

IX.—REPORT SUBMITTED TO THE DEPARTMENT OF THE INTERIOR ON THE PRACTICAL AND SCIENTIFIC INVESTIGATIONS OF THE FINMARK CAPELAN-FISHERIES, MADE DURING THE SPRING OF THE YEAR 1879.*

By PROFESSOR G. O. SARS.

In accordance with a plan made some time ago, it was my intention this year to give special attention to the so-called capelan-fisheries, which I had not yet investigated, and which on account of their varying character, seemed to deserve a closer examination. The loud complaints raised during the last few years regarding the injurious influence on the capelan-fisheries of Mr. Foyn's whale fisheries, especially in the Varanger-fiord, compelled me to some extent to change my original plan. Instead of traveling over the entire capelan-district, as had been my original intention, the above-mentioned cause induced me to confine my investigations for this year to the Varanger-fiord, which has been, and is still, the principal scene of the whale-fisheries.

In order to be present at the beginning of the capelan-fisheries, I went north as early as the 28th of March, and arrived at Vadsøe on the 11th of April. At that date there had not yet been any fisheries of importance, and no capelan had entered the Varanger-fiord. Considerable masses of capelan, however, had approached the coast of Western Finmark and the fishing-stations near the North Cape, where the fisheries were already in full operation. Capelan had also been noticed near the eastern fishing-stations as far as Vardøe. On the 15th of April the first capelan entered the Vadsøe sound, and a few boat-loads were captured. But on the following day most of the capelan had disappeared, and after this only approached the coast in small numbers. I, nevertheless, succeeded during these days in making a number of important observations of the capelan, and expected at a later period to have ample opportunity to complete these observations. This expectation, however, was doomed to disappointment. The great mass of capelan did not go any nearer this coast this year than Kiberg, from which place they seemed to have taken their course across the mouth of the fiord towards the Fisher Island on the coast of Russia, whilst only a few scattered schools entered the Varanger-fiord. Those who had previously expressed the

* "*Indberetning | til | Departementet for det Indre | fra | Professor, Dr. G. O. Sars | om de af ham i Vaaren 1879, anstillede praktisk-videnskabelige | Undersøgelser over | Loddø-fisken | ved Finmarken.*" | Christiania, 1879.—Translated by HERMAN JACOBSON.

opinion that Foy'n's whale-fisheries had injured the capelan-fisheries, saw in this circumstance a further corroboration of their views, whether justly or not I shall endeavor to explain below.

As no capelan schools of any importance entered the Varanger-fiord, I intended to change my place of observation to one of the outer fishing stations, either Kiberg or Vardoe. But, unfortunately, I contracted a severe cold, accompanied by acute bronchitis, soon after my arrival at Vadsoe, probably owing to the severity of this northern climate. I was therefore compelled to stay where I was, and was prevented from making any further observations during the first half of my stay. After I had recovered from my indisposition, I visited two other points on the Varanger-fiord, viz, Bugönæs and Mortensnæs. In both of these places I made observations and gathered information relative to the capelan-fisheries during this and the preceding years. Complaints were heard everywhere about the scarcity of bait; but whenever bait was obtained there was good fishing, and even exceptionably good fishing, until the 24th of June.

Foy'n's whale-fisheries did not commence till May (those of the Iarfiord Company had commenced somewhat sooner), and were principally carried on in the outer portion of the fiord, off the coast of Kiberg and Vardoe and off the coast of Russia. The whales which were brought in were carefully examined, and information was obtained regarding the circumstances under which they were caught.

On the 9th of July I left Vadsoe for the south, and arrived at Christiania on the 20th of the same month.

I shall in the following state in detail the results of my observations, both as regards the capelan-fisheries in general, and the supposed influence on them of the whale fisheries; but I must at the very outset direct attention to the fact that I do not consider my observations on this subject as completed. Many and complicated conditions have to be examined, and even, under the most favorable circumstances, a year's time would hardly be sufficient to complete this investigation. A beginning has at any rate been made this year, and, although there are a number of gaps in my investigation, I think that even now I am prepared to speak, with a tolerable degree of certainty, on several important and hitherto neglected conditions of the capelan-fisheries, as well as on the much discussed whale question.

A.

ON THE CAPELAN-FISHERIES IN GENERAL.

It is well known that the name "capelan fisheries" is the technical term employed by the fishermen to designate the codfisheries, carried on during the spring months (April-June) on the coast of Finmark, and which are dependent on the occurrence of a smaller kind of fish, the capelan (*Osmerus arcticus*), which approaches these coasts in large num-

bers for the purpose of spawning. At this season the capelan constitutes the food of the cod, and is therefore almost exclusively employed as bait. The cod-fisheries therefore essentially depend on a regular and numerous approach of the capelan to the different fishing-stations. I have already had occasion to make a brief statement regarding the capelan, and the so-called capelan-cod, in my report on the practical and scientific investigations made during the last polar expedition; and the investigations of the capelan-fisheries made by me during the present year have not caused me to change any of the opinions expressed in said report.

As I have said in that report, I have reason to suppose—and I base this supposition on the extensive physical and biological investigations made in the Polar Sea—that the proper home of the capelan is the sea between Spitzbergen, Greenland, Iceland, and Jan Mayens, especially that portion of it, which forms the immediate boundary of the polar current. This, however, does not imply that the capelan is not likewise found in other parts of the Polar Sea. Here it seems, for the greater part of the year, to lead a roving (pelagian) life, like the herring, which it resembles closely, not only as to its form, but also in its propagation and mode of life, although it belongs to an entirely different family. Towards spring the mature individuals gather in large schools and go south towards the northern coasts of Europe and America, in order to spawn. During this time it is pursued by whales and different fish of prey, the principal one of which is the cod. It is so well known that the capelan is found near Greenland and Iceland, that I did not deem it necessary to mention this fact in my report. On the other hand I thought that it was not generally known that large schools of capelan visit the coast of Labrador and the northern and eastern coasts of Newfoundland, where they cause codfisheries of exactly the same character as those of Finmark to spring into existence. I have therefore deemed it proper to direct attention to this interesting fact in my report above referred to, after having obtained not only satisfactory information regarding these fisheries, but also specimens of capelan from Newfoundland.

