THE RIGHT WHALES IN THE PACIFIC OCEAN

S.K. Klumov

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Translated by Iris E. Scarff
Edited by James E. Scarff
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COMMENTS ON KLUMOV'S REPORT AND THE TRANSLATION

By James E. Scarff

Introduction

Despite the right whale's being perhaps the most endangered population of large whales in the world, remarkably little is known about this species in the North Pacific. Its taxonomic status as a subspecies, a distinct species or even their genus is still in doubt. The population in the eastern North Pacific is in desperate condition, while the population is the western North Pacific is, at best, highly endangered. This state of jeopardy exists today notwithstanding international treaties protecting right whales for over 60 years.

Given the urgent need for more attention to be paid to these populations, and the dearth of scientific studies on these whales, every bit of data assumes importance. As one of the few studies of North Pacific right whales, Klumov (1962) has been cited frequently in reviews of this species, although the reviewers rarely were able to review the report itself, having to rely on a very general one page English summary of the report that appeared with the original article. In this context, a translation of Klumov's entire article is important notwithstanding its age and numerous errors.

The English Summary of the Russian Article

The original Russian article includes a one page summary in English. This summary was all that most non-Russian reading scientists knew of Klumov's data until now. The original English summary is included at the end of this translation verbatim. The summary consists entirely of Klumov's conclusions and does not describe the underlying data or methods. As a result, other researchers were unable to evaluate or test Klumov's conclusions. One of the primary purposes of undertaking this translation is to allow non-Russian reading researchers to see the underlying data.

Many of the conclusions contained in the English summary are not supported by the data Klumov reviewed or the scientific literature, even that available in 1962. Other conclusions are based on little or no data, and thus the summary substantially overstates the results of the research. Unfortunately, in subsequent years many non-Russian researchers have relied on the conclusions in the English summary and cited Klumov's article as proof of Klumov's assertions.

Conclusions contained in the English summary not supported by the data or based on grossly insufficient data include:

- Western and Eastern North Pacific right whales do not interbreed,
- Western North Pacific right whales belong to two separate stocks, the Okhotsk and Pacific stocks,
- Dates of the mating and calving,
- Duration of gestation, and
- Growth rates during gestation and after birth.

Notes on the Translation

In May 1980, Dr. Peter Best of the Mammal Research Institute of the University of Pretoria, Republic of South Africa, requested the Language Services Bureau in Pretoria to prepare a translation of Klumov (1962). A rough translation was done, but because of concern about inaccuracies in the translation, was circulated among only a few researchers. We obtained a copy from Scott Kraus at the New England Aquarium. We used this 1980 translation as a check against our own work; however, the current translation was checked in its entirety against the original Russian text.

In making this translation, we tried to stay close to the syntax and flavor of the original Russian. This makes for some awkward English, but it more accurately reflects the logic, or lack of logic, of Klumov's arguments than any attempt to put the text into more eloquent English.

In general, the entire text has been translated. One exception is in Klumov's use of scientific names. He included the scientific name of species immediately after the common name repeatedly through the article. We followed the more modern practice of when there is a generally understood common name then including the scientific name only after the first occurrence of the common name. We also omitted a few parenthetical phrases that may be used in Russian, but confuse the reader when translated into English. We do not believe that any of these changes alter the meaning or results of Klumov's article.

Taxonomy

Klumov does not devote much attention to the taxonomic status of North Pacific right whales. He makes a few comments about the size and proportions of North Pacific right whales, then concludes that the specimens the Russian expedition captured should be considered the same species as with North Atlantic right whales, *i.e. Eubalaena glacialis*. At the subspecies level, Klumov treats all stocks of North Pacific right whales as belonging to the subspecies *E.g. sieboldii* (Gray 1864).

Until recently, taxonomists defined the distinctions between bowheads and right whales and between bowheads of the various oceans only with reference to a few bones whose value as indicators of phylogenetic differences was never tested. Using these morphological character(s), Rice (1998) argues that the genus *Eubalaena* should be subsumed into the genus *Balaena* putting right whales and bowhead into the same genus. Other scientists have considered North Atlantic and North Pacific right whales to be subspecies of *Eubalaena glacialis – E.g. glacialis* and *E.g. japonica* (Gray 1864)(Schevill 1986).

More recently genetic studies have shed light on the phylogeny of right whale populations. Rosenbaum *et al.* (2000) performed an analysis of mitochondrial DNA of right whales from the North Pacific, the North Atlantic and the Southern Hemisphere as well as bowheads. They conclude that the differences between right whales and bowheads are sufficient to justify maintaining right whales in the separate genus *Eubalaena*. They also concluded that their analyses: "provide unequivocal character support consistent with distinguishing the three right whales lineages as phylogenetic species": *E. glacialis* in the North Atlantic, *E. australis* in the Southern Hemisphere, and *E. japonica* (Lacépède 1818) in the North Pacific. Moreover, they found that the North Pacific right whales were genetically more similar to Southern Hemisphere right whales than to right whales in the North Atlantic. This finding makes inappropriate the combining of North Atlantic and North Pacific right whales into a single species distinct from the Southern Hemisphere right whales, a practice that has been used by the International Whaling Commission and others.

Distribution

Perhaps the most interesting data in Klumov's article are the sighting data from the voyages in the Kuril Islands 1951-1957. Klumov reports 323 sightings of right whales in this area (shown in Figures 3-10). The data do not allow estimates of population size since the searching effort was not structured and there is no data that indicated how many of the sightings represented resightings of the same individuals.

The area around the Kuril Islands was also noted as a site of concentrations of right whales by pelagic whalers in the 19th century (Maury 1852 *et seq.*, Townsend 1935, Scarff 1991). Surveys of this area conducted by Japanese researchers between 1990-1999 have revealed that a remnant population of right whales still persists in this area (Miyashita and Kato 2001, Brownell *et al.* 2001).

Bowheads in the Sea of Okhotsk

Klumov (1962) brought to his study a belief that bowhead whales did not occur in the Sea of Okhotsk. Without having conducted a survey of the regions of the Sea of Okhotsk where others had reported bowhead whales, Klumov dismissed all reports of bowheads in the Sea of Okhotsk as error by the observers or writers. Klumov argues that all these reports of bowheads actually referred to right whales. By including bowhead catch locations and sighting as right whale data, Klumov over-estimated the range and numbers of right whales in the Sea of Okhotsk.

Klumov's adamancy about bowhead whales not occurring in the Sea of Okhotsk is remarkable since the western portion of the Sea of Okhotsk was a major whaling ground for bowhead whales in the mid and late 19th century. The large amount of American pelagic whaling for bowheads in this area was documented Scammon (1874) and Townsend (1935). Klumov was aware of both these studies and others, but dismisses Townsend's data, insisting that 19th century whalers "undoubtedly" confused right whales and bowheads in the Sea of Okhotsk and elsewhere. Klumov writes "there are no doubts about the fact that all, in any case the majority, of locations of right whale catches in the Sea of Okhotsk are right whales (*E. glacialis sieboldii*) and not bowheads." Klumov dismisses Scammon's (1874) description of bowhead whaling in the Sea of Okhotsk as being filled with "contradictions" and unreliable, the whales in question being "of course right whales", not bowheads. Klumov cites Gilmore (1956) as supportive of his conclusion about bowhead distribution, although that article is mainly a report of a single right whale sighting off San Diego, California.

Since Klumov's report, other researchers have documented a population of bowhead whales in the western and northern Sea of Okhotsk (Berzin and Doroshenko 1981, Henderson 1983, Berzin *et al.* 1986, Shelden and Rue 1995). This is the same population of bowheads reported correctly in Townsend (1935) and by Scammon (1874).

Stock Identity

Eastern North Pacific Stock – Klumov states that the right whales seen in the eastern North Pacific are from a distinct stock of right whales. He provides no new data or analysis to support this view, relying only on an interpretation of Townsend's (1935) charts. However, Scarff (1991) argues that the apparent distribution of right whales in two concentrations shown in Townsend (1935) may be an artifact of searching effort rather than two discrete populations. Scarff notes that the effort-adjusted sighting data from Maury (1852 *et seq.*) do not show such a strong segregation of whale concentrations, and argues that the hypothesis that the eastern North Pacific population is discrete needs to be more rigorously tested. Brownell *et al*. (2001) argue that the twentieth century sighting data support the hypothesis that right whales in the western and eastern North Pacific are two stocks.

Sea of Okhotsk v. "Pacific" stocks – Klumov argues that the right whales in the western North Pacific are separated into two stocks—a Sea of Okhotsk stock and a Pacific stock. Klumov argues that the Sea of Okhotsk stock summers in the Sea of Okhotsk and winters in the Sea of Japan and Sea of China. He argues that the Pacific stock summers in the Kuril Islands and along the coast of Kamchatka and winters along the east coast of Japan. Omura (1986) notes that populations of right whales migrate along both the east and west coasts of Japan, though he does not go so far as to state that these represent two separate breeding stocks.

Klumov's analysis is confused by his assumption that all the sightings of bowheads in the Sea of Okhotsk are of right whales. His figure 21 shows the right whales in the Sea of Okhotsk stock migrating into the western and northern Sea of Ohkotsk, areas where historic and recent studies have found only bowhead whales. If the whales migrating up the west coast of Japan are a separate stock, their northern migration probably stops along the east coast of Sakhalin Island and in the Kuril Islands. However, these are same areas Klumov suggests are occupied by the Pacific stock. The 1998 IWC Scientific Committee's Right Whale Workshop report (IWC 2001) and Brownell *et al*. (2001) both express skepticism that two separate breeding stocks of migratory right whales would occur in such geographic proximity.

Behavior

Mating, Gestation, and Birth Dates

Klumov estimated that right whale mating occurs in November and December. He based this preliminary conclusion was based on calculating a single embryonic growth rate of 2.42 cm/day from a sample of a 1.9 m embryo taken on 17 May and another 4.4 m embryo taken on 28 August. He then extrapolated back to dates of conception using this rate. Based on a view that the mating season of other baleen whales is highly synchronized, he assumed that the period of right whale mating is also highly synchronized. Subsequent studies of right whales in the western North Atlantic have shown mating behavior occurring over a longer period.

Klumov estimated that the gestation period of North Pacific right whales at 11-12 months. Best's (1994) observations of right whales in the southern hemisphere show a gestation of 357-396 days, about a month longer than Klumov calculates. Births in the western North Atlantic have been reported between December and April (Kraus *et al.* 1993) over a longer period than Klumov assumed.

Age at weaning

Klumov states that right whale calves are weaned at 6-7 months of age. He bases this conclusion on finding a single 10.75m male calf killed on 22 July "in the process of being weaned" since it had both milk and krill in its stomach and one 11.35m female killed on 11 August that had some krill and no milk. Analyses of much larger samples of living North Atlantic right whales show that weaning may occur between 8 to 17 months (Hamilton and Marx 1995).

Frequency of pregnancy

Klumov does not present any direct evidence for the frequency with which North Pacific right whales have calves. However, he assumed that the reproductive cycle of this whales was the same as for other mysticetes, and that they gave birth at two year intervals. He does not entertain the possibility that intervals between births of right whales of three or more years might be a more common interval.

Echolocation

Klumov's practice of mixing speculation with observation reaches its most extreme result in his discussion of how right whales find food. During the course of his study, neither Klumov nor his assistants appear to have made any observations of right whales feeding, although the whales were on their feeding grounds when collected. His conclusions appear entirely based on the stomach contents of the whales killed and his review of previous studies.

Klumov then asks rhetorically how right whales find their food. He concludes it cannot be by sight since "it is generally accepted that the vision of whales is poorly developed." He senses that touch may play some role in feeding behavior, pointing to the hairs located on the right whale's head. He concludes that echolocation "is the principal means that both baleen and toothed whales (Odontoceti) orient themselves when searching for food at various depths both at day and in darkness." In support of this proposition he cites three previous reports of his own on krill available only in Russian.

Klumov proposes that baleen whales generally use active sonar rather than simply listen for food. He states "..whales in general, and baleen whales in particular, are known to make sounds…There is no doubt that whales can use echolocation to locate concentrations of food." Klumov also suggests that right whales may passively hear their food. He writes: "It is quite clear that even large concentrations of zooplankton, not to mention the schools of squid (*Loligo*) or fish, emit sounds which attract whales." Klumov publishes no data to support these ideas. No sound recordings of right whales were made by Klumov. To my knowledge there is no evidence that right whales use sound either actively or passively to locate food.

Feeding on the bottom

Klumov writes that the copepod prey of North Pacific right whales occurs in the upper part of the water column – "Right whales feed mainly in the top 25m where the concentrations of food are greatest." However, he later writes: "A detailed investigation of the front end of the lower jaw of right whales, as well as of humpback whales, and of sperm whales shows that in most of these animals the very front tip of the lower jaw shows clear traces of chafing, and sometimes there can even be a 'blister'. This gives us the basis to insist that some whales when feeding on the bottom, place their body at an angle of 30-45° in respect to the bottom, and can by this action lean against, and apparently they really sometimes support their jaw or in any case they touch it to the sea floor."

Klumov does not consider any other possible causes for these abrasions. Possibly they could have been caused in the act of hauling the whale carcasses onto the flensing deck at the shore station. Alternately they could have been caused during bouts of intraspecific aggression.

Morphology

Other than the right whales specimens described by Klumov, the only other specimens of North Pacific right whales that have been measured by scientists are 13 animals taken by Japanese whalers 1957-1969 (Omura 1958, Omura *et al*. 1969, Omura, Nishiwaki, and Kasuya 1971). All of 10 whales described by Klumov were captured in the Kuril Islands north of Japan. In contrast, of the 13 whales taken by the Japanese, 2 were taken off the coast of Japan, 2 more either off Japan or in the Sea of Okhotsk. Of the remaining whales described in their reports, 3 were taken in the Gulf of Alaska and 6 were taken in the Bering Sea.

Much less detailed descriptions of an additional right 20 whales taken at Alaskan shore whaling stations between 1917-39 appear in Reeves, Leatherwood, Karl, and Yohe (1985) and Brueggeman, Newby, and Grotefendt, (1986). Other published records of right whales in the North Pacific usually describe little more than visual estimates of overall body length (*see* Braham 1986, Scarff 1986, Brownell *et al*. 2001).

Conservation Status of Right Whales

Whaling for Right Whales in the North Pacific before 1950

Right whales were the principle targets for large numbers of American pelagic whalers in the North Pacific between 1839-1909 (Webb 1988). Best's (1987) study of American whalers during this period resulted in estimates of the total American catch of 14,480 and 15,374 northern right whales. Scarff (2001) adjusted this catch data to account for struck-but-lost mortality and non-American whaling. He estimates the total mortality in this fishery in the range of 26,500-37,000 animals during this period. Scarff estimated in the single decade of the 1840s, that between 21,000-30,000 northern right whales may have been killed in the North Pacific, Sea of Okhotsk and Bering Sea, amounting to 81% of the northern right whales killed in this region during the period 1839-1909.

As described in detail in Brownell *et al*. (2001), whaling nations continued to take right whales in the North Pacific between 1900 and 1950. This occurred despite various treaties seeking to protect right whales. The whaling occurred prior to the ratification of the treaties, by nations that were not signatories to the treaties, and during World War II when the treaties were not in force (Scarff 1977). However, commercial whaling on right whales was supposed to end with the signing of the International Convention on the Regulation of Whaling in 1946 which protected right whales and the subsequent creation of the International Whaling Commission with the inclusion of the Soviet Union, Japan, and the United States, the major whaling nations in North Pacific.

One exception to the prohibition on taking right whales was, and remains, the authority of member nations of the International Whaling Commission to issue themselves "scientific permits" for the taking of protected species. This is what Japan did in issuing its whalers scientific permits to take a total of 13 right whales in 1956 (2), 1961 (3), 1962 (3), 1963 (3), and 1968 (2) (Omura 1958, Omura *et al.* 1969). This is also what the Soviet Union did in 1955 resulting in the catch of 10 right whales described in Klumov's article.

There was and is no requirement in the Schedule of the International Whaling Commission that prohibits the commercial use of whales taken under scientific permit. The whales described in Klumov's report were all rendered and the oil, meat and other by-products placed in the flow of other whale products from the fleet.

