XXXIII.—The Right Whale of the North Atlantic, *Balæna biscayensis*: its Skeleton described and compared with that of the Greenland Right Whale, *Balæna mysticetus*.

By Principal Sir Wm. Turner, K.C.B., D.C.L., F.R.S., President of the Society, Knight of the Royal Prussian Order Pour le Mérite.

(With Three Plates, and Figures in Text.)

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Historical Introduction.

From the thirteenth to the seventeenth century a successful whale fishery was prosecuted in the Bay of Biscay and in the North Atlantic by seamen from the Basque ports of France and the north of Spain. So daring was their enterprise that they pursued their avocation northward to Iceland and even westward to Newfoundland and the adjoining shores of the American continent. The reputation of the Basque sailors as skilful whaling fishermen was so widely recognised that, when the whaling companies in England and Holland were started in the early years of the seventeenth century, Biscayan seamen were employed as the harpooners to strike the whales, and as coopers to construct the casks to contain the blubber. Up to that time the knowledge of the specific differences amongst the large whalebone whales was most imperfect, and it is not unlikely that both Right Whales and Fin Whales were captured as opportunity offered, though the former, from the greater length of whalebone and the thickness of blubber, were more prized. In 1611 an English whaling company sent for the first time an expedition to Spitzbergen, and from the instructions given to its commander, Thomas Edge, it would seem that two kinds of Right Whales had even then been noticed, the one larger and more valuable from the oil which it yielded and the length of the baleen, now known as the Greenland Right Whale, *Balæna mysticetus*, and the other a smaller whale, called the "Sarda." A whale captured off the coast of Iceland by the French and Spanish seamen, locally named "Sletbag," was probably the same as the Right Whale the "Sarda." With the development of the whale fishery in the Arctic Ocean, it became more evident that the Greenland Right Whale was distinct from the

smaller animal which had previously been the object of pursuit. In 1671 F. MARTENS gave* the name "Nordcaper" to Baleen Whales captured near the North Cape; they differed from those which frequented the Spitzbergen seas in being smaller, with less blubber, shorter whalebone, more active and more dangerous to kill. The name Nordcaper continued to be employed as equivalent to the Baleine de Sarde of the French naturalists, and BONNATERRE and LACÉPÈDE, adopting *nordcaper*† as a specific name, distinguished it from *Balæna mysticetus*, La Baleine franche, or the Greenland Right Whale.

Owing to diminution in numbers, the pursuit of this whale terminated at the end of the eighteenth century, and many naturalists believed that its continued capture during the centuries had led to its extinction. G. CUVIER‡ threw doubts, however, on the existence of the Nordcaper as a distinct species, and believed that, driven northward for refuge to the ice of the Arctic Sea, it was the same as the Greenland Whale; F. CUVIER§ agreed also with his brother in this belief. In a memoir published in 1820,|| PETER CAMPER recognised them as distinct species with different habitats, the *mysticetus* frequenting the whole extent of the icy Arctic, and the Nordcaper not living in such high latitudes, but in the seas of Iceland and Norway from the North Cape up to the Arctic zone.

In 1861 ESCHRICHT and REINHARDT¶ published a splendid memoir on the Greenland Right Whale, *B. mysticetus*, which contained an analytical description of its geographical distribution and of its osteology, and which fully established by facts and arguments its specific difference from the Nordcaper. Additional interest was given to this question by the report that two whales, mother and young, had been seen, in January 1854, off the harbour of San Sebastian in the Gulf of Gascony, that the young one had been captured and its skeleton preserved in the Museum in Pampeluna. On hearing of this capture, ESCHRICHT visited Pampeluna, and in a letter to VAN BENEDEN,** written in September 1858, he stated that the whale was the same as the Sletbag of the Icelanders, the *Balæna biscayensis*, as he now named the species. He purchased the bones for the Copenhagen Museum, and submitted a memoir to the French Academy†† in which he stated that it was not a *mysticetus*, but was allied to the *Balæna* of the Cape, which like the Nordcaper frequented temperate seas. ESCHRICHT did not live to publish a description of this skeleton, but the authorities of the Museum granted permission to Professor GASCO of Naples to examine, make drawings, and write‡‡ an account of the skeleton, in which he confirmed the opinion of ESCHRICHT that it was *Balæna*

* *Journal d'un Voyage au Spitzberguen*, Amsterdam, 1732.

† LACÉPÈDE, *Histoire nat. des Cétacées*, Paris, l'an xii. de la République (1804). *B. nordcaper*, La machoire inférieure très-arrondie ; très-haute et très-large ; le corps alongé ; la queue alongée.

‡ *Recherches sur les Ossemens fossiles*, v., Paris, 1825.

§ *Hist. nat. des Cétacés*, Paris, 1836.

|| *Observations anatomiques sur la structure intérieure de plusieurs espèces de Cétacés*, with Atlas of 53 plates, Paris, 1820.

¶ *Kong. Danske Videnskr.*, v., 1861. Translated in Ray Soc. Publications, London, 1866.

** "Hist. nat. de la *Balæna biscayensis*," *Mém. couron. Acad. Roy. Belgique*, 1886.

†† *Comptes rendus*, p. 294, 1860 ; *Ann. des Sc. nat.*, 5th series, t. i., 1864.

‡‡ *Ann. del Museo Civico di Storici nat. di Genova*, vol. xiv., 1879.

biscayensis. A drawing of the whale which had been made by Dr MONODERO was reproduced by VAN BENEDEN,* whilst measurements were recorded by FISCHER, the author of instructive memoirs on the Cetacea of the south-west of France.†

In February 1877 an important capture of a female Right Whale took place in the Gulf of Taranto, South Italy. Professor CAPELLINI examined it, and published a description‡ with a coloured drawing by HUEBER of the animal, and also figured some of the bones. He gave it the name *Balæna tarentina*, and regarded it as closely resembling *B. australis*. In the following year GASCO published a more detailed account of this specimen,§ which he named *B. biscayensis*. He reproduced a coloured drawing by MARRULLIER, and, as the skeleton had been acquired by the Museum in Naples, he was able to figure many of the bones. In 1889 Professor DE LA PAZ GRAELLS‖ gave an account of the whales which frequent the coasts of Spain, and noted the skeletons in some of the provincial museums. He saw in the Institute of Secondary Instruction, San Sebastian, the skeleton of a *B. biscayensis* which had been taken apparently in February 1878 near Guetaria, in the Bay of Biscay. He figured the skeleton and some of the individual bones. He also referred to the skeleton of another specimen in the Museum, Santiago, caught about 1880 off the coast of Galicia.¶

In 1891 Professor POUCHET, from a comparison of two photographs, one of which was that of a Right Whale taken at Algiers in 1886,** a part of the skeleton of which is in the Museum of Natural History, Paris, whilst the other was a photograph of a whale caught off Cape Cod, Massachusetts, concluded that they were of the same species, *B. biscayensis*. The specimen from Algiers supplied a second example of the capture of this whale in the Mediterranean.

In 1893 Professor GULDBERG stated†† that from 1889 to 1891 Norwegian captains had caught Right Whales, which were Nordcapers, off the coast of Iceland. In 1889 he received at the Museum in Christiania a skull, and in 1891 a skeleton, and specimens had also been presented to Copenhagen and Bergen. It is obvious, therefore, that *Balæna biscayensis* had not been exterminated, and that isolated examples had been caught during the nineteenth century in seas as remote from each other as those of Iceland and the Gulf of Taranto in South Italy.

We may now inquire into the occurrence of the Nordcaper in Scottish waters. Some years ago the late Mr THOMAS SOUTHWELL called attention to this matter.‡‡

* *Ostéographie des Cétacés*, by VAN BENEDEN and GERVAIS, plate vii.

† *Ann. des Sciences nat.*, vol. xv., 1871 ; *Actes de la Soc. Linnéenne de Bordeaux*, vol. xxxv., 1881.

‡ *Mem. dell' Accad. delle Scien. di Bologna*, vol. vii., 1877.

§ *Atti della R. Accad. delle Scien.*, Napoli, vol. vii. 1878.

‖ *Mem. de la R. Acad. des Ciencias*, Madrid, vol. xiii., 1889.

¶ In the course of his inquiry, Signor GRAELLS made the interesting observation that the shields of the municipalities of the coast towns, Bermeo, Lequeitio, Castrourdiale, Ondarroa and Plencia in Viscayo, showed their early association with the whale fishery, as Basque fishermen giving chase to whales with boats and harpoons are represented.

** *Comptes rendus de la Soc. de Biologie*, Paris, 1891.

†† "Zur Kenntniss des Nordkapers," *Zool. Jahrbuch*, vii.; also in *Biol. Centralblatt*, Leipzig, xxiii., 1903.

‡‡ *Proc. Nat. Hist. Soc.*, Glasgow, 1881 ; also in his work on Seals and Whales, 1881, and in *Ann. Scot. Nat. Hist.*, January 1907.

He stated that in 1806 an old Right Whale, with its sucker which was killed, came into Peterhead Bay; also that in 1872 Captain DAVID GRAY saw one sporting off the Headland of that bay. They were at the time believed to be Greenland Right Whales which had wandered south, but our present knowledge that this animal does not leave the icy north justifies the inference that they were specimens of *Balæna biscayensis*. The recent establishment by the Norwegians of fishing stations in Shetland, Harris in the Hebrides, and on the west of Ireland has thrown much additional light on the species of large whales which frequent the seas to the north and west of Scotland. In addition to the Great Fin Whales, *Balænoptera musculus*, *B. borealis*, *B. sibbaldi*, several specimens of the Sperm Whale, the Humpback (*Megaptera boops*), and *Balæna biscayensis* have been taken. Mr SOUTHWELL recorded the capture of a Nordcaper * in July 1903 in lat. 61° N., about 50 miles west of Shetland. Mr R. C. HALDANE † recorded six specimens of the same species, four bulls and two cows, as having been brought to the whaling station at Buneveneader, Harris, in 1906. The same naturalist further reported that in the years 1907 to 1909 sixty-eight examples of *B. biscayensis*, thirty-four bulls and thirty-four cows, many of the latter of which were with young, were taken, and of these sixty-six were at the Harris Station, and two, a bull and a cow, at the Alexandra Station in Shetland. Mr D. G. LILLIE has recorded ‡ the capture in 1908 of four bulls and a cow from the fishing station at Inishkea, in the west of Ireland, but no specimen of this whale was taken at the Bellmullet Station in 1911.§ Professor R. COLLETT has summarised || the takes of this whale by the Norwegians from April 1889 to 1908 as about eighty animals, the sexes being in almost equal numbers. As the fishing was conducted around Iceland, the Faroe Islands, and to the west of the Hebrides, his statistics include the specimens referred to in Mr HALDANE'S narrative to the same date. COLLETT ¶ reproduced four figures to show the external characters of this whale.**

Buneveneader, on West Loch Tarbet, is favourably situated as a station to which whales may be taken when captured during their migration northwards in the early summer. As regards the Nordcaper, the course which it usually makes is west of the Flannan Islands and St Kilda on the way to Iceland. Mr EAGLE CLARKE, the energetic Keeper of the Natural History Department of the Royal Scottish Museum, came into communication with Mr CARL F. HERLOFSON, the Manager of the Company at this station, and found him most willing to assist the Museum in adding to its collection specimens of the larger Cetacea frequenting the North Atlantic. Mr HERLOFSON presented to the Museum in 1911 a splendid skull of an old male Sperm Whale, and subsequently one of *Megaptera boops*. In the summer of 1912 the almost complete skeleton of *Balæna biscayensis* arrived, which, by the permission of the authorities of

* *Ann. and Mag. Nat. Hist.*, vol. xvi., 1905.

† "Whaling in Scotland," *Ann. Scot. Nat. Hist.*, January 1907.

‡ *Proc. Zool. Soc.*, London, October 1910.

§ *Report*, British Assoc. Ad. Sc., Dundee, 1912.

|| *Proc. Zool. Soc.*, London, vol. i., 1909.

¶ *Proc. Roy. Soc.*, London, 1909.

** F. FREUND described, *Deutsche Arbeit*, xi. p. 417, 1911–12, the use of the harpoon gun in the whale fishery off the Faroe Islands. *B. biscayensis* was seldom seen.

the Museum, I have examined, and an account of which I now submit to the Society, with illustrative figures. The animal was captured in 1910, west of St Kilda. Mr HERLOFSON gave every facility for the preservation of the bones, and under the supervision of Mr ARTHUR J. EDWARDS, one of the assistants in the Museum, they were carefully packed and despatched by steamer to be forwarded to Edinburgh. I have also to express my personal indebtedness to Mr HERLOFSON for presenting through me to the Anatomical Museum of the University the skull of an adult male *B. biscayensis*, caught 20 miles north-east of St Kilda in June 1912. The characters of this skull are also included in the description of the skull of the complete skeleton. The tympano-petrous bones accompanied the skull.

SPECIFIC NAME AND GEOGRAPHICAL DISTRIBUTION.

In the preceding section it is stated that the Right Whale frequenting the European waters of the North Atlantic was known locally as Nordcaper, Sarda or Sarde, Sletbag, and Biscay Whale. Its proper zoological designation should now be considered. The name *Balæna biscayensis* was given by ESCHRICHT and was adopted at the time by VAN BENEDEN, FISCHER, GRAY, FLOWER and many other cetologists. In an important monograph recently published,* F. W. TRUE has revived the name *Balæna glacialis*, introduced into cetological literature by KLEIN† and the Abbé BONNATERRE,‡ and has applied it to designate the Nordcaper or *B. biscayensis*; in the employment of this name he has been followed by Professor COLLETT.§ In connection with the term *glacialis*, it should be kept in mind that during the eighteenth century the specific distinction between the Nordcaper and the Mysticete was imperfectly understood, though it had been recognised that the Mysticete frequented the icy seas of Spitzbergen and Greenland, whilst the Nordcaper was found in the more temperate waters to the south. FISCHER speaks of KLEIN and BONNATERRE as compilers, and he indeed doubts if they had ever seen a whale.|| If the term *glacialis* is to be retained as the specific name of a Right Whale, it would be a more appropriate synonym of the Greenland Right Whale, which is a denizen of ice-bound waters; on the other hand, it would be a complete misnomer for the Nordcaper, which, to use the words of VAN BENEDEN, is the Right Whale of the Gulf Stream, as it would mislead and give a most erroneous idea of its habitat.