The only place on our coast where the capelan come in large numbers is the coast of Finmark. Farther south only small and scattered schools or stragglers, which seem to have lost their way, have been observed; even as far south, however, as the Christiania fiord. As the capelan-district proper we must designate the portion of the sea extending from the Lapland Sea in the west to the Varanger-fiord and Vardoe in the east, more particularly the northern coast of Russia from the Varanger-fiord to the fishing-stations near the mouth of the White Sea (the so-called Murman coast). The capelan, as a general rule, make their appearance simultaneously at the different fishing-stations on the north coast of Finmark. In the Varanger-fiord, and on the coast of Russia, however, they invariably come somewhat later. The capelan do not always appear in the same number along this entire extent of

coast, but it has often been observed that when they appear in exceptionally large numbers in one place their number was smaller in other places, or they even staid away altogether from some places. With regard to this matter, a comparison between the capelan-fisheries of East and West Finmark will be found interesting, as showing that during some years their character has been entirely reversed. With the view of further illustrating this fact, I shall give below some statistics showing the quantities of fish captured in the two districts above referred to during a period of twenty-one years :

*Statistics of the Finmark capelan-fisheries, 1856-1876.**

Year.	According to the governors' reports the fisheries were in--		Entire yield of the Finmark capelan-fisheries.
	West Finmark.	East Finmark.	
1856	Good	Remarkably good	?
1857	Good	Tolerably good	?
1858	Almost a failure	Good at Vardoe; otherwise poor....	?
1859	Good	Rather poor	?
1860	Exceptionally good	Rather poor	?
1861	Excellent	Inconsiderable	6 millions.
1862	Good	Good	9 millions.
1863	Poor	Good	5 millions.
1864	Very poor	Exceptionally good	10 millions.
1865	Very poor	Exceptionally good	11 millions.
1866	2.5 millions	10.6 millions	13 millions.
1867	2.2 millions	11.4 millions	13.6 millions.
1868	0.5 million	11.18 millions	12.6 millions.
1869	2.03 millions	7.45 millions	9.48 millions.
1870	3.12 millions	9.05 millions	12.17 millions.
1871	5.07 millions	6.45 millions	11.52 millions.
1872	3.42 millions	6.05 millions	9.47 millions.
1873	6.83 millions	9.36 millions	16.19 millions.
1874	6.95 millions	10.61 millions	17.56 millions.
1875	3.93 millions	15.79 millions	19.72 millions.
1876	4.13 millions	1.12 millions	5.25 millions.

* For the years prior to 1866 no exact figures were given by the governors. The data given for those years were furnished by the Statistical Bureau, and are sufficient to show the difference between the fisheries of the two districts. From 1867 on, the figures are taken from the governors' fish reports published in "*Norges Officielle Statistik*," and are entirely reliable.

From the following data, kindly furnished by Mr. *Nordvie*, from a Russian work, by *Danilewsky* on the fisheries of the Murman coast, it will be seen that the capelan-fisheries have also on the coast of Russia been very changeable:

- 1828 was a good fishing year.
- 1829 was not so good.
- 1830, poor (good in Norway).
- 1831, very poor.
- 1832-1836, not very good.
- 1837, good.
- 1839, poor in the west, good in the east.
- 1840, an excellent fishing year.
- 1841, poor.
- 1842-1843, good.
- 1844, poor.
- 1845, good halibut, but poor cod-fisheries.

1846, good fishing west of Tsypnavolok.

1847-1848, average fisheries.

1849, poor.

1850, poor.

1851-1857, exceptionally good.

1858-1859, not as good as formerly.

1860, good in the beginning; afterwards poor.

1867, the best fisheries within man's memory.

1868, the same.

I shall below give a number of statistical data regarding the capelan-fisheries in the Varanger-fjord, showing that there, too, the capelan-fisheries have varied considerably from year to year. The approach of the capelan is noticed at a considerable distance from the shore by the columns of steam rising from the pursuing whales, and by enormous numbers of birds, mostly kitti-wakes (*Larus tridactylus*). At the same time, or somewhat later, the so-called capelan cod begins to appear in large numbers, voraciously devouring the capelan. These codfish differ from the common winter codfish by their brighter color, their larger livers, and their sexual organs, which are but little developed. Their size varies a good deal, much more so than is the case with the common cod (*Gadus morrhua*). The schools of capelan evidently consist of individuals of very different age, from the so-called "*smaagjed*" (small pike) to old codfish. The enormous numbers in which they appear exclude the idea that these schools are only those fish which live near the coast or in the waters immediately outside the respective coast. They evidently contain fish which have gathered from a wide extent of sea, and the opinion seems very plausible that they have gathered by degrees during the migrations of the capelan schools towards the coast. The important discovery, made during our last expedition, of the widely extended Polar Sea barrier, taken in connection with the direct observations of the frequent occurrence of cod near the Bear Island, has led me to the opinion—mentioned in my report above referred to, and further corroborated in this report—that both the Loffoden-cod and the capelan-cod have their home near said barrier; and up to the present time I have seen no reason to change this opinion. By direct comparison I have convinced myself that the Finmark capelan-cod is the same fish as the cod found near the Bear Island and Spitzbergen; and I have already, in the report referred to, mentioned an interesting observation which seems directly to prove the identity of the two fish.