Klumov's Comments about the Recovery of Right Whale Stocks

Klumov's report states that the observations made between 1951-1957 during the course of this study show "without question" that the population is increasing. He is optimistic about the future of right whales in the North Pacific. He opines that protection came soon enough to save the western North Pacific population, but that such protection must to be continued "to not allow the killing of a single whale" to ensure the faster recovery of the population. He "assumes" that the population of right whales in the eastern North Pacific is also increasing. He calls for cooperation in further research between the scientists in the Soviet Union, Japan and the United States. He concludes that the time when commercial exploitation of right whales can resume may not be very far off. As will be seen below, Klumov's statement that "all is in our hands!" regarding the future of this species is sadly ironic.

Illegal Soviet Whaling in the 1950s and 1960s

Until very recently, the reports of the International Whaling Commission and other scientific reports reflected only the catches of whales reported to the Bureau of International Whaling Statistics. During the 1970s and earlier there were unconfirmed reports of illegal and pirate whaling in this region.

Yablokov (1994) mentions some whaling from Paramushir Island in the Kurils prior to the late 1950s (in addition to the whales described in Klumov's report. Brownell *et al.* (2001) note that several whaling stations began operating in the Kurils in 1948. They note that there may have been an extensive unreported catch of right whales in this region in the 1950s. They also speculate that the right whale "sightings" reported in Klumov (1962) and other Russian sighting reports may reflect catches of right whales rather than simply sightings.

After the dissolution of the Soviet Union, Russian officials revealed that during the 1950s and 1960s, Soviet whalers had caught thousands of protected whales illegally and failed to report them. Details about illegal Soviet killing of right whales in the North Pacific, mentioned by Yablokov (1994), was not published until 2000. Doroshenko (2000) wrote that during the early 1960's that at every opportune instance, prohibited right whales were taken by Soviet whalers. The extent of this intensive whaling can be seen in the following table from that report.

Table 1. Number of right whales taken illegally by Soviet whaling fleets in the North Pacific and adjacent waters 1963-1971 from Doroshenko (2000).

Year	Gulf of Alaska	SE Bering Sea	E. Sakhalin Island	Northern Kurile Islands	Total
1963	141	-	-	-	141
1964	87	113	-	-	200
1965	20	-	-	-	20
1966	3	-	-	-	3
1967	-	8	126	-	134
1968	-	-	-	-	-
1971	-	-	-	10	10
Total	251	121	126	10	508

The impact of Soviet illegal whaling for right whales in the North Pacific is discussed in some detail in Brownell *et al.* (2001). Klumov's confidence in the quick recovery of right whales in the North Pacific, did not take into consideration the scale and intensity of illegal hunting of right whales that was soon to occur in this region.

Acknowledgements

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INTRODUCTION

Since ancient times and especially during the 17th to 19th centuries, the right whales [literally translated as "Japanese smooth whales"] of the Pacific Ocean, the slowest and most accessible [whales] to whalers from either shore or whaling ships, underwent a ruthless destruction. As a result of this predatory industry, these whales were nearly exterminated by the beginning of the 20th century. Right whales were seldom found by the end of the 19th century on the "whaling grounds" that formerly were very rich according to the writings of whalers. One could assume that right whales were commercially extinct. Scientists and whalers reached this sad conclusion because, in addition to the species' rarity, it became a known fact that whales have a very slow rate of reproduction: each pair of right whales is able to produce only one calf each two years.[2]

In 1936 the first international treaty was signed by the participants in the whaling industry--the [International] Convention on the Regulation of Whaling. One provision of this Convention was a complete prohibition on the killing of right whales in the entire Pacific Ocean.

After World War II, in 1946, the Convention for the International [Regulation of] Whaling was renewed, this time with the Union of Soviet Socialist Republics taking part. The convention was signed by 17 countries involved in whaling. The paragraph prohibiting the killing of right whales remained unchanged.

Analyzing observations made during the last few years and looking ahead a bit, it can be said that the efforts of many countries were successful. The prohibition on killing right whales has led to an increase in their numbers in the North Pacific. Now, it can be said without reservation that the population levels can again be stabilized, even of such animals as whales, that are characterized by a very slow rate of reproduction and that were brought to an extreme level of depletion by the overly intensive whaling industry (at one time only individual whales could be found).

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1 This work represents one of the several parts of my complete work which was dedicated to the results of the expedition that studied far-east whales (Cetacea) undertaken during the years 1951 to 1956.

2 More careful research which was done in recent years by soviet and foreign scientists about the reproductive cycle of rorquals disclosed that most females probably have calves nearly every year. However, similar research has not been done in the case of right whales. It is quite possible that collection of corresponding materials could bring us to the same results even in the case of right whales.

This fact is extremely important not only in connection with this case, but in principle. This fact proves that if it is not entirely too late, if appropriate protection is introduced, and if when the essential agreements were created at least some possibilities for reproduction are left, even if not very great, there will always be a chance of population increase. That is the principal biological law--the law of species preservation.

With correct regulation of the catch of any commercial species, even one with a very slow rate of reproduction, guided by biological laws taking into consideration the changing conditions of the environment, it is possible to reach such a high degree of improvement in management that the populations of these animals will never be on the brink of extinction. However, at present we do not have all the necessary data for all these commercial species, and there is a great effort needed for this purpose. But for some animals science is already able to give industry the necessary information and recommendations. All that is necessary is that the planning organizations and the workers in the industry give serious attention and react with responsibility to the recommendations of scientists, making proper use of the scientists' results for planning and organization of catches of commercial species.

Currently we have enough observed examples of species which had been considered extinct, but thanks to application of strict protection and sometimes even biotechnical measures, have been restored not only up to previous population levels, but increased to higher levels than previously characteristic. For example, at present numbers of sable (*Mustela zibellina*) have been completely reinstated in most regions of Siberia. In some areas as a result of a prohibition of hunting and artificial insemination, they have become so abundant that the surpluses of this little animal cannot be used fully (for example, the region of Podkamennaja Tunguska) (see Syroechkovdkij and Rossolimo, 1960).

The saiga antelope (*Saiga tatarica*), which had been considered extinct, has increased now to such an extent that permits were recently issued for a regulated hunt of more than 100,000 animals (Bannikov A., Zhirnov L., Lebedeva L., Fandeev A., 1961).

The European elk (*Alces alces*), which was greatly depleted throughout its range in the 19th century and was on the verge of extinction, began to multiply so fast after the ban on hunting that now it has reached such population levels that its limited hunting became biologically desirable and in some cases indispensable (Kochetkov, 1960).

These examples confirm that when mankind establishes a reasonable and cautious relationship to nature, it can take advantage of nature's resources indefinitely .

* * *

In the Russian and foreign literature, data about the distribution and biology of right whales, including the North Pacific right whale ["Japanese smooth whale"] *Eubalaena glacialis sieboldii* (Gray), in the western North Pacific are very scanty and incomplete. Even in the report of A.G. Tomilin (1957), there is very little new information on this species and the material studied by the author is limited to three baleen plates.

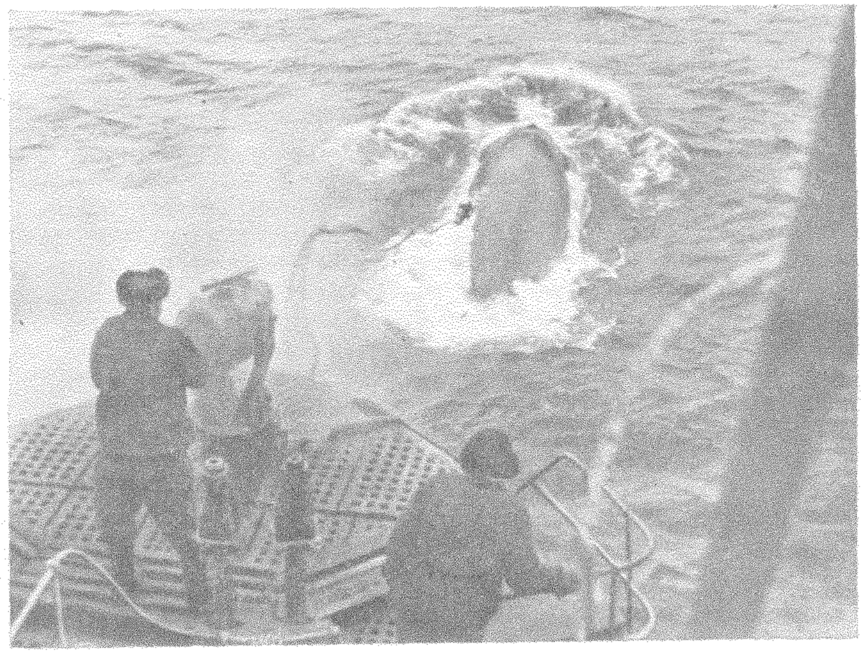

Figure 1. The moment of harpooning a right whale (Sea of Okhotsk, August 1955). Photo by Kozlova.

V. Ch. Doubin (1957) states about right whales: “Because the principal data about the life history of whales had been obtained only during this century we are in a rather strange position because we know the least about the life of those species of cetaceans that were hunted most.”

We organized in 1955 a regular expedition of the Institute of Oceanology of the Academy of Sciences of the U.S.S.R. [TINRO] to study Far East whales, and obtained a special permit from the Minister of Fishing of the U.S.S.R. (No.0113/2010, issued 3 March 1955) to kill ten right whales for scientific research, issued in accordance with article 16 of the International Convention for the Regulation of Whaling. These whales were killed according to our instructions by the whaling ships of the 2nd Far East fleet in waters near the Kuril Islands (see Figure 1), and they were flensed at coastal whaling stations (see Table 1 and Figure 2).

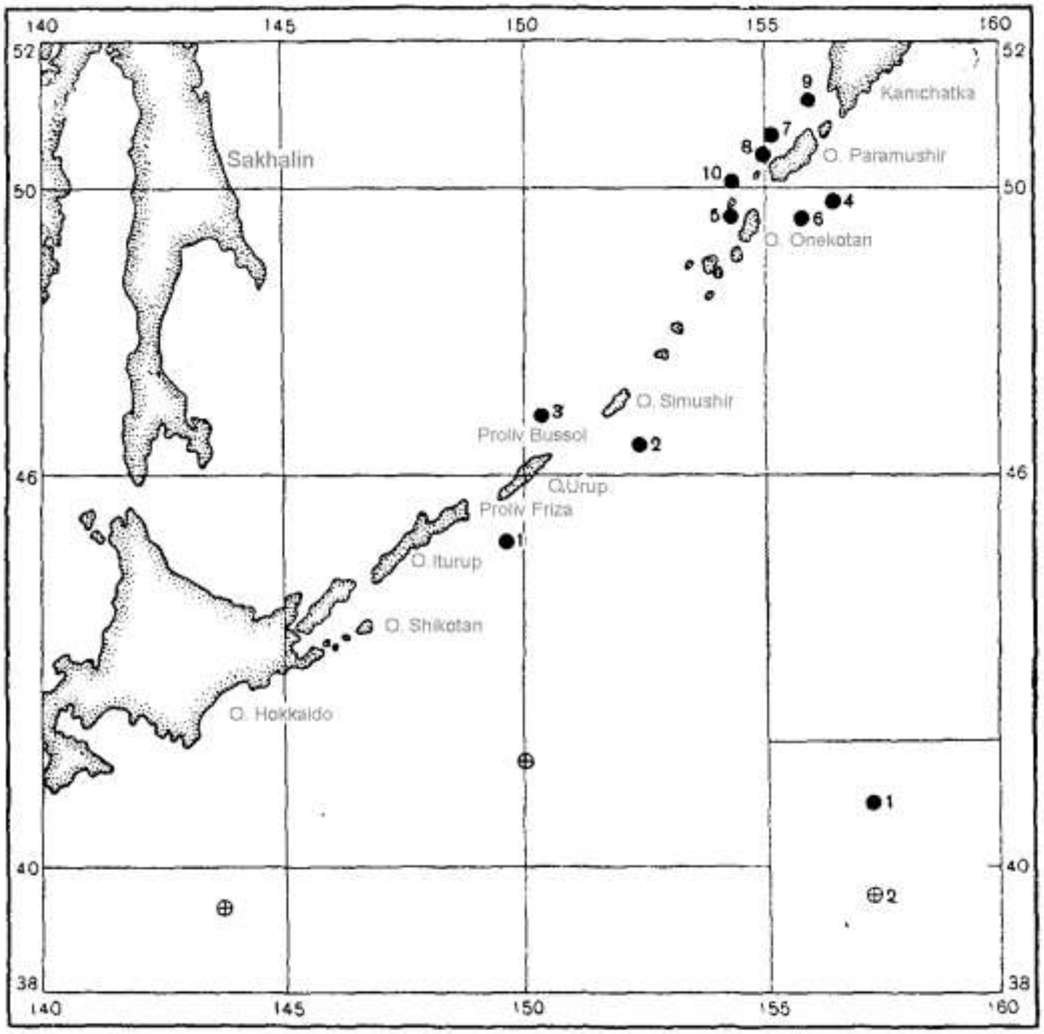

Figure 2. Locations where 10 *Eubalaena glacialis sieboldii* were killed in 1955 for scientific research purposes by the Soviet whaling fleet (1), and in 1956 by the Japanese (2). The number attached to the point corresponds to the number in Table 1.

The killed whales were analyzed biologically by members of the expedition: I.A. Zelerova, E.I. Ivanova, A.S. Skrjabin, E.S. Chuzhakina, and the author. Several whales were weighed in sections. [Table 16] In addition to collecting biological materials during the expeditions in 1951, 1955 and 1956, at our request, crews of the whaling ships recorded observations of right whales near the Kuril Islands. These crews reported their observations daily by radio. We made similar observations from the ship that was assigned to the expedition work in that area. During 1953 and 1954 only a few observations from several whaling ships were made, and for this reason there are only incomplete data for those years. In 1957, we used the observations of crews of the whaling ships that were recorded and submitted to me by I.A. Zelenova. To make the maps of right whale distribution near the Kuril Islands during the period April-November, I had at my disposal observations of whaling ship crews and of my colleagues from the expeditions that were undertaken in the last six years (1951-1957). These are summarized in Table 2 and in Figures 3-10. In addition to those materials, I used the maps compiled by Townsend (1935) from the logbooks of American whaling ships which show the locations of right whales killed in the North Pacific from 1785-1913. Probably not all whalers of the last century understood the whale because the level of science then was not high, and more than once there were cases where North Pacific right whales (*E. glacialis sieboldii*) were entered in the ship logbooks as bowhead whales (*Balaena mysticetus*) and *vice versa*.

Table 1. Data about the *Eubalaena glacialis sieboldii* that were killed for scientific research purposes in 1955 near the Kuril Islands.

No.	Sex	Length (m)	Fat (cm)	Date killed	Location	Whaling ship
1	Female	18.3	23.0	17 May	45 °08' N, 149° 46' W	*Uragan*
2	Male	17.0	24.0	1 June	46° 23' N, 152° 34' W	*Siava-I*
3	Female	16.3	25.0	19 June	47° 01' N, 150° 25'W	*Vjuga*
4	Male	17.06	23.5	13 July	49° 44' N, 157° 17' W	*Shkval*
5	Female	17.4	25.3	22 July	49° 34' N, 156° 35' W	*Buran*
6	Male	10.75	19.0	22 July	49° 42 N, 154° 31 W	*Buran*
7	Male	16.6	20.6	10 August	50° 47' N, 155° 21' W	*Purcha*
8	Male	16.6	20.6	10 August	50° 22' N, 155° 12' W	*Purcha*
9	Female	11.35	20.6	11 August	51° 05' N, 155° 51' W	*Shtorm*
10	Female	17.8	23.0	28 August	50° 00' N, 154° 25' W	*Purcha*

Of great assistance to our expedition were the crews of the whaling ships belonging to the 2nd Far East Whaling fleet. I would like especially to mention Captains of the whaling ships G.V. Vajner, S.I. Kisela, V.M. Jeremenko, N.A. Panov and others. Commander Director of the above-mentioned fleet N.N. Martynov watched our work with great attention, helped to accomplish our objectives, and systematically reported his personal observations of Pacific right whales. My hearty thanks go to all mentioned.

N.A. Nikonova and I. R. Shmelkova undertook detailed weighing of the Pacific right whale, and allowed me to make use of data obtained in this way for which I express my thanks.

The Senior Laboratory Worker of the Institute of Oceanology, V.M. Gudkov, proved to be of great assistance when collecting the necessary material during the difficult conditions of the expedition as well as during the laboratory work for which I express my great acknowledgment.

V.A. Arsenev undertook a very difficult task--namely to do the editing of my manuscript; during this job he made several useful comments. I find it a pleasant task to thank him specially for the work rendered and for his good advice.

