroneously called *Hyperoodon gervaisii*) were pointed out by Duvernoy (Annales des Sciences Naturelles, 1851, p. 24).

[2] The animal described by Cope, apparently without personal examination, as *Hyperoodon semijunctus* (Proc. Acad. Nat. Sc. Philadelphia, 1865, p. 280), and stated to be in the Charleston Museum, is evidently not a *Hyperoodon*, but most probably a true *Ziphius*. It was but between twelve and thirteen feet long, has the four posterior cervical vertebræ free, has ten pairs of ribs, and two more vertebræ than *Hyperoodon*.

[3] The skeleton of *Ziphius cavirostris* at Jena has but nine pairs of ribs.

ZIPHIUS, Cuvier[1].

Skull with the præmaxillæ immediately in front and at the sides of the nares expanded, hollowed, and with elevated lateral margins, the posterior ends rising to the vertex and curving forwards, the right being considerably more developed than the left; the conjoined nasals forming a strongly pronounced asymmetrical eminence at the top of the cranium, projecting forwards over the nares, flat above, most prominent and rounded in the middle line in front, and separated by a notch on each side from the præmaxillæ. Anteorbital notch not distinct. Rostrum (seen from above) triangular, gradually tapering from the base to the apex, upper and outer edges of maxillæ at base of rostrum raised into low roughed tuberosities. Mesethmoid cartilage usually densely ossified, and coalescing with the surrounding bones of the rostrum.

A single conical tooth of moderate size on each side of the mandible, close to the anterior extremity, with its apex directed forwards and upwards.

The type of this genus is *Ziphius cavirostris*, Cuvier, founded on an imperfect skull picked up in 1804 on the Mediterranean coast of France, near Fos, Bouches-du-Rhône. and described and figured in the 'Ossemens Fossiles'[2], under the impression that it was that of an extinct species, a view which Gervais has clearly shown to have been erroneous. This is *Petrorhynchus mediterraneus* of Gray's Suppl. Cat. Seals and Whales in British Museum, 1871, p. 98.

A second specimen was taken on the coast of Corsica: its external characters are described and figured by Doumet in the 'Revue Zoologique,' v. 1842, pp. 207, 208; and its skeleton is preserved at Cette[3].

A third specimen was stranded near Aresquiers, Hérault, South France, in 1850. The skull, which is preserved in the Paris Museum, is described by Gervais (Annales des Sciences Nat. 3e sér. tome xiv. 1850). This is the *Hyperoodon gervaisii* of Duvernoy (Annales des Sc. Nat. 1851), *Ziphius gervaisii* of Fischer, and *Epiodon desmarestii* of Gray's Catalogue[4].

A fourth is a skull is the Museum of Arcachon. It was found on the beach at Lanton, Gironde, West France, in 1864, and is very carefully described and figured by Fischer in the 'Nouvelles Archives du Muséum,' tome iii. 1867, p. 42, pl. 4[5].

5. A complete skeleton of a very old animal in the Anatomical Museum of the University of Jena. This was obtained at Villa Franca in 1867, by Professor Haeckel, but has not yet been described.

[1] "J'appliquerai au genre dont elle [skull of *Z. cavirostris*] devient le premier type, le nom de *Ziphius*, employé par quelques auteurs du moyen âge (voyez Gesner, i. p. 209) pour un Cétacé qu'ils n'ont point déterminé."—CUVIER, *Ossemens Fossiles*.

[2] This skull is also figured in Van Beneden and Gervais's 'Ostéographie des Cétacés,' pl. 21. fig. 7.

[3] Figured in Van Beneden and Gervais, *op. cit.* pl. 21. figs. 8, 9.

[4] Figured in Van Beneden and Gervais, *op. cit.* pl. 21. figs. 1–6.

[5] Figured in Van Beneden and Gervais, *op. cit.* pl. 21. fig. 6.

6. A skeleton in the Museum at Gottenburg. From Gullmarsfjärden, on the Swedish coast, north of Gottenburg, 1867 (*vide* Malm, "Hvaldjur i Sveriges Museer ar 1869." Kongl. Svenska Vetenskaps Akademiens Handlingar, Band 2. no. 2. 1871).

7. A skull in the Anatomical Museum, Edinburgh, obtained from Shetland, 1871.

8. A skeleton in the Museum at Pisa from the Mediterranean. Professor Gervais has informed me of this specimen, which has not been described.

9. In the Museum of the University of Louvain is a skull of an animal of this genus brought from the Cape of Good Hope, of which an excellent description has been published by Professor Van Beneden, under the name of *Ziphius indicus* (Mém. de l'Acad. Roy. de Belgique, coll. in-8vo, tome xvi. 1863[1]).

10. A very similar skull in the British Museum, also from the Cape of Good Hope, has been described by Gray (Proc. Zool. Soc. 1865, p. 524) under the name of *Petrorhynchus capensis*; and the same name is retained in the Suppl. Cat. Seals and Whales (1871), p. 98, although its specific identity with the last-named previously described specimen is admitted. It is further described by Owen (Crag Cetacea, Palæont. Soc. 1870, p. 7)[2].

11. A complete specimen of a young male, 3·95 metres long, was taken near Buenos Ayres in 1865, and is the subject of an elaborate memoir by Burmeister (Anales del Museo publico de Buenos Aires, vol. i. p. 312, 1869), accompanied by detailed figures of external characters, skeleton, and some of the viscera. The specimen was first named in a preliminary notice (Ann. & Mag. Nat. Hist. 1866, xvii. p. 94) *Ziphiorrhynchus cryptodon*, but described subsequently as *Epiodon australis*.

Until more abundant materials are obtained, and especially a complete knowledge of the external characters or entire skeleton of several individuals, it is impossible to determine whether the differences that have been noticed in the above specimens are the results of age, sex, individual peculiarity, or whether they denote specific distinctions. For the present it may be advisable to admit *Z. cavirostris* (Nos. 1, 2, 3, 4, 5, 6, 7, and 8) and *Z. indicus* (Nos. 9 and 10) as species; but with reference to No. 11, it is not improbable that it is the young of one of the others. It should be remarked that Fischer, after a careful comparison, arrives at the conclusion that No. 3 is specifically distinct from *Z. cavirostris*, although not agreeing with Duvernoy's opinion that it should be placed in the genus *Hyperoodon*.

Mesoplodon[3], Gervais.

Præmaxillæ not greatly expanded and hollowed in front of the nares, rising suddenly

[1] Figured in Van Beneden and Gervais's 'Ostéographie des Cétacés,' pl. 21. figs. 11–13.

[2] Figured in Van Beneden and Gervais, *op. cit.* pl. 21. fig. 10.

[3] There is much difficulty in determining the most appropriate name for this genus. The earliest known specimen was assigned by its discoverer Sowerby to *Physeter*, from which, however, it is clearly distinct. In the classification of the Dolphins furnished by De Blainville to Desmarest's article "Dauphin" in the 'Nouveau

on the sides of the nares to the vertex, where they are dilated laterally, the right one especially, the outer edges curving backwards, their anterior surface arching forwards above, overhanging the nares. Nasals lying, more or less sunken, in a hollow between the upper ends of the præmaxillæ; their anterior surface more or less concave, not projecting so far forward as the upper part of the præmaxillæ, and not separated on each side from those bones by a distinct notch. Anteorbital notch not very distinct. Rostrum long and narrow. No maxillary tuberosities. Mesethmoid generally ossified in its entire length, and coalescing with the surrounding bones.

A much compressed pointed tooth in each ramus of the mandible, variously situated, but generally at some distance behind the apex; its point directed upwards, and often somewhat backwards, occasionally developed to a great size (in the males ?).

Dictionnaire d'Histoire Naturelle,' 2nd edit. Paris, 1817, the subgenus *Heterodon* comprises eight species, of which five (*D. grœnlandicus, chemnitzianus, edentatus, bidentatus*, and *butskode*) are synonyms of *Hyperoodon rostratus*, one (*D. epiodon*) an ill-described species from the Mediterranean, perhaps a true *Ziphius*, and two (*D. sowerbensis* and *D. densirostris*), undoubtedly belong to the section at present under consideration, being founded on the only specimens at that time known to naturalists. It is clear, therefore, that Blainville's *Heterodon* is equivalent to the present section, *plus Hyperoodon*; and the latter being removed, the name might very well have been retained for the remainder, if it had not been previously in use for a genus of snakes. *Heterodon* is employed in the same sense as by De Blainville for a subgenus in Desmarest's 'Mammalogie,' pt. 2. 1822, and as a genus in Lesson's 'Manuel de Mammalogie,' 1827. The specimen taken at Havre in 1825, apparently a female of Sowerby's Dolphin, supposed by its first describer, De Blainville, to be of the same species as the Dolphin described by Dale (now considered a *Hyperoodon*), was named by Cuvier *Delphinus micropterus*, and forms the type of the genus *Delphinorhynchus* of F. Cuvier's 'Histoire des Cétacés' (1836), being associated with several other Dolphins of very different structure and even belonging to different families. But *Delphinorhynchus* had been previously used by Blainville, in the article above cited, for a heterogeneous group of Dolphins, among which none of the present genus appears; so that it is perfectly inadmissible. The term *Diodon*, proposed by Lesson for the male, was already in general use for a genus of fish. *Aodon* (Lesson, Compl. de Buffon), changed to *Nodus* (Wagler, Syst. de Amph. 1830), likewise proposed for the female, being positively erroneous in signification, have never been generally received. Wagner (Schreber, Supplement, p. 352, 1846) constituted *Micropterus* as a subgenus of *Delphinus*, for the then known animals of the group, uniting them into a single species, but overlooking the fact that the name had already been given to more than one genus in the animal kingdom. Eschricht, however, adopted it in a generic sense (Nordische Wallthiere, p. 50, 1849), altering the spelling to *Micropteron*, in which form it has been used by Huxley (Proc. Geol. Soc. 1864, p. 388). In 1850 Gervais (Annales des Sciences Naturelles, 3e sér. tom. xiv.) divided the group (as defined above), though, as appears to me, on very insufficient grounds, into two genera, which he named *Mesoplodon* and *Dioplodon*, Blainville's *Heterodon sowerbensis* being the type of the one, and his *H. densirostris* the type of the other. In the following year Duvernoy, in a memoir in the same journal, reunited them, bestowing the name of *Mesodiodon* on the whole group. Subsequently Fischer (Nouv. Archives du Muséum, iii. 1867, p. 67), not recognizing Gervais's divisions, adopted his name *Mesoplodon* for the entire genus, in which I have followed him. Owen, as above mentioned, includes this group, with all the rest of the subfamily, except *Hyperoodon*, in the Cuvierian genus *Ziphius* (Crag Cetacea, Palæont. Soc. vol. xxiii.), while Gray (Suppl. Cat. Seals and Whales in Brit. Mus. 1871) divides it into *Ziphius, Dolichodon, Neoziphius*, and *Dioplodon*, which, with *Berardius*, constitute the family Ziphiidæ—the type of Cuvier's *Ziphius* being placed, under the name of *Petrorhynchus mediterraneus*, in a different family.

The specimens of animals referable to this genus preserved in museums are more numerous than those of *Ziphius*. They include :—

1. An imperfect skull in the University Museum, Oxford, from the animal (a male 16 ft. long) obtained on the coast of Elginshire, figured and described by Sowerby (Brit. Miscellany, p. 1, 1804) under the name of *Physeter bidens*, but to which the specific name of *sowerbiensis* or *sowerbyi* has since been generally attached. It is called *Delphinus* (*Heterodon*) *sowerbensis* by Blainville (Nouveau Diction. d'Histoire Naturelle, 2nd ed. tome ix. 1817, p. 177), and *D. sowerbyi* by Desmarest (Mammalogie, 1822, p. 521).