The spawning-season of the capelan, like that of other fish, extends over a tolerably long period, the schools which arrive first spawning much earlier than those which arrive later. The earliest date when I noticed spawning this year was during the first days in May. Among a number of specimens captured in the *Busse* sound, near Vardoe, on the 5th of May, and sent to me for examination, were several which had almost done spawning, and in the stomach of a few I found recently-emitted roe. At the fishing-station north of Vardoe spawning probably com-

menced even earlier. In the Varanger-fjord and on the coast of Russia the fish seem to spawn latest. As late as the last days of June I obtained at Vadsoe, from the stomachs of coal-fish, capelan with fully-matured roe, which, however, was not yet ready for spawning. As a general rule the spawning-process occurs on sandy bottom, at a depth of 4 to 20 fathoms. It is probable, however, that it can also proceed on rocky bottom, and at a greater depth; but we are still without reliable data on this question. As soon as the roe has been emitted, and has become impregnated, the capelan again go out to sea, and the schools of cod disappear in proportion as the capelan leave the coast in order to seek their accustomed hunting grounds. It happens quite frequently, however, that some schools of capelan stay at the bottom of the deep fjords till autumn and winter, just as the spring herring are sometimes known to do. This seems to have happened with tolerable regularity in the innermost and most sheltered portion of the Varanger-fjord, the so-called *Mæskefjord*, where, during certain years, the capelan have been observed to remain under the ice in considerable numbers. These so-called winter-capelan, which must be considered as stragglers which have lost their way out to sea, are very lean and lank, but are nevertheless greedily pursued by cod and other fish of prey, in the stomachs of which they are frequently found. These are probably the capelan, which, on going out to sea, are occasionally seen near Vardoe as early as January.

It is hardly probable that the capelan schools, after having spawned, take exactly the same route when they leave the coast as when they came. There are many indications that the capelan when they leave the coast, at any rate near East Finmark, go out to sea in an easterly direction. On the coast of Russia the route of the capelan can be traced in an easterly direction as far as the fishing-stations near the mouth of the White Sea. Farther east there are no capelan fisheries. But the occurrence of capelan observed later in summer on the west coast of Nova Zembla makes it probable that at any rate a portion of the capelan schools take this route, afterwards following the boundary of the Polar current in a westerly direction, past the Bear Island, and thus reaching their proper home, the sea between Greenland and Spitzbergen.

B.

ZOOLOGICAL, ANATOMICAL, AND EMBRYOLOGICAL OBSERVATIONS RELATIVE TO THE CAPELAN.

Of the investigations made in this direction I shall, in this report, only give those points which relate to the spawning and mode of life of the capelan while near the coast.

According to its whole build the capelan is a genuine pelagian fish, and both in its internal and external organization shows a great similarity with the herring; although it is generally in accordance with cer-

tain zoological characteristics, especially the so-called "fat-fin" on the back—classed with the salmonoids. It is a peculiarity of the capelan that there is a very sharply marked external difference between the sexes, which has caused the adoption of separate designations for the male and female. In these northern latitudes the female is generally called "herring-capelan" or "roe-capelan," and the male "*faxe*"-capelan. Both generally come near the coast at the same time, but sometimes the number of "herring-capelan" is larger, and at other times smaller than that of the "*faxe*"-capelan. On opening individuals caught in the beginning of the fishing-season, one will, without exception, find the sexual organs completely developed. The greater portion of the abdominal cavity of the "herring-capelan" is filled with rather coarse-grained reddish-yellow roe, which, on closer examination, appears to be inclosed in a single thin-skinned bag, lying to the left of the intestinal duct. The right roe-bag; on the other hand, is never fully developed, the capelan in this respect differing from other fish. In the "*faxe*"-capelan both the ribbon-shaped milt-bags are found, but the right one is invariably smaller (hardly half the size of the left). By exercising a gentle pressure on the abdomen, both milt and roe are easily extracted, and can then be more closely examined. As soon as the roe is emitted it sinks to the ground, and by means of a peculiar slime, which coagulates in the water, it adheres to any object on the bottom of the sea with such a tenacity that it requires some force to tear it off. Sometimes the roe gathers in large lumps or cakes, one grain of roe adhering to the other. The milt also sinks to the bottom and is absorbed by the roe, which thereby becomes impregnated. Soon after the roe has been emitted, the first preparatory process of development begins, as a portion of the yolk (the germ) becomes separated from the other portion (the food portion), and, differing in this from the roe of the cod, collects near the upper end of the egg. This is followed by the first "farrowing process," whereupon the fetus begins to develop in the usual manner. I have not yet had an opportunity of ascertaining how long it takes the fetus to reach its full development, but it is probable that the time varies according to the temperature of the water.

The young fry of the capelan was first observed near Vadsoe on the 17th of June after a fresh breeze from the east, with a strong landward current. These small fish had evidently been recently hatched, as none of those which were captured measured more than 8 to 10 millimeters in length; but it is certain that the hatching-places were at some distance east of the coast, as this year no roe was observed on the bottom, neither at Vadsoe nor at two other points on the Varanger-fjord which I had occasion to visit. The fry at this stage of their development are as transparent as clear water, and have a very thin body encased in a single clear skin, and a shapeless, broad head with two large eyes glittering like silver. They were observed in large numbers swimming about near the surface of the water, and were easily caught with a fine muslin net. At this

period of its life the capelan is extremely tender, and even when treated in the most careful manner dies soon after it has been taken out of the water. Later in the season the young fish were repeatedly observed as far up the fiord as *Morteusnaes*. Towards the end of my stay in these parts the capelan formed the principal bait for codfish, and were found in enormous numbers, together with small crustaceans and other pelagian animals. The codfish which were captured had the stomach almost invariably full of a jelly-like substance, which, on closer examination, proved to be young capelan, with but few other fish among them. The largest specimens caught with the fine net had at that time reached the length of 23 millimeters, and all the fins were completely developed, so that with absolute certainty they could be recognized as genuine young capelan.

An examination of the contents of the stomach and intestines of the grown capelan showed that it feeds exclusively on pelagian animals. At the furthest end of the intestinal duct remnants of *themists* and other characteristic animal forms of the arctic seas could be distinguished. In the stomach itself there were found various copepods of the species *Calanidæ*, some pelagian worms (*sagitta*), and occasionally *Thysanopoda*; therefore only such animals as had been observed in the fiord at the same time as the capelan.

C.

THE APPROACH OF THE CAPELAN TO THE COAST AND THE CONDITIONS WHICH SEEM TO EXERCISE AN INFLUENCE ON THE SAME.

The capelan approach the coast in dense schools, and often seem to move with great rapidity, swiftly passing islands and capes, and rushing into bays and sounds and out again. When the roe and milt are ready for spawning this process commences in the first suitable place, and seems to go on very fast. If the capelan does not immediately find a suitable place it roams about, sometimes near the coast and at other times farther from it, until it finds such a place.

