

SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ON THE DISTRIBUTION OF MARINE MAMMALS.*

I. INTRODUCTORY REMARKS.

Most of the recent writers on Geographical Distribution have confined their attention to terrestrial mammals, or, at any rate, have but casually alluded to the marine groups of that class. On the present occasion I wish to call your attention to some of the principal facts connected with the distribution, over the world's surface, of the marine, or aquatic, members of the class of mammals.

Aquatic mammals, which pass their lives entirely, or, for the greater part, in the water are, of course, subject to very different laws of distribution from those of the terrestrial forms. As regards aquatic mammals, land is, of course, an impassable barrier to their extension, and, subject to restrictions in certain cases, water offers them a free passage. Just the opposite is the case with the terrestrial mammals, to which, in most cases, land offers a free pas-

* Read before the Zoological Society of London on March 16th.

sage, while seas and rivers restrain the extension of their ranges.

The groups of aquatic mammals that are represented on the earth's surface at the present time are three in number, viz. : (1) the suborder of the Carnivora, containing the Seals and their allies, generally called the Pinnipedia, which are semi-aquatic ; (2) the Sirenia, which are mainly aquatic, and (3) the Cetacea, which never leave the water, and are wholly aquatic. We will consider briefly the principal representatives of these three groups, following nearly the arrangement of them employed in Flower and Lydekker's 'Mammals living and extinct.'

II. DISTRIBUTION OF PINNIPEDS.

The Pinnipeds, which I will take first, comprise three distinct families—the Otariidæ, the Trichechidæ, and the Phocidæ. Beginning with the Otariidæ, or Eared Seals, commonly known as Sea-lions and Seabears, we find the greater number of the species confined to the South Polar Ocean, where they pass most of their time at sea, but, as is well known, resort to the land at certain seasons for breeding purposes. In the Atlantic Ocean, so far as I know, the Eared Seals have never been ascertained to occur further north than the estuary of the La Plata on the American coast and the vicinity of the Cape on the African coast. But in the Pacific, on the contrary, three distinct species of *Otaria* are found all over the Arctic portion of that ocean, and there are well founded traditions of Eared Seals having been formerly met with in the Galapagos, while they still occur on the coast of Peru and Chili. I think, therefore, we may assume that *Otaria* was originally an Antarctic form, but has traveled northwards along the west American coast and is now firmly established in the North Pacific. In a parallel way in the class of birds, the Albatrosses (*Diomedea*), which are essentially

a group of the Antarctic Seas, are represented by three distinct species in the North Pacific.

The second family of the marine Carnivora, on the other hand, the Walruses (*Trichechidæ*), are entirely Arctic in their distribution ; one species (*Trichechus rosmarus*) being peculiar to the North Atlantic, while a second nearly allied species (*T. obesus*) takes its place in the Northern Pacific.

The third family of Pinnipeds is more numerous and varied, both in genera and species, than the two preceding and has a more extended range. The Seals, *Phocidæ*, embracing about nine different generic forms, are most numerous in the Arctic and Antarctic seas, but are also feebly represented in some intermediate localities. Beginning with the North Atlantic, we find several species of *Phoca* inhabiting various parts of this area, and the Gray Seal (*Halichoerus*) and the Bladder-Seal (*Cystophora*) exclusively confined to it. In the North Pacific all the four true Seals belong to the genus *Phoca*, and three of them are identical with the North Atlantic species, but when we descend as far south as the Gulf of California on the American coast we meet with a species of Sea-elephant (*Macrorhinus*) which, like *Otaria*, has no doubt penetrated up here thus far from its ancestral abode in the Antarctic Ocean.

Returning to the central Atlantic we find two species of seals inhabiting these waters, both belonging to the same genus *Monachus*. One of these (*M. albiventer*) inhabits the Mediterranean and the adjoining coasts of the Atlantic, while the other (*M. tropicalis*) is in these days restricted to some of the smaller and less known islands of the West Indies.