2. A skull in the Paris Museum, from a female specimen 15 feet long, stranded at Havre, September 9th, 1825, described by Blainville (Nouv. Bulletin Sciences, Soc. Philom. t. iv. 1825, p. 139) as the "Dauphin de Dale," by Cuvier (Règne Animal, 1829, t. i. p. 288) as *Delphinus micropterus*, by F. Cuvier (Hist. Nat. des Cétacés) as *Delphinorhynchus micropterus*, and afterwards by other authors under a variety of different names, but now generally considered to be specifically identical with the first mentioned[1].

3. A complete skeleton in the Brussels Museum from a young specimen stranded at Ostend, August 31st, 1835, described by Dumortier (Mém. Acad. Royal. Bruxelles, 1839, t. xii. tabb. 1–3) under the name of *Delphinorhynchus micropterus*. The skeleton subsequently described by Van Beneden as *Mesoplodon sowerbiensis* (Mém. Acad. Belgique, coll. in-8vo, t. xvi. 1863)[2].

4. A skull and part of skeleton in the Museum at Caen, from Sallenelles, Calvados, north of France, 1825; described by E. Deslongchamps (Bulletin de la Soc. Linn. de Normandie, tom. x. 1866) as *Mesoplodon sowerbyensis*[3].

5. A mutilated skull in the Museum of the Irish Academy, Dublin, from an animal 15 feet long, stranded in 1864 in Brandon Bay, Kerry, Ireland (Andrews, Trans. Roy. Irish Academy, vol. xxiv. 1869, *Ziphius sowerbyi*).

6. The skull of another specimen from the same locality, a male, about 17 feet long, stranded May 31st, 1870 (Andrews, Proc. Roy. Irish Acad. ser. 2, vol. i. p. 49).

7. A mandible in the Museum at Christiania, from the Norway coast, figured and described by Van Beneden (Bulletin de l'Acad. Roy. de Belgique, t. xxii. 1866) as *Mesoplodon sowerbiensis*.

8. A skull in the University Museum, Edinburgh, of unknown origin. (I am indebted to Professor Turner for information of this specimen, which has not yet been described.)

9. A complete skeleton in the Gottenburg Museum, described by Malm (*loc. cit.*) under the name of *Micropteron bidens*. From the coast of Norway, 1869.

All the above appear to belong to one species.

10. A skull in the Museum at Caen, from an animal caught in the entrance of the

[1] Figured by Van Beneden and Gervais, *op. cit.* pl. 26. figs. 5–8.

[2] Ibid. pl. 22.

[3] Ibid. pl. 26. figs. 1–4.

Channel about 1840. Described by Gervais as *D. europæus*, by E. Deslongchamps (*loc. cit.*) as *Dioplodon gervaisii*[1].

This appears to be at present a unique specimen.

11. In the British Museum is a skull received from the Cape of Good Hope, with remarkably developed teeth in the lower jaw, passing upwards and backwards, and finally curving inwards so as to meet over the rostrum. This has been named *Ziphius layardii* by Gray (P. Z. S. 1865, p. 358), and is figured and fully described by Owen (Crag Cetacea, p. 12, pl. 1). The condition of the teeth suggest an individual peculiarity; but Mr. E. Layard has in his possession a single tooth of another individual (also from South Africa) having an exactly similar conformation.

12. The Australian Museum at Sydney has lately obtained a skeleton of an animal of this group, stranded at Little Bay, about six miles from Sydney, which has not yet been described; but, judging from the photograph sent by Mr. Krefft, it is closely allied to, if not identical with the last. The teeth, however, are much less developed.

13. A skull in the Paris Museum, from the Seychelle Islands, has been figured and described by Duvernoy (Annales des Sciences Naturelles, 1851) under the name of *Mesodiodon densirostris*, being apparently identical with the rostrum, of unknown origin, described by De Blainville under that name (Nouv. Dict. d'Histoire Nat. 2nd edit. tome ix. 1817). It has also received the specific name of *seychellensis* from Dr. Gray[2].

14. A complete skeleton of an animal of the same species, obtained from Lord Howe's Island, is in the Australian Museum at Sydney. A brief description has been given of it by Krefft (P. Z. S. 1870, p. 426), and an outline figure in Ann. and Mag. Nat. Hist. vol. vi. 4th ser. 1870, p. 343.

The last two belong undoubtedly to a species distinct from any of the others, characterized by the peculiar form of the ramus of the lower jaw, and of the very massive tooth which it supports. It is to be hoped that further details of the structure of the skeleton, especially of the cervical vertebræ (which appear to be different from those of other members of the group), will be published before long.

15. In the Museum at Wellington, New Zealand, is a skull and some bones of an animal 9 feet 3 inches long, figured and partially described by Dr. Hector in the Trans. New-Zealand Institute, vol. ii. p. 27, and vol. iii. pls. 14 and 15. This has been named *Berardius hectori* by Gray (Ann. and Mag. Nat. Hist. August 1871). The conformation of the skull shows that it is a member of the present group; but the single compressed tooth in the lower jaw is situated further forwards than in any other known species, thus completing, with *densirostris*, *sowerbyi*, *layardii*, and *europæus*, the series of different positions in the side of the ramus occupied by the developed tooth, and proving its little importance as a generic character.

16. In the Report of the Director of the Museum of Comparative Zoology at Cambridge, U. S. A., for the year 1869, among the additions made to the collection by

[1] Figured by Van Beneden and Gervais, *op. cit.* pl. 24.

[2] Ibid. pl. 25. figs. 2, 3.

donation, a skull of "*Mesoplodon sowerbyensis*" is mentioned as presented by Stephen C. Martin, but without any further details.

Berardius, Duvernoy.

Upper ends of the præmaxillæ nearly symmetrical, moderately elevated, very slightly expanded, and not curved forwards over the nares. Nasals broad, massive, and rounded, of nearly equal size, forming the vertex of the skull, flattened in front, most prominent in the middle line. Anteorbital notch distinct. Rostrum long and narrow. Mesethmoid only partially ossified. Small rugous eminences on the outer edge of the upper surface of the maxillæ at base of rostrum.

Two moderate-sized, compressed, pointed teeth on each side of the symphysis of the mandible, with their apices directed forwards, the anterior being the larger of the two, and directed forwards[1].

History of Berardius arnouxi[2].

The genus *Berardius* was founded by Duvernoy[3] upon a skull received at the Museum of Paris in 1846, having been obtained from an animal stranded in Akaroa Harbour, Banks Peninsula, New Zealand. The following brief description of the animal, and the circumstances attending its capture, was supplied by M. Arnoux, surgeon to the corvette 'Rhin,' commanded by Captain Bérard, by whom the skull was presented to the Museum.

"Cet animal vint échouer, sur la côte, dans le port d'Akaroa. . . . . Des habitants anglais, voisins de ce lieu, le tuèrent à coups de lance. . . . . Ils en retirèrent trois barils de graisse. La corvette 'le Rhin' rentra dans le port d'Akaroa trois ou quatre jours après cet événement . . . . Je m'empressai d'aller voir les restes de cet animal, et je m'emparai de la tête et d'un aileron. . . . . L'animal vivant avait 32 pieds anglais de longueur totale; il était pourvu d'une nageoire dorsale assez étendue précédée d'une bosse assez considérable. Sa couleur était entièrement noire, sauf une partie grisâtre claire vers les organes génitaux: c'était un mâle."

No portion of the animal except the skull was brought to the Museum. Duvernoy's description of this is accompanied by a figure of the upper surface of the cranium, of the mandible, and a side view of one of the teeth[4].

[1] In the specimen in the Wellington Museum the second tooth does not seem to be developed. See Trans. New-Zealand Institute, vol. iii. pls. 13 & 14, p. 129. This, together with the circumstances mentioned with respect to the teeth of different species of *Mesoplodon*, shows that the diagnoses of the genera of Ziphioids from the teeth alone, relied upon by some authors, as Fischer, are insufficient.

[2] Spelt *arnuxii* by Duvernoy, *arnouxi* and *arnouxii* by other authors.

[3] "Mémoire sur les caractères ostéologiques des genres nouveaux ou des espèces nouvelles de Cétacés vivants ou fossiles." (Annales des Sciences Naturelles, 3e série, Zoologie, tome xv. 1851, pp. 1–71.)

[4] *Loc. cit.* pl. 1.

In the great work on the osteology of the Cetacea in the course of publication by Van Beneden and Gervais, figures on a larger scale are given of several views of the same skull (pl. 23), but the description has not yet appeared.

Until the arrival of the subject of the present communication the Paris skull was the only portion of *Berardius* contained in any European museum. The length of the cranium is 55 inches.

2. The next indication of the existence of *Berardius* is thus recorded by Mr. F. J. Knox:—

"In January 1862, a male specimen was embayed in the Porirua harbour, and was captured by Mr. London, of which I was only able to make a rude sketch and take a few of the measurements."

The following are the dimensions given:—

	ft.	in.
"Total length	27	0
Greatest circumference	14	0
Tail, from tip to tip	7	0
Head.—Length of basal surface	4	4
Height	2	2
Breadth across occiput	2	0
Length of lower jaw	3	10
Length of pectoral extremity, free	3	0

"Produce of fine sperm oil, about 240 gallons; spermaceti, a considerable quantity in the upper surface of the face"[1].

Except a statement that in the recent state no vestige of teeth could be discovered, no further description and no preparations were obtained from this specimen, which can only be conjectured to be a *Berardius* from its locality and size. The extremely slight sketch (pl. xiii. fig. 1) of the outline of this animal shows only the characters common to the Ziphioid Whales, except that the pectoral fin is unusually long and pointed. This, however, corresponds neither with Mr. Knox's measurements nor with the form of the manus of the present skeleton[2].

3. No animal of the species was again observed until the subject which afforded the skeleton to be described in the present memoir was stranded, of which event the following account was given by Dr. Julius Haast, F.R.S., the eminent geologist and energetic curator of the Museum at Christchurch, Canterbury. As our knowledge of this rare animal is so scanty, I think it desirable to reproduce Dr. Haast's notice entire:—

[1] Transactions and Proceedings of the New-Zealand Institute, 1870, vol. iii. p. 126.

[2] It may be noticed that further doubt is thrown on the accuracy of this sketch by its being attributed in the letterpress to two quite different animals, viz. the 27-feet long *Berardius*, taken in 1862 in Porirua Harbour (p. 126), and the 9-feet long *Mesoplodon*, taken in 1866 in Titai Bay (p. 125).

"*Preliminary Notice of a Ziphioid Whale, probably* Berardius arnuxii, *stranded on the 16th of December, 1868, on the Sea-beach, near New Brighton, Canterbury, New Zealand.* *By* Julius Haast, *Ph.D., F.R.S.*

"Towards the latter part of December, last year, it was stated that a whale had been stranded on the sea-beach, near the mouth of the Avon. Unfortunately the notice reached me too late to enable me to see the body in its fresh state; and when I went to the sea-beach the blubber had been cut off nearly a week, and the animal was already in such an advanced state of putrefaction that the external appearance was greatly destroyed. Before entering into a description of its affinities and peculiarities, I may be allowed to offer a few observations on its capture.

"Mr. William Walker, a fisherman, living near the mouth of the Avon, one mile and a half below New Brighton, observed, on the 16th of December, early in the morning, that a huge animal was in the surf, making the most strenuous efforts to return to deeper water. The fisherman had only a large sheath-knife with him, with which he stabbed it several times, making it bleed very freely. Each time when the surf reached it, it threw out a large quantity of water and sand from its blowers, like a fountain; at the same time it moved its tail with such vehemence that it threw its captor several times when he came too near it. Seeing that he could not manage the large animal by himself, he returned home to fetch a rope, a larger knife, and assistance. After having, with some trouble, placed the rope round the tail, and fastened it securely to the stump of a tree on the beach, he inflicted with the large knife some deep wounds, from which the blood ran copiously; but the animal, notwithstanding this great loss of blood, still lived for fourteen hours. The fisherman also put a large stick several times into its mouth, which, to use his own words, made the whale 'bellow like a bull.'