I take the opportunity to give my thanks to Professor H. Omura who sent me his interesting investigations that were made for the purpose of studies of cetacea in the Pacific.

The following work represents an attempt to systematize data on the biology and distribution of Right whales in the North Pacific based on the original observations and research of the last years undertaken under the leadership of the author.

DISTRIBUTION OF PACIFIC RIGHT WHALES

Most cetaceans in the Northern Hemisphere, including North Pacific right whales, move south in winter into warmer waters. In spring, all cetaceans return north, some reaching the temperate waters while others go up to subarctic and even arctic waters. The patterns of migration of whales have not as yet been studied sufficiently, but their conservatism has been fairly well established: year after year migrating from south to north and *vice versa*. They apparently make use of the same migration routes and reuse the same summer feeding grounds and wintering grounds (Klumov, 1957).

I suggest that in the western North Pacific, right whales form two local stocks that have separate winter and feeding grounds. I express this hypothesis based on material we obtained from our observations of these whales, the scientific literature (Harmer, 1928, Omura, 1958, and others), as well as [Townsend's] detailed examination and study of whales during 128 years--from 1785 to 1935. I subdivided that map (Townsend, 1935) into several maps by month (data shown in the Townsend map are aggregated annually) for greater clarity.

On the map which shows where Pacific right whales were killed on the winter grounds (*e.g.* January, February and March) from 1785-1913 (*see* Figure 11), there are only a small number of dots where these whales were obtained. However, even these scanty data, in association with further observations during the spring and fall, allow us to reach certain conclusions. Apparently one stock, which I call the "Okhotsk Stock" winters in the southern part of the Sea of Japan, in the East China Sea, touches the Strait of Taiwan, and possibly the northern part of the South China Sea, that is the region between 40°N and 20°N.

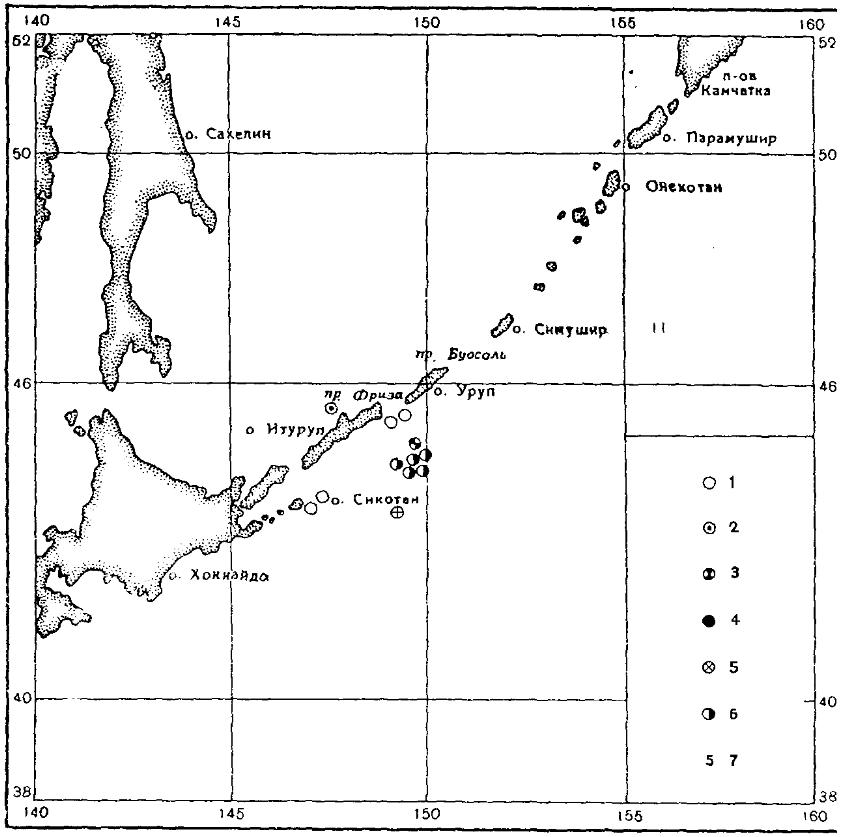

Figure 3. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **April** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). 1 - 1951; 2- 1953; 3 - 1954; 4 - 1955; 5 - 1956; 6 - 1957; 7 - the number describes the number of observed whales. [For a translation of place names, see Figure 2.]

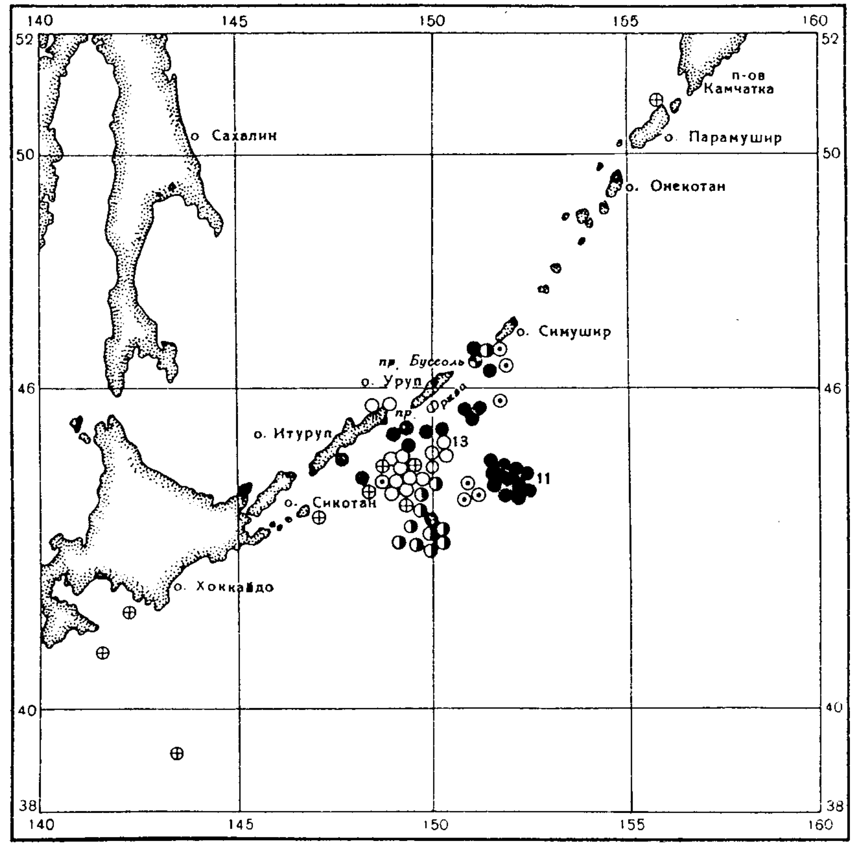

Figure 4. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **May** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a key to the symbols see Figure 3. For translation of place names, see Figure 2.]

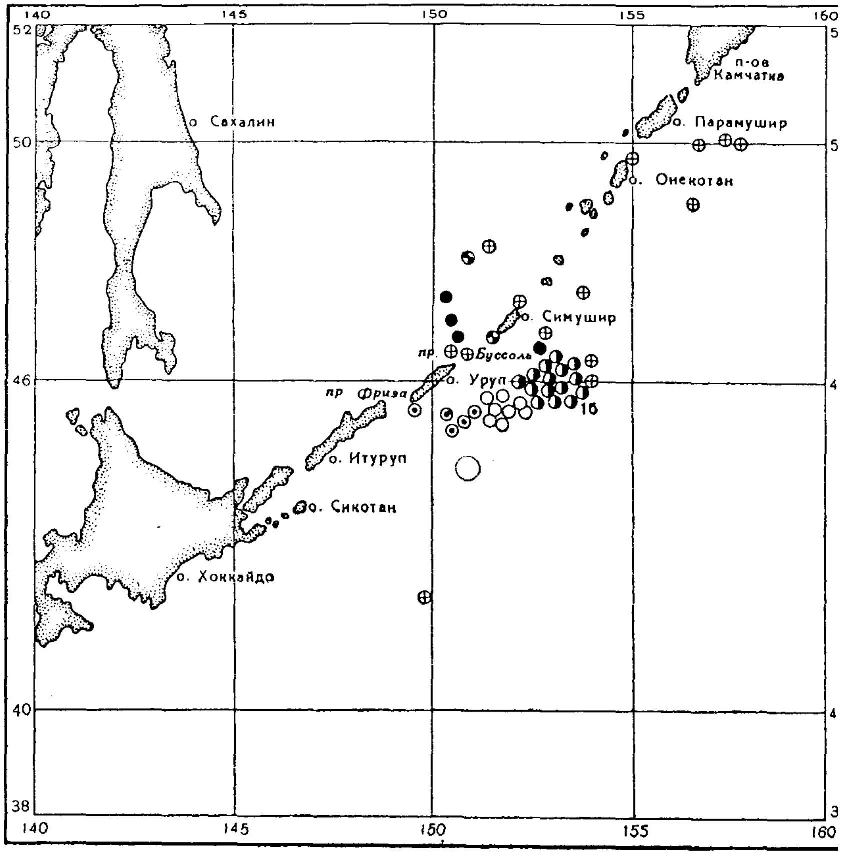

Figure 5. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **June** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a key to the symbols see Figure 3. For translation of place names, see Figure 2.]

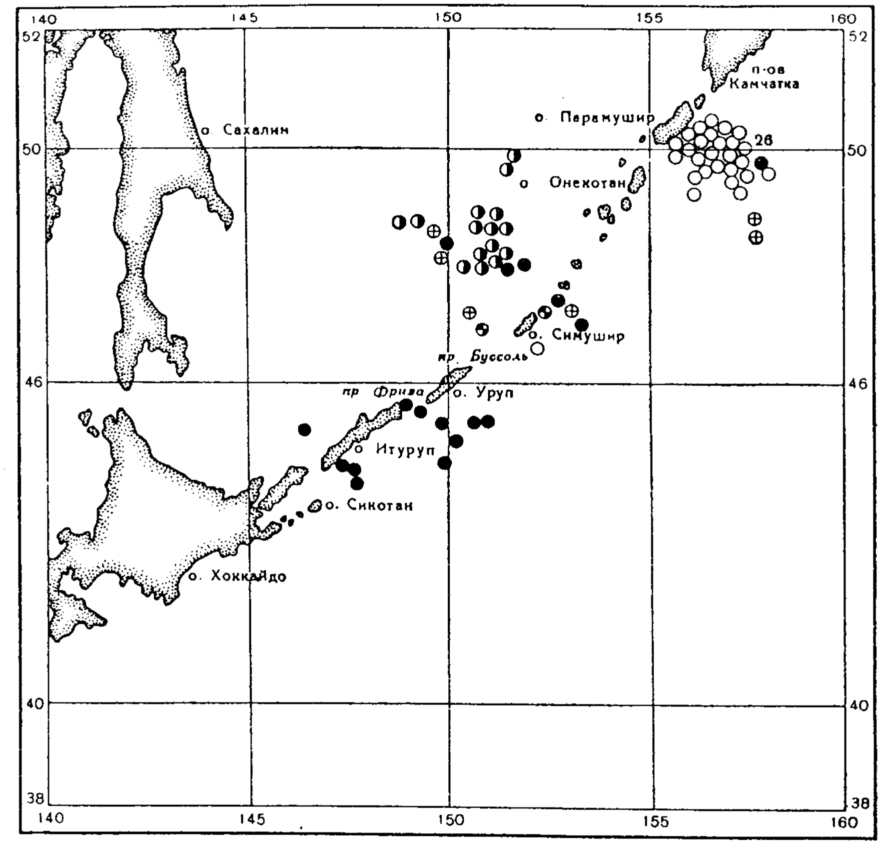

Figure 6. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **July** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a key to the symbols see Figure 3. For translation of place names, see Figure 2.]

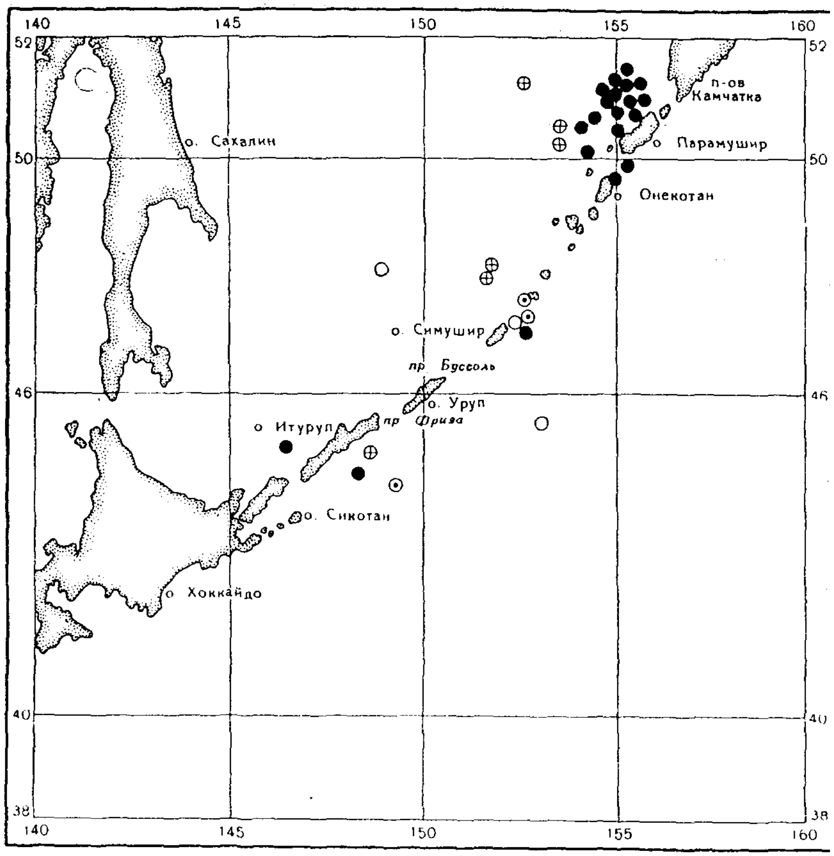

Figure 7. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **August** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a key to the symbols see Figure 3. For translation of place names, see Figure 2.]

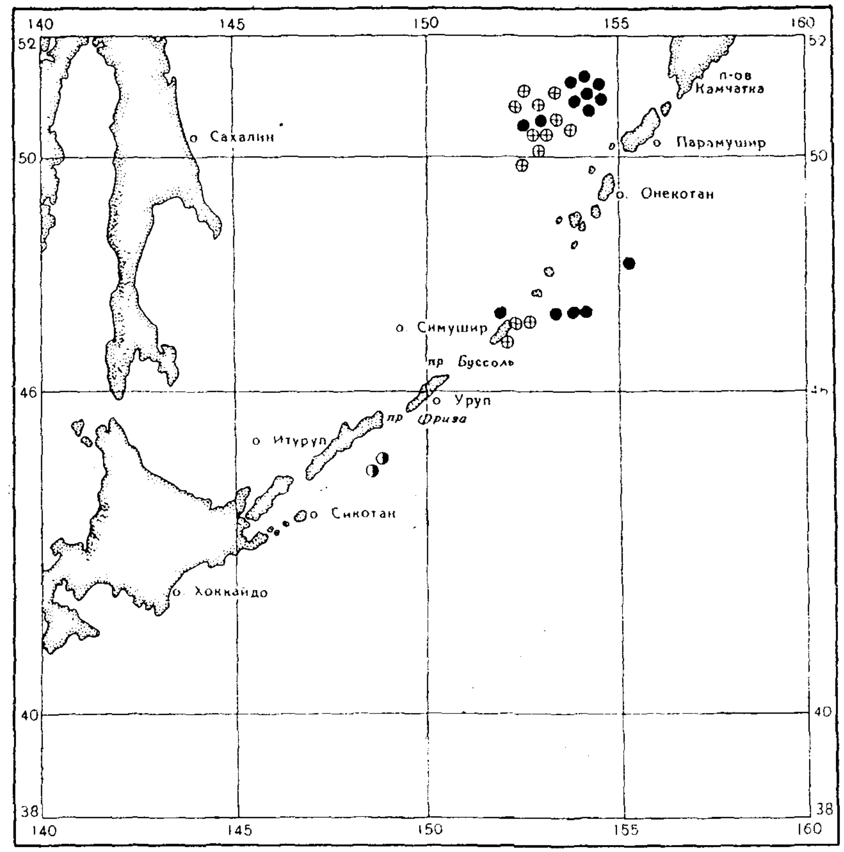

Figure 8. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in **September** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). 1 - 1951; 2- 1953; 3 - 1954; 4 - 1955; 5 - 1956; 6 - 1957; 7 - the number describes the number of observed whales. [For a key to the symbols see Figure 3. For translation of place names, see Figure 2.]