It was to the patient labours of ESCHRICHT that a scientific demonstration of the geographical distribution, external characters, and to some extent the anatomy of the Right Whales were put on a sound basis; and so long as a special name is given to the Nordcaper or Right Whale of the temperate waters of the North Atlantic, it is due to

* "The Whalebone Whale of the Western North Atlantic," *Smithsonian Contributions*, Washington, 1904.

† *Historia piscium naturalis*, 1740.

‡ *Tableau encyclopédique et méthodique: Cétologie*, pp. 3 and 4, Paris, 1789.

§ *Proc. Zool. Soc.*, London, 1909.

|| BONNATERRE evidently relied on the descriptions by ANDERSON and HORREBOWS in their histories of Iceland for an account of the mode of fishing of this whale, though the latter disputed the accuracy of ANDERSON'S statements. BONNATERRE'S specific characters are as follows: "Le Nord Caper. *B. glacialis*, B. maxillis subæqualibus; inferiore rotundâ, in medio latiore; dorso impinni, albicante."

ESCHRICHT that his name *biscayensis* should be preserved, and in this connection, therefore, it is employed in this memoir.

Early, however, in the nineteenth century it was recognised that in the American waters of the North Atlantic, as well as in the temperate seas of the southern hemisphere, Right Whales were found smaller in size, and with shorter whalebone than is present in *mysticetus*. DESMOULINS * described in 1822 by the name *Balæna australis* a whale which frequented the seas around the Cape of Good Hope. Right Whales had been captured near New Zealand, and as far south as Kerguelen Island, also in the seas of Japan and Korea, to which local names, as *B. antipodarum* and *japanensis*, had been applied. FISCHER described a fœtus of *B. australis* caught in 1831 near Tristan da Cunha in the South Atlantic.† ESCHRICHT and REINHARDT referred to whales regularly caught off the coast of New England as probably the same species as the Nordcaper.

In the year 1865 Professor COPE commenced his series of memoirs on the Cetacea caught off the coasts of the United States by describing the skeleton of the Black Whale in the Museum of the Academy of Sciences, Philadelphia,‡ and he named the species *Balæna cisarctica*. The skeleton, including the intervertebral cartilages, was 37 feet long, the skull of which measured 8 feet 5 inches. In a memoir published in 1883, J. B. HOLDER described § three specimens: a male 40 feet 4 inches long, caught at Charleston in 1880; a female 48 feet long, off the coast of New Jersey in 1882; and a third, sex unknown, 35 feet long, on Long Island, New York. F. W. TRUE, in his important memoir, continued the data collected by HOLDER, supplied additional facts and opinions, reviewed and summarised the evidence bearing on the Right Whale which frequented opposite coasts of the North Atlantic, and came to the conclusion that *B. biscayensis* and *B. cisarctica* were the same species.

Many naturalists are of opinion that the Right Whale of the southern hemisphere should not be regarded as a species distinct from the Right Whale of the North Atlantic, and as the name *B. australis* given by DESMOULINS to the southern species preceded ESCHRICHT'S name *B. biscayensis*, it has been held that it should be the specific name for the Right Whale which frequents the temperate waters of both hemispheres. It should, however, be remembered that the Right Whale of the Bay of Biscay and the North Atlantic had been known, captured, and many of its characters recognised long before the southern Right Whale had been seen by zoologists.

Half a century ago, largely under the influence of the late Dr J. E. GRAY, it would have been thought impossible for the same species of whale to have lived both north and south of the Equator, and specific names were multiplied to indicate distinct species living not only in opposite hemispheres, but in different seas in the same hemisphere, even though they corresponded in their generic characters. For example, the beaked whale *Ziphius cavirostris*, obtained by CUVIER in the Mediterranean in 1804, was regarded by zoologists as both specifically and even generically distinct from certain

* *Dict. Class. d'Hist. Nat.*, ii., 1822.
‡ *Proc. Acad. Nat. Sc.*, Philadelphia, 1865.
† *Actes de la Soc. Linnéenne de Bordeaux*, xxvii., Nov. 1868.
§ *Bull. American Museum*, New York, vol. i. No. 4, 1883.

other beaked whales found in the southern hemisphere. In a memoir on the skull of *Ziphius cavirostris* from Shetland,* I compared it with the descriptions of beaked whales from the south of the Equator named by GRAY *Petrorhynchus capensis*, by BURMEISTER *Epiodon australis*, and by VAN BENEDEN *Ziphius indicus*, and I came to the conclusion that they were only southern forms of the *Ziphius cavirostris* obtained by CUVIER in the Mediterranean and by myself from Shetland. In my *Challenger Report* on the bones of the Cetacea † I described the skull of a beaked whale from the Chatham Islands, which Sir JAMES HECTOR had originally named *Epiodon chathamiensis*. I compared it with the Shetland skull, and came to the conclusion that they were of the same species, though one had lived in the far north and the other many degrees south of the Equator. I also noted that, since my first memoir on *Ziphius* was published in 1872, VAN BENEDEN and HECTOR had accepted the view that the southern as well as the European crania of *Ziphius* were all examples of one species. I do not know if this whale has been caught in the tropics, but in my examination of the ear-bones collected by the *Challenger* and brought by the dredge from the floor of the ocean, I identified a tympanic bone obtained at 2275 fathoms in lat. 29° 35′ S. as identical in characters with that of the *Ziphius cavirostris* from Shetland.‡

A wide geographical distribution prevails with Sperm Whales (*Physeter macrocephalus*). They are caught in the temperate seas of New Zealand, also as far north as Shetland and the Faroe Islands,§ they are regularly hunted in the intermediate tropical seas, and no evidence of specific distinction exists between them whatever be their habitat. To all appearance, the great Sperm Whales are descended from a common ancestry. When oceans communicate directly or indirectly with each other, an opportunity is given to the Cetacea to make an extensive migration, which for them, as for other migratory animals, seems to be mainly determined by the amount and nature of the food-supply, which in the Right Whales consists of plankton organisms, mostly minute crustacea, and in many other Cetacea of either cephalopods or small fish.‖ Differences in habitat therefore do not necessarily imply specific difference, and on this ground no sufficient reason exists why the smaller Right Whale of the European and American coasts of the North Atlantic should not be the same species as the *Balæna australis* of the southern hemisphere. No adequate evidence has been given to prove the presence of this whale, so characteristic of temperate waters, in the seas of the tropics.

In the concluding volume of the *Reports* ¶ of the Challenger Expedition, Sir JOHN MURRAY has collected and analysed the results obtained from the sounding, dredging and trawling stations. He has shown that numerous species of Invertebrata, identical in character, were found in both the Arctic and Antarctic Oceans, and that a similarity of species existed in certain invertebrates from the temperate zones of the seas north and

* *Trans. Roy. Soc. Edin.*, vol. xxvi., 1872. † *Zoology*, part iv., 1880.

‡ See plate ii. figs. 9, 10, in my *Challenger Report* on the Bones of Cetacea, part iv., 1880.

§ *Proc. Roy. Soc. Edin.*, vol. xxiv., 1903.

‖ The Killer Whale, *Orca gladiator*, is a flesh-eating cetacean, for it attacks and devours seals and porpoises.

¶ *Summary of Results*, 2nd part, 1895.

south of the tropics, though these species were not represented in the waters of the tropics. A few species of fish were also obtained from opposite hemispheres which possessed a specific similarity.

Although the great whale of the Arctic Ocean, *Balæna mysticetus*, has not been found in the Antarctic, the characteristic Right Whale of the temperate zone is present in the waters of both hemispheres, though not found in the intermediate tropics. If the conditions of temperature and food-supply in the tropical zone had in previous times permitted these whales to migrate across the equator, as is now the case with the great Sperm Whale, these Right Whales would probably have had, like *Physeter*, a common ancestry; but if conditions such as now exist had prevailed in bygone times, throughout the stages of evolution of the Balænidæ, it is difficult to believe that a migration across the intermediate tropical zone could have taken place. Of the Right Whales, therefore, in each of the northern and southern temperate areas one may speculate that an independent descent in each area from, it may be a more primitive form, may possibly indicate the course of their evolution.

Colour—Baleen—Size.

Colour.—It is customary in the description of the external characters of the Nordcaper to state that it is black on the back, the sides, and the belly. The authority for this colouring is apparently the drawing by Monodero of the young San Sebastian specimen (1854), which was reproduced by van Beneden.* Similarly, Capellini's reproduction of Hueber's drawing of the Taranto specimen is also black. Gasco, in his figure of the Taranto whale, represented it of a uniform blackish colour, but made the head proportionally less than in Capellini's figure. Guldberg described the deep black colour of the entire body, though, on the authority of Captain Berg, individuals shewed white spots here and there on the black surface. Collett stated that the Nordcaper was usually all black, though in some 10 per cent. the belly was more or less white, well defined against the black; at times the white patch was constricted in the middle, and spotted with black. He figured the ventral surface of a female in which these characters were well marked. Mr Edwards has kindly given me the opportunity of reproducing a photograph by Mr Herlofson of the belly of one of the Nordcapers brought into his station (fig. 16). A broad white patch extended from the ventral surface of the throat as far back as the pectoral limbs, immediately behind which it was intersected by a black band, and was then continued white to the region of the anus. Obviously, therefore, a white belly more or less extensive and marked with black spots or bands may sometimes occur.

One of the noticeable external characters of this whale was the presence on the snout and the front of the lower jaw of a wart-like growth, called by whaling seamen the "bonnet." It was figured in Capellini's memoir on the Taranto whale, and recently in Collett's memoir. It consisted of a mass of crustaceous Epizoa belonging to the genus Cyamus.

* *Ostéographie des Cétacés*, by van Beneden and Gervais, fig. 1, pl. vii.

LÜTKEN and SARS have identified the species as usually *Cyamus ovalis*,* a form of whale louse. Mr EDWARDS told me that in a specimen which he saw, the growth formed a moving mass 12 inches in diameter and 2 inches deep, so strongly attached to the snout that he had to employ pliers to remove it. GULDBERG stated that these Epizoa may be scattered over the body generally, and EDWARDS found them on the skin around the anus and female parts.

Baleen.—The triangular baleen plates were black in colour, though COLLETT stated that sometimes the most anterior were white; their bristles were black, and fine as silk. As in *mysticetus*, their bases were narrow in conformity with the palatal area from which they grew. The maximum length recorded was a little more than 7 feet, which is about one-half that of the longest plates in *mysticetus*. Specimens of the plates of *biscayensis*

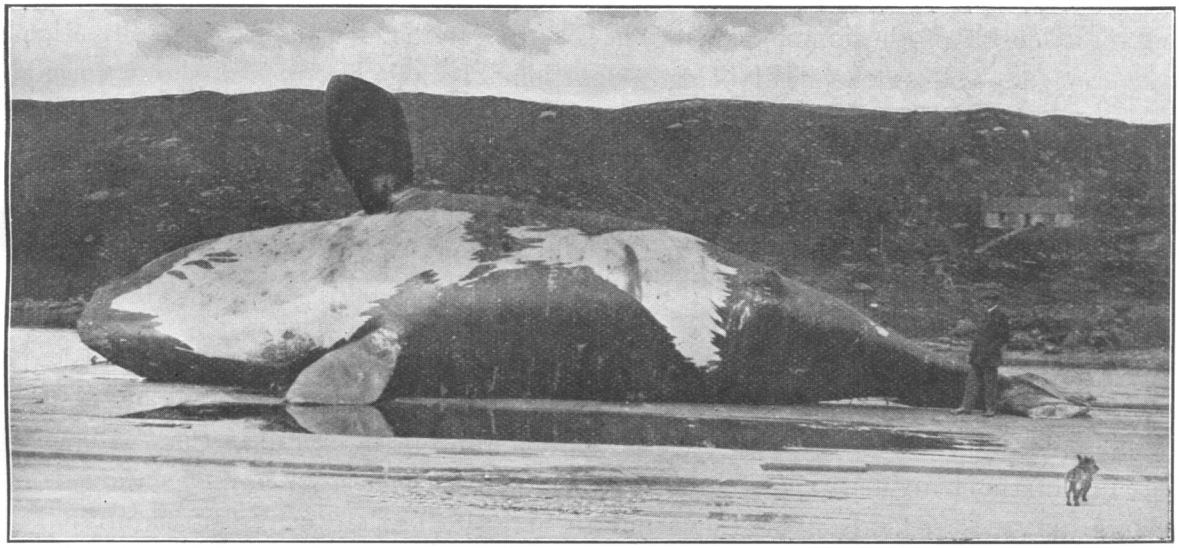


FIG. 16.—Ventral surface.

in the Royal Scottish Museum ranged from 4 feet to a little more than 7 feet in length, and from $6\frac{3}{4}$ to 9 inches in width at the base; and GULDBERG gave 7 feet 1 inch as the length in an Iceland specimen. SCORESBY gave 13·7 inches as the maximum length in *B. mysticetus*, but from 10 to 12 inches is more usual.

Size.—The young specimen caught at San Sebastian in 1854 was said to be 24 feet $9\frac{1}{2}$ inches long, and another specimen from Guetaria was 34 feet 3 inches. That at Taranto, a female, was 39 feet 4 inches (12 metres). GULDBERG gave the length of a female as 42 feet, and that of other specimens from Iceland as ranging up to 51 feet 8 inches, the smallest of which were not full-grown; he also reproduced three photographs of a male lying on the beach at Dyrefjord in Iceland. The success in recent years of the Norwegian whalemen has enabled many additional measurements to be made. HALDANE stated that, of 67 specimens of both sexes, the bulls ranged from 43 to 51 feet,

* LÜTKEN has given in *Vidensk. Selsk. Skr.*, Copenhagen, 1873, an elaborate account of the species of Cyamus which infest whales.

the average being 45·9 feet; the cows ranged from 44 to 51 feet, with an average of 46·9 feet; the cows therefore exceeded in average length the bulls, but the maximum in each sex seemed to be about 51 feet. COLLETT'S measurements, which included those noted by HALDANE, ranged in 44 specimens from 36 to 48 feet in 24 bulls; from 31 feet (9·45 m.) to 50 feet (15·2 m.) in 20 cows, the average length in the females being a little more than in the males.