"A very interesting fact may be deduced from the observations of Mrs. Walker, who accompanied her husband on the second trip. She told her husband that each time he put the stick into the whale's mouth, she could see several large teeth in front of its lower jaw, which, however, were not observed by any body else, and the existence of which was only revealed when the skull was cleaned, when, in front of the lower jaw, two large triangular and movable teeth on each side became exposed. It thus seems that the Ziphioid Whales, when defending themselves from their enemies, or attacking their prey, have the power to protrude these four teeth at will. Such an hypothesis gains still more in probability when we consider the nature of the principal food of the animal, which, judging from the contents of its stomach, seems to consist almost exclusively of the common Sea-Spider, or *Octopus*—a cephalopod which, as in the northern hemisphere, does not seem to be very numerous along the coast. In the stomach of the whale in question there was about half a bushel of the horny beaks of this cephalopod, which were nearly all of the same size. It would be rather difficult for any whale to obtain possession of such an agile animal as the *Octopus*, had not nature furnished the former with the means of taking good hold of it. It is interesting that the allied genera *Ziphius* and *Hyperoodon*, of the northern hemisphere, feed also on similar species of cuttlefish, as I learn from a paper of Dr. J. E. Gray, of the British Museum (Proc. Zool. Soc. 1868, p. 422). Also the Sperm Whales are said to feed almost exclusively on the same vivacious animal, which, by its agility and organization, is so well adapted to make great havoc amongst the smaller inhabitants of the sea. And, as Dr. Gray justly observes, it proves, at the same time, that these cephalopods, although apparently of rare occurrence, must in many localities be very numerous, as it would otherwise be impossible to understand how they could furnish those huge whales with sufficient food.

"When I proceeded to the beach the animal was still lying in the surf, partly covered with sand, but still intact. I measured its length exactly, and found it to be 30 feet 6 inches from the tip of the nose to the end of the lobes of the tail. The colour of the whole animal was of a deep velvety black, with the exception of the lower portion of the belly, which had a greyish colour. The tail was 6 feet 6 inches broad, and had the usual two falcate lobes. The pectoral fins were situated near the neck, a little above the middle of the body, and were 17 inches broad and 19 inches long. They had a triangular form; and one of them was buried in the sand when I saw the animal first. The dorsal fin was unfortunately destroyed when I first saw the whale, so that I cannot describe its form and position from my own observations; but Mr. Walker told me that it was small, had the usual falcate form, and was situated not far from the tail.

"I may here observe that, from the form of the skull and some other characteristics, it appears evident that this whale is the *Berardius arnuxii* of Duvernoy, of which a specimen was caught in 1846, in Akaroa harbour, the skull of which, of the length of four feet, is at present in the Imperial Museum in Paris. The animal to which it belonged is described as having been 32 feet long, and possessing a large dorsal fin, with a large boss or hump in front of it. As putrefaction and the cutting off of the blubber had greatly changed the outlines of the animal, I could not observe whether it possessed the larger boss in front. Mr. Walker did not speak of it when he gave me a description of the animal as it appeared when captured. However, as the figure of the skull, as given by Duvernoy in the 'Annales des Sciences Naturelles,' and copied into Dr. Gray's British-Museum 'Catalogue of Seals and Whales,' is identical with that of our own specimen, I do not hesitate to state that both belong to the same species. It also seems to me that this whale is very local, probably inhabiting only the coast of New Zealand, and perhaps the regions south of it, because, as far as I can find, it has never been observed elsewhere. It has without doubt not been met with on the coasts of Australia (or it would not have passed unnoticed), as, amongst others, the energetic director of the Australian Museum, Gerard Krefft, F.L.S., has not observed it. I may here state that the form of the skull is very peculiar, reminding one strongly of that of a dolphin.

"There seems to be nothing known of this peculiar whale, except its external appearance and its skull; and it is therefore a matter of congratulation to us that we shall be able to supply all the details of its osteological characteristics, which are peculiar in many respects.

"The specimen in our possession was evidently a young animal, because all the disk-like epiphyses of the vertebræ are still detached. The same is the case with the epiphyses of the limb-bones, which are not yet united with them; also the sutures of the cranium are not yet obliterated. The beginning of coalescence is, however, to be observed in the seven cervical vertebræ, of which the first three are already anchylosed, the first two completely, and the second and third only partially, as the neural arches and transverse processes are not yet united into one bone. In the allied *Hyperoodon* all the cervical vertebræ coalesce; and it is therefore possible that when *Berardius* is in an adult state the same will take place. The *Ziphius* has six cervical vertebræ separate; and it will therefore be necessary to examine very carefully into the character of the uncoalesced vertebræ of our skeleton before giving a decided opinion upon the subject. It possesses ten dorsal vertebræ, in common with *Ziphius sowerbiensis*; the Hyperoodont Whales have nine, and the Dolphins thirteen to fifteen. I have not yet been able to count and examine the lumbar and caudal vertebræ, as the animal was in such a state of putrefaction that, after cleaning the bones as well as possible and leaving often a great portion of the vertebral column together, we put them at once to macerate. We obtained only one of the small pelvic bones, the other having probably been washed away by the surf; it might, however, owing to its diminutive size and sticking loosely in the flesh, easily have been overlooked. As soon as the bones are clean, so that I can examine them, I shall offer a few more observations upon the osteology of this remarkable animal, for the complete skeleton of which the Canterbury Museum is indebted to the members of the Philosophical Institute, without whose pecuniary assistance I should have been unable to secure it for the Provincial collections."—*Proc. Phil. Institute of Canterbury, New Zealand, May* 5, 1869; also *Annals and Magazine of Nat. History, October* 1870, p. 348.

It is much to be regretted that no mention is made in this account of the sex of the animal, especially as some of the allied forms are supposed to present considerable sexual differences.

4. In January, 1870, a large Ziphioid Whale was stranded in Worser's Bay, near the entrance to Port Nicholson, and was captured. Its dimensions are thus given by Mr. Knox:—

	ft.	in.
Total length	27	0
From beak to nostrils	3	6
From nostrils to occipital foramen	1	6
Total length [of head?] over vertex	5	0
Head.—Tip of beak to occipital foramen, basal surface	4	0
Greatest height	2	0
Length of lower jaw	3	10
Length of symphysis	1	0
Breadth between condyles	1	10
Breadth at symphysis	0	6

The skull, the cervical vertebræ, scapula, and imperfect pectoral limb of this animal are preserved in the Museum at Wellington, and have been figured on a reduced scale in the Transactions of the New-Zealand Institute, vol. iii. Although there was but a single tooth on each side of the lower jaw, near the apex, the skull in form and size so closely resembles that in the Paris Museum, that it is difficult to believe that they are not specifically identical.

Though no complete description of the portions of this animal which were preserved has yet been published, the following paragraph relating to it by Dr. James Hector, F.R.S., is important:—"The preparation of the nose (figures 4 *a* & 4 *b*) shows that, notwithstanding this is a full-sized animal, the tooth is still sheathed in the gum, being imbedded in a tough cartilaginous sac, which adheres loosely in the socket of the jaw, and is moved by a series of muscular bundles that elevate and depress it"[1].

The dimensions of the skull are thus given by the same naturalist:—

	inches.
Length of head	59·5[2]
Length of nose	31·0
Length of dental groove	15·0
Length of lower jaw	43·0
Width of notch	14·5
Width at orbits	24·5
Width at blow-holes	7·0
Width at nose	5·0
Height of occiput	19·5[3]

[1] Trans. New-Zealand Institute, 1870, vol. iii. p. 129.

[2] This is evidently a mistake, as it is far too large for the other dimensions. According to the figure it should be 47·5.

[3] The smaller specimen, 9 feet 3 inches in length, which was described in the 2nd vol. of the Trans. N.-Z. Inst. (p. 27) under the name of *Berardius arnuxii*, and which has since been named by Dr. Gray *Berardius hectori* (Ann. & Mag. Nat. Hist. August 1871), belongs, as above mentioned, to a different section of the group.

Description of the Skeleton of Berardius arnouxi.

I must return to No. 3 of the above list, of which the skeleton has been lately placed among the fine series of Cetaceans in the Museum of the Royal College of Surgeons; which fortunate circumstance is due partly to the extremely liberal desire of Dr. Haast that it should be made as available as possible for scientific examination, comparison, and description, and partly to the generosity of Mr. Erasmus Wilson, F.R.S., a Member of the Council of the College, in providing the means of adding it to the collection without expense to the Institution.

The skeleton is complete, with the exception of one of the pelvic bones, and a few of the phalanges. Although it may have attained nearly to its full size, the condition of the bones shows that the animal was far from adult. The terminal epiphyses of the bodies of the vertebræ are separate throughout the thoracic, lumbar, and caudal regions, though united to the rest of the bone in the neck-vertebræ. The epiphyses of both ends of the radius, the upper end of the humerus, and lower end of the ulna are free, but that of the lower end of the humerus has partially coalesced with the shaft.

The length of the skeleton as now mounted is 29 feet in a straight line from the tip of the lower jaw to the end of the tail; but, notwithstanding the careful indications kindly furnished by Dr. Haast, it is possible that the allowance made for the intervertebral substance is not quite exact.

Viewing the skeleton as a whole (see Pl. XXVII.), the most striking feature is the small size of the head, compared with the great length of the vertebral column, and the massiveness of the individual vertebræ, especially of the lumbar and anterior caudal regions. It presents a remarkable contrast to *Physeter* in this respect, though agreeing generally with the other Ziphiinæ.

Skull.—The cranium agrees so closely in form with the type specimen in the Paris Museum, described and figured by Duvernoy, and subsequently by Gervais, that a detailed description of its external characters will not be required. That specimen, however, is one inch longer than the present one, and probably belongs to a fully adult individual. The most prominent parts of the pterygoid bones are broken off, which alters the contour of the lower margin in the figure; and the petro-tympanic bones are wanting. The present specimen is quite perfect; and as a longitudinal median vertical section has been made through it, I am enabled to give for the first time this highly characteristic view (Pl. XXVIII. fig. 7).

As compared with the other Ziphioids, the most remarkable features of the skull are the almost perfect bilateral symmetry of the upper surface and the comparative simplicity of the posterior ends of the præmaxillæ, which do not curve forwards to overhang the superior narial apertures as in the other members of the group.

The vertex is formed by the massive nasals (*Na*), prominent and rounded in the middle line in front and above, and behind these by a small, but elevated, portion of the united frontals (*Fr*), which at this spot, instead of being solid, are composed of several

distinct irregular and freely moveable wedge-shaped pieces of bone of the nature of the so-called "Wormian bones."

The mesethmoid (*ME*) forms a strong ridge between the narrow nostrils, rising to a level with the præmaxillæ; its ossification becomes irregular and nodular anteriorly, and extends as far forwards as 2 inches in front of the base of the rostrum (*i. e.* a line drawn between the deepest part of the two anteorbital notches, and which is supposed to mark off the rostrum from the cranium proper). In the Paris specimen the ossification extends somewhat further, doubtless in consequence of the superior age of the individual; but it is not likely that it ever attains to the remarkable extent and solidity characteristic of some species of Ziphiinæ.

As in *Hyperoodon* and other allied forms (but not in *Physeter*) the bone which lies in ordinary Dolphins beneath the anterior part of the orbital plate of the frontal, in contact with the maxilla in front, the frontal behind, and the palatine on the inner side, is divided by a distinct suture into two parts. The anterior part gives origin to the slender zygomatic arch, and undoubtedly corresponds to the malar of ordinary mammals; while the posterior part appears to represent the lachrymal, as pointed out by F. Cuvier[1], Eschricht[2], Van Beneden[3], and others, though Duvernoy considered it a prolongation of the orbito-sphenoid.