It is a fact well known among fishermen that the weather has a considerable influence on the approach of the capelan. When there is a high sea and a strong wind blowing landward the capelan do not seek the sandy bays, but keep in deep water, where they probably spawn. When the wind, however, blows from the land, and the sea is calm, this is considered favorable to the approach of the capelan. The temperature of the sea is likewise important. Like most other fish, the capelan is very sensitive in the matter of sudden changes of temperature, and therefore endeavors, as much as possible, to keep in water of a tolerably uniform temperature. As long as the schools keep in the open sea they will not, during their migrations, be exposed to any very sudden changes, but when they come nearer the coast this will be different. Here they often meet with different currents of greatly varying

temperature, and this cannot but have a considerable influence on their approach to the coast. The water of the deep Finmark fiord is generally very cool in spring, owing to the severe cold of the winter, and near the surface its temperature is often several degrees lower than in the open sea immediately outside the fiords. This difference of temperature, traces of which are found for a long time in the deep portions of the water, gradually disappears with the increasing warmth of summer. But as the heat of summer comes early one year and late another, the period when the temperature of the surface is the same in the fiords as in the open sea varies considerably from year to year, and this circumstance cannot fail to influence the character and location of the capelan-fisheries. It will therefore easily be understood why unusually cold weather during the early part of summer is considered as very unfavorable for the entrance of the capelan into the fiords.

Although the capelan are, during their approach to the coast, pursued by numerous enemies, both whales, fish, and birds of prey, this seems to have much less influence on the course of the capelan schools than the above-mentioned physical conditions. The capelan, on the whole, seems to be rather a lazy fish, and, especially when gathered in large schools, by no means shy. On this point I have made several observations; the first on my way north in the Sanfjord near Nordkyn. While the steamer stopped to unload goods a number of capelan were observed quietly swimming by the side of the steamer. When the machinery again began to work and the steamer resumed its motion, it did not seem to affect them in the least, some of them even kept close to the stern without changing their course in the slightest, in consequence of which some were struck by the propeller and were thrown upward in a half-dead condition. It is well known that the method formerly employed for obtaining bait was very simple, and consisted in dipping the capelan out of the water with a sort of purse net. Although of late years small seines have been used for this purpose, the above-mentioned primitive method is still successfully employed in many places, and I have once seen how two boat-loads of capelan were obtained at Vadsoe in this manner, although the schools were by no means large. This shows that the capelan is not at all shy. Its worst enemy is the coal-fish. This greedy fish of prey, by its peculiar method of chasing the capelan, often succeeds in scattering the schools, and in disturbing the approach of the capelan to the coast. Neither the so-called "capelan cod," nor whales, nor birds seem to produce this effect.

D.

THE CAPELAN-FISHERIES IN THE VARANGER-FIORD.

As has already been mentioned, the capelan-fisheries are as a general rule not very steady, the principal fisheries being one year in West Finmark and another year in East Finmark. The Varanger-fiord cape-

lan-fisheries seem to be still more uncertain. In going over the different fish-reports, and examining the condition of the fisheries in previous years, I found ample proof of this assertion, and there have even been years when the Varanger-fjord fisheries proved an entire failure, the capelan either staying away altogether or not advancing beyond *Kibergnæs*, where the Varanger-fjord proper commences. According to the official reports this has been the case during the years 1869, 1871, and 1876, and the present year must also be classed among the years when the capelan only enter the Varanger-fjord in small and scattered schools. Old fishermen say that in former times there were also years when no capelan came near the coast. Even if such is the case, however, some fishing is going on, as the "capelan-cod," before leaving the coast, likes to follow the raised portion of the bottom as far as possible. I had occasion during the present year to observe this circumstance. Although the great mass of capelan which, after passing Vardoe, approached the coast, evidently took their course from Kiberg across the mouth of the fjord towards the coast of Russia (where they were observed soon afterwards), a considerable number nevertheless entered the Varanger-fjord at Vadsoe, but more especially at Bugönæs; where on certain days, when bait (herring) could be obtained, there was very good fishing (about 1½ tons of liver per boat). But the lack of bait brought the fisheries to a stand-still, and it is probable that a large number of cod would during this year have been caught in the Varanger district if there had been a sufficient quantity of bait. It is greatly to be deplored that, after the experience of former years, no measures were taken to supply this urgent want. A swift steamer, which could have supplied the fisheries in the fjord with bait from Vardoe or the nearest fishing-stations having plenty of capelan, would doubtless have proved an inestimable advantage. I have no doubt that even with preserved capelan or herring (packed in ice or slightly salted) large numbers of cod might have been caught. It is stated that attempts made in this direction in former years have proved unsuccessful, but in making these statements no regard seems to have been had for the peculiar circumstances under which these attempts were made. When the sea is full of capelan, it is quite natural that the cod prefers the fresh capelan to preserved fish. In years like the present, however, when but few, if any, capelan are found near the fishing-stations, the cod will doubtless take to the bait, even if it is not fresh fish.* I myself have seen a large quantity of cod caught near Bugönæs with herring which were so old and soft that they could hardly be fastened to the hooks, which shows that the cod was not over nice in the matter of food. As lines are almost exclusively used in the Varanger-fjord cod-fisheries (not hand-lines as at most of the other fishing-stations), it cannot be considered a misfortune, but rather the contrary, that there are so few capelan during the fishing-season, as it

*It is well known that in the Loffoden fisheries salt herring are almost exclusively used for line fishing.

would be much more difficult to catch the cod with lines when the sea was full of capelan.

As a peculiarity of this year's fisheries in the Varanger-fjord it must be mentioned that during the whole season the cod went very deep, so that the first good hauls were made near the edge of the outer bottom-elevation. I think that I can explain this by purely physical and meteorological causes, of which more below.

In answer to the question what caused the capelan this year to stay away from its usual spawning places in the Varanger-fjord most fishermen will say that the whale-fisheries were the only cause of this. No facts, however, are given on which to build this opinion, and I believe, and expect to show in the following, that I am able to mention a much more plausible cause, which will also explain the failures of former years, when there were no whale-fisheries.