SCORESBY, in his classical work on the Arctic Regions, stated that of 322 individuals of *B. mysticetus*, in the capture of which he was personally concerned, not one exceeded 60 feet, though he had been told of one 67 feet long, and another as much as 70 feet; but of six which he measured, four, apparently adults, ranged from 50 to 58 feet. In the animal 58 feet long the head was 19 feet, therefore about one-third the total length of the animal.

In *B. biscayensis* again, observers agree that the head bears a smaller proportion to the total length of the animal, about one-fourth. In being smaller, therefore, than *mysticetus*, as well as the head being proportionately less, *biscayensis* shows specific characters which distinguish it from the Right Whale of the Greenland seas. The large skull of *B. biscayensis* in the University Museum of Anatomy was from an animal whose length was stated by Mr HERLOFSON to be 51 feet. The skeletons, the skull included, of eleven American specimens of the North Atlantic Right Whale recorded by TRUE, are stated to have ranged from 30 to 53 feet in length.

SKELETON.

The material at my disposal for purposes of study consisted of the skull and almost complete skeleton in the Royal Scottish Museum and a separate skull in the Anatomical Museum of the University, also three tympano-petrous bones. I have been aided in making the measurements by Mr ROBERT REID, assistant in the Royal Scottish Museum, and by Mr ERNEST J. HENDERSON, Assistant Conservator to the Anatomical Museum of the University, and I am indebted to the latter for the photographs of the bones from which most of the illustrations have been prepared.

SKULL.

In outline the skulls possessed the highly arched facial region characteristic of a Balæna. In Table I. measurements are given of the two skulls, and in the same table are included the measurements of two skulls of the Greenland Whale, *B. mysticetus*, in the Anatomical Museum of the University.* (See Plates I., II.)

The *occipital* bone in *B. biscayensis* formed a large proportion of the wall of the cranium. It mounted to the vertex and articulated with the thin edge of the frontal which separated it from the nasals. The vertical and transverse diameters of the squama were almost equal; the posterior surface was convex and raised into a mesial vertical ridge in its upper part, but on each side it showed a shallow concavity which extended to the side of each condyl. The foramen magnum was almost circular. The

* *Marine Mammals in the Anatomical Museum of the University of Edinburgh*, pp. 21, 22, 1912.

condyls were separated behind by a marked interval, but were only an inch asunder in front. The exoccipital extended outwards from the condyl to the squamous temporal.

The *frontal* contributed only a narrow edge to the vertex, but broadened on each side and ended in a strong bar which formed at its outer end the upper border of the orbit with the pre- and post-orbital processes, the latter of which was the larger. The malar and lachrymal bones had not been preserved in the skull from the skeleton, and the boundary of the orbit was incomplete. (See p. 919 for orbit in separate skull.)

The *parietal* did not reach the vertex, and articulated by its upper border with the lateral border of the occipital squama. It was seen on the side of the cranium locked between the frontal and squamous temporal.

The *squamous temporal* was a massive bone nearly equal in vertical and transverse diameter, which gave breadth to the posterior part of the cranium. It ended externally in two blunt processes, the anterior of which was a little behind the orbital part of the frontal, whilst the posterior and most depending process provided the shallow glenoid concavity, one foot 2 inches in diameter, for the temporo-mandibular joint. The petrous temporal on the under surface of the cranium was locked between the squamous temporal and exoccipital.

TABLE I.

Measurements of Skulls of Balænidæ.

	B. biscayensis.				*B. mysticetus.*			
	R. S. M.		U. An. Mus.		U. An. Mus.		U. An. Mus.	
	ft.	in.	ft.	in.	ft.	in.	ft.	in.
Length, condylo-premaxillary, in straight line,	12	6½	13	9	11	5	8	0
,, ,, over vertex curve,	15	0	16	0	13	2	...	
,, from glenoid to tip of premaxillary,	11	5½	12	7	10	3	7	4
,, of superior maxilla,	10	5	11	3½	9	8	...	
,, of premaxilla,	11	1	11	7¼	10	2½	...	
,, of rostrum in straight line,	9	6	10	2	8	7½	...	
,, from tip of premax. to middle of upper orbital border,	11	3	12	4	10	1	7	3
Breadth in squamoso-occipital region in straight line,	7	7½	8	2½	5	7	4	2
,, in frontal region between post-orbitals in straight line,	8	2½	8	10	5	7	4	2½
,, base of rostrum in straight line,	2	11	3	1	1	9	..	
Occipital bone, greatest breadth,	3	6	3	11	3	1½	2	8
,, ,, height from foramen magnum,	3	2½	3	3	2	5	1	10
,, ,, ,, from back of condyl,	3	10	3	9	2	9	...	
,, ,, ,, of foramen magnum,	0	5	0	6	0	5¾	0	4
,, ,, breadth of foramen magnum,	0	5	0	5½	0	4¼	...	
Between pre- and post-orbital processes,	0	7½	0	8	0	6	0	5½
Nasal bone, length mesially,	1	1	1	0	1	0¼	...	
,, ,, greatest breadth of each nasal,	0	6	0	7¾	0	5¼	...	
Anterior nares, greatest breadth,	1	3	1	5	0	10	...	
,, ,, long diameter,	2	3½	2	5	2	1½	...	
Posterior nares, vertical diameter,	0	8¼	...		0	5½	0	2
,, ,, transverse diameter,	1	1	...		0	8	0	8
Hard palate, length along curve,	12	10	...		11	3	...	
,, ,, greatest breadth,	2	6	2	8	1	8	...	
Mandible, length of outer surface of ramus,	13	2½	13	6	...		...	
,, chord of arc of ramus,	11	8½	12	5	...		7	9½
,, girth in front of condyl,	3	1½	3	7	...		2	2¼
,, vertical depth, 3 feet in front of condyl,	1	3½	1	4½	...		0	8½
,, ,, 4 feet behind free end,	0	11	0	11	...		...	
,, diameter of condyl,	1	2	1	2	...		...	

The facial part of the skull formed the rostrum, or beak, highly arched from behind forwards. The *superior maxilla* articulated at its nasal end with the frontal; it widened laterally into a triangular plate which passed downwards and outwards parallel to and in front of the strong bar of the frontal. The plate did not overlap the outer surface of the frontal, but was prolonged below its deeper surface, and ended externally in a pointed apex 6 inches internal to the pre-orbital process of the frontal. Near the base of the plate the bone was pierced by five large foramina for the transmission of vessels and nerves to the beak. The superior maxilla formed the outer border of the rostrum to within 6 inches from the tip; it diminished in breadth from behind forwards, and its anterior end was about an inch broad; its upper surface was longitudinally grooved in the greater part of its extent. The base of the beak was not, as in the Odontoceti, definitely marked by a notch, but was indicated approximately by the most posterior of the large vascular foramina; it was about 3 feet broad.

The *premaxillæ* extended from the frontal at the vertex to the tip of the beak; they were arched from behind forwards, and convex from side to side. In breadth each bone attained a diameter of from 8 to 9 inches, and as they were longer and broader than the superior maxillæ they formed the more noticeable constituents of the beak. A horizontal line drawn from the edge of the glenoid cavity to the tip of the beak formed the chord of the arc of the beak, and a perpendicular drawn from it to the outer border of the highest part of the arch of the superior maxilla measured $3\frac{1}{2}$ feet.

The *nasal* bones were locked between and articulated with the premaxillæ and the frontal. Their long axis was almost horizontal, the upper surface was flattened, the under surface entered into the roof of the nose, the thickened posterior border was in line with the upper ends of the superior and pre-maxillæ, the anterior border was slightly concave and had a short projection at its mesial angle.

The *anterior nares* opened forwards in front of the nasals, their antero-posterior diameter was somewhat more than 2 feet, and their greatest breadth a little in front of the nasals was more than 1 foot; each side was formed by the inner surface of the premaxilla. On looking into the nares an ethmoido-turbinal was seen on each side, the anterior border of which was about $1\frac{1}{2}$ foot behind the anterior border of the nasal. The vomer was not a mesial plate at the anterior nares, but was spout-like in form; its two lateral borders articulated with the premaxillæ, and its mesial groove lodged a thick band which represented a mesethmoid.

The *hard palate* had a strong mesial keel formed by the vomer, which was visible between the palatal surfaces of the superior maxillæ to within about 4 feet from the tip of the beak. The keel divided the palate into two equal lateral halves, each of which, concave from side to side and from before backwards, contained foramina for vessels and nerves to supply the palatal mucous membrane and the baleen plates.* The hard palate along the curve was nearly 13 feet long, and its greatest breadth, measured in a straight

* For an account of the structure and vascularity of whalebone, see my memoir on *Balænoptera sibbaldi* in *Trans. Roy. Soc. Edin.*, vol. xxvi., 1870.

line across the mesial ridge, was about 2 feet 6 inches. The pair of palate bones formed the hinder part of the hard palate; they articulated with each other mesially, and both the anterior and the outer borders articulated with the superior maxilla. The pterygoids were seen behind the palates and the posterior surface of each was hollowed into a sinus-like chamber.

The *posterior nares* had a transverse diameter about one-third greater than the vertical. The sharp posterior mesial border of the vomer, which did not extend so far back as the opening, was seen; it articulated below with the mesial borders of the palate bones, and in this region separated the nasal chambers from each other.

The *Mandible* consisted of two distinct rami not fused at the symphysis. The rami arched strongly outwards, and they enclosed a buccal chamber of large dimensions for the lodgment of the tongue, whilst the high arching of the palate permitted the vertical growth of the long baleen plates in this cetacean. The outer surface of the ramus was convex; the inner, almost a plane surface, had a large dental foramen, the edge of which projected upwards in front of the condyl, also other smaller foramina for vessels and nerves; the upper and lower borders were narrow. A horizontal line drawn from the condyl to the tip of the arched ramus gave the chord of the arc, and a perpendicular from it to the upper border of the bone measured 1 foot 9 inches. The condyl was smooth and was defined by a neck; the coronoid process was not developed. The rami were free and pointed at their anterior ends, which had doubtless been connected together by fibrous bands.

Hyoid bone.—The body, great cornua (thyro-hyals), small cornua (cerato-hyals) were fused together and formed a bone, convex on the ventral, concave on the superior

FIG. 17.—Hyoid bone.

surface (fig. 17). It measured between the tips of the great cornua 2 feet 4 inches along the convex surface, and 1 foot $11\frac{1}{2}$ inches in a straight line. The great cornu was somewhat cylindriform, 1 foot $1\frac{1}{4}$ inch in girth. The small cornua projected for $1\frac{1}{2}$ inch from the anterior border close to the mesial plane, and were only one inch asunder. The stylo-hyals had not been preserved.

In the general form and construction of its skull *B. biscayensis* corresponded with *B. mysticetus*, but owing to the much longer baleen plates in the latter the head was

higher and the mouth was deeper and wider. In comparing the measurements of the two species in Table I., it should be kept in mind that the skulls of the Biscay Whale were adult; those of *mysticetus* were immature—the one with the mandible was from a young skeleton, about 25 feet long, and therefore not quite half the length of the adult, whilst the other, with a skull $11\frac{1}{2}$ feet long and without the mandible, was from an older though not an adult animal, perhaps about 40 feet long.*

In *biscayensis* the smaller adult skull was 12 feet $6\frac{1}{2}$ inches long, and its breadth in the fronto-orbital region was 8 feet $2\frac{1}{2}$ inches, the breadth being about two-thirds the length, whilst in the larger *mysticetus* the breadth, 5 feet 7 inches, was about half the length, 11 feet 5 inches, which doubtless is a specific difference. The occipital squama differed in the two species; in *biscayensis* the greatest breadth of the posterior surface was somewhat more than the height measured from the foramen magnum, whilst in *mysticetus* the breadth was yet greater than the height. The character of the posterior surface of the squama was also different: in *biscayensis* the mesial vertical ridge, narrow below, expanded laterally about the upper half, but was bounded on each side by a broad concavity; whilst in *mysticetus* the mesial ridge expanded in the upper part to form an almond-shaped convexity which occupied a considerable proportion of the squama and left room for a relatively narrow lateral concavity. In *biscayensis* the breadth of the skull in the squamoso-occipital region was less than in the fronto-orbital, and the post-orbital process projected beyond the anterior process of the squamous temporal; in *mysticetus* these diameters were practically the same, and the squamous temporal, pre- and post-orbitals, and the external apex of the superior maxilla were almost in the same antero-posterior vertical plane. In *biscayensis* the nasal bones were somewhat broader in relation to their length, their posterior border was transverse to their long axis and not indented, and the anterior nares were wider than in *mysticetus*; whilst in the latter the posterior border was pointed and indented, and two processes from the frontal extended forwards between the nasal bones for 3 inches.

Figures of the skulls of European examples of the North Atlantic Right Whale had previously been given by GASCO for the Taranto specimen; by DE LA PAZ GRAELLS for the specimen in the Cabinet of Secondary Education at San Sebastian, who also figured the mandible of one preserved in the Institute at Gijon in Asturias.

The external characters of the American Right Whale from New Jersey have been figured by HOLDER, as well as the skulls of the Charleston and New York specimens; TRUE in Plates 42 to 46 figured the skulls of the New York and Charleston examples, also COPE'S type specimen of *B. cisarctica*, and the head of one caught off Cape Cod in April 1895. VAN BENEDEN figured in Plates I. and II. of the *Ostéographie* the skull and skeleton of *B. australis* in the Paris Museum of Natural History, and in

* These crania are catalogued in my *Marine Mammals in the Anat. Mus. of the University*, pp. 21, 22, London, 1912. As the skeleton of the smaller mysticete was suspended in the Museum at a considerable height, difficulty occurred in making complete measurements.