There are several differences in detail in the form and arrangement of these bones between *Berardius* and *Hyperoodon*, one of the most important being that the orbit of the former is considerably smaller than that of the latter, which, together with the inferior size of the optic foramen, would indicate a smaller organ of vision.

The zygoma, like that of *Hyperoodon*, is broader and flatter, especially at its anterior extremity, than in the ordinary Dolphins.

A most important and characteristic region of the base of the skull in the Cetacea, as in other Mammals, is that surrounding the organ of hearing. Here *Berardius* agrees with the other Ziphioids in showing affinity to *Physeter*[4] rather than to the true Dolphins, both in the form of the tympanic bulla, and in the greater fixedness by which it is attached to the skull. This is chiefly effected by a large irregular wedge-shaped process (Pl. XXIX. figs. 1 & 2, *m*), which passes backwards and outwards from the hinder edge of the portion of the tympanic which articulates with the periotic, and lodges in a groove between the exoccipital and squamosal, reaching the external border of the skull. This process so closely occupies the position of the "mastoid" in ordinary Mammals, that it has very naturally received that name: but its exact homology must be cleared up by a study of its development; for it differs from

[1] Histoire Naturelle des Cétacés (1836), p. 76, pl. 7, *l*.

[2] Untersuchungen über die nordischen Wallthiere (1849) p. 44.

[3] Mém. sur une nouvelle espèce de *Ziphius*, Mém. de l'Acad. Royale de Belgique, coll. in-8vo, tome xvi. 1863, p. 14.

[4] And more remotely to the Whalebone Whales, as pointed out by Eschricht.

the ordinary mastoid in being united to the tympanic instead of the periotic. To the anterior and inner side the tympano-periotic is supported by a long slender process of the squamosal, with which it comes into closer contact than in the true Dolphins[1].

The tympano-periotic bones are slightly larger than those of *Hyperoodon* (Pl. XXIX. fig. 6), but have much the same general form, with certain differences in detail, of which the most important are:—in the tympanic the anterior (Eustachian) end (*e*) is more prolonged, pointed, and spout-like; the groove between the posterior lobes is deeper; the posterior articular surface (*a*) for the periotic is larger and smoother; the periotic is more elongated, the notch between its anterior (*a.l*) and middle lobe (*m.l*) is wider, the anterior lobe is more prolonged and pointed in front, and the orifice of the meatus auditorius internus (*i.a.m*) is rather smaller.

It is important to note that in every one of these points of difference, *Hyperoodon* approaches nearer than *Berardius* to *Physeter*—a confirmation of the great taxonomic value of the characters of this region of the skull.

On comparing the median section of the skull (Pl. XXVIII. fig. 7) with that of *Hyperoodon*, the main difference is the smaller degree of elevation and of antero-posterior compression in the great supracranial crest, and the greater extent, both in vertical and antero-posterior direction, of the bony mass formed by the coalescence of the presphenoid, mesethmoid, and frontals which lies in front of the cerebral cavity, separating it from the nasal passages. In these, as in so many other respects, *Hyperoodon* approaches much nearer to the Cachalot than does *Berardius*.

The hinder edge of the vomer, which is prolonged beneath the presphenoid and basisphenoid, is much less massive in *Berardius* than in *Hyperoodon*; but, generally speaking, the conformation of the cranium and the relations of the bones to each other as seen in this view are strikingly similar[2].

The basioccipital and the basisphenoid have completely coalesced; but the fissure between the latter and the presphenoid is open to the extent of more than a quarter of an inch. The floor of the cranial cavity is less curved from before backwards than in *Hyperoodon*, and therefore much less than in *Physeter*; and the commencement of the spinal canal is not directed upwards to the same extent. The pituitary fossa is very indistinct; but at some distance behind it there is a broad and deep groove on the upper surface of the basioccipital.

The cerebral cavity presents much the same general form and size as in *Hyperoodon* and the allied species, being high, very broad, and flattened from before backwards. Its greatest breadth is $11\frac{1}{2}$ inches, its greatest vertical height 7 inches, its length 8 inches. The posterior upper part has a strong median projection, or osseous *falx*

[1] See the description of this region in *Hyperoodon* by Eschricht (*op. cit.* p. 45), and in *Ziphius indicus* by Van Beneden.

[2] The comparison was made with the skull of a *Hyperoodon* of corresponding age in the Museum of the College of Surgeons; it is figured in Trans. Zool. Soc. vol. vi. pl. 56. fig. 3.

cerebri, which, in the figure, conceals the real height of the lateral parts of the cavity. A well-marked ridge, more conspicuous than in *Hyperoodon*, commencing on the orbito-sphenoid below, and extending upwards on the frontal almost to the vertex, divides the anterior from the posterior cerebral fossa. The cerebellar fossa is relatively larger than in *Hyperoodon*, and is separated from the posterior cerebral fossa by a strong ridge. There is no olfactory fossa.

The periotic bone is excluded from the cerebral cavity by a distance of $3\frac{1}{2}$ inches.

The foramina which pierce the base of the cranium, as seen from within, are:—

1. A very small hole, $\frac{1}{4}$ inch from the middle line, and 3 inches in front of the suture between the presphenoid and basisphenoid, and passing through the posterior lateral expansion of the mesethmoid which corresponds to the cribriform plate of other mammals, to the nasal passage, may be an olfactory foramen. A similar foramen has been noticed in *Ziphius* by Fischer, and exists on a larger scale in *Physeter*[1].

2. The optic foramen is a rather small oval fissure (0·4 inch by 0·3 inch) perforating the orbito-sphenoid, near its hinder border, and soon joining the great orbital or sphenoidal fissure. It is less than half the size of the corresponding opening in *Hyperoodon*.

3. Immediately behind the sharp ridge formed by the hinder edge of the orbito-sphenoid is the large funnel-shaped opening, compressed from side to side (about 1 inch by $\frac{1}{2}$ inch in diameter at the narrowest part), corresponding to the sphenoidal or orbital fissure together with the foramen rotundum, as it transmits the nerves to the orbit, as well as the middle division of the fifth nerve.

4. The foramen ovale, for the third division of the fifth, forms a distinct perforation through the alisphenoid, about 0·3 inch in diameter. It is connected with the last by a shallow groove.

5. Behind the orbito-sphenoid is a large infundibuliform depression, divided at the bottom into an anterior smaller circular aperture (0·3 inch in diameter) and a posterior larger oval opening (1 inch by 0·4 inch). The former is for the seventh nerve, which it conducts to the meatus auditorius internus on the periotic; the latter for the various nerves commonly known as the eighth pair; this is further divided near its termination on the surface by a narrow bony septum.

6. Immediately behind the last, in the cerebellar fossa, and $1\frac{3}{4}$ inch from the middle line, is the small condylar foramen (0·3 inch by 0·2 inch in width) for the hypoglossal nerve. After a course of about four inches through the bone, it opens into a groove in the hinder surface of the skull between the basioccipital and the exoccipital.

7. In the basisphenoid, 1 inch from the middle line, opposite the prominence in front of the sella turcica (*tuberculum sellæ*) is the longitudinal narrow oval aperture (0·4 inch by 0·2 inch) for the carotid artery. This canal opens externally in the pterygoid close to its posterior border.

[1] See "Osteology of the Sperm Whale (*Physeter macrocephalus*)," Trans. Zool. Soc. vol. vi. p. 316.

In general arrangement these foramina correspond very closely with those of *Hyperoodon*. In the Sperm-Whale the greater massiveness of the cranial walls, compared with the brain-cavity, and the consequent greater distance that has to be traversed by the nerve-canals, causes some alteration in the condition of the foramina, several (as in the case of that for the seventh and eighth nerves) more completely coalescing into a single aperture, at least at their cerebral ends, than in the smaller-headed Ziphioids.

Dimensions of the Skull.

	inches.
Extreme length of cranium	54
Length of rostrum (from the apex of the præmaxillæ to the middle of a line drawn between the anteorbital notches)	36·2
Anterior end of vomer to anterior end of præmaxillæ	13·6
From middle of hinder edge of palate (formed by pterygoid bones) to end of præmaxillæ	43·2
Greatest height of skull, from top of nasals to lower border of pterygoids	21
Greatest breadth, across postorbital processes of frontals	27
Breadth across zygomatic processes of squamosals	26·4
Breadth between outer borders of suprafrontal processes of maxillæ	24·6
Breadth of occipital condyles	7·5
Breadth of foramen magnum	2·4
Height of foramen magnum	2·5
Breadth of exoccipitals	20·5
Breadth of base of rostrum (between bottom of anteorbital notches)	15·7
Breadth of rostrum at middle	6
Nasal bones, antero-posterior length	5·2
Nasal bones, greatest breadth of the two	4
Anterior nares, greatest width of the two	2·9
Breadth between outer borders of præmaxillæ opposite nares	6·6
Breadth between outer borders of præmaxillæ at their widest part, in front of the nares	8·2
Breadth between outer borders of præmaxillæ at middle of rostrum	3·6
Mandible.—Length of ramus	49
Length of symphysis	12·2
Vertical height of ramus at coronoid process	8·3
Apex of mandible projecting beyond apex of rostrum	2·7

The rami of the mandible are not ankylosed at the symphysis. They are more massive in form and of a denser substance than in *Hyperoodon*, especially near the symphysis, corresponding with the greater development of the teeth. A slight irregular groove, with numerous minute vascular canals opening into it, extends along the

upper margin from the apex for two thirds the length of the ramus, to opposite the entrance of the wide infundibuliform dental canal on the inner side. Just before its posterior termination this groove becomes wider and deeper than elsewhere; behind it the superior edge of the ramus rises into a sharp elevated crest, terminating behind in the feebly marked coronoid process.

At the anterior extremity of the ramus the groove dilates into a large, oval, narrow, alveolar cavity, 2·7 inches long, 1 inch wide and 2 inches deep. Two and a half inches behind this is another, smaller alveolus 1·8 long, 0·6 inch wide in front, and very narrow behind. The floors of both these cavities slope backwards and upwards; and their openings are directed forwards.

Teeth.—Each of the above-mentioned alveolar depressions contains a tooth, which very nearly fills the socket, and projects but slightly above the level of the upper surface of the ramus of the jaw.

The anterior tooth of the left side, although loose in its alveolus, cannot be removed from it as long as the bone is intact. The right tooth, however, was extracted without much difficulty (see Pl. XXIX. fig. 7). It is compressed laterally to the form of a nearly equilateral triangle, with a base, an apex, and an anterior and a posterior margin. The base is 2·8 inches long, the anterior margin 2·8 inches, the posterior margin 3·2 inches, the height from the middle of the base to the apex 3 inches, the greatest thickness between the lateral surfaces 0·8 inch. The pulp-cavity is completely closed below, the base being rounded and rugose. The inner surface is concave, the outer one slightly convex in both directions. Both surfaces are marked with irregular shallow furrows and ridges running in a longitudinal direction, or rather radiating from apex to base. The apex itself is conical, with a deep linear longitudinal groove on the middle of its inner side; it appears to be formed of dentine, without any enamel covering, and projects for a distance of 0·3 inch from the mass of cementum which covers the greater part of the tooth. The extremity is somewhat polished, but presents no distinct signs of wear.

The left tooth, as far as can be seen without removing it from the alveolus, exactly resembles the right. The apex projects scarcely one inch above the level of the alveolar border; so that before the gum was removed very little, if any, of the tooth could have been exposed.