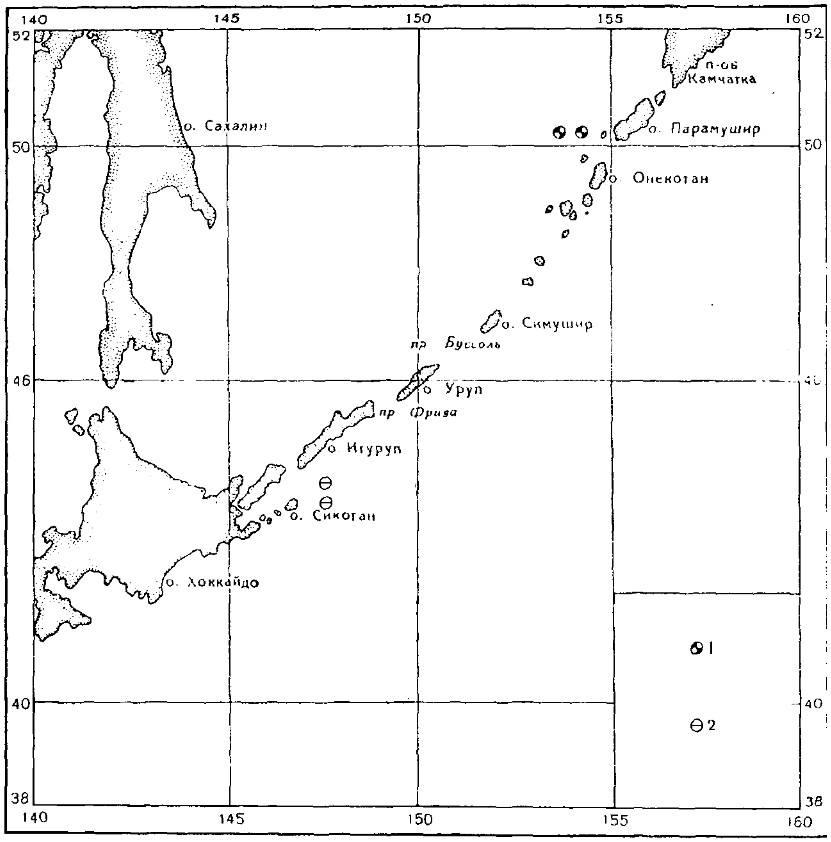

Figure 9. Distribution of Pacific right whales in waters adjacent to the Kuril Islands in (1) **October** and (2) **November** 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a key to the symbols see Figure 3. For a translation of place names, see Figure 2.]

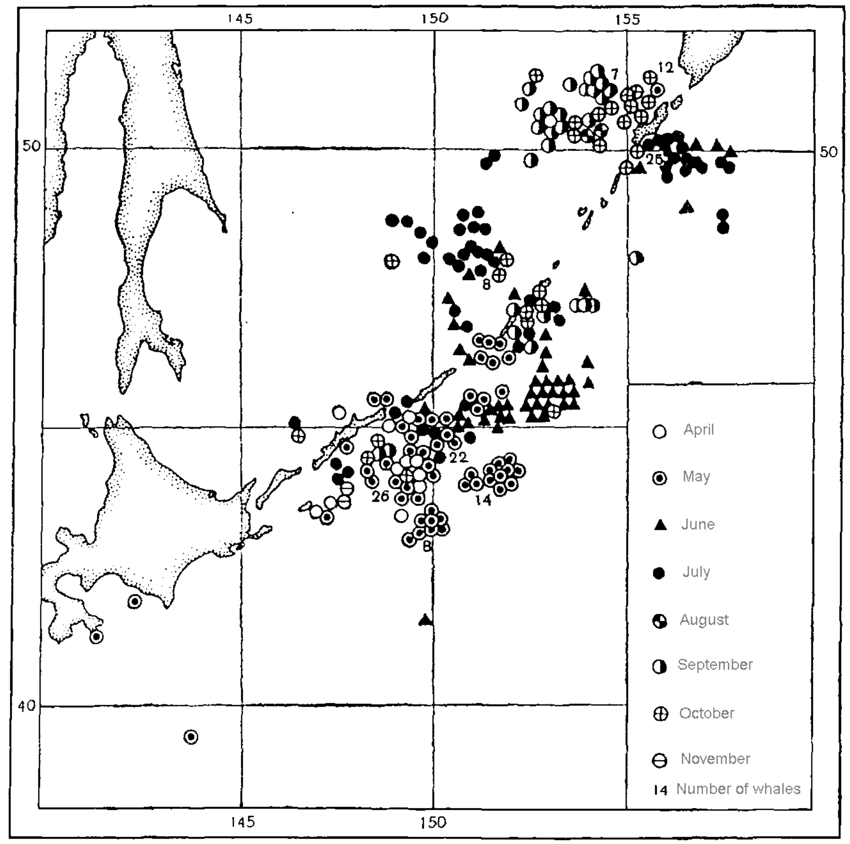

Figure 10. Map of the distribution of Pacific right whales in the waters adjacent to the Kuril Islands in April-November 1951-1957 (from the sightings by the expedition of the Institute of Oceanology of the Academy of Sciences of the USSR and the whaling fleet). [For a translation of place names, see Figure 2.]

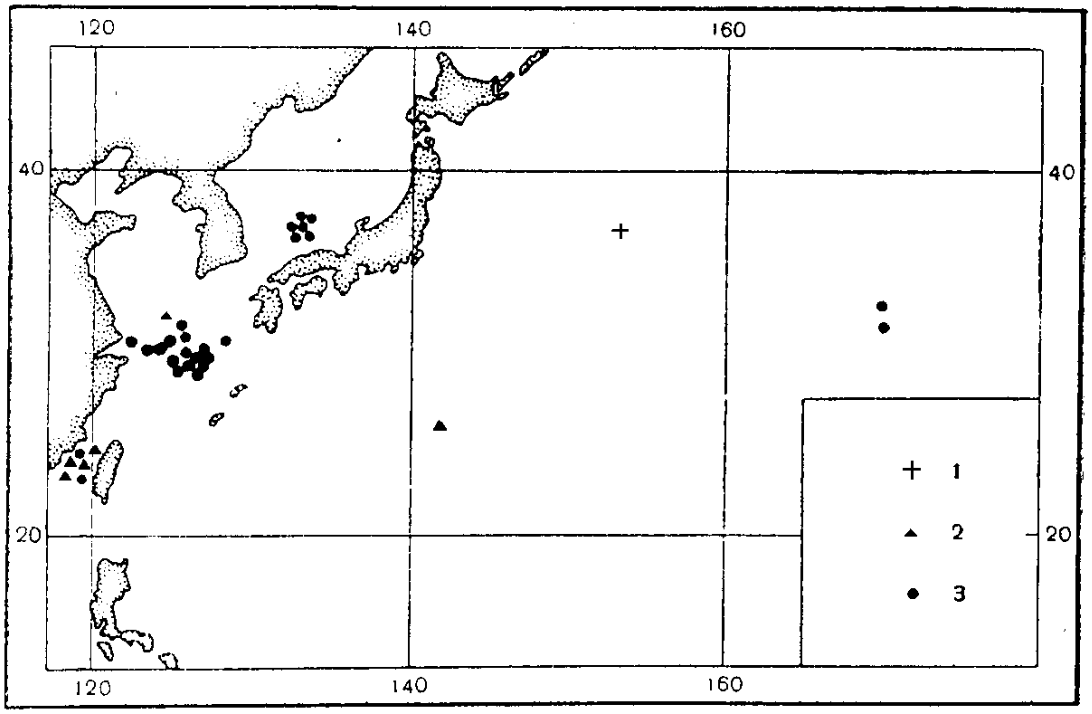

Figure 11. Location of catches of Pacific right whales on their winter ranges during January to March between 1785-1913 (Townsend, 1935). 1 - January; 2 - February; 3 - March.

The second stock, which I call the "Pacific", winters within the same latitudes, occupying in the Pacific Ocean a large area located across the southern Japanese islands.

The first stock has its summer feeding ground in the Sea of Okhotsk, mainly in its western half; the second stock has its summer grounds in the Pacific Ocean and to a significantly smaller degree in the eastern Sea of Okhotsk adjacent to the Kuril Islands. The first stock remains to a great extent near the coast, much more than the second stock which is most often found far from the coast (see Figure 12).

The Okhotsk stock of right whales was nearly exterminated at the end of the last century, and it has not yet recovered. The Pacific stock also underwent intensive exploitation, but the number of surviving individuals was greater than in the case of Okhotsk stock, and for this reason the recovery [of the Pacific stock] has been more successful, especially after the prohibition on killing right whales [adopted in] the International Convention on the Regulation of Whaling.

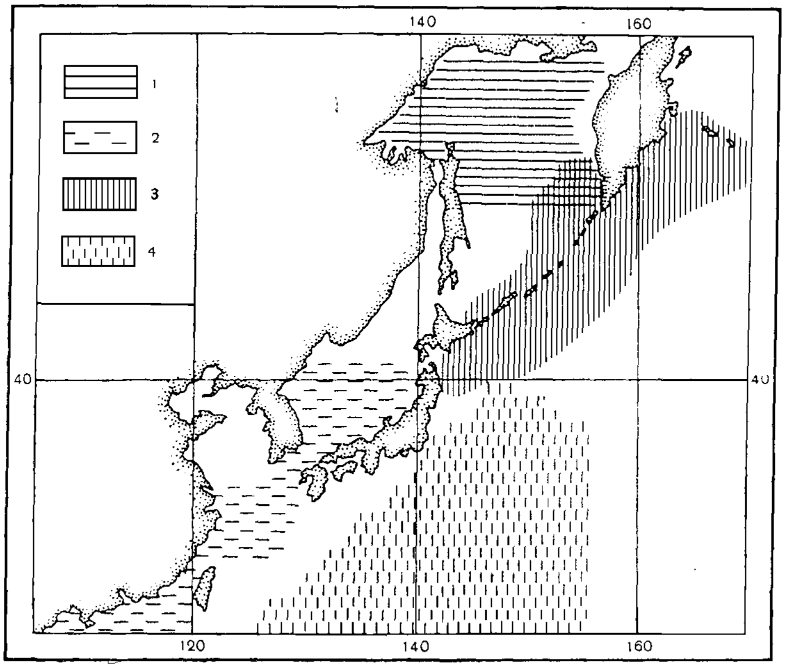

Figure 12. Summer feeding and winter ranges of the Okhotsk and Pacific stocks of Pacific right whales of the Asian population. 1 - sumer range of the Okhotsk stock; 2 - winter range of the Okhotsk stock; 3 - summer range of the Pacific stock; 4 - winter range of the Pacific stock.

It seems to me, because the Okhotsk stock stayed closer to the coast, in denser concentrations and in a smaller range than the Pacific stock, the former represented an easier target for whalers. For this reason, the Okhotsk stock became the first, easy victim of the predatory whaling industry, and nearly became extinct. On this issue V. Zbyshevski (1863), provides especially valuable information when describing the American whalers in the Sea of Okhotsk, writing: "...from the year 1847 there was not a single summer of respite for the whales of the Okhotsk Sea: Yankee [whalers] took a tax from our sea each year, and in some years the hostility between them and our whales reached such a degree that they killed them with a fleet numbering up to 200 ships...They exported from the Sea of Okhotsk during the last 14 years (*i.e.* up to 1861) fat [oil?] and whalebone [baleen] in the value of 130,000,000 dollars, *i.e.* 200,000,000 rubles in silver." Further on he states: "Near many rivers and streams that enter the sea at the Shantarsk Islands [Shantarskiye Ostrova] are mollusks [krill?] everywhere and whales thrive there, but as soon as the ice goes away--a difficult life starts for them: Yankees hurl themselves fiercely into the region; for instance in 1855 not less than 50 ships hunted near the island Feklistov. At this island are places where all that fleet anchored, killing approximately 50 whales a day." [ed.'s note – these were all bowheads]

F.D. Nordman (1874) reports that extermination of whales in the Sea of Okhotsk by "North American industrialists" was continued still in the 1860s, and that the Russian whaler [Otto W.] Lindholm came to Leningrad [St. Petersburg] in the year 1873 specially to ask "top navy staff for the protection of his whale industry from the uninvited foreign whalers who daringly exterminate whales in our water knowing that they are not followed by Russian navy cruisers..." (Nordman, 1875).

Such a predatory industry on right whales in the Okhotsk Sea went on at least until 1913 (Townsend 1935). Moreover, the Okhotsk stock of right whales not only underwent destruction during summer, that is during the whales' stay on the feeding grounds in the Sea of Okhotsk, but also on their winter grounds in warm waters.

Harmer (1928), Omura, Maeda and Miyasaki (1953), Maeda and Teraoka (1956), Omura (1958), as well as others, write that when the whaling industry was born in Japan right whales were caught, with nets [set] from rowed whaleboats in the coastal waters of the southern Japanese islands. The whaling industry operated usually from December to March with the maximum peak in January, *i.e.* during the [whales'] winter stay in those waters. Whaling occurred along the shorelines of Shikoku, Kyushu and other islands, as well as along the southern part of Honshu, mainly on the Sea of Japan side.

Observation points were located on the tops of coastal volcanoes and the whaleboats were prepared with nets for action on the shore. After the observer gave a signal that a whale was in sight, whalers rowed out in their whaleboats, surrounded the whale with nets, and killed it with hand harpoons.

This type of industry, which had started by the beginning of the 18th century, was continually developing, reaching its greatest expansion between 1818 and 1853 when whales were hunted on some 39 whaling grounds along the coast of the southern Japanese islands (Omura, Maeda and Miyaski, 1953).

The above-mentioned scientists report that during the period when Japanese were involved in coastal net whaling, American (sail) whaling ships were operating in the same waters. In this way, at one end of its range the Okhotsk stock of right whales was decimated on the summer feeding grounds in the Sea of Okhotsk (Zbyshevskij, 1863; Nordman, 1874, 1875; Townsend, 1935), while on the other end the stock was intensively hunted on the winter grounds in the southern part of the Sea of Japan, the East China Sea and in the northern part of the South China Sea (Townsend, 1935; Harmer, 1928; Omura *et al*., 1953; Omura, 1958). As a result of combined effort of American and Japanese whalers, the Okhotsk stock of Pacific right whales was decimated.

Omura (1958) writes that the coastal net whaling from whaleboats for right whales was interrupted around 1880 because the number of right whales was decreasing yearly in the southern Japanese islands, and by 1890 all these whales were totally destroyed.

In waters around the Kuril Islands, the Japanese continued this practice until the Kuril Islands were given back to the Soviets. Evidence of this whaling includes the large number of baleen plates we discovered near the sites of the Japanese whaling stations in the southern Kuril Islands. (See Fig. 13)

In recent years, we have records of only solitary right whales in the Sea of Okhotsk. I.G. Nikulin, and coworkers with the Kamchatka Department of the Pacific Ocean Institute of the Fishing Economy and Oceanography (TINRO), communicated to me that he saw one right whale in the Sea of Okhotsk in October 1932 in the vicinity of the Shantarsk Islands. [*ed. - more likely to be a bowhead*]

The head of industrial research at the same institute, Captain of Long Distance Navigation, N.A. Egorov, informed me that in June 1958, while sealing on the ice near the Shantarsk Islands, captains of the sealing schooners reported to him that they saw Pacific right whales several times in those waters. It is necessary to mention that the [seal] hunting crews and whaling crews did not distinguish Pacific right whales from bowheads, describing all right whales as “Greenland” [*i.e*. bowhead] whales in their reports and observations.

The scientific collaborator of TINRO, E.A. Tikhomirov, gave me his observations made during his voyages in the Sea of Okhotsk on [seal] hunting schooners sent there for research purposes. He observed Pacific right whales twice: the first time on 18 August 1958 when he was on the sealing schooner *Vojampolka* in the northeastern part of the Sea of Okhotsk (54° 06'N, 140° 32'E. The right whale was observed, as E.A. Tikhomirov writes, “among dirty, hummocked ice at a wind force of 5.”

All the above data prove that the Okhotsk stock of right whales [*ed. –this region is occupied bowheads, not right whales*] undoubtedly continues to exist, and that there is realistic hope that it can be restored on its previous grounds after all--that is in the Shantarsk Islands, in the Gulfs of Tugursk and Ulbansk, in the Udskaja Inlet, in the region of Ostrov Iona [St. Iona Island], in the vicinity of Tujska Inlet, and in other places as well that were famous for the abundance of right whales, and that represented “The Promised Land” or “a real El Dorado for the whalers”, according to the writings of Zybshevski (1863).