Plate III. the bones of the so-called *B. antipodarum* in the same Museum; he did not reproduce the skull of *B. biscayensis*, for, as is shown in Plate VII., he had access to only a few bones of the skeleton.

Tympano-petrous Bones.—From the study of these bones in the Cetacea* it is obvious that importance is to be attached to their size, form and markings in estimating specific characters. The *Tympanic bone* in *Balæna mysticetus* was massive; in the adult it was from 5 to 6 inches long, from 3 to 4 inches broad, and between 4 and 5 inches in vertical diameter. The outer surface was divided into two unequal convex portions, the posterior of which was much the larger, by a long, wide and deep oblique groove; from its upper border a lip-like process, bounded behind by a groove, projected for the attachment of the malleus; the lower part of the outer surface showed a shallow concavity and ended inferiorly in a strong keel, which extended the length of the bone (Plate III. fig. 11). The inner surface was convex and striated with vertical grooves; its upper border was almost horizontal, moderately thick as compared with the same border in Balænoptera, and was rounded into the tympanic cavity, its anterior end was slightly notched for the Eustachian tube (Plate III. fig. 13).

The description of the tympanic in *B. biscayensis* is based on the examination of three specimens, which in their general form have the characters of Balæna and not of Balænoptera. They varied in length from $5\frac{3}{8}$ to $5\frac{5}{8}$ inches, in breadth from $3\frac{3}{8}$ to $3\frac{1}{2}$ inches, in vertical diameter from $4\frac{3}{8}$ to $4\frac{1}{2}$ inches; in all, the height was greater than the breadth. *B. biscayensis* differed from *mysticetus* in the anterior division on the outer surface being more rounded, in the lip-like process from the upper border being defined behind by a deep notch and not by a short groove, in the posterior border being more rounded and less ridge-like than in *mysticetus*, in the anterior border being more gently continued into the keel and the junction not being almost rectangular as in *mysticetus*, in the latter of which the keel was prolonged further forward (fig. 10). The striated part of the inner surface was more flattened in *biscayensis*, its upper border was thinner and more oblique, and it terminated anteriorly in a distinctly deeper Eustachian notch than in *mysticetus* (fig. 12).

When compared with two tympanics of *B. australis* a striking resemblance in general form with *biscayensis* was observed. Also in the details of the outer surface, in the deep notch defining the posterior border of the lip-like process, in the rounding off of the posterior border into the keel, in the obliquity of the upper border of the inner surface, and in the depth of the Eustachian notch *B. biscayensis* and *australis* closely corresponded, though the striated part of the inner surface in *australis* was not so flattened as in *biscayensis*, and its upper border was relatively thin (fig. 14). In all the essential characters, therefore, the tympanics of these animals were practically alike. In the genus Balæna the height of the tympanic was materially greater than the breadth, whilst in Balænoptera these dimensions were almost equal.

* I may refer to my recently published volume, *Marine Mammals in the Anatomical Museum of the University of Edinburgh*, London, 1912, for observations on and figures of the tympanic bones in many species of the Cetacea.

The *Petrous bone* was fused in two places with the tympanic in *B. mysticetus*, *biscayensis* and *australis*: the more anterior was in front of the great oblique groove at the upper border of the anterior division of the outer surface; the more posterior was fused with the upper part of the inner surface close to the opening into the tympanum. The *periotic* proper constituted a small proportion of the petrous, and was situated opposite and internal to the opening into the tympanum. It was formed of hard dense bone, and in *B. mysticetus* measured $2\frac{3}{8}$ inches by $1\frac{3}{8}$ inch; in *biscayensis* $2\frac{3}{4}$ by $1\frac{3}{4}$; in *australis* $2\frac{7}{8}$ by $1\frac{7}{8}$. The three species closely resembled each other in the characters of the periotic proper: the inner or cranial surface was jagged and marked by the canals or foramina for the auditory vessels and nerves; the outer or tympanic surface showed the fenestra ovalis for the stapes. The inferior surface of the petrous was relatively smooth; the superior surface was more spongy in character and articulated with the cranial wall. In *mysticetus* the so-called mastoid was 6 inches long, in *biscayensis* $4\frac{1}{2}$ inches, and in *australis* $8\frac{1}{2}$ inches.

Two of the *Tympanic ossicles* were present in more than one specimen. The Malleus was fused with the lip-like process of the tympanic, the Incus articulated with the malleus, the Stapes was absent.

The tympanic ossicles of the Taranto *biscayensis* were figured by CAPELLINI and GASCO in their respective memoirs on this animal, and the malleus and incus from one of my crania are figured in Plate III. fig. 15.

VERTEBRAL COLUMN.

I arranged the bones of the spine in groups with the bodies in contact with each other. The vertebral plates, with few exceptions, were either wholly or partially fused with their bodies; the intervertebral discs were fused with the cervicals, but were otherwise absent. The length of the spine from the atlas to the terminal caudal, in a straight line, was 26 feet 8 inches. Had the discs been in place the length would probably have been from 30 to 31 feet. The condition of ossification showed that the whale had reached maturity. The vertebral formula was $C_7D_{14}LCd_{35} = 56$. The vertebræ were weighty in relation to their size, as also in *Balæna mysticetus*.

Cervical Region.—The seven cervical vertebræ with their discs were fused into a mass of bone, in which the constituent vertebræ could readily be recognised, though the fusion of the anterior six with each other was much more complete than that of the 6th with the 7th, for in these two the osseous union was limited to their inferior or ventral surfaces, where an osseous outgrowth united the two bodies (Plate II. fig. 6). The length of the cervical mass, measured on the ventral aspect, was 13 inches, the greatest width between the tips of the transverse processes of the atlas was 2 feet 3 inches. The anterior surface of the atlas possessed two separate articular concavities for the occipital condyls, the diameter between their outer borders was 14 inches, and the vertical diameter of each was 11 inches. The spinal foramen was $5\frac{1}{4}$ inches broad and 7 inches vertically. The spines of the anterior six cervicals were fused together, also the

laminæ from the 1st to the 3rd, but the laminæ of the 4th to the 6th were free. The laminæ of the axis formed a plate $6\frac{1}{2}$ inches broad (fig. 6). The spine and laminæ of the 7th cervical were not fused with the 6th.

The transverse processes had several interesting features. In the Atlas a massive process, not perforated, represented the diapophysis or superior transverse process of the vertebra (fig. 7). It was fused near its outer end with a corresponding process of the axis, which arose by two roots, of which the anterior joined the above process of the atlas, whilst the posterior was fused with the superior transverse process of the 3rd vertebra; the roots were distinct at their origin, and bounded an ovoid foramen 2 inches in diameter. The superior transverse process of the 3rd was also fused with one from the 4th cervical. That from the 5th was partially fused with one from the 6th, and in these cases an elongated ovoid foramen intervened, where the fusion was incomplete. The superior transverse process of the 7th was not fused and was broad at its outer end.

In the Atlas the inferior transverse process or parapophysis, $4\frac{1}{2}$ inches long, was situated 2 inches below the flattened superior process. That from the Axis projected for 4 inches from the body. The corresponding inferior processes from the 3rd and 4th vertebræ were not symmetrical on opposite sides. The right side of the 3rd possessed a slender inferior process 4 inches long, which was fused at its outer end with the corresponding process of the axis. From the right side of the body of the 4th a tubercle about an inch long represented the inferior transverse process; the 3rd and 4th cervicals had no corresponding inferior processes on the left side, and the 5th, 6th, and 7th had none on either side of the body. The outer ends of both the diapophyses and parapophyses were free, and in no vertebra did they join to form a large lateral foramen, on the side of the cervical spine, which, in the adult Balænopteridæ, were occupied by the arterial meshwork of the rete mirabile.*

Dorsal Region.—Fourteen vertebræ possessed costal articular surfaces. Those on the 1st dorsal were relatively thin at the free end of each transverse process. The 2nd and 3rd dorsals had similar articular surfaces. In the 4th to the 10th the transverse process was thickened and articular at its free end, and in addition a distinct costal articular surface was present on each side of the body near its posterior border. The 11th to the 14th had no costal surfaces on the sides of the body, the 11th and 12th transverse processes, broad, flat, and long, had each a costal articulation at its outer end; in the 13th and 14th dorsals the transverse processes, also articular, were long and narrow, and thickened at the end. The spines of the dorsal vertebræ were as a rule large plates flattened laterally and truncated at the free end, but the 1st to the 3rd were somewhat pointed. The anterior articular processes were strong and directed forwards and upwards. The ventral surface of the body from the 7th to the 12th had an antero-posterior mesial ridge.

As regards dimensions, the dorsal vertebræ increased in size from before backwards.

* See my memoir on *Balænoptera sibbaldi* (*op. cit.*), 1870.

The height of the 1st from the ventral surface to the free end of the spine was one foot 9 inches, that of the 14th was 2 feet $4\frac{1}{2}$ inches; the breadth of the 1st between the free ends of the transverse processes was 2 feet $4\frac{1}{2}$ inches, that of the 14th was 3 feet $3\frac{1}{4}$ inches. The transverse diameter of the body of the 1st was $10\frac{1}{2}$ inches, that of the 14th was 12 inches; the vertical diameter of the body of the 1st was 9 inches, that of the 14th was $9\frac{1}{2}$ inches. The length collectively of the bodies of the dorsal vertebræ, measured in a straight line, was 7 feet.

Lumbo-caudal Region.—Thirty-five vertebræ were present between the last dorsal and the terminal caudal. Of these, I regard the 22nd to the 33rd, both inclusive, twelve in number, as *Lumbar*, although the 33rd had an indication of an articulation for a chevron bone at the posterior border of its ventral surface. The lumbars were the largest vertebræ (fig. 8), and if we take the 7th as a type of the series, its height from the ventral surface to the free end of the spine was 2 feet 5 inches, and its breadth between the free ends of the transverse processes was 3 feet $5\frac{1}{2}$ inches; the transverse diameter of the body was $12\frac{1}{2}$ inches, and its vertical diameter was 11 inches. The spines in the series were flattened laterally and usually truncated at the free ends, but in the 11th and 12th they tapered a little. The transverse processes, flattened from above downwards, projected in the middle part of the region about 15 inches from the body. The anterior articular processes, strong and flattened laterally, projected forwards and upwards. The ventral surfaces of the bodies from the 3rd to the 11th had a mesial antero-posterior ridge. The length of the collective lumbar bodies, measured in a straight line, was 8 feet 2 inches.

The *Caudal* vertebræ were twenty-three in number. The anterior eleven possessed spines, and eight of these had also transverse processes, which like the spines diminished in projection and size from before backwards. The vertebræ which followed the above, representing only the bodies, were flattened on the anterior and posterior surfaces, were circular in outline, and the largest resembled in form curling-stones without a handle (Plate II. fig. 9). They gradually diminished in size, the most anterior was 10 inches in diameter, the last two were fused with each other, the penultimate was $2\frac{1}{2}$ inches by $2\frac{1}{4}$ inches, the last was a nodule $1\frac{1}{2}$ inch broad at its base, but tapered to a point behind; from its appearance and size no other bone had been posterior to it. The 5th and the succeeding caudals with transverse processes were pierced by a vertical foramen at the root of each process, whilst in those still more posterior each side of the body was perforated by a vertical canal as far as the third from the end. The length of the caudal bodies, measured in a straight line, was 10 feet 4 inches.

Chevron Bones.—Judging from the articular surfaces visible on the ventral aspect of the bodies of the caudal vertebræ, eleven or twelve chevron bones had been present, and of these ten had been preserved. In eight the two originally distinct lateral plates had fused together to form a mesial ventral spine, which enclosed the caudal vascular canal. The upper ends of these plates were thickened and articulated with their

respective vertebræ, so that each chevron belonged to two vertebræ with the intervertebral cartilage. The larger chevrons were massive and ranged in dimensions from 11 to $9\frac{3}{4}$ inches in vertical diameter and from $7\frac{1}{2}$ to $6\frac{1}{2}$ in transverse diameter across the basal articulation. The smallest chevron was $5\frac{1}{4}$ by $6\frac{1}{4}$ inches (fig. 18). In

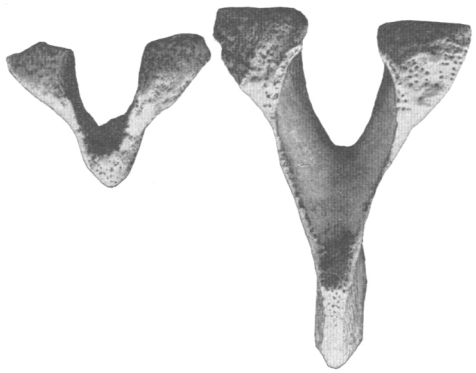


FIG. 18.—Chevron bones.

two bones the lateral plates were not fused together mesially and there was no spine; in the larger each plate was 6 inches by 4 inches; in the smaller, $3\frac{1}{2}$ inches by 3 inches.

In this skeleton the number of vertebræ corresponded with those recorded in the European skeletons of this whale which GASCO, in the specimen from Taranto, and GULDBERG, in two from Iceland, had examined and described. In these the cervicals numbered seven, and the dorsals fourteen, except perhaps in that captured at San Sebastian in 1854, where the number of dorsals was said by GASCO to be thirteen.* The skeletons of *B. cisarctica* chronicled by TRUE from the American coast also had fourteen dorsals. With these numbers the skeleton now described is in accordance. Twelve is the customary number for the lumbar vertebræ, and twenty-three, or in one specimen twenty-four, for the caudals. In the skeleton described in this memoir, the vertebra which I have regarded as the 12th lumbar had a partial articulation at the posterior border of its ventral surface for a chevron bone. Some might be disposed to regard it as the 1st caudal, which would reduce the lumbars to eleven bones, and would add this vertebra to the caudal series. The formula of the adult spine of the North Atlantic Right Whale is $C_7D_{14}L_{12}Cd_{23} = 56$. GASCO has figured the block of cervical vertebræ of the immature Taranto *biscayensis*, as well as representatives of the other groups of vertebræ in which the vertebral plates were not ossified to the bodies.