The second tooth (Pl. XXIX. fig. 8) fits very well into, and nearly fills its alveolus; but, owing to the form of its root, it is readily removed. It also is compressed and triangular, but narrower from before backwards than the other. Its base is closed; and its apex is formed, as in the other, of a small cone of dentine, emerging out of an enveloping mass of cement; the anterior margin is thicker, more rounded and curved than the posterior. The whole tooth lies very obliquely in its alveolus; so that the posterior margin is nearly horizontal, and the apex projects forwards. Such a very small portion is raised above the level of the alveolus, that we might naturally infer

that in life the tooth was entirely concealed[1]. The height of the right tooth from the middle of the base to the apex is 1·8 inch, the length of the base is 1·1 inch, the length of the anterior margin is 1·5 inch, of the posterior margin 2 inches, the greatest thickness 0·6 inch. The left tooth is slightly larger than the right.

A longitudinal section in the antero-posterior direction having been made through these teeth, their structure was seen to be very similar to that of *Mesoplodon sowerbyi*, as described by Mr. E. Ray Lankester[2]. In the larger anterior tooth the only remains of the pulp-cavity is a small irregular vacuity (*p*), an inch below the apex of the tooth, and consequently more than an inch and a half from the base. The true dentine (*d*) is limited to the portion of the tooth above this spot, the large bulk of the tooth below being composed of very coarse-looking osteo-dentine with numerous wavy fissures and channels, having a general longitudinal direction; immediately around the pulp-cavity a tissue (*g*) having a botryoidal or globular arrangement forms a transition from the last-named structure to the true dentine. There is no enamel. The surface of the tooth, except at the apex and base, is covered with a layer of cement (*c*), which nowhere exceeds $\frac{1}{10}$ inch in thickness. The constituent elements of the smaller tooth are arranged in a precisely similar manner.

Hyoid bones.—The basihyal and the thyro-hyals are not yet united (Pl. XXVIII. fig. 9). The former is more elongated transversely than in *Hyperoodon*, being 5·8 inches in width, and 2·7 inches in antero-posterior length at the middle. The posterior border is straight; the anterior border excavated in the middle, and with a roughened prominence near each end for the attachment of the anterior cornua.

The thyro-hyals are each 9 inches long, and 2·5 inches in greatest diameter. Their under surface is flattened. They are less wide in proportion to their length than in *Hyperoodon*, and thus, as in so many other details of the skeleton, they show that *Berardius* recedes further from *Physeter* than does that genus[3], and consequently approaches nearer to the ordinary Dolphins.

The stylo-hyals are 14 inches long, and 2·9 inches in greatest thickness, slightly curved, and with three distinct surfaces bounded by three longitudinal ridges, the broadest and flattest surface being in the concave side of the bone. Towards what appears to be the upper end there is a neck-like constriction, surmounted by an expanded and obliquely truncated head.

Vertebral Column.—The numbers of the vertebræ are:—cervical 7, thoracic 10,

[1] See the remarkable observations upon the teeth of the animal when alive, recorded by Dr. Haast (p. 214), and the mention of "muscular bundles" by which they are moved by Dr. Hector (p. 216), which accord so little with any thing hitherto known in mammalian anatomy, that further observations on this subject are extremely desirable.

[2] Transactions of the Royal Microscopical Society, new series, vol. xv. 1867, p. 55.

[3] The breadth and flatness of the thyro-hyals is eminently characteristic of both the genera of Physeterinæ, *Physeter* and *Kogia*; and the affinity of the Ziphiinæ to them is in this respect only slightly marked, though most so in *Hyperoodon*.

lumbar 12, caudal 19; total 48. This appears to be very nearly the usual number in *Ziphius* and *Mesoplodon*, and to exceed that of *Hyperoodon* by 3.

Though generally resembling that of the three allied genera, the column differs from *Mesoplodon sowerbyi* (Van Beneden and Gervais, pl. 22) chiefly in the spines of the anterior dorsal region being smaller, more pointed, and more recumbent—also in all the other spines sloping more backwards, and being smaller in proportion to the body, both in height and width from before backwards; thus in a middle lumbar vertebra, the antero-posterior diameter of the spine in Sowerby's Dolphin is about two thirds the length of the body, while in *Berardius* it is little more than one third. *M. densirostris* and another as yet undetermined species in the Sydney Museum agree generally with *M. sowerbyi* in these respects, judging from photographs of their skeletons sent by Mr. Krefft. *Ziphius australis* appears in Burmeister's figure to be rather intermediate between *Mesoplodon* and *Berardius* in the form of the spines of the vertebræ. In *Hyperoodon* the spines are as long as in *Mesoplodon* and as slender as in *Berardius*.

Cervical Vertebræ.—The vertebræ of the neck (Pl. XXVIII.), especially those of the posterior part of the region, are better developed than in most Dolphins, and, indeed (except for the coalescence of the first three), bear a considerable resemblance to those of the Beluga. Among the Ziphiinæ, as far as is yet known, *Mesoplodon* and *Ziphius* both approach *Berardius* in the structure of this important region, while, as will be seen, *Hyperoodon* offers the greatest possible contrast.

The entire length of the bodies of the seven cervical vertebræ, when placed in contact, is 10 inches. The atlas, axis, and the third vertebra are united firmly by their bodies; and the first two are also united by the laminæ of the neural arches, but the axis and the third only by that portion of the arch corresponding to the zygopophyses, the upper part being free. All the remaining vertebræ are separate throughout. The free ends of their bodies show traces of the epiphyses by which they have been completed; and their surfaces appear so completely formed or finished, as it were, that it does not appear probable that much, if any, further union would have taken place had the animal attained a greater age.

In *Hyperoodon* not only is the whole length of the cervical region scarcely more than half that of *Berardius*, but the bodies of all seven vertebræ are firmly united together, and the spines of all, except the seventh, join to form a single elevated conical mass; the vertebræ, except the first two and the last, are evidently extremely compressed, almost rudimentary in fact. In *Ziphius australis*, according to Burmeister, the first, second, and third are united, and also the fourth and fifth to each other, though not to the third, and the sixth and seventh are free. In the specimen of *Ziphius cavirostris*, from Corsica, briefly described in Fischer's memoir, the six anterior vertebræ are stated to be united and the seventh free. In Sowerby's *Mesoplodon* at Brussels the first two only are united, and all the others free. In *M. densirostris*, according to Krefft[1], "the

[1] P. Z. S. 1870, p. 426.

first three cervical vertebræ are anchylosed, the next one is more or less free, and the remaining three are anchylosed again." In another specimen of the same genus lately added to the Sydney Museum, the first, second, and third are said to be united and the remainder all free (Krefft, MS.).

The articular surfaces on the atlas for the occiput (fig. 2) are considerably smaller than in *Hyperoodon*, and do not coalesce at their inferior margins. Above the upper end of each there is a deep groove for the suboccipital nerve, instead of a foramen as in *Hyperoodon*.

The coalesced spines of the first and second vertebræ are but moderately developed, and slope backwards, overhanging the short pointed spine of the third (see fig. 1). The transverse process of the atlas is very little developed, and placed low on the sides of the bone; it does not unite at its extremity with that of the axis as in *Hyperoodon*. The inferior surface of the conjoined bodies of the first three vertebræ has a backward projecting compressed tubercle, wanting in *Hyperoodon*, and probably representing that so well developed in the Narwhal and Beluga.

The axis has two very short transverse processes on each side, compressed from before backwards, both placed on the side of the body, the lower one corresponding serially with the transverse process of the atlas, and being of about the same length.

The third has two distinct transverse processes on each side, further apart than those of the second, the upper one arising from the upper part of the body and root of the arch; the lower one is longer and narrower, and directed downwards and backwards.

Each of the three following vertebræ (figs. 3, 4, and 5) have two transverse processes, the upper ones (*diapophyses*) arising from the pedicle of the arch, rather slender, conical, and inclined downwards, in the sixth also somewhat forwards; they increase in size from the fourth to the sixth. The lower processes (*parapophyses*) arise from the inferior outer angle of the body, are thick and massive; that of the fourth vertebra is most compressed and longest, while that of the sixth, though scarcely extending laterally beyond the body of the vertebra, is greatly developed downwards, forwards, and inwards (passing beneath the body of the antecedent vertebra), being, in fact, little more than a great development of the inner basal tubercle of the others, and answering to the "inferior lamella" of the transverse process of the corresponding vertebra of the Carnivora, Ungulata, &c.[1].

The seventh vertebra (fig. 6) has only the upper transverse process from the arch, the inferior projecting edge of the well-marked articular surface for the head of the first rib taking the place of the inferior process.

The bodies of all these vertebræ are broader than they are high. The arches of the fourth and fifth are incomplete in the middle line above for a space of more than half an inch. The arches of the sixth and seventh are complete, and incline backwards, but without any distinct spinous process.

[1] See 'Introduction to the Osteology of Mammalia,' p. 22, 1870.

The neural arches thus differ greatly from those of *Hyperoodon*, which has one tall conical upright spine springing from the conjoined arches of the six anterior vertebræ, and a second slender but equally elevated and vertical spine, belonging to the seventh vertebra alone. On the other hand they resemble generally those of *Ziphius* and *Mesoplodon*, as far as their condition in these genera is at present known; for the incompleteness of the upper part of the arch exists in the fourth and fifth vertebræ in *Ziphius australis*, and in the third, fourth, and fifth in *Mesoplodon sowerbyi*. Perhaps even more strikingly does the presence of well-developed inferior transverse processes to the third, fourth, fifth, and sixth cervical vertebræ show the affinity of *Berardius* to these two genera and its dissimilarity to *Hyperoodon*.

Dimensions of the Cervical Vertebræ.

	inches.
Antero-posterior length of bodies of all seven, lower surface	10
Length of body of united first, second, and third	3·6
Length of body of fourth	1·4
Length of body of fifth	1·4
Length of body of sixth	1·5
Length of body of seventh	1·8
Height from top of spine to lower edge of body of second	10·7
Height from top of spine to lower edge of body of seventh	8·5
Breadth between outer borders of articular surfaces of atlas	8·7
Height of articular surfaces of atlas	5·8
Breadth between tips of transverse processes of atlas	11·5
Height of neural canal in arch of atlas	2·9
Greatest breadth of neural canal in arch of atlas	3·3
Height of neural canal in arch of seventh	3·3
Greatest breadth of neural canal in arch of seventh	3·6
Breadth of body of seventh	5·2
Height of body of seventh	4·2
Breadth between tips of transverse processes of seventh	9·5

Thoracic Vertebræ.—The bodies of the twelve thoracic vertebræ increase gradually in length (see table on p. 228, and Pl. XXVIII. fig. 1). The inferior surface of those at the commencement of this region is broad, flat, and somewhat rough; posteriorly they gradually acquire a median keel.

The spines are moderately high, compressed, sloping much backwards; that of the first is very little developed, and pointed; though tapering in the anterior vertebræ, they gradually become more obtuse and truncated at the extremity as they approach the posterior end of the series.

The zygapophyses are unusually well developed, continuing on the contiguous anterior

and posterior edges of the arch until between the eighth and ninth dorsal vertebræ inclusive, but not developed between the ninth and tenth.

Metapophyses first appear as distinct tubercles on the transverse processes of the third, and gradually increase in size and become more compressed, pointing forwards and slightly upwards.

Articular surfaces for the heads of the ribs are developed only on the hinder edges of the bodies, without any corresponding surface on the anterior edge of the next vertebra, so that the head of the rib appears not to articulate directly with the body of the same vertebra to which the tubercle is attached, but only to the one in front of it. In the first vertebra this surface is entirely on the side of the body, in the second at the junction of the body and the arch, from the third to the seventh at the root of the pedicle of the arch; on and after the eighth it is absent altogether, and the rib is attached only to the transverse process.