I give below some statistical data, taken from the fish-reports reprinted in "*Norges Officielle Statistik*," relative to the capelan-fisheries in the Varanger-fjord during the last few years, from which it will be seen that there has not been a uniform decrease of the capelan-fisheries since the beginning of the whale-fisheries, as is maintained by some persons, but that the fisheries have varied considerably from year to year.

Statistics showing the number of fish caught in the Varanger-district during the period 1868-1878.

1868	3, 160, 000
1869	446, 000
1870	1, 192, 000
1871	797, 900
1872	431, 200
1873	900, 000
1874	1, 187, 000
1875	961, 000
1876	476, 000
1877	1, 120, 000
1878	569, 000

E.

ON THE SUPPOSED INFLUENCE OF THE WHALE-FISHERIES ON THE CAPELAN-FISHERIES IN THE VARANGER-FJORD.

As this question is for the time being of vital importance to the inhabitants of the coast, I have given special attention to it, and have, after the best of my ability, during my stay at Vadsoe sought to examine all the points which seem to have any bearing on this question. It is the general opinion in these parts, as is well known, that the whale-fisheries exercise an exceedingly hurtful influence on the capelan-fisher-

* The figures for the last two years have been kindly furnished by the Statistical Bureau.

ies, and that the failure of the Varanger-fiord fisheries during the last few years is principally owing to the growing development of the whale-fisheries. No satisfactory proof of this opinion, however, has as yet been given, and the bill introduced in the *Folkething* (Norwegian Parliament) during its last session to limit the whale-fisheries, did not, therefore, pass. My private opinion has always been that no such hurtful influence can be ascribed to the whale-fisheries, and I have freely stated this opinion to the department on former occasions. But, as at that time I had not yet personally observed the capelan-fisheries, and as the whale-fisheries were carried on in a somewhat different manner from what they are now, I thought it desirable to make another thorough investigation of the whole matter, in which I could engage with entire impartiality, as I did not consider myself bound to abide by any opinion previously expressed by me, and was not hampered by any considerations of a personal nature.

In examining this matter the following points seem to me to be of special importance; and from my present experience I shall endeavor to answer each one of them as best I can:

(1.) What justifies the supposition that the whales chase the capelan from the sea towards the coast?

(2.) Does the whale, during good capelan-fishing, cause the capelan to stay for a considerable time in shallow bays and sounds?

(3.) Which kinds of whales come near the coast during the capelan-fisheries, and which of these must be considered as the capelan-whale proper?

(4.) Can any considerable decrease be noticed in the number of whales at the present time, and can it be supposed that, as these fisheries are carried on at present, the whales will be exterminated in the near future?

(5.) Will an actual decrease or the extermination of the whales have any influence on the character of the capelan-fisheries?

(6.) Do the whale-steamers, while cruising near the coast, scare away the capelan schools, and disturb their approach to the coast?

(7.) In how far can there be any direct conflict between the whale and other fisheries?

(8.) Is it probable that the refuse from the captured whales fills the sea with impure matter to such a degree as to drive the capelan away from places where whales are slaughtered?

(9.) Does impure matter from the same source gather at the bottom of the sea and make it unfit for the development of the roe of the capelan?

(10.) What physical and meteorological causes can be supposed to have an influence on the entering of the capelan into the Varanger-fiord?

In the following I shall endeavor to answer each one of these questions under its respective number:

(1.) It is a very old opinion, as is well known, that the approach to the coast of the capelan and herring is solely caused by the whales,

and that nature had appointed these gigantic animals to gather the scattered schools of herring and capelan from the different parts of the ocean and chase them towards certain portions of the coast in order that man might get his share of the wealth of the sea. For this reason a sort of veneration was, in olden times, shown for whales, which were considered the special servants of Providence. Our time is less fanciful in its interpretation of natural phenomena, and we hesitate somewhat to assign to the whale the part of a disinterested benefactor of mankind. It has been shown with a sufficient degree of certainty that both the spring herring and the capelan approach the coast at certain seasons of the year from a natural instinct, in order to spawn in suitable places, and that the whales simply follow the schools of herring and capelan, because they supply them with food. Although it might be supposed that no educated person could any longer entertain the antiquated notion above referred to, the opinion seems still to be very generally spread among fishermen that the presence of the whale during the capelan-fisheries is of great significance and benefit. Though the more enlightened fishermen will grant that, even if the whales staid away, the capelan must come near the coast for the purpose of spawning, they still think that it is owing to the whales that the capelan spawn so near to the coast, and that there are successful fisheries. Experience, however, does by no means bear out this opinion. There have been years when large whales were seen out at sea and no capelan approached the coast, and at other times there have been instances (as in the Varanger-fjord) when the capelan came quite near the coast without a single whale making its appearance outside.

(2.) It has been maintained that during the rich Varanger-fjord capelan-fisheries the whales formed a sort of cordon outside the bays and sounds, thus forcing the capelan towards the coast against their will, and preventing them from returning to the deep waters. In all such cases, however, it has been ascertained that the capelan spawned in the above-mentioned bays and sounds, and also, that, after the spawning-process was finished, the capelan went out to sea again, without any regard to the whales. It is evident, therefore, that we should consider this matter in a somewhat different light, viz, that the schools of capelan have chosen their spawning-places from their own instinct and entirely independent of the whales, and that the whales have simply followed the schools, as is their wont, and that when the capelan schools stopped in certain places the whales likewise stopped somewhere in the neighborhood, so as to be able to take their meals regularly. In rejecting the last-mentioned and entirely natural explanation and showing a preference for the old idea, that the whales bring the capelan to the coast and distribute them among the different fishing-stations, people only furnish another proof of how difficult it is to tear loose from old and deeply-rooted prejudices. This idea, as has been said above, is evidently based on a complete misunderstanding of the mutual relations between

the capelan and the whale. There are no reliable facts to show that the approach of the capelan schools is influenced to any great degree either by the pursuing whales or by the cod, or by flocks of birds; but there is every reason to suppose that only physical and meteorological conditions determine the course of the capelan while near the shore.