However, the population of right whales of the Okhotsk stock is apparently still very small, because we have no records yet that confirm their existence in the southern Sea of Japan, in the Yellow Sea, or the East China Sea, *etc.*, *i.e.* in all those wintering grounds where Pacific right whales used to occur in large numbers in the first months of the year (Townsend, 1935) (Figures 11 and 14). In addition, V.S. Kalinovskij, Chair of Techniques of industrial fishing *Dalrybvtuz*, studying commercial fishing opportunities in the southern Sea of Japan and in the Yellow Sea, spoke to me about the existence of only fin whales (*Balaenoptera physalus*) during winter in those regions. A similar conclusion is made in a report which I received from the Fishing Industry Institute of the East Seas, K[orean] N[ational] D[emocratic] R[epublic] (Director Kim Sun-duk).

The Pacific stock, whose winter and [summer] feeding grounds encompassed a larger area in the Pacific than the grounds of the Okhotsk stock, survived better until hunting right whales was prohibited, because the larger range and the high cost of hunting made complete extermination [of the Pacific stock] more difficult. Therefore, we now observe a relatively faster recovery of that stock which was saved fully by not being hunted both on its winter and summer grounds as well as during its spring and fall migrations. Thus, the following discussion concerns mainly the Pacific stock of right whales.

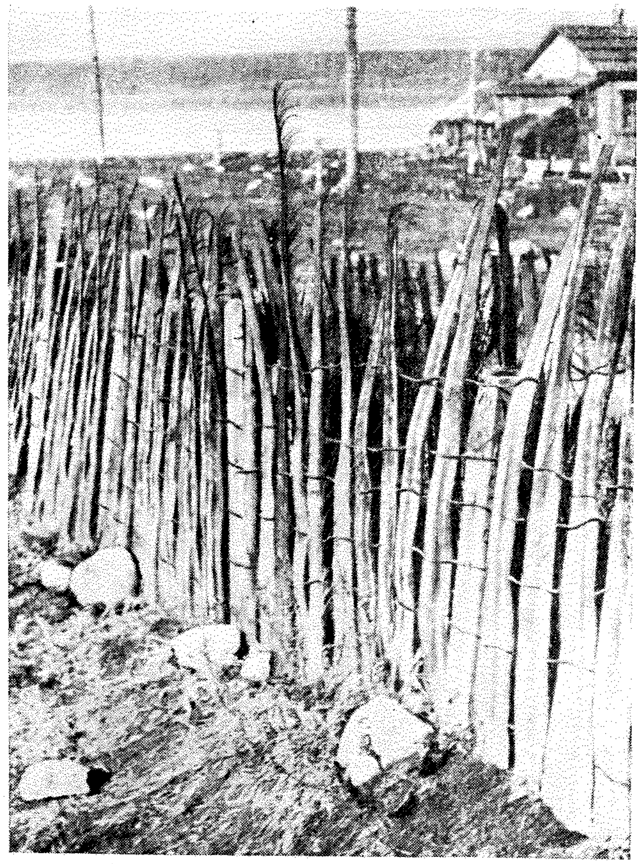

Figure 13. A fence constructed from baleen of Pacific right whales, which was left by Japanese on Iturup Island (Kasatka village). Photo by C.D. Bereleshina.

As our observations show, and the materials collected during 1951-1957 as well as Townsend's (1935) data prove, Pacific right whales begin their northward migrations from their winter grounds starting in mid- to late March or very early April, depending on the sea and weather conditions (See Figures 3,4,10,14 and 15). These northward migrations continue to develop during April, May and June (Fig. 5, see as well Fig. 24 and 25).

From Table 2 and Figure 3 it is apparent that the first whales observed during April in waters around the Kuril Islands do not go further north than the Friza channel [Proliv Friza between Iturup and Urup Islands in the Kuril Islands], *i.e.* up to 45°N. Although the sperm whale (*Physeter catadon* L.) and fin whale industries operate at that time of year adjacent to the Kuril Islands north to Paramushir Island (50°N), during recent years these whalers have never seen Pacific right whales in April north of 45°N. The same picture can be seen from the map of Omura (1958) (see Fig. 24), and the map prepared by Townsend [1935] (Fig. 14). Several points in Fig. 14 which maps the locations of Pacific right whales caught north of 45°N--in the mouth of Shelikhov Bay [Zaliv Shelikhova], in the Ozernaya region [western coast of Kamchatka], and around

Table 2. Observations of Pacific Right Whales near the Kuril Islands, 1951-57.

Month	**1951**	**1953**	**1954**	**1955**	**1956**	**1957**	**Total No. Whales seen**
April	**4** on Pacific side of South Kuril Island	**1** Sea of Okhotsk near center of Iturup Island	**1** on Pacific side of Iturup island	-	**1** on Pacific side south end of Iturup Island	**5** on Pacific side north end of Iturup Island	**12**
May	**15** total. Near north end Iturup Island, 2 in the Sea of Okhotsk, 13 on the Pacific side.	**7** total. 4 in the Fries Channel, 3 in the Bussol Channel	**1** in the Bussol Channel	**24** in Pacific Ocean between central Iturup Island to north part of Bussol Channel	**8** total. 7 between Hokkaido to the Friese Channel, 1 in Sea of Okhotsk at north end of Paramushir	**11** total. 10 on Pacific side of Iturup Island, 1 in the Bussol Channel	**66**
June	**8** total. 5 near Urup Island and Bussol Channel	**5** in the Pacific Ocean near the central part of Urup Island	**2** total. 1 in the Pacific Ocean at south end of Simushir Island, 1 in Sea of Okhotsk near the Diana Channel	**3** total in the Bussol Channel 2 in Sea of Okhotsk, 1 in Pacific	**12** total. 11 in the Pacific Ocean between Black Friars and Paramushir, 1 whale in Sea of Okhotsk near Rasshua Island	**15** on Pacific side of Urup Island	**45**
July	**26** total. On Pacific side of Paramushir Island.	-	**2** total. 1 in the Diana Channel, 1 in the Sea of Okhotsk in the Bussol Channel	**18** total from southern Iturup Island to Paramushir Island, 4 in Sea of Okhotsk, 14 in Pacific Ocean.		**16** in Sea of Okhotsk between Simushir and Shiashkotan Islands	**68**

Table 2 cont'd.

Month	**1951**	**1953**	**1954**	**1955**	**1956**	**1957**	**Total No. Whales seen**
July	**26** total. On Pacific side of Paramushir Island.	-	**2** total. 1 in the Diana Channel, 1 in the Sea of Okhotsk in the Bussol Channel	**18** total from southern Iturup Island to Paramushir Island, 4 in Sea of Okhotsk, 14 in Pacific Ocean.		**16** in Sea of Okhotsk between Simushir and Shiashkotan Islands	**68**
August	**2** between Diana and Bussol Channels	**3** total in the Pacific Ocean. 2 at the Richord Channel, 1 near Iturup Island	-	**25** total. 18 in Sea of Okhotsk near Paramushir, others scattered to south end of Iturup Island		**60** in the Sea of Okhotsk and Pacific near the north Kuril islands	**99**
September	-	-	-	**14** total. Sea of Okhotsk near Alaid Island (4) Simushira (1), in Pacific near Shiashkotan (1) and Rasshua (3)	**13** total. 10 in Sea of Okhotsk near Channel 4, 3 in Pacific near Simushira	**2** in Pacific Ocean near north end of Iturup Island	**29**
October	-	-	-	-	**2** in Sea of Okhotsk near 4th Kuril channel	-	**2**
November	**2** near south end of Iturup Island	-	-	-	-	-	**2**
Total	**57**	**16**	**6**	**85**	**50**	**109**	**323**

Onekotan Island [in the northeastern Kuril Islands], could be attributed to a year during which a warm early spring enabled right whales to penetrate into these regions in early April. These points could also refer to the plunder of right whales who stayed back in the Sea of Okhotsk. These cases are known to us. We do not think that these were Greenland [*i.e*. bowhead] whales in the Sea of Okhotsk. In any case, during the last 40-50 years, as well as previously, there is not a single reliable observation that could confirm the entrance of these whales [*i.e*. bowheads] into the Sea of Okhotsk. If bowheads occurred in the Sea of Okhotsk during the 17th-19th centuries, then probably it was the rarest exception. I think that the reports in the literature that describe hunting bowhead whales in the Sea of Okhotsk (Townsend, 1935), without exception, are in fact descriptions of Pacific right whales.[3] [*ed. – the whales Townsend refers to were bowheads, see editor's introductory note.*] This problem will be discussed in greater detail later. In this way, it may be considered as a typical feature of Pacific right whales that they can be found as far north as the Friza channel in April.

In May, one can observe further northern movement of right whales as the main part of the population reaches the Bussol Channel [Proliv Bussol between Urup and Simushir Islands in the Kuril Islands] (approximately 46° 30'N) while individuals reach as far as Paramushir Island (50° 30'N). At the same time, right whales can be observed still on their winter grounds, that is in the vicinity of 40°N (see Figures 10, 25). The same information is shown in Townsend's (1935) charts (See Figure 15). It is necessary to mention here that the 128 year period (1785-1913) studied by Townsend (1935) shows no killing of right whales in the Sea of Okhotsk in May because the main mass of the Okhotsk stock was still in the northern [*sic*.] part of its winter range, *i.e.* the Sea of Japan (see Figure 15).

This [absence of records from the Sea of Okhotsk] could be explained by the presence of ice in May in the southern part of the Sea of Okhotsk and the northern part of the Tatar channel [Tatarskiy Proliv between Sakhalin Island and the mainland]. However, observations prove that [the apparent absence of right whales in the Sea of Okhotsk] is an error in Townsend's data, because during some years the above-mentioned regions become ice-free very early, and for that reason right whales of the Okhotsk stock can freely penetrate into the Sea of Okhotsk even in May. That [*i.e.* the ability of whales to enter this region] is confirmed by Townsend's data which describe the killing of bowhead whales in the Sea of Okhotsk in May in the 19th century. In our opinion, the locations plotted on [Townsend's] chart as the kill of [bowhead] whales in the Sea of Okhotsk (see Figure 16) were of Pacific right whales, not bowheads, which is confirmed by the data of Zbyshevski (1863). At the same time, Townsend's (1935)

[3] There is not a single reliable observation of a bowhead whale in the Sea of Okhotsk during the last 40 years. *(*ed. – see introductory note).*

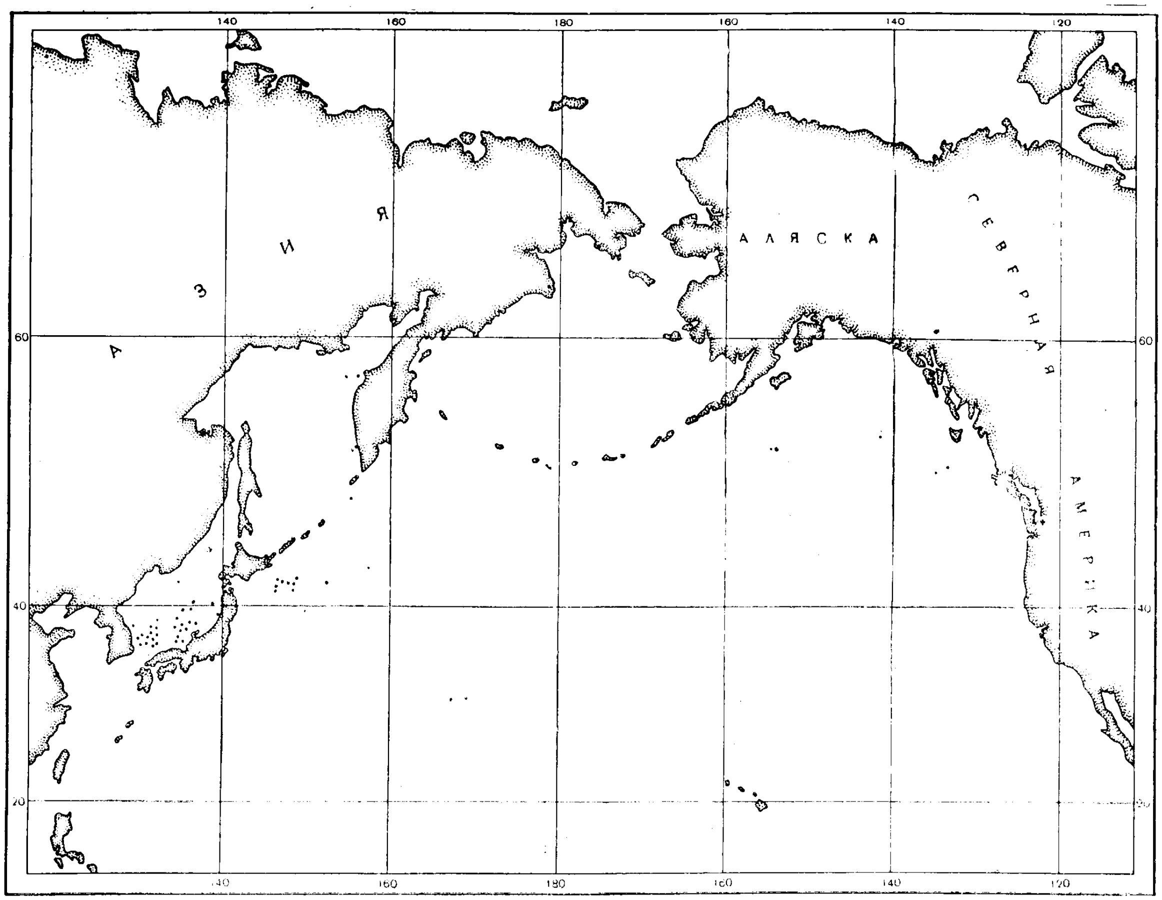

Figure 14. Location of the catches of Pacific right whales in **April** 1785-1913 (Townsend, 1935).

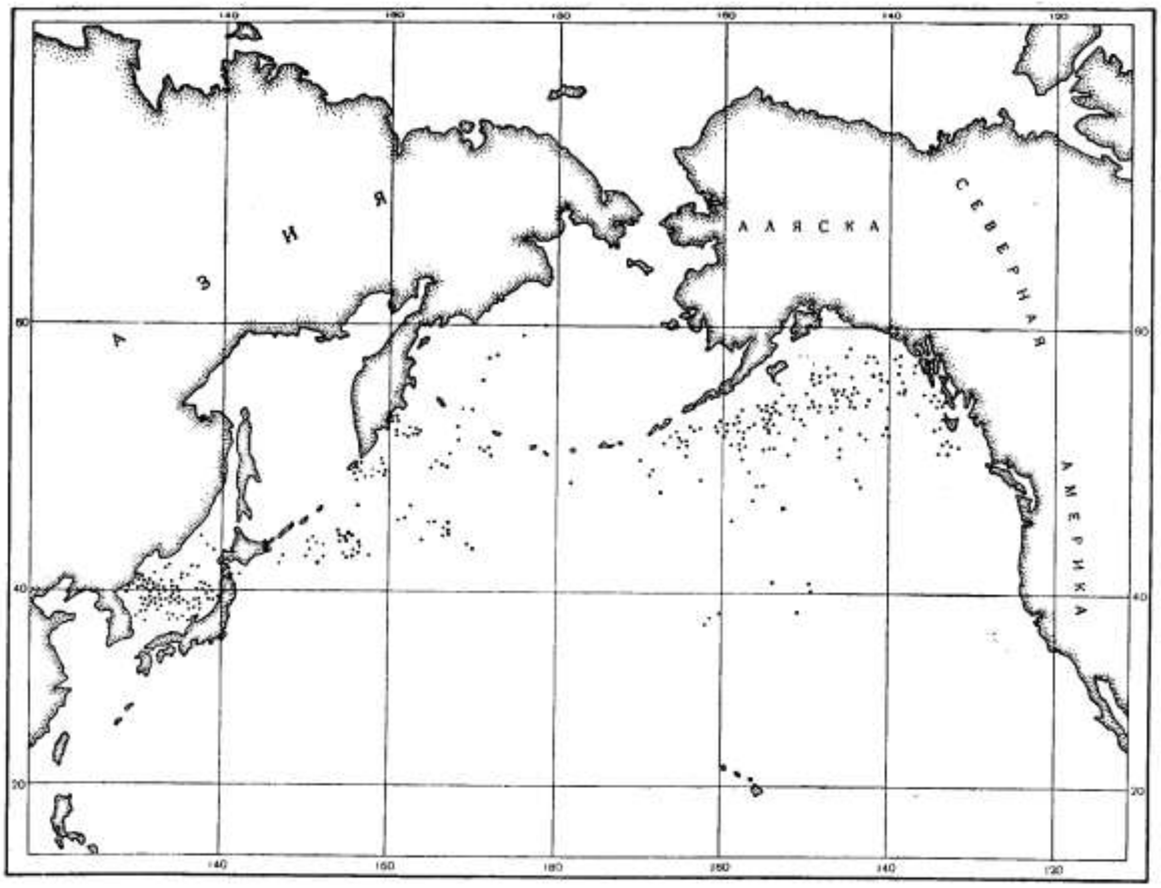

Figure 15. Location of the catches of Pacific right whales in **May** 1785-1913 (Townsend, 1935).

locations of killing of right whales at 58-60°N in the western Bering Sea (see Figure 15) are, in fact, records of bowhead whales. [This conclusion is confirmed] by looking at Figure 16. First, the sea and ice conditions in the Bering Sea in May and second, a simple calculation which shows that Pacific right whales can hardly travel in one month from their wintering grounds (20-40°N) (they never start moving north before the end or March or the beginning of April as our observations prove) to the central part of the Bering Sea (58-60°N). It is even possible that some of these plotted catches of bowhead whales as shown in Figure 16 that are located in the vicinity of the Commander Islands [Komandorskiye Ostrova] and the east coast of Kamchatka are in fact Pacific right whales, and not bowheads.