The transverse processes, in a line with the upper transverse processes (*diapophyses*) of the cervical region, are short and thick, with large rounded articular extremities for the tubercles of the ribs. In the seventh vertebra this process is small, and in the eighth reduced to a mere low longitudinal ridge on the outside of the metapophysis, which has here acquired a considerable size. In the ninth vertebra a large and massive process springs from the upper part of the side of the body near the anterior edge, in a situation corresponding to which no trace of a process exists on any of the vertebræ in front. It has a large articular surface at its extremity, looking somewhat backwards, for the ninth rib. The tenth vertebra bears a corresponding process, but rather longer, more depressed, wider from before backwards, situated rather lower on the side of the body, and not quite so near its anterior edge. Its articular surface (for the tenth rib), also directed obliquely backwards, is not so large as that of the ninth. This process corresponds serially with the transverse processes of the lumbar vertebræ.

Berardius thus conforms to the type of the Physeteridæ in the transverse processes of the dorsal vertebræ not gradually sinking from the arch to the body, as in the true Dolphins, but disappearing near the end of the series, and being replaced by a new process; but it differs from *Physeter*, and exactly agrees with *Mesoplodon*[1], in not having both upper and lower processes developed simultaneously on several of the vertebræ. *Hyperoodon* approaches nearer to *Physeter* in this characteristic feature, as its seventh thoracic vertebra has distinct upper and lower transverse processes, which in some specimens completely unite at their extremities, so as to form a ring, to the outer edge of which the rib is attached.

The twelve *lumbar vertebræ* are very much alike. Their bodies increase in size towards the hinder end of the series, where they are remarkably elongated. Below

[1] In the skeleton of Sowerby's *Mesoplodon* in the Brussels Museum, the upper process continues as far as the seventh vertebra, and the lower process commences abruptly on the eighth.

the transverse processes they are compressed or pinched in, as it were, at the middle of each side; and the inferior surface has a well-marked median keel.

The arches arise nearer the anterior than the posterior end of the bodies. The spines are long, compressed, of nearly equal antero-posterior breadth from base to apex, the edges being approximately parallel, and roundly truncated above; they slope backwards forming an angle of 45° with the long axis of the body. The anterior end of the arch, below the spine, develops a conspicuous, broad, flattened metapophysis, the lower edge of which carries another tubercle. The metapophyses remain at the same level throughout the series, instead of gradually rising on the sides of the arch in the posterior lumbar and caudal vertebræ, as in *Physeter* and *Orca*.

The *caudal vertebræ*, reckoning from the first which bears a chevron bone at its hinder border, are nineteen in number.

The first resembles those of the lumbar region; but it is distinguished from them by wanting the median keel on the inferior surface, and by the pair of articular facets on its hinder edge for the first chevron bone. Its spine is also shorter and considerably broader than in the last lumbar vertebra.

The bodies gradually shorten, though retaining their vertical height as far as the ninth; the tenth is much compressed; the eleventh is small, being the "transitional vertebra." The series of depressed vertebræ, or those of the tail proper, begins at the twelfth; but they are less flattened and less transversely extended than in the true Dolphins.

The under surfaces of the bodies are deeply channelled in the middle line, and have strongly marked tuberosities at each corner for the attachment of the chevron bones; the anterior and posterior tuberosities of each side become united in the seventh and succeeding vertebræ, enclosing a foramen which gradually diminishes in size.

The spines gradually decrease to the tenth, after which they are no longer developed. The transverse processes also gradually diminish, and cease to be apparent after the eighth. The last vertebra is a small depressed triangular nodule.

Antero-posterior length of the Bodies of the Thoracic, Lumbar, and Caudal Vertebræ.

	inches.		inches.		inches.		inches.
Thoracic: first	2·3	Lumbar: second	7·0	Lumbar: twelfth	9·8	Caudal: tenth	5·6
second	2·7	third	7·1	Caudal: first	9·7	eleventh	4·1
third	3·5	fourth	7·3	second	9·5	twelfth	3·5
fourth	4·0	fifth	7·9	third	9·0	thirteenth	3·1
fifth	4·3	sixth	8·1	fourth	8·5	fourteenth	2·9
sixth	4·6	seventh	8·7	fifth	8·1	fifteenth	2·7
seventh	5·0	eighth	9·1	sixth	7·8	sixteenth	2·2
eighth	5·5	ninth	9·3	seventh	7·5	seventeenth	1·8
ninth	6·0	tenth	9·7	eighth	7·1	eighteenth	1·5
tenth	6·2	eleventh	9·8	ninth	6·6	nineteenth	0·9
Lumbar: first	6·4						

As noticed by Van Beneden[1] in *Mesoplodon sowerbyi*, the bases of the transverse processes of the hinder lumbar and caudal vertebræ are not perforated by vertical vascular canals as in most Dolphins, but only the bodies of the posterior caudal vertebræ (beginning at the tenth) have such perforations.

There are nine chevron bones. The first consists of two pieces, not united in the middle line. The fourth is the largest. Their principal characteristic is that their spines are not particularly elongated downwards, but are large from before backwards.

The Ribs.—There are ten pairs of ribs, tolerably stout, especially thickening at their lower ends, though somewhat contracted rather above the middle.

The first is short and broad, articulating above by a well-developed tubercle with the transverse process of the first thoracic vertebra, and by a short capitular process with the body of the seventh cervical. It has a strongly pronounced angle.

The second to the sixth gradually increase in length, and diminish in thickness; afterwards they gradually become shorter. As far as the seventh inclusive, they have all distinct tubercles articulating with the transverse processes, and well-developed capitular process articulating with the hinder edge of the body or root of the arch of the vertebra in front. After the fourth the angle becomes obscure and is lost in the general convexity of the upper surface of the bone. In the eighth rib the tubercle is rudimentary, and does not reach the much diminished upper transverse process of the vertebra; the head articulates with the hinder edge of the base of the pedicle of the seventh vertebra, and on the right side only it has a small irregular articulation (not found in any other case) with the anterior edge of the pedicle of the arch of the eighth vertebra.

The ninth rib wants the whole of that portion representing the head, neck, and tubercle of the ribs in front, and has a truncated upper extremity, articulating to the end of the large transverse process of the ninth thoracic vertebra. The tenth rib is similarly articulated with the corresponding process of the tenth vertebra, and is nearly as well developed as the one in front of it.

The greatest length of each rib, in a straight line, is—

	inches.		inches.		inches.
First	18	Fifth	39	Eighth	38
Second	26	Sixth	39	Ninth	32
Third	$32\frac{1}{2}$	Seventh	$38\frac{1}{2}$	Tenth	29
Fourth	37				

As in *Physeter*, *Hyperoodon*, and the other known Ziphioids, there are no ossified sternal ribs.

The Sternum.—The sternum (Pl. XXVII. fig. 3) is remarkably long and narrow. It

[1] *Loc. cit.* p. 42.

resembles generally the form of the same part in *Ziphius* and *Mesoplodon*, but is proportionally longer than in *Hyperoodon*, and still more than in *Physeter*. The inferior surface is slightly convex from before backwards, and also from side to side.

It consists of five distinct segments, not connected together by bone. The anterior segment is the largest, and has a shallow fossa in the middle line in front; the posterior segment ends in a pair of narrow xiphoid processes, of which the right is slightly larger than the left.

As in the other Ziphioid Cetaceans, development is less complete along the middle line of the sternum than at the sides; not only are there median notches at each extremity, but there are three large median fenestræ, one between the first and second segments, one between the second and third, and one between the third and fourth segments. The edges of these fenestræ are bevelled and smooth; so that it does not appear that ossification would have advanced further in this direction if the animal had lived to be older.

Each side of the sternum shows six rough articular facets for sternal ribs:—the first near the anterior end of the first segment, at its broadest part; the second at the junction of the first and second segments; the third at the junction of the second and third segments; the fourth at the junction of the third and fourth segments; the fifth near the hinder end of the fourth segment; the sixth on the side of the fifth segment, near its anterior end.

The entire length of the sternum in a straight line is 45 inches. The greatest breadth of the first segment is 12·8 inches, of the second segment 10·9 inches, of the third 10 inches, of the fourth 9 inches, of the fifth 8·8 inches.

Pectoral Limb.—The pectoral limb, as in all other members of the group to which *Berardius* belongs, is small in proportion to the size of the animal.

The scapula bears a considerable resemblance to that of *Hyperoodon*; it is less narrow and elongated than in *Physeter*, and more regularly triangular, and less fan-shaped than in the ordinary Dolphins. The external surface is smooth and slightly concave, with one vertical ridge near the hinder border. The acromion is large and flat, curving regularly inwards, and somewhat upwards towards the extremity. The coracoid is rather longer, and more slender and rounded than the acromion. The glenoid fossa is irregularly oval, the outer edge more convex than the inner, and the anterior extremity more pointed than the posterior.

The humerus and bones of the forearm are elongated, slender, and simple in character; the latter more resemble the corresponding bones of a *Balænoptera* than of one of the Delphinidæ.

The humerus has a rounded head and single tuberosity, formed by a large and still free epiphysis. The lower epiphysis includes little more than the articular surface, and is united to the shaft, though the line of separation is distinct in many points. The radial border of the bone presents, near the middle of its length, a low rounded

protuberance, representing the deltoid ridge, with a shallow groove below it. Rather higher than this, just below the commencement of the expansion for the head, on the outer surface of the bone, is a roughened shallow depression. The articular surface for the ulna encroaches for a space of $1\frac{1}{2}$ inch on the corresponding margin of the humerus.

The radius is a simple narrow flattened bone of almost equal breadth throughout.

The ulna has more pronounced characters, having a very well-developed, broad, and flattened olecranon, with a strongly marked groove in the middle of the outer side of its upper border, apparently for the passage of a tendon, and which I have not observed in any other Cetacean. The bone is considerably contracted in its upper third, and expands moderately towards its lower extremity.

Both radius and ulna have well-marked epiphyses at either extremity, including the whole of the articular surfaces: that of the upper end of the ulna is united to the shaft; but the other three are still separate.

The carpus (Pl. XXVIII. fig. 10) presents some unusual features in the mode of union of its several elements with each other. All the bones which are met with in *Hyperoodon* and the other Ziphioids appear to be present and well ossified. There is thus one bone more (viz. the magnum) than in the ordinary Dolphins and in the Sperm-Whale.

The scaphoid (*s*) and the lunar (*l*) have almost completely united, though a groove shows their original limits. The cuneiform (*c*), which is the largest bone of the carpus, is united at its outer edge with the unciform (*u*); and a long bone to the distal side of which the second and third metacarpals are articulated, represents the magnum (*m*) and the trapezoid (*td*) coalesced as in the skeleton of *Mesoplodon sowerbyi* at Brussels. The bone, of the distal row, most to the radial side might well be considered the trapezium; but it represents the bone which, in other Cetacea, has been considered, with good grounds, to be the first metacarpal. Excluding this, the number of carpal bones are reduced by ankylosis to four. The arrangement on the two sides is precisely similar.

The second and third digits are of nearly equal length, the fourth (*IV*) not much shorter; the fifth (*V*) is well developed and stands considerably apart from the others; the first (*I*) is very small and adpressed. The phalanges were artificially articulated before they came under my observation; and some of the smaller terminal ones are probably missing; but the numbers present are, including the metacarpals, in the first digit 2, in the second 5, in the third 4, in the fourth 4, in the fifth 3.