We are now in a position to examine the proportion of each region of the spine to its entire length, and of the length of the skull to that of the vertebral column. The block of *cervical vertebræ*, 13 inches long, represented the thickness of both the bodies of the vertebræ and their ossified intermediate discs. On an estimate that the entire spine

* One dorsal had probably not been preserved.

with its intervertebral cartilages was about 30½ feet long, it was 28 times longer than the cervical spine. As the individual vertebræ of the neck were immobile on each other, movement in this region was restricted to the occipito-atloid articulations and to the joints between the 7th cervical and the 1st dorsal vertebra. The head therefore, large and weighty, was articulated by a movable joint at the anterior end of the spine to a compact mass of bone formed of the seven cervical vertebræ and ossified discs.

The length collectively of the bodies of the *dorsal vertebræ* was 7 feet, to which 18 inches may be added as the probable thickness of their intervertebral cartilages, together about 102 inches. The entire spine was from 30 to 31 feet long, about 3½ times longer, therefore, than the dorsal vertebræ plus their cartilages. The dorsal region was characterised by the mobility of the vertebræ on each other and by that of the ribs on the vertebræ during respiration.

The length collectively of the bodies of the *lumbar vertebræ* was 8 feet 2 inches, the thickness of their intervertebral cartilages was probably 19 inches, together 117 inches. The entire spine was about 3 times longer than the lumbar vertebræ with their cartilages.

The collective length of the bodies of the *caudal vertebræ* was 10 feet 4 inches, that of their intervening cartilages was possibly 12 inches, together 136 inches. The entire column was about 2¾ times longer than the caudal region. The length of the entire lumbo-caudal region was 253 inches. The bones of this region have attached to them the powerful muscles concerned in the movements of the hinder part of the body of the whale, more especially in the working of its broad tail, so that more than one-half the length of the spine takes a part in locomotion, and enables a speed of 8 to 10 or even a greater number of miles an hour to be obtained.

In the specimen with the spinal column, the skull proper, in a straight line from the occipital condyl to the tip of the premaxilla, was 12 feet 6½ inches long. As the free ends of the mandible apparently projected slightly beyond the premaxillæ, the skull was longer by a few inches, and may be at least 13 feet (156 inches). The entire vertebral column was about 2⅓ times longer than the skull.

The skeleton, including the skull, mandible, and intervertebral discs of this adult male was probably about 44 feet long, and if one were to add a foot as representing the thickness of the soft parts at the mandibular and caudal ends, the estimated length of this specimen was about 45 feet, so that the proportion of the head was somewhat more than one-fourth the entire length of the animal.

In *Balæna mysticetus* the vertebral column usually contained 55 vertebræ, though 56, or only 54, have been noted. They are grouped as follows: $C_7D_{13}LCd_{35}$ or $_{36}$. The cervicals, as in *biscayensis* and *australis*,* are fused together as a large block. ESCHRICHT and REINHARDT have shown that in the new-born *mysticetus* and in the fœtus the cervicals form one undivided mass of cartilage, so that the fusion is funda-

* I have described the cervicals of *B. australis* from New Zealand in my *Challenger Report* on the Bones of the Cetacea, *Reports, Zoology*, part iv., 1880.

mental. It constitutes, therefore, a marked difference from the Fin Whales, in which these vertebræ are distinct from each other in the fœtus.* I know of no observations on these vertebræ in the fœtus of the other species of Balæna, though doubtless they corresponded in their development with *mysticetus*.

As the dorsal vertebræ were provided with costal articulations, their number corresponded with that of the pairs of ribs. The customary number in *mysticetus* was 13, though ESCHRICHT and REINHARDT saw a rudimentary 14th rib in a fœtus, and in a young individual only 12 pairs of ribs were present. In the adult *biscayensis* described in this memoir 14 dorsals were seen, which corresponded with the number already referred to on page 907 in other skeletons, so that both in its dorsal vertebræ and in the pairs of ribs this whale differed from *mysticetus*.

I have stated on page 907 that the precise separation between the lumbar and caudal regions is associated with the position of the most anterior chevron bone, and I have regarded that vertebra as the 1st caudal, the ventral surface of the body of which articulated with both the 1st and 2nd chevrons, whilst the vertebra immediately anterior, which articulated with only half the 1st chevron, is regarded as the 12th lumbar. In their great memoir on the Greenland Right Whale ESCHRICHT and REINHARDT had previously reached the same conclusion, for they said that the 1st caudal can only be distinguished from the last lumbar by both its anterior and posterior borders on the ventral surface of the body being provided with articular facets for chevron bones. The lumbo-caudal formula in *mysticetus* is $L_{13}Cd_{22}$, in *biscayensis* $L_{12}Cd_{23}$. Here also is a specific difference, though not of the same importance as the difference in the number of dorsal vertebræ and ribs in the two species, for the caudals in the same species are subject to variations in number in some individuals. In the seven skeletons tabulated by TRUE of the vertebræ in the American Right Whale, six had the formula L_{11}, and in five the caudals ranged from 23 to 25, the complete formula being $C_7D_{14}L_{11}Cd_{23\text{ to }25}$, in all 55 to 57 vertebræ. In the number and grouping of its vertebræ this whale (*B. cisarctica* of COPE) corresponded essentially with *B. biscayensis*.

In *B. biscayensis* and *B. australis* the head has been regarded as one-fourth the total length of the animal, though in this specimen of *biscayensis* the skull was between one-third and one-fourth of the computed total length. On the other hand, in *B. mysticetus* the head is described as one-third of the total length.

RIBS.

Fourteen pairs of Ribs were present, which corresponded in number with the dorsal vertebræ. All the ribs articulated with the dorsal spine, either to the transverse processes only, or to both the bodies and the transverse processes. Only the 1st pair articulated with the sternum, as is customary in the whalebone whales, and the others

* I found this to be the case in an advanced fœtus of a *Balænoptera sibbaldi* dissected in 1869–1870. The fœtus is described in *Trans. Roy. Soc. Edin.*, 1870.

came to a free end ventrally. They formed a series of arches which entered into the construction of the sides of the thorax. As they varied so greatly in length, I give in Table II. the length of the right ribs measured along the outer convex surface from the vertebral end to the ventral end, as well as the chord of the arc between its two extremities; the measurements give the dimensions in feet and inches.

TABLE II.

	1st Rib.	2nd Rib.	3rd Rib.	4th Rib.	5th Rib.	6th Rib.	7th Rib.
Length of Rib	4 8¼	6 8¾	7 10	9 8½	10 1	10 2	10 1
Chord of Arc	3 9	4 8½	5 4½	5 7	6 1	6 1	5 9

	8th Rib.	9th Rib.	10th Rib.	11th Rib.	12th Rib.	13th Rib.	14th Rib.
Length of Rib	9 8	9 1½	8 7½	8 0	6 11	5 4½	2 0½
Chord of Arc	5 10	5 7¾	5 8	5 6¾	5 5	4 6	2 0

The right 1st rib was 7 inches broad at the sternal end, the vertebral end was attenuated and articulated with the transverse process of the 1st dorsal, the surfaces were flattened and the margins were rounded. The left was about 3 inches shorter than the right. The ribs increased in length and in curvature from the 1st to the 6th, and then diminished gradually to the 14th, which was almost straight and was the shortest member of the series. The 2nd and 3rd articulated with only the transverse processes of their respective vertebræ. The 4th to the 10th inclusive had each developed a neck which extended inwards beyond the surface of articulation for the transverse process, and reached the side of the body of its vertebra, to which it had been articulated; it constituted the proper head of the rib; whilst the articular surface for the transverse process represented the tubercle of the rib. The 11th to the 14th had each only one articular surface for the transverse process of its vertebra. No rib possessed two heads in the proper sense of the word, *i.e.* was provided with two necks springing from a common shaft, each of which ended in an articular head to reach its appropriate vertebra. The shafts of the 2nd to the 4th ribs were somewhat flattened, that of the 2nd was about 6 inches at its broadest part. Behind the 4th the shafts were more rounded and afterwards more slender. The 12th and 13th had the shafts twisted, and they and the 14th were pointed at the tip.

GASCO figured several ribs of the Taranto whale. GRAELLS represented in Plate III. of his memoir a profile and dorsal view of the skeleton of the *B. biscayensis* in the Cabinet of the Institute in San Sebastian.

Sternum.

The Sternum or breast-bone consisted, as in the Baleen Whales generally, of a single plate-like segment,* with which the 1st pair of ribs had articulated. The base or anterior border was deeply notched and the outline was cordiform, the posterior border was prolonged into a blunted apex, each lateral border was thickened in its anterior half and formed an articular surface for the 1st rib. The ventral surface was a little convex, and the superior or thoracic surface was concave. The greatest breadth at the base was $21\frac{1}{2}$ inches, the length from the apex to the cordiform notch was 13 inches, and to the most projecting part of the anterior border $18\frac{1}{4}$ inches (fig. 19A). The cordiform

Fig. 19A.—Sternum *B. biscayensis.*

Fig. 19B.—Sternum *B. mysticetus.*

sternum in *biscayensis* has been figured by Gasco and Guldberg, whose drawings have been reproduced by True. In *mysticetus* the sternum has been carefully described by Sir John Struthers.† In one specimen the base showed a shallow cordiform concavity, in the other the base was pointed. The latter bone, presented by him to the University Anatomical Museum, was 27 inches long by 20 inches at its broadest part; it had only one costal articulation on each side, and its posterior end was attenuated (fig. 19B).

The sternum of *B. biscayensis* has been figured by Capellini, Gasco, Guldberg and True; that of *B. mysticetus* by Eschricht and Reinhardt, Struthers and True.

* I figured many years ago the sternum of a fœtal *Balænoptera sibbaldi* which had a small supplementary second segment (*Journ. Anat. and Phys.*, vol. iv., 1870, and *Marine Mammals, op. cit.*, 1912).

† *Journ. Anat. and Phys.*, vol. xxix., 1895. Fig. 19B is from one of his specimens.

Thorax.

The bony walls consisted of 14 dorsal vertebræ, 14 pairs of ribs, and the single segment of the sternum. Owing to the marked curvatures of the great majority of the ribs, the side walls of the chest arched outwards so as to enclose in a great chamber the heart, the pair of lungs, and other subordinate viscera. From the relatively feeble curve of the 1st pair of ribs, the thoracic inlet was laterally compressed and somewhat ovoid in form (fig. 20, D1). Through their sternal attachment they could be fixed in inspiration by the action of the intercostal and other muscles attached to them. Starting from the first pair, the intercostals attached to the ribs behind could elevate

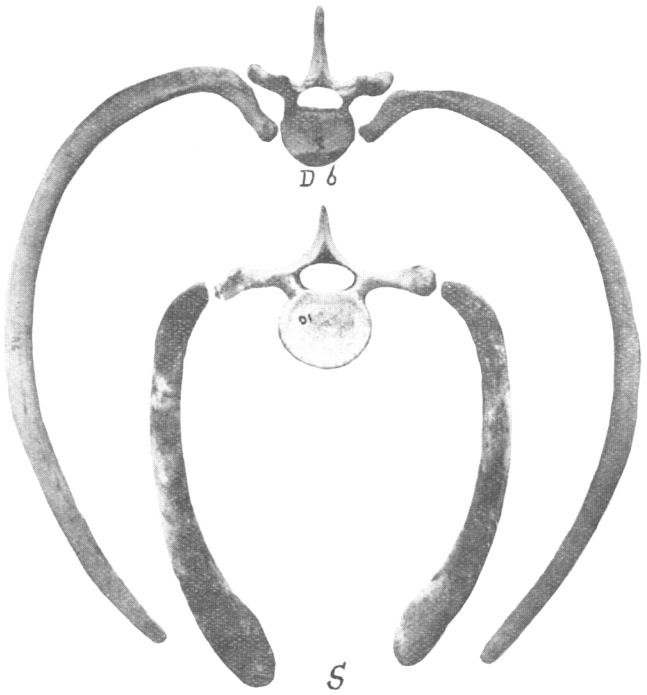


Fig. 20.—1st and 6th dorsi-costal segments.

and rotate outwards their respective bones, so as enormously to increase the thoracic cavity laterally and dorsi-ventrally, whilst the diminution of the arch of the diaphragm would increase its capacity in the antero-posterior direction. The absence of a fixed attachment to bone of their ventral ends enabled these ribs on opposite sides to be drawn much further asunder than was their relative position during expiration, which also would materially contribute to the increase in size laterally of the thoracic cavity. If in man, where seven pairs of ribs articulate ventrally with the sternum, the expansion of the lungs and of the thoracic capacity is three or even four times greater at the end than at the beginning of a full inspiration, there can be little doubt that in the large Cetacea with a single-segmented sternum the expansion of the lungs and chest-wall will be proportionally larger. It is through the thoracic construction, therefore, that the great whales during inspiration are enabled so to distend the air-cells

of the lungs prior to diving, that they can remain below the surface of the sea for 5 to 10 minutes, or even 20 minutes or longer when feeding, as was observed by SCORESBY. The same authority also related that when struck by the harpoon they can descend to a depth of 400 fathoms, and under special circumstances to 700 to 800 fathoms.

An idea may be formed of the capacity of the thorax in the state which corresponds with complete expiration by articulating to a dorsal vertebra the first pair of ribs which belong to it, and by adapting the sternum between their ventral ends (fig. 20). The 1st dorsi-costal segment was 3 feet 5 inches in its greatest transverse diameter, and 3 feet $3\frac{1}{2}$ inches in its dorsi-ventral diameter. These measurements gradually increased to the 6th segment, in which the ribs had the maximum length and curve, when the transverse diameter was 7 feet 4 inches and the dorsi-ventral 5 feet 6 inches (fig. 20, D6). Further back the length and curve gradually diminished, and in the 14th segment the ribs were so short and had so feeble a curve that they exercised practically no influence on the dimensions of the thorax. In *biscayensis* as in *mysticetus* the thorax in its general form was barrel-shaped, due to the wide curve of the majority of the ribs, which contrasted with the form of the skeleton in the Fin Whales (Balænopteridæ), in which the side walls were more flattened. HOLDER, who figured the entire skeleton of the New York Right Whale, saw 14 pairs of ribs in it and in the other skeletons described in his memoir. Another specific distinction between *biscayensis* and *mysticetus* is therefore to be recognised. The ribs of *B. australis* have been figured by VAN BENEDEN.