The *Phocidæ* of the Antarctic Ocean all belong to genera distinct from the Arctic forms and more nearly allied to *Monachus*, the seal of the mid-Atlantic. They are of

four species belonging to as many genera: *Ogmorhinus*, *Lobodon*, *Leptonychotes* and *Omatophoca*. Besides these the sea-elephant of the whalers (*Macrorhinus*) is essentially an Antarctic form, though now nearly extinct there, after long persecution by man. But, as already noted, it extends, or has in former days extended, far up the west coast of America, and is still occasionally found on Santa Barbara Island, on the coast of California.

III. DISTRIBUTION OF SIRENIANS.

Only two forms of Sirenians are at the present time existing on the earth's surface—the Manatee (*Manatus*) and Dugong (*Halicore*)—each representing a distinct family of the Order. The Manatee is an inhabitant of the coasts and estuaries of both sides of the middle Atlantic Ocean—one species (*Manatus senegalensis*) occurring on the African shores, and another (*M. americanus*) on the South American coast and in the Antilles. A third species (*M. inunguis*), so far as we know at present, is found only in fresh water high up the Amazons.

The Dugong (*Halicore*) is distributed from East Africa, along the shores of the Indian Ocean and its islands, to North Australia. Three species of this genus have been established—*Halicore tabernaculi* from the Red Sea, *H. dugong* from the Indian Ocean, and *H. australis* from Australia; but it is doubtful how far these forms are actually distinguishable.

Besides *Manatus* and *Halicore*, a third quite distinct form of Sirenian was formerly an inhabitant of the North Pacific. This was Steller's Sea-cow (*Rhytina stelleri*), by far the largest animal of the group, which was exterminated by human agency about 1768. Fortunately recent researches in Bering's Island have been successful in supplying specimens of its skeleton for our principal museums, and Steller, its dis-

coverer, left to posterity a good account of its habits and anatomy.

IV. DISTRIBUTION OF CETACEANS.

Adopting the recognized division of the Cetaceans into two Suborders, Mysticoceti and Odontoceti, according as to whether their mouths are furnished with baleen ('whale-bone') or teeth, we will first consider the True or Whale-bone Whales, which consist of a single family, Balænidæ, usually divided into five genera: *Balæna*, *Neobalæna*, *Rhachianectes*, *Megaptera* and *Balænoptera*. Of these, *Balæna*, *Megaptera* and *Balænoptera* are almost cosmopolitan—species of them, whether distinct or not is at present more or less uncertain, being met with in nearly every part of the ocean. But *Rhachianectes* has, as yet, been ascertained to occur only in the Northern Pacific, and *Neobalæna* in the South Polar Ocean, so that we have in these cases two well-marked local types to deal with.

The Toothed Wales (Odontoceti) are more diversified than the preceding group, and are usually held to embrace at least four existing families, besides several extinct forms. The first family, containing the Physeteridæ, or Sperm-Whales, consists of at least six genera (*Physeter*, *Cogia*, *Hyperoodon*, *Ziphius*, *Mesoplodon* and *Berardius*). *Physeter* and *Cogia* are inhabitants of the whole oceanic area between the tropics, extending in certain localities some way beyond them. *Hyperoodon* is confined to the North Atlantic. *Ziphius* has an extensive range, and has been found in nearly every part of the ocean. *Mesoplodon* is also widely distributed, but is apparently more abundant in the Southern Hemisphere. *Berardius*, however, so far as we know at present, is restricted to the South Polar Ocean.

The Third family of Toothed Whales contains only the *Platanistidæ*, or fresh-water Dolphins, which although, in some cases at the present day entirely fluvial, must

necessarily have all descended from what were originally oceanic forms. The three known genera are *Platanista* of the Ganges and Indus, *Inia* of the river Amazon, and *Pontoporia* of the river La Plata; the last form making a connecting link between the two preceding genera and the marine Dolphins.

The fourth family of Toothed Whales, containing the Dolphins, *Delphinidæ*, is very numerous in species and embraces at least fifteen or sixteen genera. But in spite of the efforts of Mr. True, who has recently given us an excellent summary of our present knowledge of them,* both the genera and species of *Delphinidæ* are still so imperfectly understood that I cannot say much about their geographical distribution. Most of the forms appear to be very widely distributed, but it may be said generally that Dolphins are most abundant in the inter-tropical seas and less plentiful both to the north and south of them.