Dimensions of the Bones of the Right Pectoral Limb.

	inches.
Scapula.—Height from middle of superior border to middle of external margin of glenoid fossa	14
Length of anterior border, from anterior superior angle to anterior margin of glenoid fossa	15

	inches.
Scapula.—Length of posterior border from posterior superior angle to posterior margin of glenoid fossa	12
Breadth from anterior to posterior superior angle	19·8
Length of acromion	6
Vertical height of acromion at the narrowest part (near its root)	2·8
Vertical height at the broadest part (near its end)	4·1
Length of coracoid process	6·5
Length of glenoid fossa	4·5
Breadth of glenoid fossa	3·3
Humerus.—Length	10·8
Breadth at lower end	4·3
Radius.—Extreme length	11·6
Breadth at upper end	3·3
Breadth at middle	3·1
Breadth at lower end	3·3
Ulna.—Extreme length, including olecranon	12·7
Breadth at upper part, including olecranon	5·6
Breadth at narrowest part	2
Breadth at lower end	3·1
Manus.—Length, allowing for loss of terminal digits, about	16
Length of first metacarpal	1·5
Length of second metacarpal	3·8
Length of third metacarpal	4·5
Length of fourth metacarpal	3·5
Length of fifth metacarpal	3·2

Pelvic Bones.—The one pelvic bone sent with the skeleton is very light and spongy in texture, and is apparently not completely ossified at the extremities. Its length is 5·8 inches, and its greatest thickness 0·9 inch; it is thus small in relation to the general size of the skeleton, and would indicate that the animal was a female, if the same sexual proportions obtain in *Berardius* as in many other Cetaceans. It is of very simple form, subcylindrical, a little compressed, and with a slight bend at one third of the length from one end, causing a low obtuse angular prominence on one edge. The characters and dimensions of the bone would probably have been somewhat different if the age of the animal had been more advanced.

Conclusion.—The special osteological characteristics of *Berardius* will be more fully appreciated when our knowledge of the skeletons of the other Ziphioids, especially of the genera *Mesoplodon* and *Ziphius*, is more perfect. We can hardly go wrong, however, in affirming that, as far as the structure of the skeleton is concerned, *Berardius* is a peculiar form of the group, and that it occupies one end of the series of which *Hyperoodon* forms the other, the remaining Ziphioids being in a certain

sense middle forms, and that *Berardius* is, on the whole, the least modified or specialized form, and approaches, therefore, nearer to the true Dolphins, while *Hyperoodon* is the most specialized, being modified in the direction of the Physeterinæ or Sperm-Whales.

The principal points still to be ascertained with reference to the skeleton of *Berardius* are:—1. Whether in the perfectly adult animal any further ankylosis of the cervical vertebræ takes place. 2. What is the number of the phalanges of a perfectly complete skeleton. 3. The form and size of the pelvic bones in the adult of both sexes. 4. Whether there is any difference in the development or form of the teeth in the two sexes. 5. Whether there are any rudimentary, non-alveolar teeth concealed in the gum of either the upper or the lower jaw.

Any one who may be fortunate enough to see the animal in a recent state should observe whether the cutaneous furrows on the throat, noticed in all other Ziphioids hitherto examined, are present; and it need scarcely be added that all observations on the visceral anatomy as well as any facts bearing upon the geographical distribution or habits of this rare and interesting Cetacean will be of great value in elucidating its history and determining its true place in the natural system.

DESCRIPTION OF THE PLATES.

PLATE XXVII.

Fig. 1. Side view of the skeleton of *Berardius arnouxi*.

Fig. 2. The skull and vertebral column of the same, seen from above.

Fig. 3. The sternum, seen from below.

All one sixteenth of the natural size.

PLATE XXVIII.

Fig. 1. Side view of the cervical, dorsal, and two anterior lumbar vertebræ. The lines from the Roman numerals below the figure point to the surfaces for the attachment of the ribs.

Fig. 2. Anterior surface of the atlas.

Fig. 3. Anterior surface of the fourth cervical vertebra.

Fig. 4. Anterior surface of the fifth cervical vertebra.

Fig. 5. Anterior surface of the sixth cervical vertebra.

Fig. 6. Anterior surface of the seventh cervical vertebra.

Fig. 7. Vertical median section of the skull.

Mx, maxilla; *PMx*, præmaxilla; *Vo*, vomer; *ME*, mesethmoid, united with the frontal above and the presphenoid below; *Na*, nasal; *Fr*, a number of loose wedge-shaped

fragments of bone, apparently dismemberments of the frontal; *SO*, supraoccipital; *BO*, basioccipital; *BS*, basisphenoid; *PS*, presphenoid; *Pt*, pterygoid.

Fig. 8. Inner surface of the right ramus of the lower jaw.

Fig. 9. Hyoid bones. *BH*, basihyoid; *TH*, thyro-hyoid.

Fig. 10. Dorsal surface of the left manus, some of the terminal phalanges missing. *R*, radius; *U*, ulna; *s*, scaphoid; *l*, lunar; *c*, cuneiform; *td*, trapezoid; *m*, magnum; *u*, unciform; *I* to *V*, the five digits.

All one sixth of the natural size.

PLATE XXIX.

Fig. 1. United right periotic and tympanic bones of *Berardius arnouxi*, outer surface.

Fig. 2. The same bones, under surface.

Fig. 3. The periotic bone, upper surface.

Fig. 4. The periotic bone, under surface.

Fig. 5. The tympanic bone, upper surface.

Fig. 6. The united periotic and tympanic bones of *Hyperoodon rostratus*, outer surface. From a specimen in the Museum of the University of Cambridge.

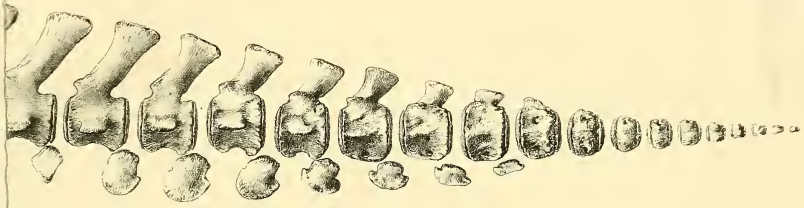
Letters to all the above figures:—*per*, periotic; *ty*, tympanic; *a*, principal or posterior articular surface between these bones; *a'*, broken surface where the two bones had been united; *e.a.m*, external auditory meatus, closed in life by the membrana tympani; *e.p.l*, external posterior lobe of the tympanic; *i.p.l*, internal posterior lobe of the tympanic; *e*, groove for the Eustachian tube; *m*, posterior bony process corresponding in its relations with the mastoid of other mammals, but united with the tympanic; *i.a.m*, internal auditory meatus; *af*, aqueduct of Fallopius; *f.o*, fenestra ovalis; *f.r*, fenestra rotunda; *a.l*, anterior lobe of the periotic; *m.l*, its middle lobe; *p.l*, its posterior lobe.

Fig. 7. Median vertical antero-posterior section of the anterior tooth of the right side.

c, cementum; *d*, dentine; *g*, globular dentine; *p*, remains of pulp-cavity.

Fig. 8. Corresponding section of the posterior tooth of the same side.

All of the natural size.



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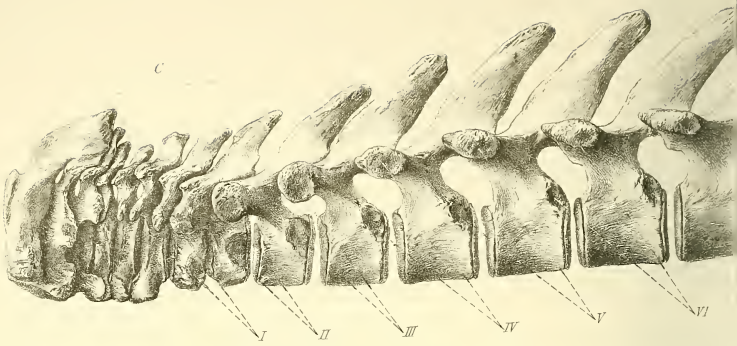

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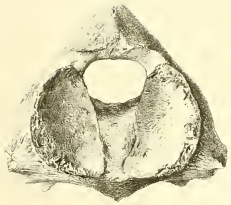

Fig. 3.

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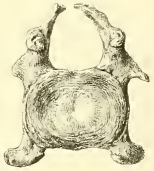

Fig. 7

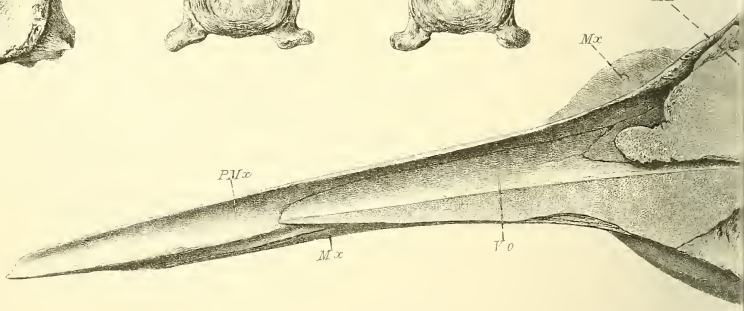

Fig. 8.

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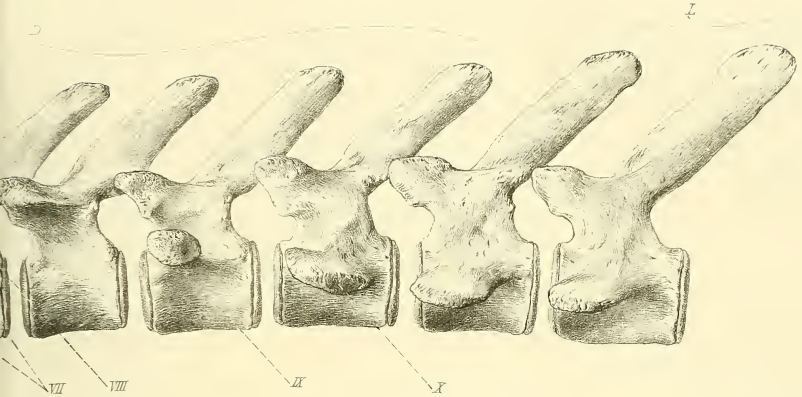

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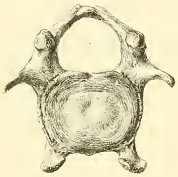

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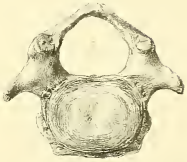

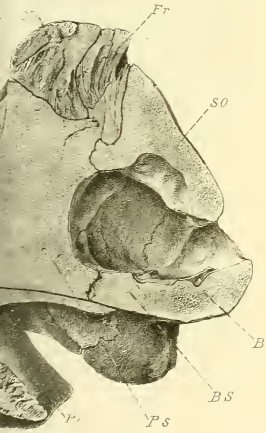

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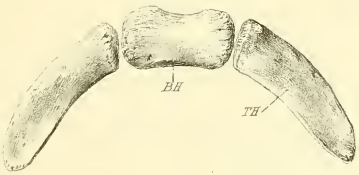

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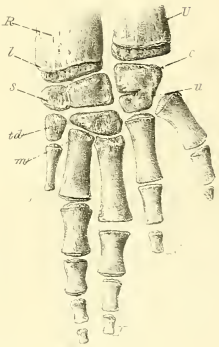