PECTORAL LIMB.

Scapula.—A large plate-like bone which measured 4 feet $1\frac{1}{2}$ inch in length between the anterior and posterior angles, and 3 feet $\frac{1}{2}$ inch in glenoido-vertebral

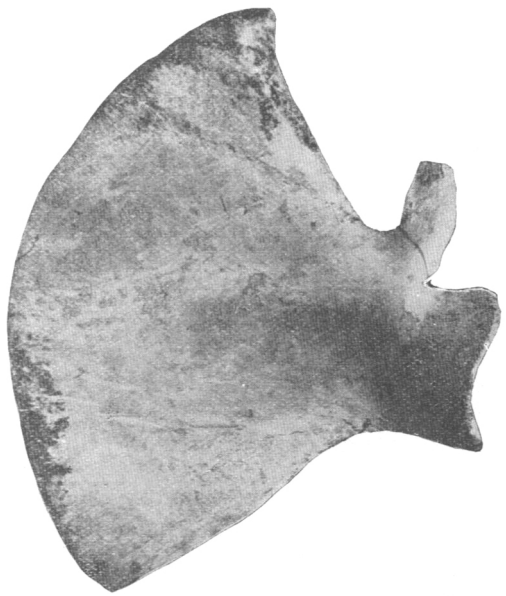


FIG. 21.—Right scapula, dorsum.

breadth. The glenoid cavity was shallow and measured $12\frac{1}{2}$ inches in height by 11 in breadth. The outer surface of the bone was marked by a faint ridge close to the anterior border which indicated a rudimentary spine; the acromion, $9\frac{1}{2}$ inches long, sprang from the bone at the anterior end of this ridge, its surfaces were flattened, 5 inches broad, and the free end was truncated (fig. 21). The inner surface was flattened. The anterior border was slightly concave, the posterior or glenoid border was concavo-convex, and the vertebral border was strongly convex. The anterior angle was more pointed than the posterior; the bone was $2\frac{1}{2}$ inches thick at these angles, and the vertebral border in places was 2 inches thick. The coracoid process was feebly indicated. The scapula has been figured by CAPELLINI, GASCO, GRAELLS, HOLDER and TRUE. In *B. mysticetus* the coracoid is a distinct process.

Humerus.—Short in relation to its bulk. Head large, articular surface smooth and convex, tuberosity large and projecting externally; neck a shallow constriction. The bone was one foot 9 inches long, the girth around the head and tuberosity 3 feet 9 inches. The shaft was short and 2 feet 2 inches in girth. The breadth at the lower end was one foot 2 inches. The radial and ulnar articular surfaces were distinct and separated from each other by a ridge; the radial surface was 8 inches and the ulnar 5 inches wide. The epiphyses were fused with the shaft (fig. 22).

Radius.—A bone with flattened surfaces; the outer border was almost straight, the interosseous (inner) border was concave. Its length was one foot $10\frac{1}{2}$ inches, its breadth at humeral end 10 inches, at carpal end 14 inches, the girth in the middle of the shaft was one foot 8 inches. The upper epiphysis was fused with the shaft, the carpal epiphysis was ossified and partially fused with the shaft (fig. 22).

Ulna.—The surfaces of the bone were more flattened in the lower than in the upper half, the inner border was markedly concave, the interosseous (outer) border was sinuous. The length was one foot $6\frac{1}{2}$ inches, the girth in the middle of the shaft was $11\frac{3}{4}$ inches. The humeral articular surface was $5\frac{1}{4}$ inches wide, and a short thick olecranon process projected at its inner end; the upper epiphysis was fused with the shaft. The carpal end was 12 inches wide, and its epiphysis, though ossified, was only partially fused with the shaft (fig. 22). In *B. mysticetus* the olecranon was prominent and associated with the humeral articulation, and the bones of the forearm were longer than the humerus.

Manus.—The Hand was pentadactylous and consisted of carpus, metacarpus and phalanges (fig. 22). The carpus was for the most part a mass of cartilage about 2 feet in breadth and one foot in vertical diameter; its ossification was limited and unsymmetrical in the two limbs. In one carpus only two bones were detected, in the other only one bone was seen. On the surface of the cartilage indented lines were present which mapped it into areas, not at all times distinctly defined. The study of the manus was greatly assisted by photographs taken by Mr ARTHUR EDWARDS after he had removed the integument. In the proximal part of the cartilage a distinct area was seen

immediately opposite the interval between radius and ulna; in one carpus a rough nodule of bone, $5\frac{1}{2}$ by $3\frac{1}{2}$ inches in diameter, was imbedded in but did not reach the surface of the cartilage, in the other the cartilaginous area was defined, but it had no ossification, it represented the carpal intermedium. To its ulnar side an unossified area represented the ulnare, and from it a cartilaginous projection constituted the pisiform, *p*.

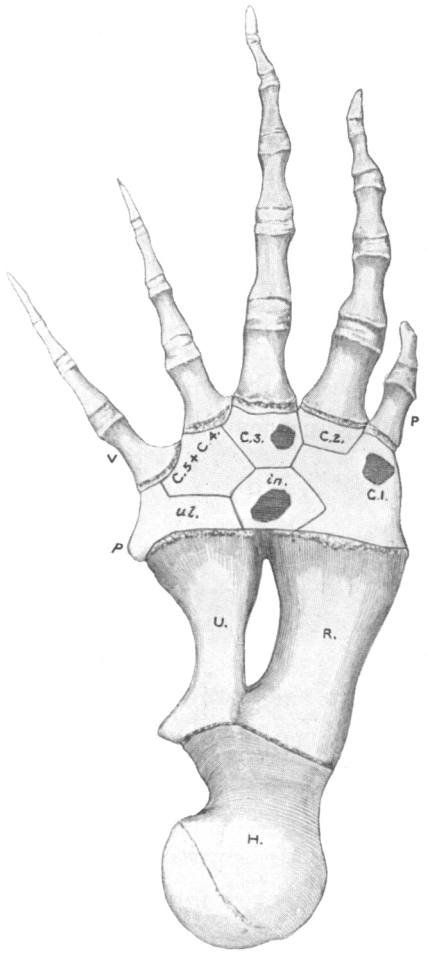


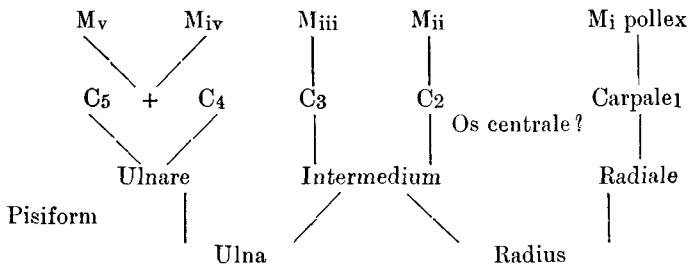
FIG. 22.—Pectoral limb, *B. biscayensis*.

On the radial side of the intermedium was a mass of cartilage imperfectly mapped into areas, the proximal part of which represented the radiale; the distal part was jointed to the metacarpal of the pollex, P, and in one carpus a rough nodule of bone $5\frac{1}{2}$ by 4 inches occupied it which was doubtless distal carpale$_1$, but in the other carpus it was not ossified. A prolongation of the cartilage between the intermedium and carpale$_2$ was possibly a potential os centrale.

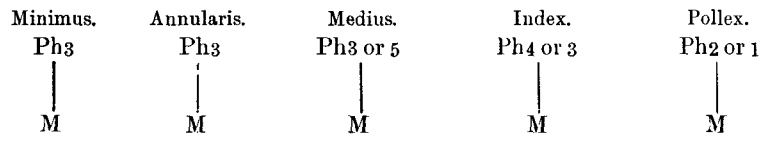
The distal part of the carpal cartilage was also mapped into areas: one associated with Metacarpal$_{ii}$ represented carpale$_2$, another with M$_{iii}$ carpale$_3$, another and larger with M$_{iv}$ and M$_v$ represented carpalia$_{4+5}$. In one carpus the distal carpalia were

unossified, in the other a nodule of bone 3 by $2\frac{1}{2}$ inches was concealed in the cartilaginous distal carpale$_3$.*

CARPO-METACARPAL FORMULA.



In the human hand, where the metacarpals are enveloped by the common integument of the palm, and the phalanges, constituting the skeletons of the free digits, have a separate covering of skin for each digit, it is customary to regard the metacarpals as belonging to the palm and to dissociate them from the digits proper. In the Cetacea, again, both metacarpals and phalanges have a common tegumental covering, and each digit consists of both its metacarpal and phalangeal elements. The formula may be represented as follows:



The two hands were not uniform in the number of phalanges in the pollex, index, and medius. The length of the metacarpo-phalangeals was obtained by placing the bones of each digit in order, allowing intervals between them to represent the thickness of the intermediate joints, the size of the intervals being estimated from the scale on the photographs of the digits taken by Mr EDWARDS. The metacarpo-phalangeals of the pollex measured 11 inches; index 2 feet 9 inches; medius 3 feet $5\frac{1}{4}$ inches; annularis 2 feet $3\frac{1}{2}$ inches; minimus 2 feet. The pollex therefore was the shortest and the medius was much the longest digit.

As regards the length and general bulk of the metacarpals, M_{ii} was the biggest, and the others in order as follows: M_{iii}, M_{iv}, M_v, M_i. The ends of the bones were more expanded than the shafts, they were rough, and no separate epiphyses were seen. The phalanges in each digit diminished in size from the first to the terminal, and the free end of the last was usually attenuated. The metacarpals and some of the phalanges at the proximal ends showed indications of an epiphysis almost completely fused with the shaft of the bone.

GASCO figured the skeleton of the pectoral limb in the Taranto specimen; the bones

* I may refer to my memoirs in *Proc. Roy. Soc. Edin.*, vol. xxix. p. 687 and vol. xxx. p. 508, also to my book on *Marine Mammals* (*op. cit.*), for figures and descriptions of the manus in the Odontoceti.

of the shaft corresponded in form with those in my specimen, the carpal cartilage was not mapped by him into areas, no centres of ossification were observed, though a pisiform cartilage was seen. HOLDER figured the manus of the New York *B. cisarctica* with a pisiform, and with eight ossific nodules, four in the proximal and four in the distal carpal row. It is not said if this was seen in the manus before maceration, so that possibly the number and arrangement may be due to the articulator. VAN BENEDEN figured the carpus of *B. australis* in the Paris Museum, the radiale, intermedium and ulnare in the proximal row, three carpalia in the distal row which represented C_2, C_3, and C_4, also a pisiform. In the skeleton of the so-called *B. antipodarum* the three bones of the proximal row were figured, two distal carpalia which represented C^3 and C_4, also a pisiform.

ESCHRICHT and REINHARDT figured in *B. mysticetus* four carpal elements and in addition a pisiform. In Sir JOHN STRUTHERS's specimens * a similar arrangement was figured. It would seem as if three of these represented the three bones of the proximal row, though they varied as to the presence of ossific nodules. The fourth evidently belonged to the distal row, and was more especially associated with the second and third digits, so that it probably represented distal carpalia$_{2+3}$.

PELVIC BONES.

A pair of Pelvic Bones accompanied the skeleton, and, in addition, a right bone from another skeleton of the same species was received from Mr HERLOFSON by the Royal Scottish Museum. Each of the paired bones was $14\frac{1}{4}$ inches long in a straight line, but it was curved, convex on the one, and concave on the other surface. It consisted of a central body from which a long process projected towards the spine, another long process was directed ventrally, whilst a third process was so short that it might be included in the body. The body with the short process was triangular in form and 4 inches broad. The ventral process, 7 inches long, was somewhat twisted and ended bluntly. The superior process, 6 inches long, tapered to its free end. On the concave surface a somewhat ovoid area, $2\frac{1}{4}$ by $1\frac{1}{2}$ inches in diameter, was situated immediately below the short process, it represented an acetabulum for articulation with the femur; though now roughened, it had at one time doubtless been covered by cartilage (fig. 23, A, B). The femur had, however, not been preserved.

The single os pelvis from another skeleton was the right bone.† It differed somewhat from the above; the ventral process was $7\frac{3}{4}$ inches long, thicker and straighter. The superior process, $3\frac{1}{2}$ inches long, was rudimentary, slender and pointed at the free end. Its origin from the body was marked by a bony bar, which seemed as if a fracture, subsequently united, might have occurred in early life. The concave surface of the body with its short process had an area 3 inches by $1\frac{1}{2}$ inch which resembled

* *Journ. Anat. and Phys.*, vol. xxix., 1895.

† This specimen has been presented to the University Anatomical Museum.

the surface on each of the paired bones which formed the acetabulum, but no femur had been preserved (fig. 23, C).