(3.) The species of whales which follows the schools of capelan seems to be almost exclusively the so-called "Fin-whale," which I have found to be identical with the *Balaenoptera musculus*, the same which generally makes its appearance during the spring-herring fisheries. The so-called "blue-whale," on the other hand, makes its appearance later, hardly before the middle of May, and does not live on capelan; but on pelagian animals of a lower class, particularly small crustaceans. I have already had occasion to show that this species of whales, which forms the principal object of Foy'n's fisheries, has absolutely nothing to do with the capelan, and the investigations made by me during the present year fully corroborate this statement. Of other whales, the *Megaptera bœops* occasionally makes its appearance, but only later in spring. Shortly before setting out on my return journey I had occasion to examine a specimen of this kind which had been captured by Foy'n's men. A thorough examination of the contents of its stomach showed that this species of whale, like the "blue-whale," lives exclusively on lower pelagian animals, especially small crustaceans. Finally, a fourth species of whales is known in these regions, the so-called "coal-fish-whale," which takes its name from the circumstance that it does not appear in any considerable number until the approach of the coal-fish. As this whale only reaches a comparatively small size, it is not caught. I have, however, obtained a tolerably close view of it at sea, which convinced me that it is the so-called "*Vaäge-whale*," well known on our western coast. It lives principally on small herring, but it must be supposed that in these northern latitudes it also, to some extent, feeds on capelan. The three last-mentioned species of whales are seen near the coast, and in the Varanger-fjord, long after the capelan have disappeared. The "Fin-whale," on the other hand, leaves the coast with the capelan, and also arrives with it. It must, therefore, be considered as the "capelan-whale" proper. Although, as has been said above, the "blue-whale" forms the principal object of Foy'n's fisheries, several "Fin-whales" have been caught during the last few years, as the whale-fisheries commence before the "blue-whale" comes near the coast. During the present year, as far as known, 15 "Fin-whales" have been caught by Foy'n's men. The stomachs of those which I examined were completely filled with capelan, and some were even found in the mouth, the whale evidently not having had time to swallow them.

(4.) To the question, "Can a considerable decrease in the number of whales be noticed on the coast of Finmark?" my experience compels me to return a negative answer: The schools of capelan are still followed by numerous whales, and the reports on the capelan-fisheries, year after

year, speak of the large number of whales and birds, just as in former times. As regards the complaint that there has been a decrease in the number of whales in the Varanger-fiord, we must take into consideration the circumstance that the whale only visits those places where it can obtain sufficient food. As it is a fact that of late years the capelan have not entered the Varanger-fiord in any considerable number, it is but a natural consequence of this fact that the whales in this fiord are not as numerous as in former years. If any species of whales may be supposed to have decreased on account of the present whale-fisheries this would be the "blue-whale," but the rich hauls made during the last few years do not seem to indicate any such decrease. As the whale-fisheries are carried on at present, it is hardly probable that there will be any noticeable decrease in the number of whales in the near future. If the whale-fisheries, however, should be further developed, and new whaling-stations be established on this coast, such an occurrence is within the range of possibility. In this case it would be advisable to take suitable measures for preserving a source of income, which doubtless in the future will yield a still greater gain, in proportion as the preparation and improvement of the raw material becomes more perfect and better apparatus is employed.

(5.) There are instances on record, unfortunately, which show that it is possible for man to exterminate an entire species of animals. Although it seems hardly possible that this should ever be the case with the whales, whose home and place of refuge is the whole vast ocean, it is quite possible that, by being too eagerly pursued for a long number of years, their number may decrease, and that finally they may be more or less driven away from certain coasts. It is not easy to say what would be the consequences of such an occurrence. It is my opinion, however, that as far as the fisheries are concerned these consequences would not be as serious as some people are inclined to think. Whilst it is certainly doubtful whether the whales to any great extent chase the capelan and herring towards the shore, it is absolutely certain that enormous quantities of these fish are destroyed by the whales. The "Fin-whales" must actually be considered as hurtful animals. The "blue-whale," on the other hand, lives almost exclusively on small crustaceans, which are of considerable importance to the fisheries, as they form the principal bait for the cod. The probable consequence of the disappearance of the whales would be an increase in the number of capelan, and an improvement in the cod-fisheries, on account of the larger number of small crustaceans; in other words, there is reason to suppose that instead of being injured, the fisheries would be benefited. It would, however, be wrong to encourage, from this point of view, a war of extermination against the whales. Although these animals do not play the peculiar part which the superstition of former years has assigned them, they doubtless have their place in the great household of nature by contributing their share towards maintaining that equilibrium which is necessary for the fauna of the sea,

if it is to preserve its present character. Any violent disturbance of this equilibrium will, under all circumstances, be fraught with danger, as we do not know what further consequences it may produce. The desire to preserve the whale-fisheries for our descendants ought likewise to prevent people from engaging in a useless war of extermination against these animals.

(6.) As during the last few years the whale-fisheries have been carried on at a time when capelan-fishing was in full activity, the question arises whether the whaling-ships are liable during their cruises to scare the schools of capelan. Some people think that the noise made by the propeller of a steamer is capable, even at a considerable distance, of frightening capelan and herring and driving them away from the coast. This, however, is merely a supposition, and has never been proved by facts. Various observations (see also those mentioned by me above), on the contrary, seem to show that at any rate the capelan is in no wise affected by this kind of noise. It is another question, whether the noise of the cannon, which are fired off by the whaling-vessels, can frighten the capelan. It cannot be denied that the capelan, like all fish, is strangely affected by any sudden noises of this kind. One can easily convince himself by actual experiment that even a slight noise, such as the falling down of an oar in the boat, &c., is noticed by the schools of capelan which are in the immediate neighborhood, and that, on hearing the noise, they make a sudden movement, which causes their shining sides to appear in the water. One may, however, at the same time, convince himself that this movement is purely temporary, and that, as soon as the noise has subsided, the schools of capelan quietly pursue their course. As the cannon shots which are fired by the whaling-vessels are by no means of the character of a continuous cannonade, but are only fired at long intervals, it cannot be supposed that the course of the capelan is in any way influenced thereby, especially when these shots, as is mostly the case, are fired at a considerable distance from the coast. It cannot be denied, however, that if these shots should be fired close to the shore, and right among the schools of capelan whilst they are engaged in spawning, the spawning-process might be endangered, and the capelan frightened to such a degree as to make their capture much more difficult. It would be still worse if a wounded whale should in its agony rush among the schools of capelan, dragging the steamer after it. Such cases will probably be of rare occurrence, but are said to have happened, and must under any circumstances be considered as extremely unfavorable to the capelan-fisheries. Some complaints on this point have been raised during the present year, and I have had occasion during my stay at Vadsoe to become acquainted with the nature of these complaints, and I must say that, although they were doubtless exaggerated, there was certainly some foundation for them. I am, therefore, prepared to grant that it will be a benefit to confine the whale-fisheries within certain limits.