In June, the northern migration of the main part of the stock slows down, although some individuals still may proceed to the feeding grounds, [also] to participate in hunting [for food] (Klumov, 1955).

During June and July, there is a characteristic phase of greater dispersion of the stock on its feeding grounds. At present, we have no reliable data about the farthest points of penetration of right whales northward during these months, and I assume that the northern edge of the range yet has not been finally determined. The northern edge of the range of Pacific right whales as reported by van Beneden (1868), as well as the data given by Sljiunin (1895), or by Townsend (1935) and by others

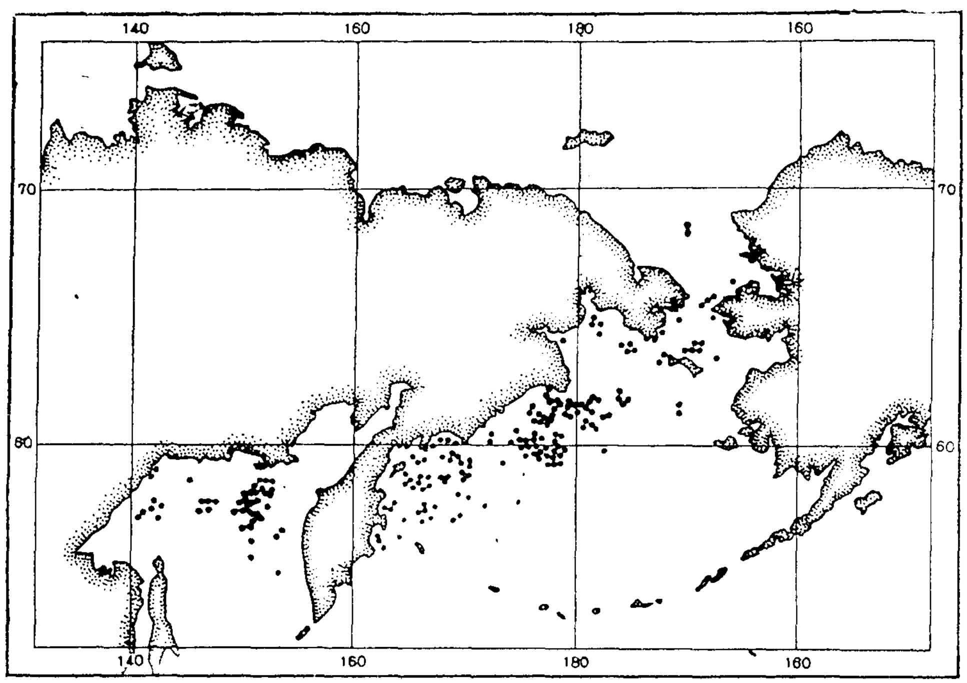

Figure 16. Location of catches of bowhead whales in **May** from 19th century whaling industry records (Townsend, 1935).

that were summarized by Tomilin (1957) cannot be accepted as absolutely precise because of the confusion in distinguishing right whales [from bowheads] in the past century and at the beginning of this century. The maps supplied by Townsend (1935) cannot serve in this respect as authoritative, because a simple comparison of his plots of bowhead whales and right whales shows clearly that whalers of that time undoubtedly mixed these two species. It is quite apparent that the locations of killings of whales in the Sea of Okhotsk in July-August (see Figures 17,18,19) do not involve bowheads because those months (as well as September--see Figure 29) are the period of the maximum warming up of waters, and the sea and ice conditions in the Sea of Okhotsk at that time are unsuitable for the bowhead whale. In support of this [conclusion] is the separation of the whaling grounds: the northern part of the Bering Sea, the Chukchi Sea, and the Beaufort Sea are unquestionably the whaling grounds for bowheads, while the Sea of Okhotsk [this is the hunting grounds for] right whales.[4] That is confirmed even by the maps of distribution of right whales that were put together by Townsend (see Figure 18, 20, 23), on which he turns our attention to the absence of locations of catches of these whales in the Bering Sea. The separation of those areas from the areas in Figures 17, 19, and 22 show especially clearly, so that in our opinion there are no doubts about the fact that all, in any case the majority, of locations of right whale catches in the Sea of Okhotsk are right whales (*E. glacialis sieboldii*) and not bowheads. [*ed. – see introductory note.*]

It is necessary to emphasize that in his time Scammon (1874) also paid attention to that fact, figuring that the right whales that have their habitat in the Sea of Okhotsk never leave its borders, and for this reason Scammon (1874:65) wrote: "no Bowheads of the Okhotsk Sea[5] have ever been seen passing in or out of the passages of the Kuril Islands, or from the Okhotsk to Bering Sea, or Arctic whales passing to the Okhotsk." This is an extremely important deduction which confirms our point-of-view about the ranges of the stocks of right whales, which Scammon made not only on the basis of his personal observations, but also primarily on the basis of reports of numerous contemporary whalers. Describing the industry of right whaling in the Sea of Okhotsk [*sic.*], Scammon (page 60) writes that these whales "...as far as known, are the same species as those of the Arctic, although in the bays is found, in addition, a very small whale, called the 'Poggy,' which yields but little oil." Further on, Scammon says that according to many whalers, the "Poggy" and the bowhead whale are different species. However, some of the whalers have their doubts because it is possible that "Poggy" are simply young bowhead whales. In a footnote, the author points out that he himself is convinced that there exist two variations of the bowhead whale that have their habitat on the same whale ground.[6]

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[4] It must be mentioned that in this part we always speak here about the right whales of the asiatic population, leaving aside right whales of the american population which will be discussed later.

[5] "The bowhead whales of the Okhotsk Sea" about which Scammon speaks here are of course right whales, while the "arctic whales" of Scammon are bowhead whales.

[6] I share the conclusion of Scammon. Our data (described later) confirm the existence of two types of right whales (right, not bowhead) whales. It is possible that these varieties may even be representatives of the Okhotsk and Pacific stocks. However, the final solution of this question must wait until we obtain sufficient factual material on the morphology of these whales.

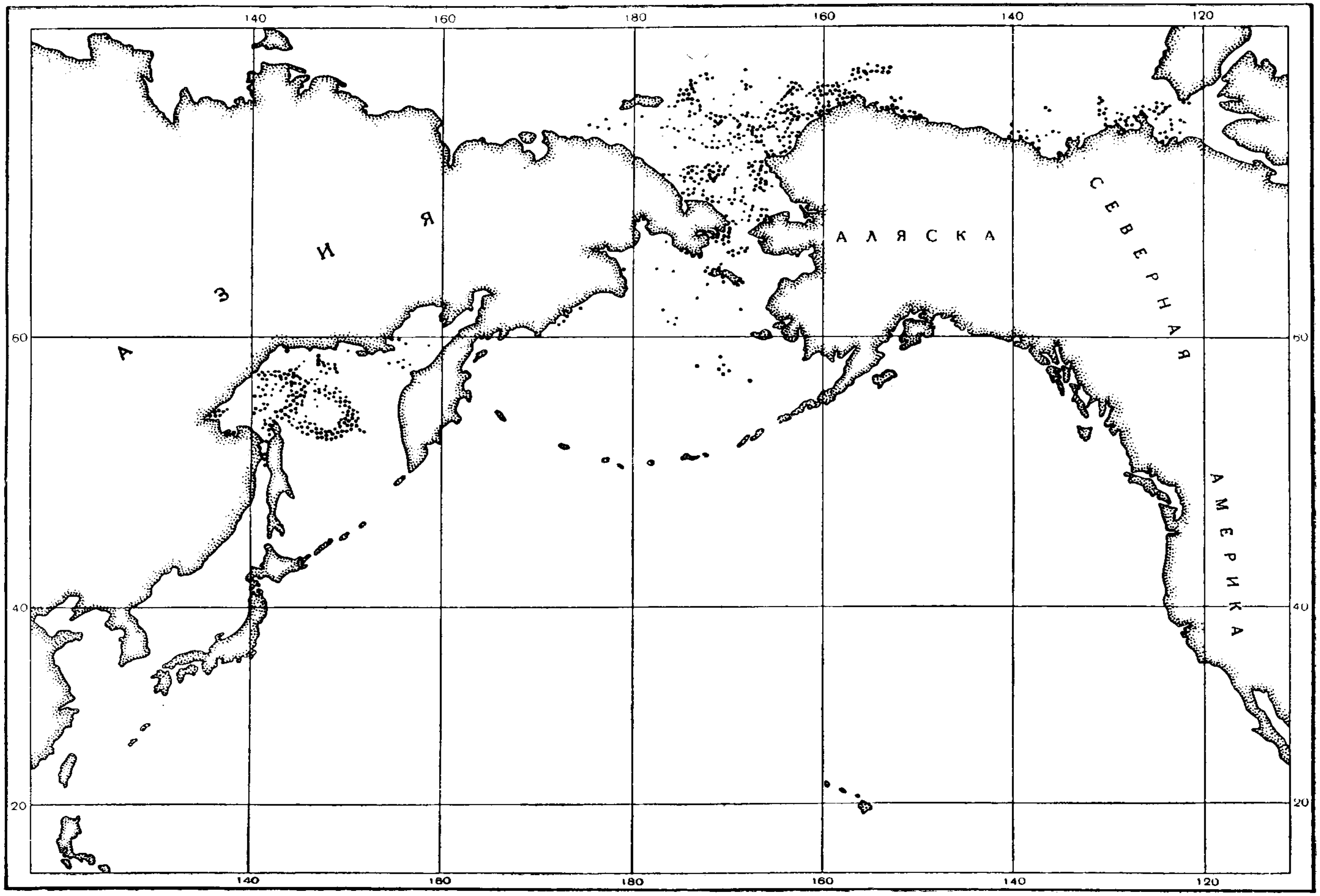

Figure 17. Location of catches of bowhead whales in **July** from 19th century whaling industry records (Townsend, 1935).

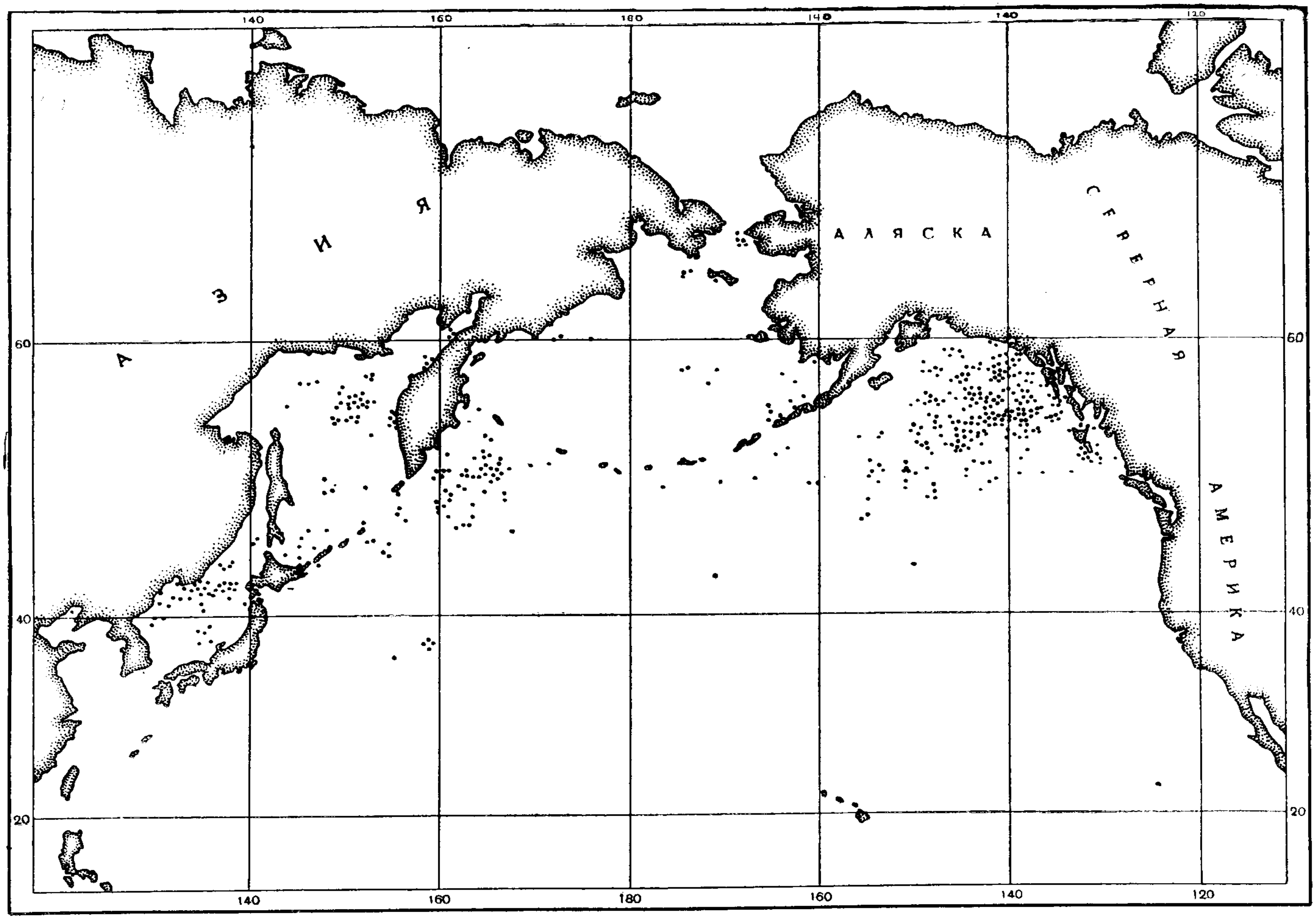

Figure 18. Location of the catches of Pacific right whales in **July** 1785-1913 (Townsend, 1935).