There are, however, two forms that are exclusively inhabitants of the North Atlantic. These are the very remarkable Narwhal (*Monodon*), in which the male is furnished with a single enormous horn-like tusk, and the Beluga, or White Whale (*Delphinapterus*), closely allied to the Narwhal in many points of its general structure. These may be looked upon as quite isolated forms characteristic of the Arctic portion of the Atlantic, but not known in the Pacific.

V. DIVISION OF THE MARINE AREA OF THE GLOBE INTO SEA-REGIONS.

From what has been already said, it will be evident that although many of the Marine Mammals have a wide distribution, others are very definitely localized; and a study of the latter will, I think, enable us to divide the oceanic portion of the globe

into six Sea-regions, corresponding to a certain extent with the six Land-regions into which I proposed to separate the terrestrial portion of the globe in 1874, and which were subsequently adopted by Mr. Wallace in his standard work on the Geographical Distribution of Animals. I propose to call these Sea-regions:

(1) The *North-Atlantic Sea-region* or *Arctatlantis* (ἄρκτος and ἀτλαντίς = the daughter of Atlas), consisting of the northern portion of the Atlantic down to about 40° N. lat.

(2) The *Mid-Atlantic Sea-region* or *Mesatlantis* (μέσος and ἀτλαντίς), consisting of the middle portion of the Atlantic down to about the Tropic of Capricorn.

(3) The *Indian Sea-region* or *Indopelagia* (Ἰνδός and πέλαγος), containing the Indian Ocean down to about the same degree of S. lat., and extending from the coast of Africa on the west to Australia and the great Oriental islands on the east.

(4) The *North Pacific Sea-region* or *Arctirenia* (ἄρκτος and εἰρήνη = pax), containing the northern portion of the Pacific Ocean down to about the Tropic of Cancer.

(5) The *Mid-Pacific Sea-region* or *Mesirenia* (μέσος and εἰρήνη) containing the inter-tropical portion of the Pacific Ocean; and finally

(6) The *Southern Sea-region* or *Notopelagia* (νότος and πέλαγος), containing the whole of the South Polar Ocean all around the globe south of the above mentioned limits.

We will now proceed to consider shortly the characteristic Mammals of these six Sea-regions.

VI. THE NORTH ATLANTIC SEA-REGION, OR ARCTATLANTIS.

Amongst the Pinnipeds, two well-marked generic forms, the Gray Seal (*Halichoerus*) and the Bladder-Seal (*Cystophora*) are exclusively confined to Arctatlantis. The True Seals (*Phoca*) and the Walrus (*Trichechus*) are found in this region and in Arctirenia; and of the former genus three species (*P.*

*See 'A Review of the family Delphinidæ,' by Frederick W. True: Bull. U. S. Nat. Mus. No. 36; Washington, U. S., 1889.

vitulini, *P. groenlandica*, and *P. barbata*) are actually common to both these Sea-regions, while the Walruses (*Trichechus rosmarus* and *T. obesus*) of the two Sea-regions are perhaps somewhat doubtfully distinguishable. It may be easily understood how this has come to pass, because the Seals and Walrus may in the course of time, during unusually mild summers, have extended themselves along the north coast of the American continent into the Northern Pacific. But Arctirenina, as we shall presently show, is markedly distinguishable from Arctatlantis, by the presence of Eared Seals (*Otaria*), which is utterly unknown in the whole of the Atlantic area. *Otaria* is, in fact, as regards Arctatlantis what I have called, on previous occasions (see P. Z. S. 1882, p. 311), a 'lipotype' of Arctatlantis, but what I now propose to designate a 'lipomorph.'*

The Sirenians are entirely absent from the North Atlantic and constitute another lipomorph of that area.

Coming to the Whales, we find the *Mystacoceti* well represented in the North Atlantic by *Balaena*, *Megaptera* and *Bolænoptera*, but of these the two latter are almost universally distributed over the ocean, and *Balaena* recurs again in the North Pacific as well as in more southern latitudes, so that there is no genus of Whalebone Whales peculiar to Arctatlantis, although the great *Balaena mysticetus* has never been found elsewhere.