(7.) The greatest danger which, in my opinion, threatens the capelan-fisheries from the whale-fisheries is that there may possibly be a conflict between these two interests. If this should really ever be the case it will be time enough to take measures for assigning certain limits to each fishery, so as to preclude the possibility of a collision. But, strange to say, very few complaints have been raised relative to this (in my opinion) very important point, and from what I heard during my stay at the fishing-stations, there has so far been very little cause for such complaints. There seem to have been a few cases where the lines of the capelan-fishers have been disturbed by the whale-fisheries, but in such cases Mr. Foyn has invariably reimbursed the fishermen for their loss in such a liberal manner as to make their gain exceed their loss. It is, however, within the range of possibility that, if the whale-fisheries should be further developed, the conflict between the two interests might become more serious. Another point should be taken into consideration—the possible danger to the lives of the fishermen, if the whale-fisheries should be prosecuted on a more extensive scale in the usual fishing-places, which are crowded with boats and implements. When a whale, which has been shot but is not yet dead, rushes furiously along with the steamer in tow, it cannot possibly make way for the boats which accidentally cross its path; nor will it be possible for the crews of such boats who are engaged in hauling in their lines and nets to escape the approaching danger. It is evident that accidents could thus easily happen, and in such cases neither Mr. Foyn nor any one else could make up for the losses sustained. For these reasons I would be inclined to favor a reasonable limitation of the whale-fisheries, promising greater safety to apparatus and human life; and it is my idea that this could best be done by drawing a certain line at some distance from the coast, within which no whale could be shot during the fishing-season. If this line were drawn one half mile (Norwegian) from the coast the whale-fisheries would not be inconvenienced, and the other fisheries could be carried on with greater safety, and the danger, to some extent well founded, that under certain circumstances the whale-fisheries might drive away the schools of capelan, would be removed.

There are a few more points regarding the whale-fisheries which have attracted attention during the last few years, and to which I will refer, because during my stay at the fishing-stations I have made them the subject of special investigations.

(8.) The fear has been expressed that the refuse from the captured whales might fill the sea with fatty and impure substances to such an extent as to prevent the capelan entering the Varanger-fiord, since the capelan seemed to avoid the places where whaling-establishments are located. As regards this last-mentioned point, I must say that experience does not prove its correctness. Whenever capelan have visited the Varanger-fiord, and this has more or less always been the case, they have gone to their accustomed places, and the Vadsoe Sound has always been

one of the best points for the capelan-fisheries; it has even been noticed that the schools of capelan seemed to prefer that portion of the sound which bordered on Mr. Foyn's establishment. On the south side of the fiord the bay into which the Jacobs River empties has always been the best place for the capelan-fisheries, and is still considered so, although the whaling-establishment of the Iarfiord Company is quite near. As regards the refuse, it is true that the Iarfiord Company only uses the oil and the whalebone, while Foyn's establishment utilizes everything except the entrails. These are taken outside of the fiord and thrown into the water to be carried away by wind and waves; they continue to float near the surface until they are either scattered or sink to the bottom after the fatty substances have disappeared. During my excursions I have several times had occasion to see such refuse. These half-decayed substances do not emit the most pleasant odor, and it is anything but agreeable for the inhabitants of Vadsoe to have the current, as will sometimes happen, carry such matter into the immediate neighborhood of the town. But the poisoning of the water of the Varangerfiord is entirely out of the question. Another disagreeable consequence is this, that during the slaughtering of the whales at Foyn's establishment a quantity of oil and fat is carried across the sound to Vadsoe by wind and current, and adheres to the piers, which suffer much from this cause, and are destroyed in a comparatively short time. One can easily convince himself of the presence of these oily substances, which are of course confined to the surface of the water whenever there is a fresh sea-breeze. It can then be noticed that the water in the immediate neighborhood of Foyn's establishment does not show the slightest ripple, but remains as smooth as a mirror, just as if there was no wind, and at the same time boats may be seen passing by at a short distance, their sails filled by the breeze. It must, however, be said that this phenomenon is only noticed in the Vadsoe Sound, and that the sea outside of the sound preserves its usual appearance. It is hardly probable that the fatty substances floating about on the surface of the water should drive the capelan away, and experience has shown that the capelan have entered the Vadsoe Sound in spite of the existence of this fatty matter. In slaughtering the captured whales a large quantity of blood likewise flows into the sea, but as it is heavier than the sea-water it is not carried as far as the oil; and I have never seen blood in the water except in the immediate neighborhood of Foyn's establishment, where the sea certainly at times resembles a pool of blood. The question has also been asked whether the close proximity of Foyn's establishment to the town of Vadsoe could in any way affect its sanitary condition. Although this question, properly speaking, did not belong to the subject which I intended to investigate, I nevertheless thought that it might be useful to gather some information on this point from the resident physician, Dr. Hartman, who has assured me that there had

not been any change for the worse in the sanitary condition of the town since the beginning of the whale-fisheries.