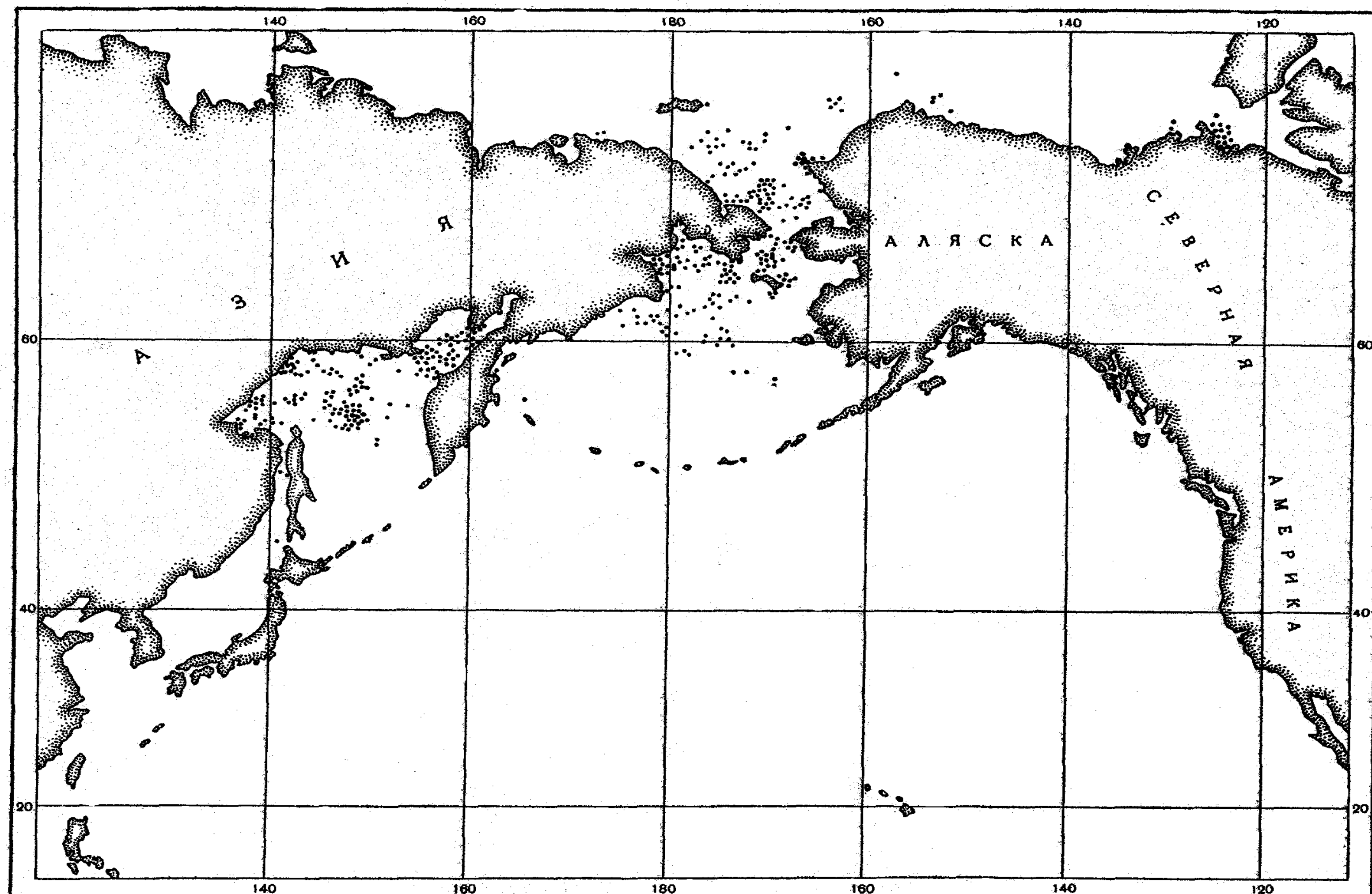

Figure 19. Location of catches of bowhead whales in **August** from 19th century whaling industry records (Townsend, 1935).

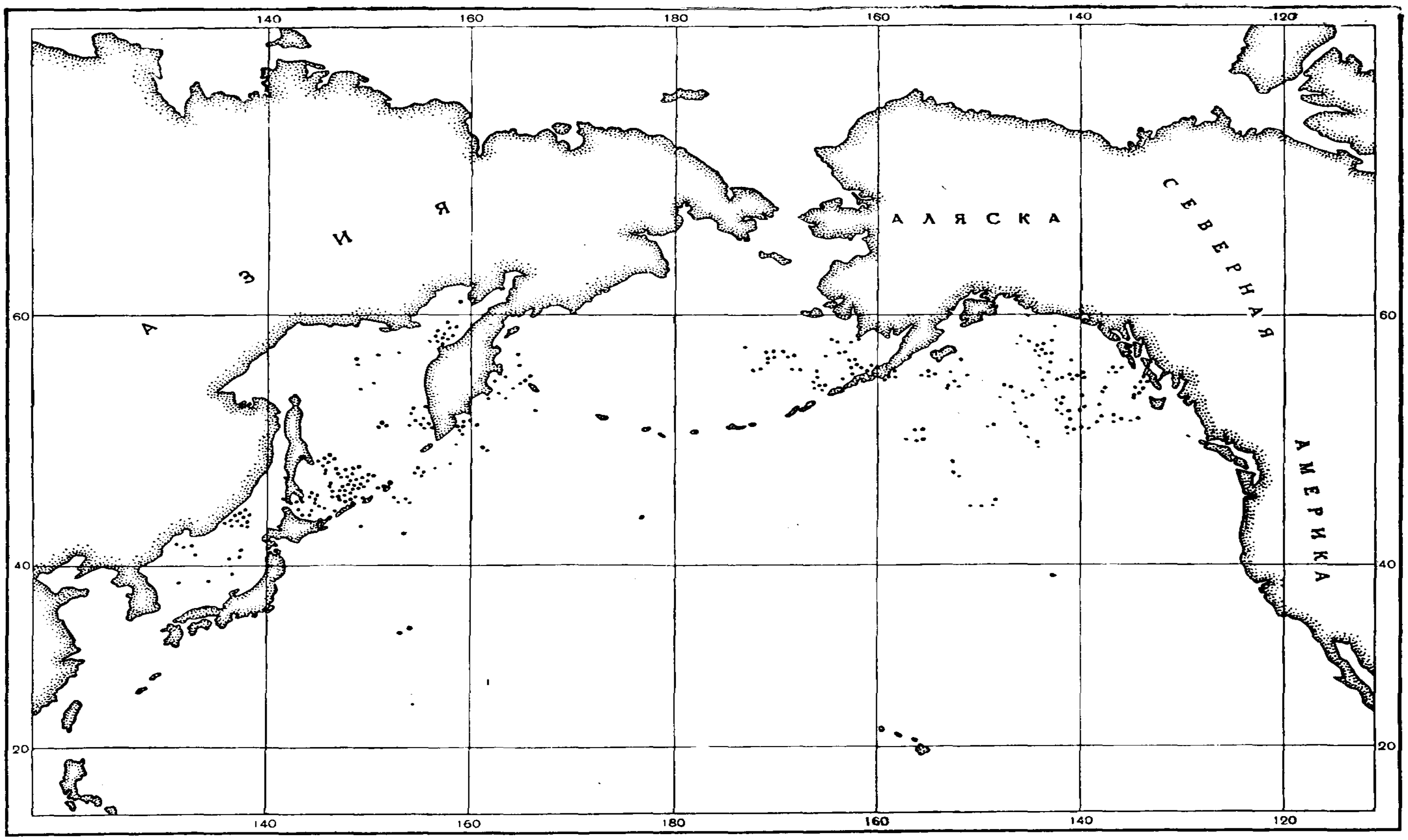

Figure 20. Location of the catches of Pacific right whales in **August** 1785-1913 (Townsend, 1935)

I brought in here all the contradictions in the work of Scammon with the intention to show that at those times commercial whalers were not able to distinguish southern [*i.e.* right whales] and arctic (bowhead) whales in all cases, which is confirmed not only by the statements of commercial whalers cited from Scammon, but also by the maps of Townsend, mentioned above.

The map of areas that right whales occupy off the Pacific coast of North America that was published recently by R. Gilmore (1956) is very interesting. That author assumes that bowhead whales spends summer months in the Beaufort Sea, along the arctic coast of Canada, whereas in winter they stay in the Bering Sea where they remain mainly north of 60°N--from Cape Olyutorski [Mys Olyutorskiy] to the mouth of Anadyr Bay [Anadyrskiy Zaliv]. Sometimes they may go a little southwest of Cape Olyutorski. [Longitudinally, their range] is bordered from 175°W to 165°W. Thus, even this scientist independently came to the opinion: bowhead whales even in winter do not range outside the borders of the Bering Sea and they can never manage to get to the Sea of Okhotsk in summer.

Of course it is possible to express another hypothesis: in the last century in the western North Pacific two stocks of bowheads whales populated that area--one stock in the Sea of Okhotsk and the other stock in the Bering Sea. The latter used to move in summer into the Chukchi Sea and into the Beaufort Sea. However, the facts at our disposal do not permit us to test this hypothesis. It [this hypothesis] requires that the bowheads of the Okhotsk stock would have logically to move for their winter stay somewhere further south or remain the whole winter among the ice in the Sea of Okhotsk. However, such observations are not available. On the other hand, Scammon (1874) quite clearly states that nobody saw the bowheads (referring to right whales) of the Sea of Okhotsk leaving it, or the “arctic whales” (i.e. the “true” bowheads) coming into the Sea of Okhotsk from the north. There is not a single case in the literature which would describe the killing of bowhead whales in the Pacific Ocean south from the Aleut ridge [Aleutian Islands?] (with the exception of the data doubted by me of Townsend's concerning the Sea of Okhotsk). There is also an absence of observations of bowheads in the Sea of Okhotsk in winter as well. It follows that such a hypothesis [that bowheads are found in the Sea of Okhotsk] is without foundation.

In August and September 1951-1957, we observed the most right whales in the waters adjacent to the northern Kuril Islands (see Figures 7,8). This does not contradict Townsend’s (1935) data (Figures 20, 23).

Observations during 1951-1957 established that towards the end of the first 10 day period in September, a clearly marked migration of sperm whales south begins. The same is true with right whales. Of course, the number of right whales is immeasurably smaller than of sperm whales and thus their [*i.e*. the right whales'] migration is less noticeable, but we did collect such data. The observers mentioned that at the beginning of September, and even at the end of August, right whales had very well marked basic direction to their movement, similar to sperm whales: most of the observed right whales were moving southwards or southwesterly. As is apparent from Figures 20 and 23, in the past years when the Okhotsk stock of right whales was still numerous, in August and September those whales were found in the La Perouse Channel and in the northern part of the Sea of Japan, confirming the beginning of the fall migration south to the wintering grounds.

For October-November we have only a few observations (see Figure 9): two whales were observed in October on the Sea of Okhotsk side of Paramushir Island and two whales were observed in November in the Pacific on the traverse of the southern end of Iturup Island. During December, right whales were not recorded in waters adjacent to the Kuril Islands in spite of special observations that were undertaken in 1955 from the whaleship *Musson* by the scientific workers of the Institute of Oceanology TINRO, A.A. Berzin and E.A. Tikhomirov. The whaling ship *Musson* cruised in the western North Pacific along the whole Kuril chain--from the southern Kuril islands to Paramushir Island during December 1955. In spite of careful, uninterrupted observations that were done from the ship during daylight during the whole voyage, not a single [right] whale was recorded.

During February-March 1958 the reconnaissance ship *SRT-1036* undertook whale observations in the Pacific in the region from Sangarsk Sound to the southern Kuril Islands. During the little more than a month that ship was in these waters, not one whale was seen, although there was an experienced crew and highly qualified observers (for instance, the Captain of the ship is a very experienced hunter, G.V. Popov and the observer is the worker of the whaling factory ship *Aleut*, Mr. Krutov).

Interviews we conducted in the Kuril Islands revealed that the local population have never seen any cetaceans during winter in the waters that surround these islands. All these facts enable us to insist that right whales cannot be found at all in the waters near the Kuril Islands in December-February, and it is possible that there are not there even in March.[21] The right whales that appeared in southern Kuril waters a month later in April (and also those that appear in May and June) pass along the Kuril chain north up to southern Kamchatka where they reach the summer feeding grounds. June to August shows a larger dispersion of these whales on their summer area. From the end of August through the beginning of September the movement of whales south begins. Migration increases during the whole month of September and also in October. In November the main part of the right whale population is already passing south to its wintering grounds, and in December-February those whales cannot be observed at all in waters adjacent to the Kuril Islands.

Just as the spring migrations of right whales from the wintering ground northward pass mainly along the Pacific side of the Kuril chain, so the fall migrations to the south generally follow the same path, although some individuals can be observed in the Pacific Ocean at a great distance from Japan and from the Kuril Islands. In the Sea of Okhotsk (in Kuril waters) in the early spring and in late autumn, only scattered individual Pacific right whales have been observed. The migration of the Okhotsk stock passes along the mainland coast (see Figure 21).

The above-mentioned periods and the scheme of migrations are confirmed by the points showing our catch of 10 right whales killed by commercial whaling ships in accordance with the special permit from May to September 1955 (Figure 2, Table 1). Supplementing these data are those based on the catch of two right whales by the Japanese (Omura, 1957, see Fig. 2). Both whales

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[21] An exception can be made only for the individuals who stayed for the winter due to an injury or other pathological factors. Such cases are only rarely observed.

were taken in spring 1956 in waters of the Pacific Ocean, one whale on 23 May on the traverse of the Odzika peninsula (Honshu Island 38°33'N) while the second whale was killed 30 June on the traverse of Cape Erimo (Erimo Misaki) (Hokkaido Island, 41°46'N) more than 200 miles from shore.[22]

Study of the catch locations of Pacific right whales by month (Table 1, Figure 2), confirms the same pattern which appears in the observations of those right whales in the waters around the Kuril Islands (Figures 3-9 and as summarized in Table 2 and Figure 10).

The distribution of Pacific right whales in Kuril Island waters and the duration of the whales' spring and fall movements to the north and south unquestionably varies somewhat depending on the sea and ice conditions and feeding conditions in different years. In spring and fall at the beginning of the migrations the most important stimulating factor appears to be the sea and weather conditions, whereas during the [summer] feeding period the distribution of whales depends basically on the distribution and composition of zooplankton.

When discussing the northern edge of the right whales' distribution in the Bering Sea, it is necessary to realize that currently we do not have the necessary reliable observations that would enable us to present a final opinion, and this question must be considered as unresolved until reliable data are collected.

It is highly recommended that the effort to study the distribution, populations, biology and ecology of right whales be continued, taking for that purpose some specimens from the North Pacific, from the Chukchi Sea, from the Beaufort Sea, from the north-central and southern Bering Sea as well as its western and eastern coasts, from the waters adjacent to eastern Kamchatka and the eastern Aleutians, from Tugursk Bay and the Shantarsk Islands in the Sea of Okhotsk, in the Pacific, and from the coast of North America. It is necessary to emphasize that the taxonomy of the right whales is insufficiently studied, and it is quite possible that collection of more specimens and further studies will yield very interesting conclusions. It is quite possible that, as Scammon (1874) writes, two varieties of right whales dwell in the Sea of Okhotsk, but it is also possible that there are two local stocks of the same subspecies *E. glacialis sieboldii,* that differ between themselves not so much taxonomically as ecologically, although we have some information which suggests the existence of morphological differences.

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22 It is necessary to stress that in 1956 the spring hydrological and biological processes in the Kuril Island waters were greatly delayed as observed by our expedition. In the southern and southwestern part of the Sea of Okhotsk, drifting sea ice was still present until the beginning of June, the ice then gradually floated out to the Pacific Ocean passing the southern Kuril channels, forming here a cooled zone. The hydrological conditions delayed much later than usual the development of zooplankton and to a certain extent detained the passing of the right whales and sperm whales.

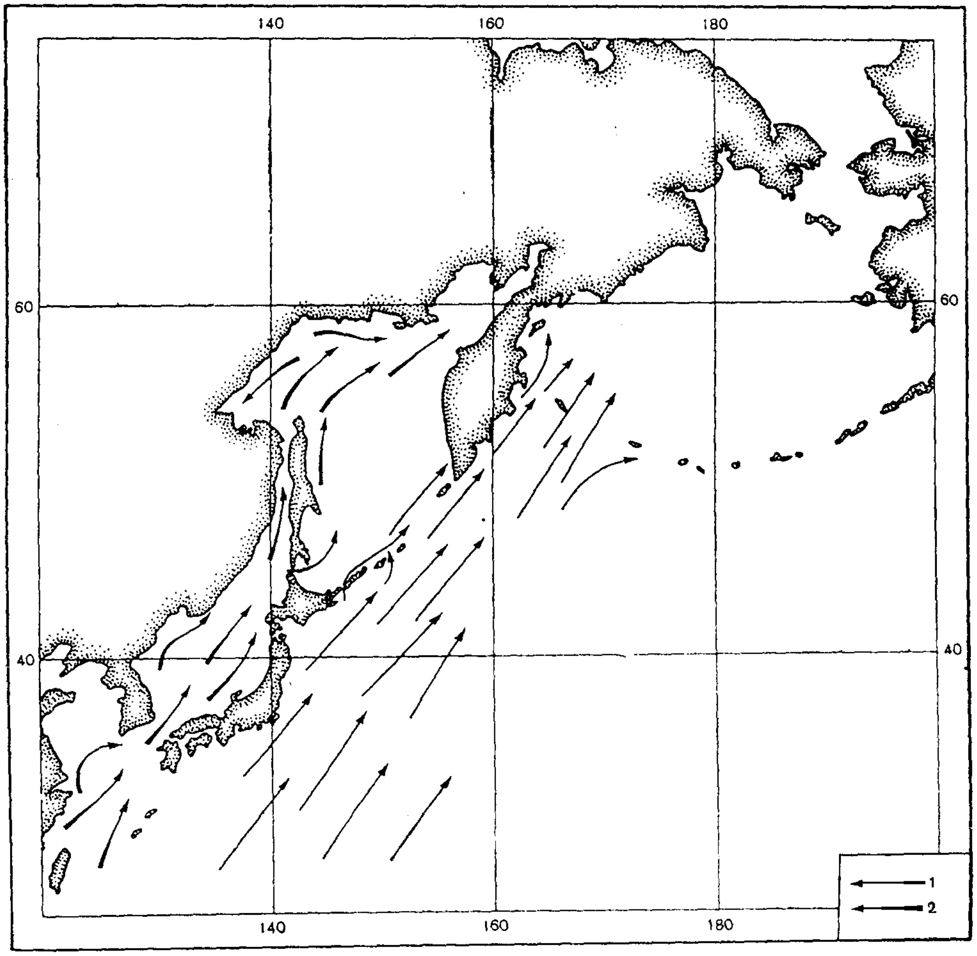

Figure 21. Pattern of spring migrations of Pacific right whales of the (1) Okhotsk stock and of the (2) Pacific stock.