Proceeding to the *Odontoceti*, the case is different. Amongst the *Physeteridae*, *Hy-*

* On former occasions I have used the term 'lipotype' for a natural group which characterizes a particular locality by its absence. It would, however, perhaps be better to change the term to 'lipomorph,' because the type and its compounds have been generally employed in reference to the particular specimens of a species upon which original descriptions are based (cf. Thomas, P. Z. S. 1893, p. 241). In the same way a natural group which characterizes a particular country may be called a 'topomorph' (τόπος *locus* and μορφή *forma*). Thus in Africa *Giraffa* and *Phacochoerus* would be 'topomorphs,' and *Cervus* and *Ursus* would be 'lipomorphs.'

peroodon is confined to Arctatlantis and, as already explained, two very well-marked types of the *Delphinidae*, *Delphinapterus* and *Monodon*, are likewise exclusively denizens of the North Atlantic ocean. Arctatlantis, therefore, may be said to be well characterized by the possession of at least five genera of Marine Mammals not found elsewhere, viz., *Halichoerus*, *Cystophora*, *Hyperoodon*, *Delphinapterus*, and *Monodon*.

VII. THE MIDDLE ATLANTIC SEA-REGION, OR MESATLANTIS.

Mesatlantis has certainly not so many forms of Marine Mammals confined to its area as Arctatlantis, but there seem to be good grounds for its separation. As we descend towards the tropics the true Seals (*Phocinae*), which are constituted to live in colder water, gradually fall off in number, and in Mesatlantis are no longer met with. But in their place we find the genus *Monachus* or Monk Seal restricted to Mesatlantis, one species (*M. albiventer*) occurring in the Mediterranean and on the North African coast, and a second (*M. tropicalis*) being found in the West Indies. Mesatlantis is likewise the true home of the well-marked Sirenian genus *Manatus*, one species of which (*M. americanus*) frequents the coast of America and another (*M. senegalensis*) that of Africa.

As regards the Cetaceans we are not able to say that Mesatlantis, although well-furnished with many generic types of this Order, has one peculiar to it. We must, therefore, rest content with assigning two genera of Marine Mammals, *Monachus* and *Manatus*, as characteristic forms or topomorphs of the Sea-Mammal life of Mesatlantis.

VIII. THE INDIAN SEA-REGION, OR INDOPELAGIA.

The Marine Carnivora, so far as we know, are entirely foreign to Indopelagia, but the

Sirenians are well represented by the Dugong (*Halicore*), which pervades all its northern coasts from North Australia to India and the Red Sea and down the African coast to Lamu*. Whether the species of *Halicore* found at different points within this area are the same or different is still a matter of discussion, but there can be no doubt that *Halicore* is an exclusive inhabitant of Indopelagia. As regards the Whales of Indopelagia, we know that *Physeter*, *Cogia* and *Ziphius*, and numerous forms of *Delphinidae*, occur there, but I am not aware of any Cetacean that is entirely restricted to this Sea-region.

IX. THE NORTH PACIFIC SEA-REGION, OR ARCTIRENIA.

As was pointed out when speaking of Arctatantis, Arctirenia has one genus of *Phocidae* (*Phoca*) in common with the North Atlantic, and three of the species of this genus appear to be actually identical in these two Sea-regions, whilst a fourth *Phoca* (*P. fasciata*) is only found in the North Pacific. The Walrus (*Trichechus*) is again a form of Marine Mammals, common to both the great northern Sea-regions. But the feature of Pinnipedian life that absolutely distinguishes Arctirenia from Arctatantis is the presence in the former of three (if not four) well-marked species of the Eared Seals (*Otariidae*), which are absolutely unknown in the vast extent of the Atlantic down at least to 30° S. lat.

Arctirenia has unfortunately lost its Sirenian, Steller's Sea-Cow (*Rhytina stelleri*), the largest and finest modern representative of this formerly prevalent group, which since the days of the Pleistocene, has greatly diminished in numbers, but I think we may still treat *Rhytina* as one of the characteristic forms of the Arctirenian Sea-region. The North Pacific is also even at the pres-

* A fine specimen of the Dugong from Lamu (on the east coast of Africa, lat. 2° 50' S.), obtained by Mr. J. C. Haggard in 1885, is in the British Museum.

ent day the sole possessor of a remarkable genus of Whalebone Wales which combines the long head and elongate form of *Balenoptera* with the smooth skin of the throat and absence of the dorsal fin of *Balæna*.* This is the Gray Whale, *Rhachianectes glaucus* of Cope, which, in these days, is confined to the North Pacific, and does not range farther south than the 20th parallel in that ocean. At the same time it should be stated that indications have been discovered that a nearly allied form existed in the Atlantic in previous geological ages, though this is by no means certain. Besides *Rhachianectes Balæna*, *Megaptera* and *Balenoptera* are all represented in the North Pacific, and also many species of *Delphinidae*, of which little is at present known. But *Rhytina* and *Rhachianectes* are the only genera of Marine Mammals absolutely confined to Arctirenia.