(9.) The idea has also been advanced that the refuse from the captured whales might fill the bottom of the sea with impurities to such an extent as to make it unfit for the development of the roe of the capelan. This idea, however, does not rest on any actual observation, but is merely a supposition. I have made this the subject of most careful and thorough investigation, the result of which by no means corroborates that supposition. Immediately on my arrival at Vadsoe, therefore, prior to the beginning of this year's whale-fisheries, I made a careful examination of the sound, both near the town and near Foyn's establishment. I found nothing of a peculiar character, except that close to the above-mentioned establishment there was an unusual quantity of those small green algæ which are used a good deal to keep the water in aquaria in a fresh condition. In the deep cavities between the stones there was a thin layer of fine mud; otherwise the bottom everywhere consisted of pure white sand, which in some places was coarser than in others. After the whale-fisheries had been going on for some time I again examined the sound on different occasions. Near Foyn's establishment stinking mud had, in some places, accumulated on the sand, and this mud was evidently composed of refuse-matter from the slaughtered whales; but at a very short distance from the shore this mud began to disappear, and farther out in the sound the bottom was exactly of the same character as when I first examined it, and I could not discover the slightest impurities. I even go so far as to say that, in spite of the whale-fisheries, the harbor of Vadsoe has a cleaner bottom than most other harbors on the coast of Finmark. Both at Vardoe and at Hammerfest and many other places I have on former occasions examined the nature of the bottom, and have invariably found a more or less extensive layer of dark mud covering the sand, composed principally of fish-refuse and other decayed organic matter. The Vadsoe harbor, however, is remarkably free from this mud. This seems to be owing to the steady and often very strong current which flows through the sound, and which does not allow any organic substances floating in the water to sink to the bottom. Farther out not the slightest trace of impurity can be discovered on the bottom of the fiord. As a general rule the upper layer is sand, then comes rock with a rich algæ-vegetation, and below this a clay bottom. Nothing anomalous could be observed in the composition of this clay; and both it and the sandy and rocky bottom were swarming with different aquatic animals which seemed to thrive remarkably well. Although I am not able to report any direct observations on the development of the capelan-roë in these regions, for the simple reason that this year the capelan did not spawn in the Varanger-fiord, I feel convinced that the nature of the bottom will not prevent the capelan from spawning either here or anywhere else. It is true that the entrails of the whales, after having floated in the water for some time, finally sink to the bottom;

but when this takes place the organic substances have for the greater part been destroyed, and the numerous aquatic animals living on the bottom do the rest of the work. I once had occasion to examine some of the remnants of the entrails of a whale which were accidentally brought up by the bottom-scraper in the fiord near Vadsoe. It looked like a mass of wool rolled together, as only the thin and tough sinews had been left, all the flesh and fat having disappeared. There was no unusual odor from these remnants. It is my opinion that but very little time is required to reduce the entrails to this condition. It is a well-known fact that in the arctic regions large animals, the walrus or polar bear for instance, are completely skeletonized by sinking them to the bottom and letting them lie there for a few days. There are a number of small marine animals, especially amphipods, which make their appearance in enormous masses, and do the work of skeletonizing very thoroughly, and which are everywhere to be considered as diligent sanitary police, clearing off from the bottom all decaying organic matter. In the Varanger-fiord these small animals are found in enormous masses. In the Vadsoe Sound alone I discovered 20 different kinds of amphipods, and these have on the whole been found to be identical with those usually found in the arctic seas.

(10.) In conclusion, if I am asked what I suppose to be the cause of the last years' poor fisheries in the Varanger-fiord, I must—referring to my investigations of this matter, and to what I have said regarding it above—express it as my conviction that the principal causes are of a physical and meteorological nature, and that the whale-fisheries have much less to do with it than is generally supposed. Although it cannot be denied that under certain circumstances these fisheries may disturb the course of the capelan and their distribution over the different fishing-stations, there is nothing to justify the supposition that the capelan have ever been driven away from the coast thereby, or have been prevented from reaching their accustomed spawning places.* During the present year the capelan-fisheries in the Varanger-fiord were not very successful, as hardly any capelan entered the fiord, and public opinion very generally ascribed this to the whale-fisheries, no one ever thinking of other possible causes. As such a cause I have mentioned meteorological conditions, and my experience in this respect is fully borne out by that of the fishermen. If we inquire into the meteorological conditions of the present year we find that the whole spring and early summer till the 24th of June were unusually cold and raw. The temperature of the sea-

* One of the complaints raised during my stay at Vadsoe was that a single cannon shot fired near *Great Ekkerø* from the steamer of the Iarfiord Company caused the schools of capelan and the whales to leave this neighborhood, not to return again; but it may well be asked why the same was not the case at Vardoe and Kiberg, in the immediate neighborhood of which shots were fired repeatedly. It was evidently a mere accident that the capelan disappeared at the same, or nearly the same, time when the above-mentioned shot was fired; and there is every reason to suppose that the same would have happened if no shot had been fired.

water in the Varanger-fjord was consequently very low, and remained in the neighborhood of $+2^{\circ}$ C. till the end of the fisheries. During the nights the temperature was often several degrees lower, and the surface water at times consequently still colder. I have not the slightest doubt that thereby the schools of capelan were to a great extent prevented from entering the Varanger-fjord. I also think that this unusually low temperature of the upper portion of the water is the reason why the capelan-cod went into such deep waters, and did not visit the banks as is their wont, and also why there was such a scarcity of small crustaceans. Even if one should not be inclined to ascribe so decided an influence on the course of the capelan to the meteorological conditions as I do, I nevertheless believe that every one will agree with me that it will not do to be led by an old prejudice, and make the whale-fisheries solely responsible for the poor fisheries in the Varanger-fjord, without taking into consideration meteorological and other conditions, which very probably have had a good deal to do with it.

I have in the above given a plain review of the opinions to which the investigations made by me during the present year have led me. If these opinions differ somewhat from those generally entertained in these regions, I can honestly confess that this is not caused by any pre-conceived prejudice on my part. On the contrary, it has been my desire as much as possible to meet the views of the inhabitants of these parts half-way; and I have therefore investigated all the complaints made against the whale-fisheries as conscientiously as possible. As a scientist I am obliged to confine myself strictly to the facts in the case, and I have found that these facts do not favor the popular opinion. If, in spite of this, I have declared my willingness to favor a reasonable limitation of the whale-fisheries, this has principally been done from reasons entirely different from those which have generally been advanced; my idea as to this proposed limitation, and the manner in which it had best be carried out, also differs greatly from that proposed in former years.