GASCO, in his memoir on the Taranto whale, figured the concave surface of one of the pelvic bones and showed the articular area for the femur, though that bone had not been preserved. GULDBERG, in his memoir on the Nordcaper, gave three figures of a pelvic bone which generally resembled those above described. He was, however, so fortunate as to obtain a specimen in which the rudimentary femur was in articulation with the os pelvis and the capsular ligament of the joint was in place. Further, the

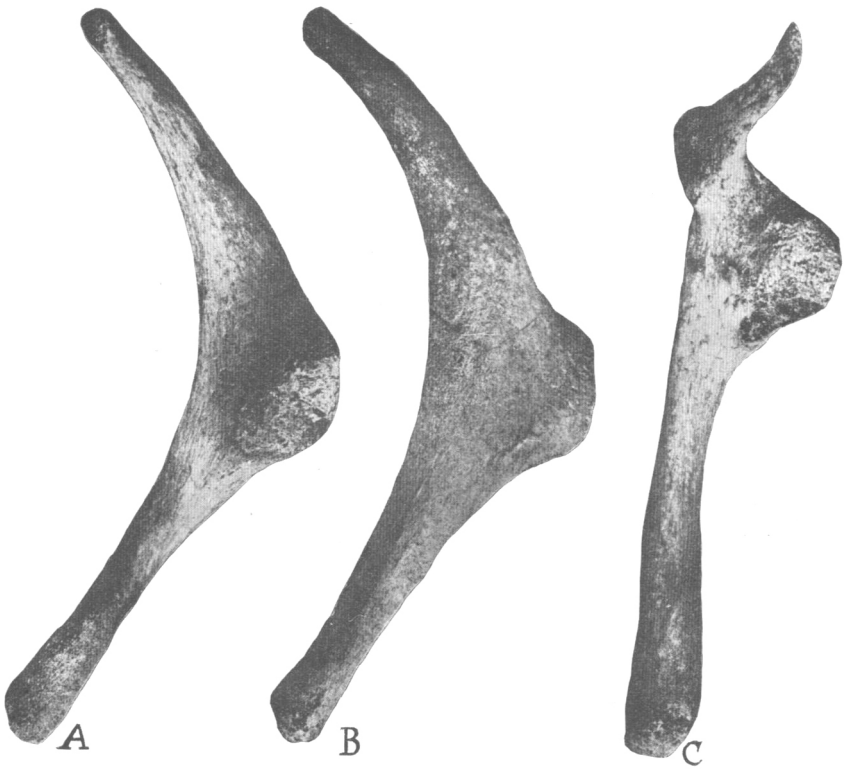


FIG. 23.—Pelvic bones.

cartilaginous tibia was also present and the articular surface at the lower end of the femur for the tibia was visible.

REINHARDT in 1843 was the first to recognise the rudimentary femur and tibia in a new-born Right Whale, *Balæna mysticetus*, and some years later ESCHRICHT and he observed them in a half-grown and in a full-grown specimen. The most complete description of the os pelvis and rudimentary hind limb in this whale was given by Sir JOHN STRUTHERS,* from its examination in five animals. In their general form the pelvic bones in *B. mysticetus* resembled those in *biscayensis*, though they were somewhat stronger in the former species. From his description and illustrative figures, the ventral process at its lower end (*o* in STRUTHERS's figures) was for the attachment of the interpelvic ligament connecting the two bones ventrally, as well as for that of the

* *Journ. Anat. and Phys.*, vol. xv., 1881.

crus penis in the male, whilst the shaft of this process gave origin to the compressor urethræ muscle. The superior process (*b* or beak in STRUTHERS's figures) seemed to be shorter and more slender than in *biscayensis*; doubtless in both species it was connected to the spine by a ligament. He also figures the femur and the cartilaginous tibia. As the femur and tibia in this skeleton of *biscayensis* had not been preserved, a comparison of the rudimentary hind limb with that in *mysticetus* could not be made, though from GULDBERG's figures it had corresponding characters in both species of Right Whale.

Os Penis.

The Os Penis had been obtained. It was $12\frac{3}{4}$ inches long, and somewhat cylindriform in shape. The deep end was swollen, 8 inches in girth, and from it the bone

FIG. 24.—Os penis.

tapered to the opposite end, which was $5\frac{1}{4}$ inches in girth (fig. 24). The presence of a bone in the penis of a Right Whale had not previously attracted attention. It was not quite as long as the corresponding bone in the walrus, and its texture was not so dense.

Orbit.

The separate skull in the Anatomical Museum, as may be seen from the measurements in Table I., is of larger dimensions than the skull on the skeleton. As its Orbit was entire, I have been able, therefore, to complete the description of this region. The upper border was formed by the outer or orbital bar of the *frontal* bone, thick and rounded, which ended in front in the pre-orbital process, and behind in the somewhat larger post-orbital. The antero-posterior diameter of the orbit was 8 inches, and its vertical diameter was $8\frac{1}{2}$ inches. Its lower border was formed by the curved *malar* bone, which articulated behind with the anterior blunt process of the squamous-temporal, and in front with the outer end of the pointed process of the superior maxilla. The temporal end of the malar was truncated and 4 inches in diameter; a disc of fibrous tissue was interposed between it and the corresponding articular surface of the temporal. The maxillary end, $4\frac{1}{2}$ inches in its greatest diameter, was irregular in shape and formed an elongated process which passed upwards behind the pointed process of the superior maxilla; a disc of fibrous tissue about half an inch thick was interposed between it and the articular surface of the maxilla. The malar bone, measured along the convexity, was 16 inches between its articular ends; it was generally concave in its long axis,

with the inner surface flattened and the outer surface vertically convex; its girth was $8\frac{7}{8}$ inches (fig. 25).*

The *Lachrymal* bone was a plate $13\frac{1}{2}$ inches long, interposed between the external or orbital bar of the frontal and the apex of the triangular plate of the superior maxilla,

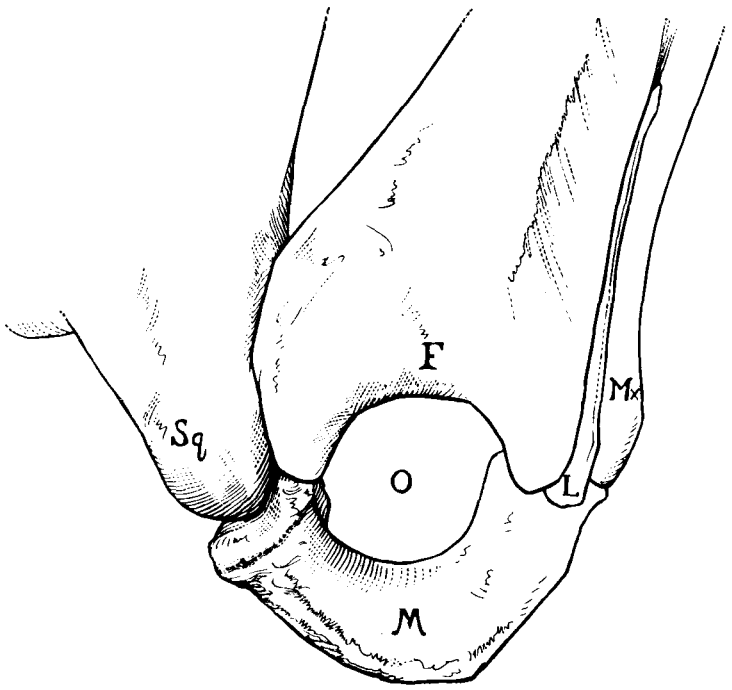


FIG. 25.—Orbit.

which lies parallel to and immediately in front of the orbital bar of the frontal. Its attachment was so slight that it could easily be drawn out of its place, when it was seen to be flattened, thin and friable; it was $1\frac{3}{4}$ inch broad in its upper third, narrowing materially at its lower end; the outer border, which appeared in the narrow cleft between the frontal and superior maxilla, was thickened and moderately strong; the inner border was thin and papyraceous.

SUMMARY.

The specific differences between *Balæna biscayensis* and *B. mysticetus* may be summarised as follows:—

The adult *biscayensis* was neither so long, nor with so great a girth, nor did its head bear so large a proportion to the total length of the animal as in *mysticetus*. The blades of baleen were not so long; the mouth was not so large in proportion; the colour was more uniformly black, though a small percentage of the animals examined had large white patches on the ventral surface; the "bonnet" was distinct at the end of the snout.

* If this figure is compared with that of the orbit of a young *Balæna japonica* in REINHARDT'S memoir on ESCHRICHT'S collection, *Vidensk. Selsk. Skr.*, 5 Række, Copenhagen, 1869, their close resemblance may be noted.

The skull of *biscayensis* was in breadth about two-thirds of its length, that of *mysticetus* about one-half. In *biscayensis* the height and breadth of the occipital squama approximated, in *mysticetus* the breadth was materially greater than the height, and the posterior surface of the squama differed in character in the two species. The fronto-orbital diameter was broader than the squamoso-occipital in *biscayensis*, whilst in *mysticetus* they were about equal. The nasals in *biscayensis* were broader relatively to the length, and their posterior border was almost transverse, whilst in *mysticetus* two processes from the frontal passed between them. The anterior nares were also broader in *biscayensis* than in *mysticetus*.

The tympanic bones were very distinctive, the most noticeable features being the presence in *biscayensis* of a deep notch on the outer surface behind the lip-like process, and a much deeper notch at the anterior or Eustachian end of the upper border of the inner surface than in *mysticetus*.

The vertebral formula in *biscayensis* was $C_7D_{14}L_{12}Cd_{23} = 56$; in *mysticetus* $C_7D_{13}L_{12}Cd_{23} = 55$, the important difference being the additional dorsal vertebra in the former, which is associated with the presence in it of 14 pairs of ribs, whilst *mysticetus* has only 13 pairs.

The sternum was notched at its base, or anterior border, more deeply in some specimens of *biscayensis* than in others, whilst in *mysticetus* the notch, when sometimes present, was shallow.

The scapula had only a rudimentary coracoid in *biscayensis*, whilst in *mysticetus* it was a distinct process.

The ulna in *biscayensis* did not possess so prominent an olecranon process as in *mysticetus*.

The manus corresponded generally in both species. The carpal elements were so imperfectly ossified in *biscayensis* that only two bones were present in one carpus, whilst the other had only a single bone. Notwithstanding the imperfect ossification the division of the cartilage into more or less definite areas was recognised, the customary three elements formed along with the pisiform the proximal row, and four apparently were in the distal row. In *mysticetus* four carpal elements and a pisiform have been described, but observations are still needed to enable a full comparison with *biscayensis* to be made.

The pelvic bones resembled those in *mysticetus*, though they were not so thick as in that species and were somewhat more curved. Both species possessed a rudimentary osseous femur and a cartilaginous tibia.

EXPLANATION OF PLATES AND FIGURES IN TEXT.

PLATE I.

Fig. 1. Profile of Skull with Mandible of adult *Balæna biscayensis*. O, orbit; *g*, glenoid fossa—page 900.

Fig. 2. Occipital squama, squamoso-frontal region, nasal region and dorsum of beak of the same skull. The figure includes the tip of the premaxillæ—page 900.

Fig. 3. Hard palate, squamoso-glenoid, fronto-orbital and maxillary regions of the same skull; *g*, the glenoid fossa—page 900.

PLATE II.

Fig. 4. Back of Cranium of *B. biscayensis*—pages 898, 902.

Fig. 5. Back of Cranium and naso-rostral region of *B. mysticetus*. The tip of the beak is not included—page 902.

Fig. 6. Lateral view of block of Cervical Vertebræ of *B. biscayensis*—page 904.

Fig. 7. Anterior surface of Atlas of the same—page 905.

Fig. 8. Characteristic Lumbar Vertebra, the 7th, of the same—page 906.

Fig. 9. The thirteen terminal Caudal Vertebræ of the same—page 906.

PLATE III.

Fig. 10. Outer surface, left Tympanic, *B. biscayensis*—page 903.

Fig. 11. Outer surface, left Tympanic, *B. mysticetus*—page 903.

Fig. 12. Inner surface, left Tympanic, *B. biscayensis*—page 903.

Fig. 13. Inner surface, left Tympanic, *B. mysticetus*—page 903.

Fig. 14. Inner surface, left Tympanic, *B. australis*—page 903.

Fig. 15. Malleus (M) and Incus (I) of *B. biscayensis*, × 2—page 904.

[The figures in this Plate and fig. 25 in the text are from drawings from nature by Mr JAMES T. MURRAY.]

FIGURES IN TEXT.

Fig. 16. Ventral surface of *Balæna biscayensis*, page 897, from a photograph of Mr HERLOFSON'S.

Fig. 17. Convex surface of hyoid bone of the same,—page 901.

Fig. 18. The largest and the smallest chevron bones of the same, reduced to show their relative size—page 907.

Fig. 19. Figures of the sternum, A, of *biscayensis*, and B, of *mysticetus*—page 911.

Fig. 20. Figures in section of the vertebro-costal arches of *B. biscayensis*, D_6, through the 6th dorsal and the 6th pair of ribs; D_1 through the 1st dorsal and the 1st pair of ribs. S, the position of the sternum,—page 912.

Fig. 21. Dorsal surface of the right scapula of *B. biscayensis*—page 913.

Fig. 22. Dorsal surface of the skeleton of the pectoral limb. H, humerus; R, radius; U, ulna; *in*, intermedium; *ul*, ulnare; radiale not differentiated; *p*, pisiform; C_1, $Carpale_1$; C_2, $Carpale_2$; C_3, $Carpale_3$; C_4+_5 $Carpalia_4+_5$ conjoined; P, pollex; V, minimus. This figure is constructed from the bones of the shaft; partly from the carpal bones and those of the digits themselves, and partly from Mr EDWARDS'S photographs. The osseous nodules found in the carpus in the two hands are figured as if in the same carpus—page 915.

Fig. 23. Three Pelvic bones. A, the concave, and B, the convex surface of the bones from the described skeleton. C, the concave surface of a right pelvic bone from another skeleton. On each concave surface the acetabular area is to be seen—page 918.

Fig. 24. Os Penis from the described skeleton—page 919.

Fig. 25. The right orbital region of the large separate skull of *B. biscayensis*. O, orbit; F, orbital border of frontal; Sq, squamoso-temporal; Mx, superior maxilla; L, lachrymal; M, malar—page 920.

SIR WILLIAM TURNER on *Balæna biscayensis*.—PLATE I.