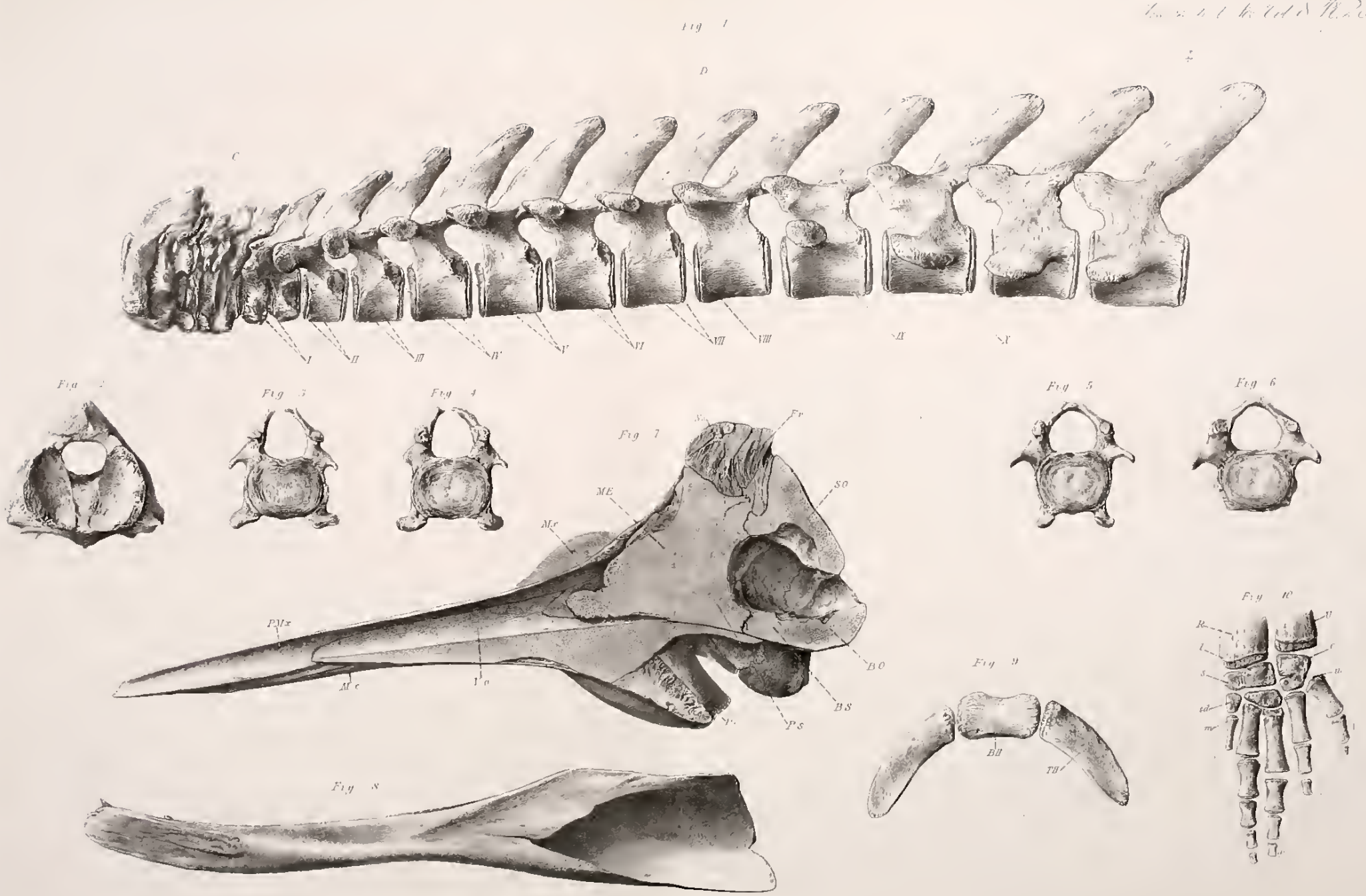
Fig 1
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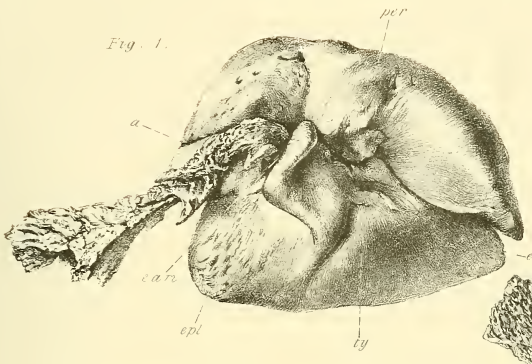

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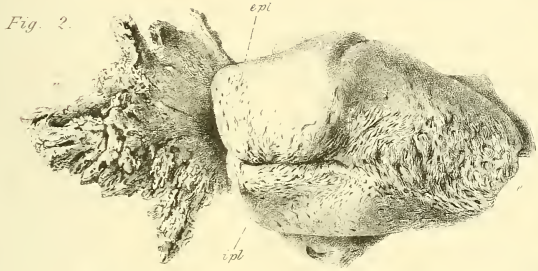

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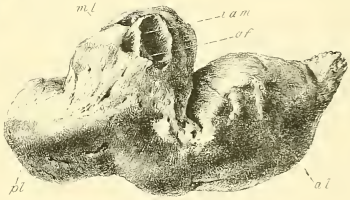

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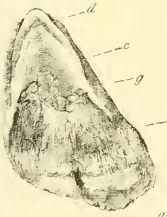

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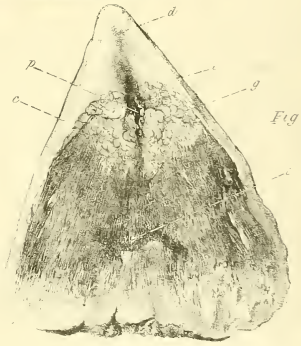

Fig. 7.

Figs. 1, 2, 3, 4, 5, 7 & 8. BERARDIUS. Fig. 6. HYPEROODON.

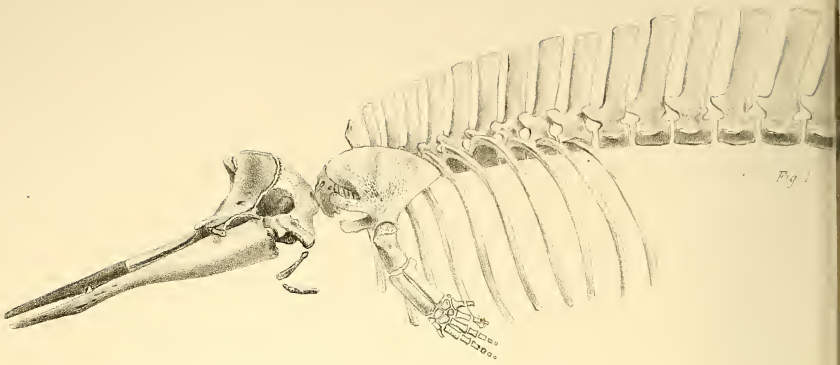

Fig 1

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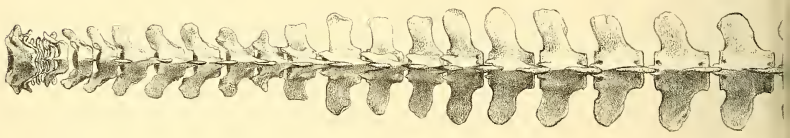
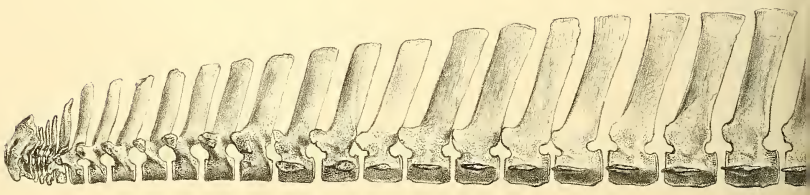


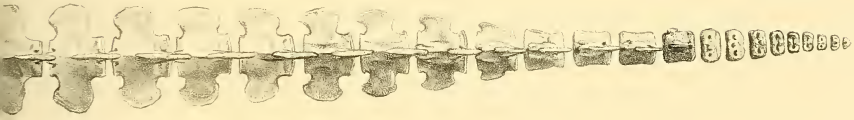


J.Smit lith.

1,2. MESOPLODON. 1,2

Fig. 5

Fig. 3



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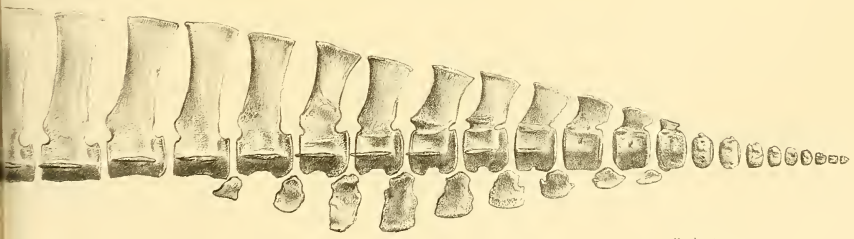

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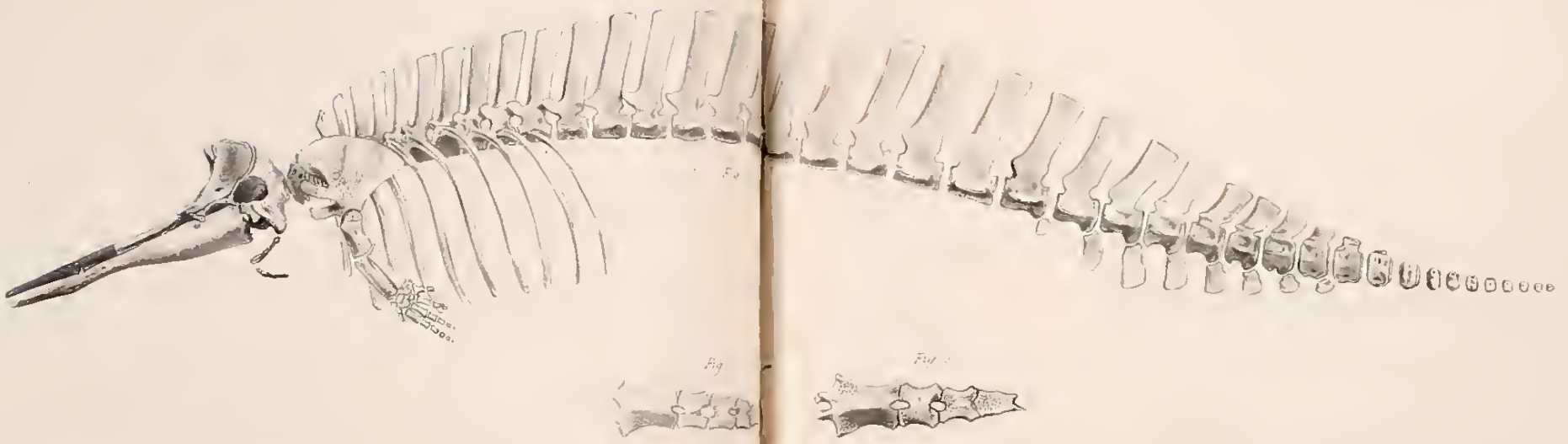

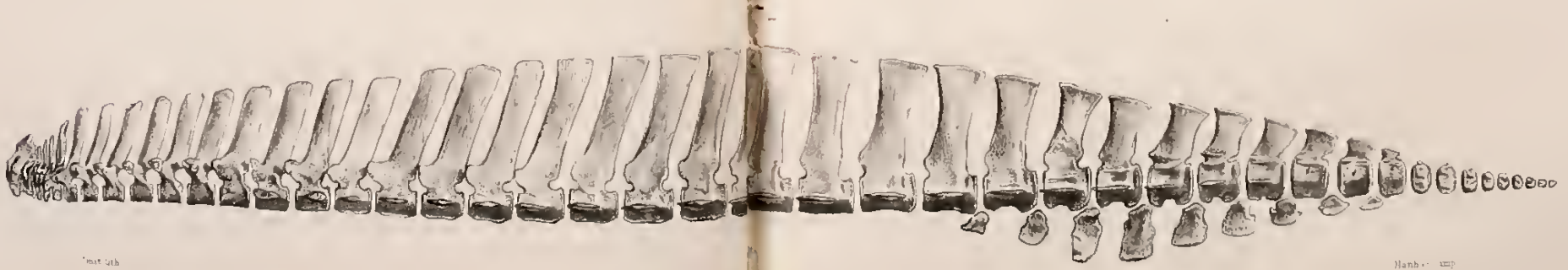

1, 2. MESOPLODON [illegible] AUSTRALIS


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