X. THE MIDDLE PACIFIC SEA-REGION, OR MESIRENIA.

The Eared Seals, *Otaria*, must have necessarily passed through Mesirenia in their passage from south to north, though the only record of their recent presence in the central part of the Pacific is, so far as I know, the report that they were formerly found in the Galapagos. It should be stated, however, that Tschudi records the occurrence of two species of *Otaria* on the islands of the coast of Peru, and that in 1802 Humboldt met with an Eared Seal on the island of San Lorenzo, in the Bay of Callao, which is only some 12° south of the Equator.

Like *Otaria*, the Sea-elephant (*Macro-rhinus*) has apparently in former ages travelled up the South American shores and established itself as far north on the coast of California as about 34° N. lat. The California Sea-elephant has been discriminated by Gill as a distinct species (*Macro-rhinus angustirostris*), but its differences from

* Flower and Lydekker, Mammals, p. 241.

the southern form (*M. leoninus*) seem to be but trifling.

As regards the Cetaceans of Mesirenia, our information is at present very imperfect, and I have little to say except that species of *Megaptera*, *Balænoptera*, *Physeter*, *Cogia* and *Ziphius* certainly occur there, besides many representatives of the widely spread *Delphinidæ*.

XI. THE SOUTHERN POLAR SEA-REGION, OR NOTOPELAGIA.

The wide ocean which surrounds the Southern Pole on every side, and extends up to 40° S. lat., seems to present, as regards its marine mammals, a nearly homogeneous fauna, which we will now briefly consider. In the first place it contains representatives of four genera of true *Phocidæ*—*Ognorhinus*, *Lobodon*, *Leptonychotes*,* and *Ommatophoca*, which are peculiar to the southern seas, and are quite distinct from all their northern representatives in the Arctic Ocean. The Sea-elephant, *Macrorhinus*, is also a denizen of Notopelagia, though, as we have already seen, it has wandered north along the South American coast far into Mesirenia.

Like *Macrorhinus*, *Otaria* also, containing the group of Eared Seals, appears to have been an Antarctic group, and the greater number of its species, although now-a-days very much reduced in numbers, are still found in the Southern Ocean. But the *Otariæ* have travelled still further north than *Macrorhinus*, and three, if not four, species, as already stated, are in these days well established inhabitants of Arctirenia.

The Sirenians are absent from Notopelagia, but Cetaceans of every kind are abundant. Besides one or more representatives of the true Whale-bone Whale (*Balæna*), No-

topelagia has a smaller representative of the group (*Neobalæna*) entirely restricted to its area. It has also representatives of *Megaptera* and *Balænoptera*, though it is doubtful how far they are even specifically distinct from some of their northern representatives.

Among the Toothed Whales (*Odontoceti*) we find a large Ziphioid form, *Berardius*, restricted to the Notopelagian area, while *Ziphius* and *Mesoplodon* also occur there. The Dolphins (*Delphinidæ*) are likewise numerous and present some distinct species, but not, so far as our present knowledge extends, any generic forms that do not occur elsewhere.

But Notopelagia is sufficiently distinguished from all the five more northern Sea-regions by possessing four genera of Seals and two of Cetaceans entirely restricted to its area.

XII. CONCLUSIONS.

It has, therefore, I think, been shown that for the Geography of Marine Mammals the Ocean may be most conveniently divided into six Sea-regions, which are as follows:

I. *Regio Arctatlantica*, characterized by its Seals (*Phocinæ*), of which two genera, *Halicærus* and *Cystophora*, are peculiar, whilst *Phoca* is common to it and Arctirenia; by the absence of Sirenians; and by the possession of three peculiar genera of Cetaceans (*Hyperoodon*, *Delphinapterus* and *Monodon*).