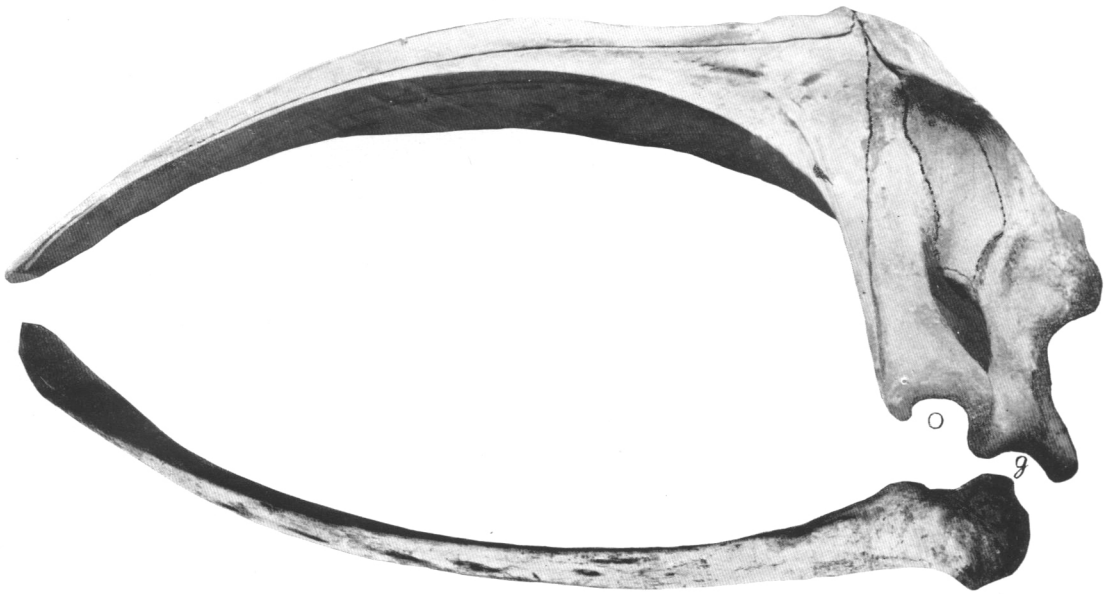


FIG. 1.

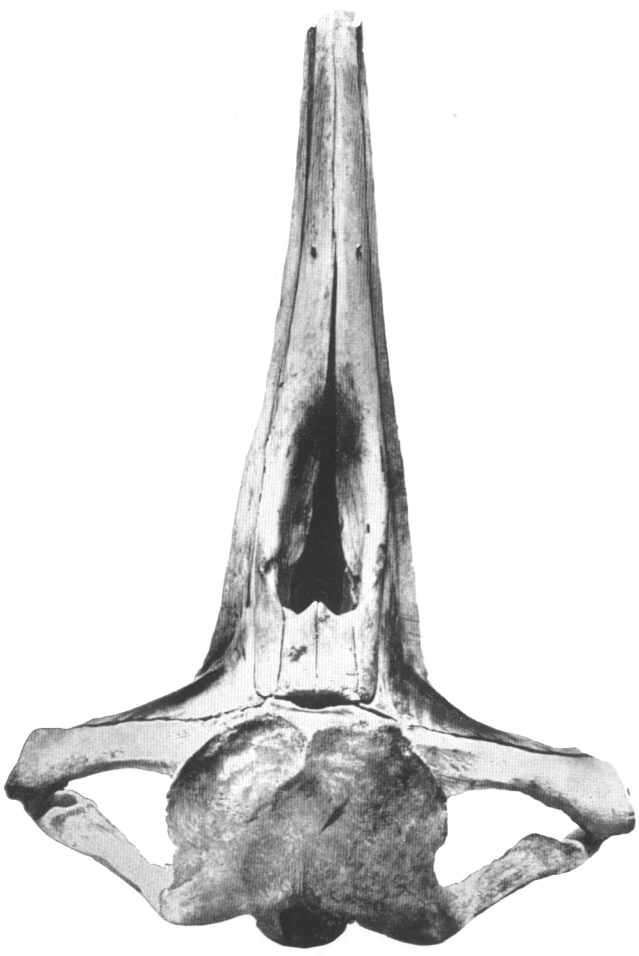


FIG. 2.

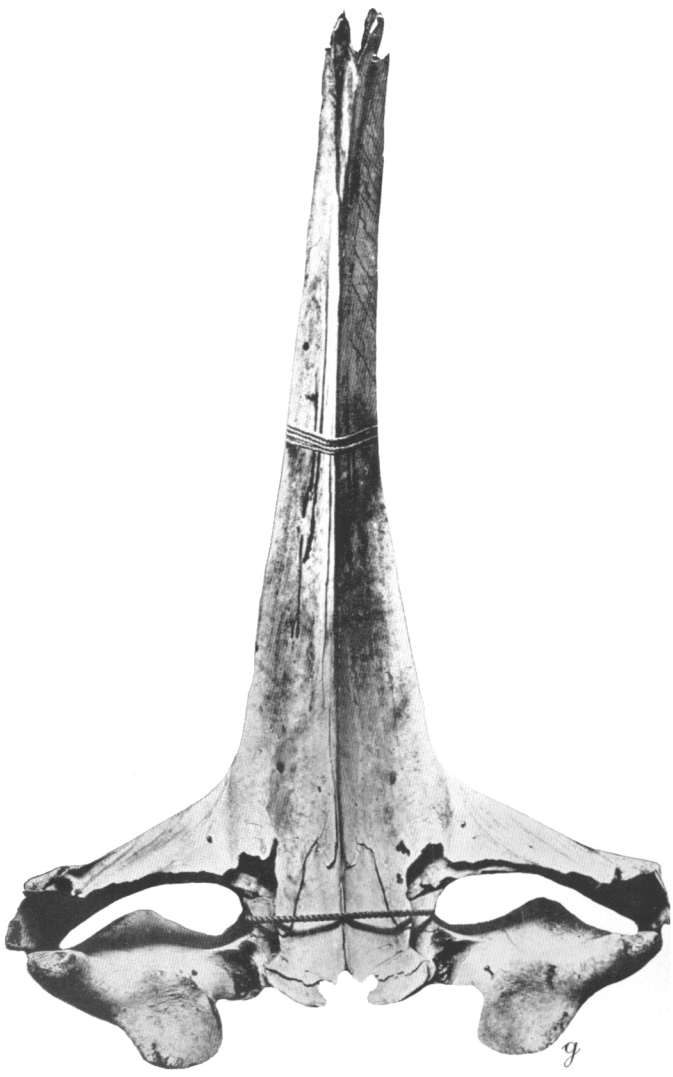


FIG. 3.

SIR WILLIAM TURNER on *Balæna biscayensis*.—PLATE II.

FIG. 6.

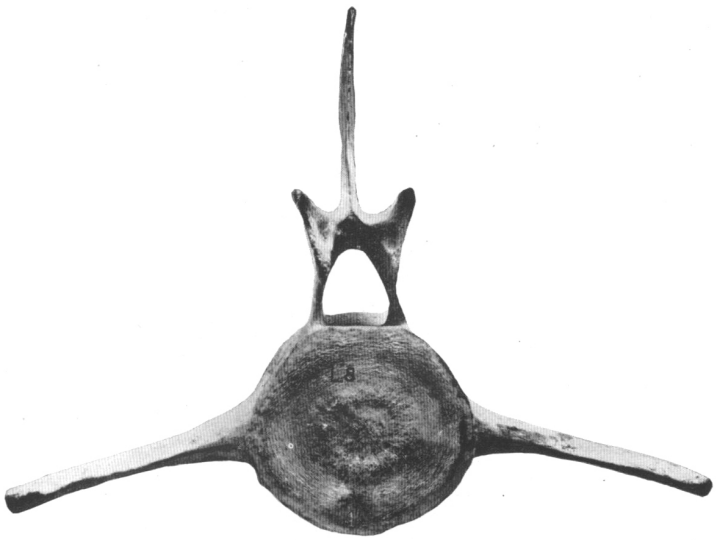


FIG. 8.

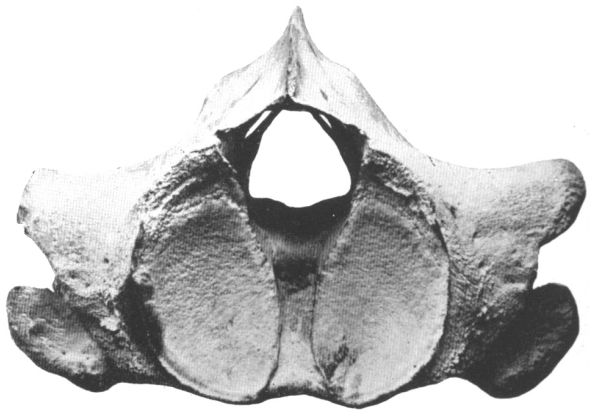


FIG. 7.

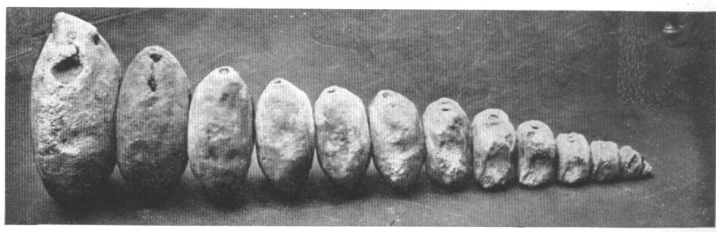


FIG. 9.

FIG. 5.—*B. mysticetus.*

FIG. 4.

SIR WILLIAM TURNER on *Balæna biscayensis*.—PLATE III.

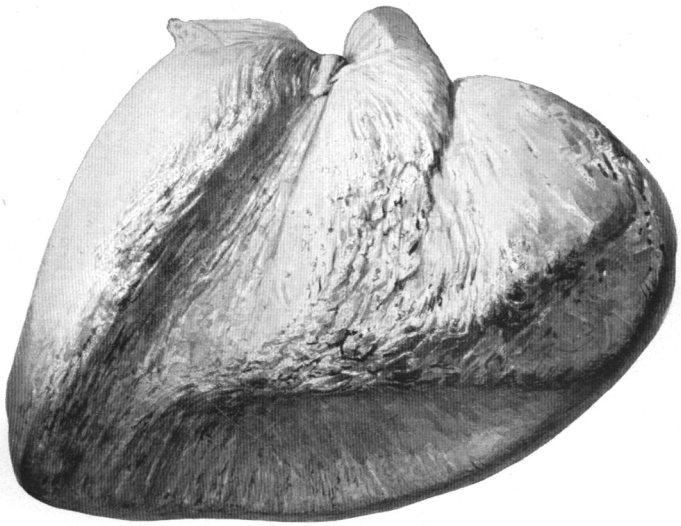


FIG. 11.—*B. mysticetus.*

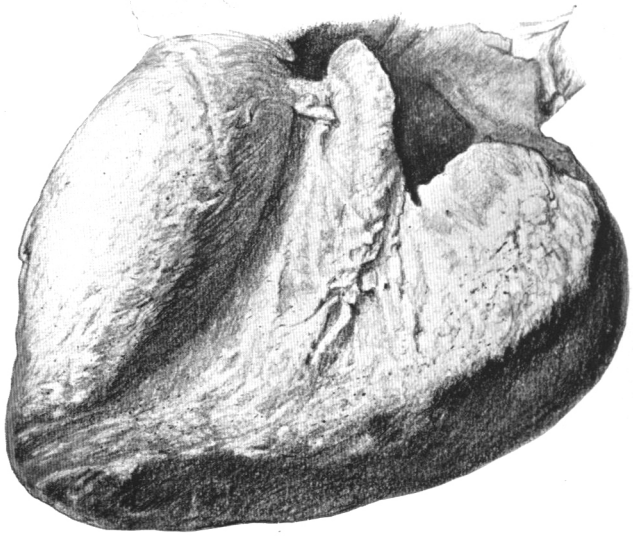


FIG. 10.—*B. biscayensis.*

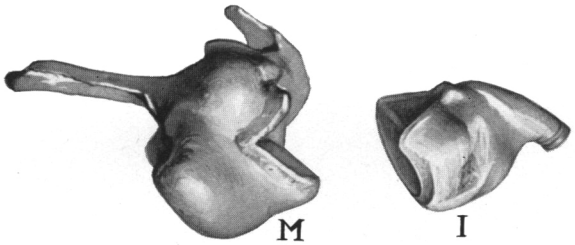


FIG. 15.—*B. biscayensis.*

FIG. 14.—*B. australis.*

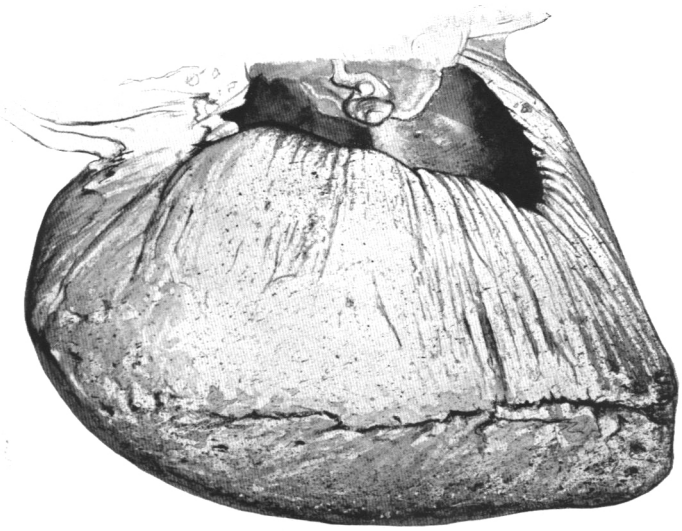


FIG. 13.—*B. mysticetus.*

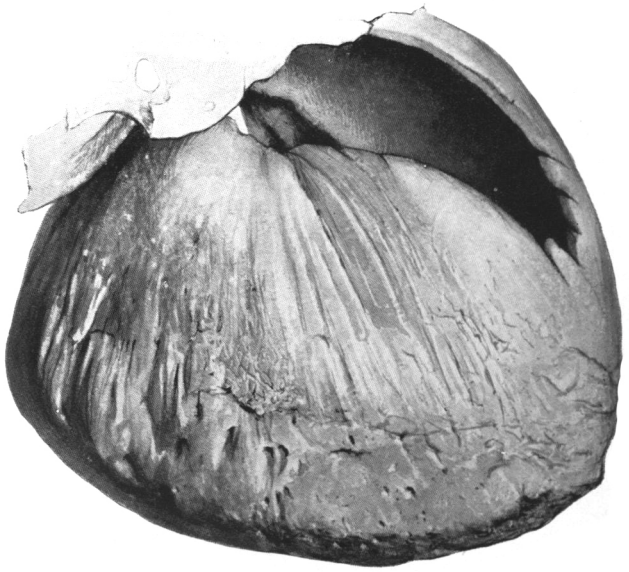


FIG. 12.—*B. biscayensis.*