II. *Regio Mesatlantica*, sole possessor of the Monk-seal, *Monachus*, amongst the Pinnipeds, and of the Sirenian genus *Manatus*.

III. *Regio Indopelagica*, characterized by the presence of the Sirenian *Halicore* and by the absence of Pinnipeds.

IV. *Regio Arctirenica*, with *Phoca*, like the *Regio Arctatlantica*, but having *Otaria* also; the home of the (now extinct) Sirenian *Rhytina* and of the endemic Cetacean *Rhachianectes*.

* This generic term, established by Gill in 1872, seems to take precedence of *Pæcilocephoca*, proposed by Flower and Lydekker for the same type (*L. weddelli*) in 1891. Cf. Allen, North American Pinnipeds, p. 418.

V. *Regio Mesirenica*, without true Seals (*Phocinæ*), but having *Otaria* and *Macrorhinus* from the south; no Sirenian known.

VI. *Regio Notopolagica*, characterized by four endemic genera of *Phocidæ*, and by the presence of many *Otariæ*; without Sirenians, but with two endemic forms of Cetaceans (*Neobalæna* and *Berardius*).

In conclusion, I will call attention to some of the more remarkable points in the general distribution of the marine Mammals, and to their apparent significance.

In the first place it is evident that the Pacific has much more in common with the Notopolagian region than the Atlantic. *Otaria* and *Macrorhinus*, quite unknown in the Atlantic, extend themselves to the northern extremity of the Pacific, the former pervading that ocean up to Behring's Straits, and the latter reaching to the Californian coast. It follows that in former ages there must have been some barrier in the Atlantic which did not exist in the Pacific to stop their progress northwards. The only barrier I can imagine that would have effected this must have been a land uniting South America and Africa, across which they could not travel. Adopting this hypothesis, we have, at the same time, an explanation of the presence of the Manatee on both the American and African coasts. The Manatee could hardly live to cross the Atlantic. It is only found close to the coast, where it browses on sea-weeds and other vegetable food in shallow water. How did it travel from America to Africa (or *vice versa*), unless there were a continuous shore-line between them? The same may be said of the Monk Seal (*Monachus*), of which one species lives in the Mediterranean and on the African coast and Islands, and another in the West Indies. We can hardly believe that these creatures could easily traverse the whole Atlantic. The hypothesis of a former barrier of land between Africa and America, which we know

is supported by other facts of distribution,* would alone explain the difficulty.

On the other hand, in the Pacific we find no such break between the north and south. The aquatic Mammals of Notopolagia have evidently had free access to the whole Pacific for a long period and have well availed themselves of this facility.

Again, while the great Southern Ocean exhibits a considerable uniformity of marine Mammalian life, we see the Northern waters divided into two distinctly recognizable Regions by the interposed masses of land. All these facts, with the one exception of the supposed Atlantic Barrier, would tend in favor of the now generally accepted doctrine that the principal masses of land and water are not of modern origin, but have existed mainly in their present shapes throughout all ages.

P. L. SCLATER.

ZOOLOGICAL SOCIETY, LONDON.

FORMER EXTENSION OF CORNELL GLACIER
NEAR THE SOUTHERN END OF MEL-
VILLE BAY.†

THE initial effort of Professor Tarr's paper is to controvert the opinions recently expressed by Chamberlin and Salisbury respecting the former extension of the general glaciation of Greenland, their view being that the coast was not universally and profoundly overwhelmed by the inland ice. The observations of Professor Tarr had a range in latitude of about $5^{\circ} 30'$, those of Mr. Chamberlin about $17^{\circ} 15'$, and those of Professor Salisbury about 12° . The joint observations of Chamberlin and Salisbury covered $18^{\circ} 30'$, the range of their landings being about $13^{\circ} 40'$. These landings embraced thirteen different localities, counting the numerous landings on the border of Inglefield Gulf as one. This statement has

* Cf. Wallace, Geogr. Distrib. Vol. I., p. 156.

† Bull. Geol. Soc. Amer., Vol. 8, pp. 251-268, Plates XXV.-XXIX., March, 1897.