The comparison of data on the distribution of right whales and calanoid copepods [*Calanus* spp.] during the summer in the North Pacific shows that in general they are geographically and temporally sympatric, confirming their closely-knit connection. That connection is [also] confirmed by direct observations at sea and by the results of analyses of the stomach contents of right whales; these will be discussed later in the section on feeding.

The observations of V. Zbyshevski (1863) and of the captain of the whaling ship *Uragan*, V.K. Vystavkina, described below, confirm the stable, repetitive, annual occurrence of right whales in the same regions during summer feeding. The same picture was drawn by us for the right whales of the American population.

Gilmore (1956) shows that the main areas of right whale feeding during summer were in the vicinity of the North American coast, the "Kodiak ground" which appears to be the place the "enormous Alaska...Gyre," and the southeastern Bering Sea where can be observed "the small Bristol Gyre." It is well known that in the region of the collision of currents, in the region of circular currents, and in other similar regions, a rather intensive and stable mixing of waters, upwelling of biogenic elements and the enrichment of the upper levels of the water column with the nutrients takes place. In such places there are stable local concentrations of [zoo]plankton, which can be observed every year with very small shifts in distribution from year to year. The same conditions also describe the distribution of feeding whales observed by Gilmore (1956). However, these general observations [on the correlation between sea conditions and concentrations of right whales] do not fully explain these relationships because in these regions concentrations of plankton occur that are not significant items in the right whales' diet.

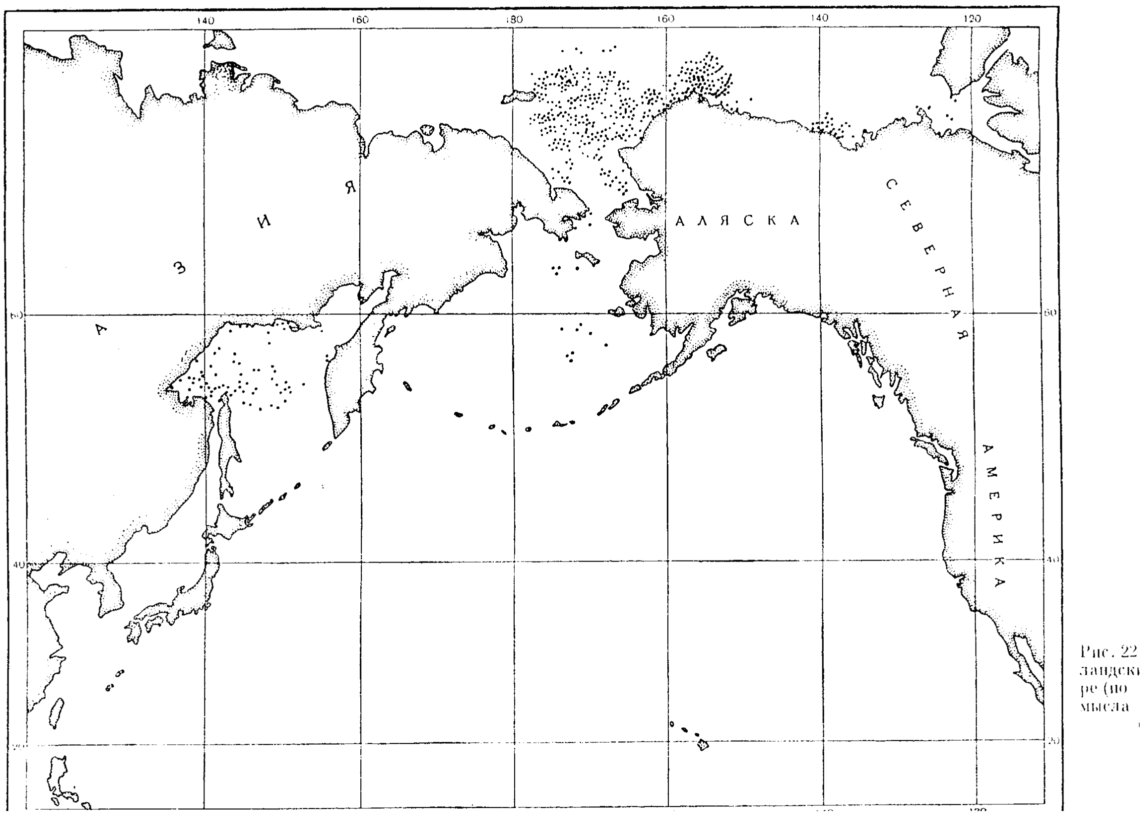

Figure 22. Location of catches of bowhead whales in **September** from 19th century whaling industry records (Townsend, 1935).

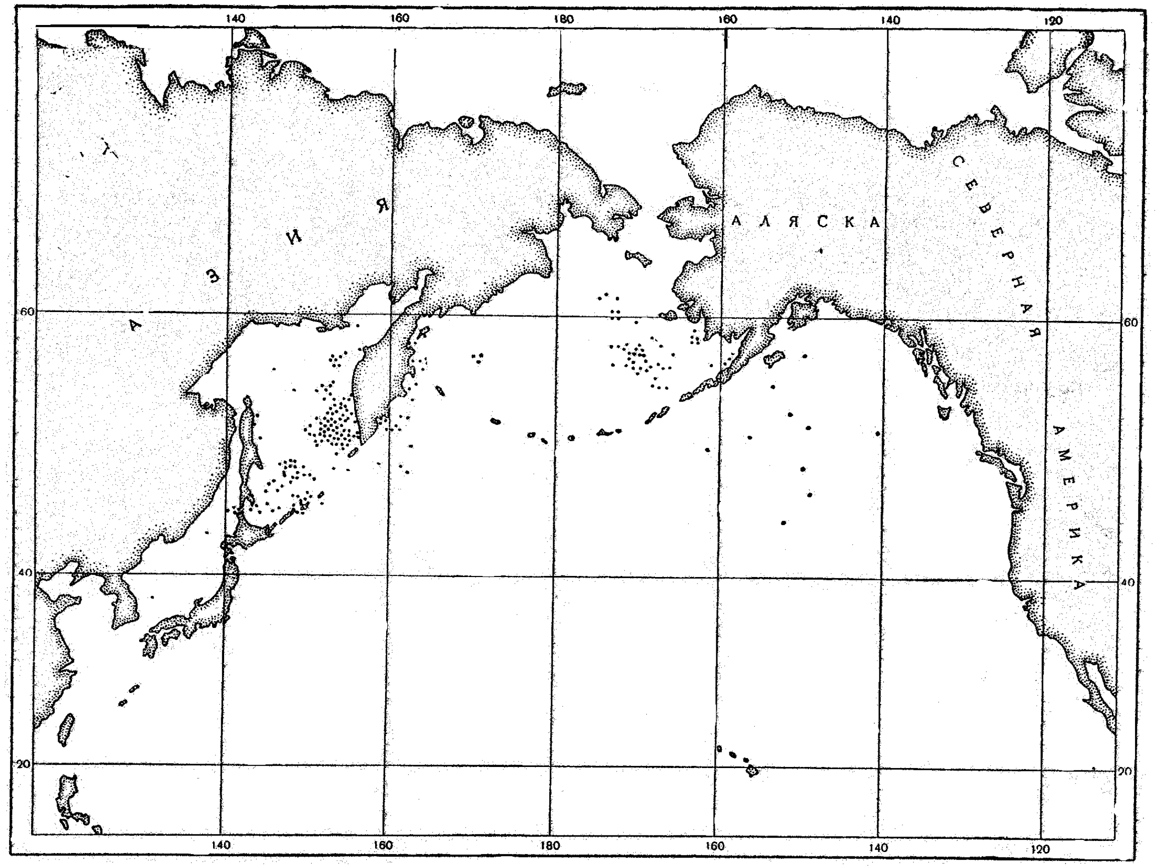

Figure 23. Location of the catches of Pacific right whales in **September** 1785-1913 (Townsend, 1935).

Omura (1958) presents maps which summarize observations of right whales by Japanese whaling ships over 17 years (1941-1957) in the southeastern Bering Sea, and northwestern and northeastern Pacific Ocean. On those maps (see Figs. 24,25, and 26) we can see that the greatest number of right whales was observed in July-September in the region located between the eastern islands of the Aleutian chain and the Pribilof Islands, near to 170° W. The data from the Townsend (1935) charts also show catches of right whales north of the Aleutian Islands (see Fig. 20, 23).

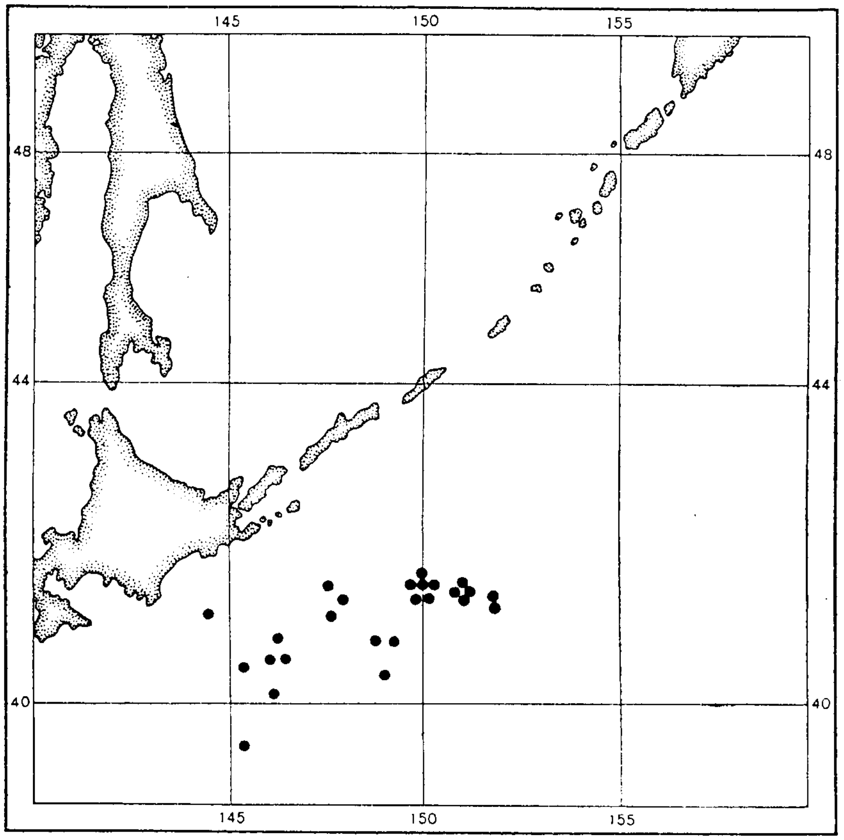

Figure 24. Distribution of right whales during **April** 1941-1957 in the North Pacific (Omura, 1958).

In the year 1956, our expedition worked in that region on the special ship *Nerpa*. The planktonologist of that expedition, Ju. A. Filipova, who undertook the collection and processing of the zooplankton, established that in September and October accumulations of plankton consist mainly of calanoid copepods and in that region are mainly *Calanus glacialis*.[23] Comparing the locations of observations of right whales with the regions of concentrations of calanoid copepods found by our expedition, we find nearly complete coincidence in their distribution.[24]

23 This identification was verified by Professor V.A. Yashnov to whom I express my thanks in this way.

24 I do not present here maps of the distribution of zooplankton for technical reasons although those maps exist.

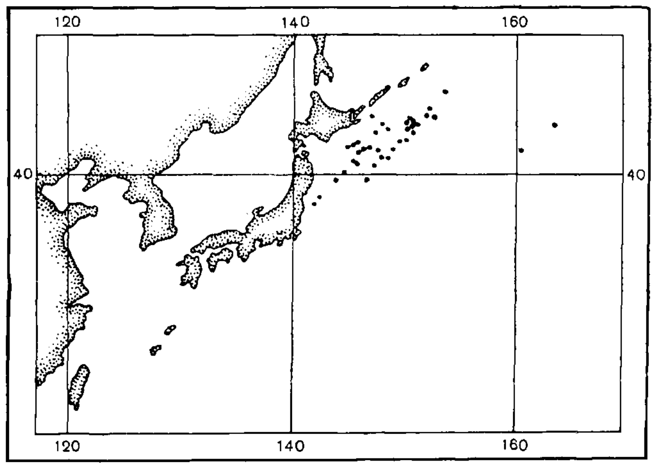

Figure 25. Distribution of right whales during **May** 1941-1957 in the North Pacific (Omura, 1958).

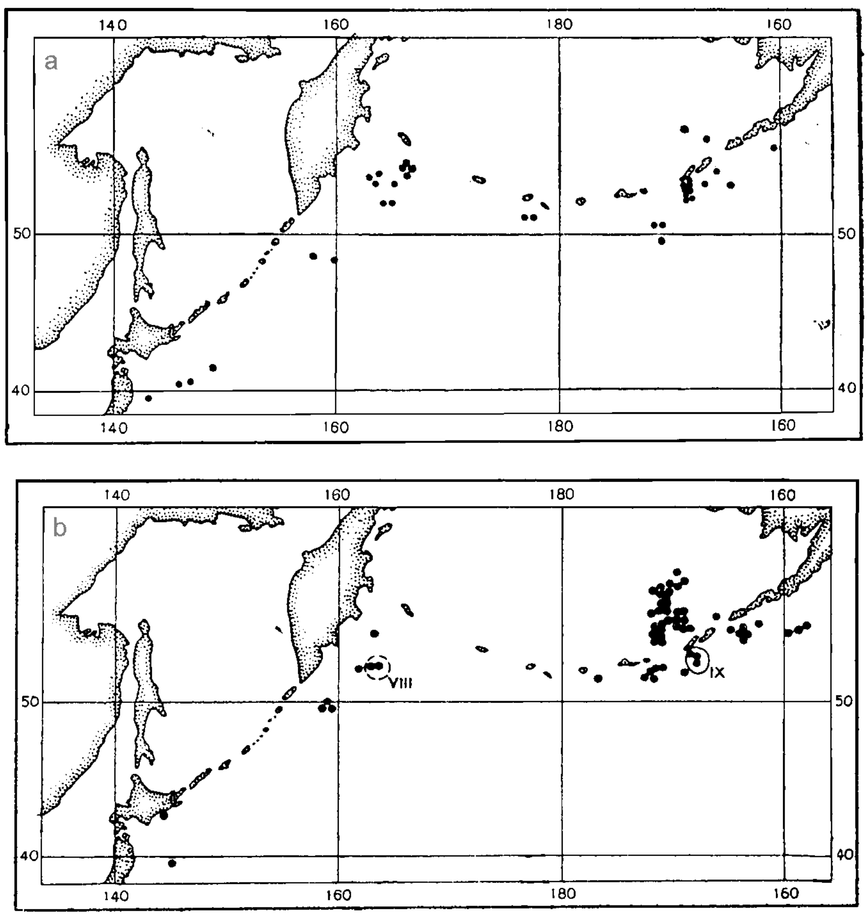

Figure 26. Distribution of right whales in (a) **June** and in (b) **July-September** 1941-1957 in the North Pacific (Omura, 1958).

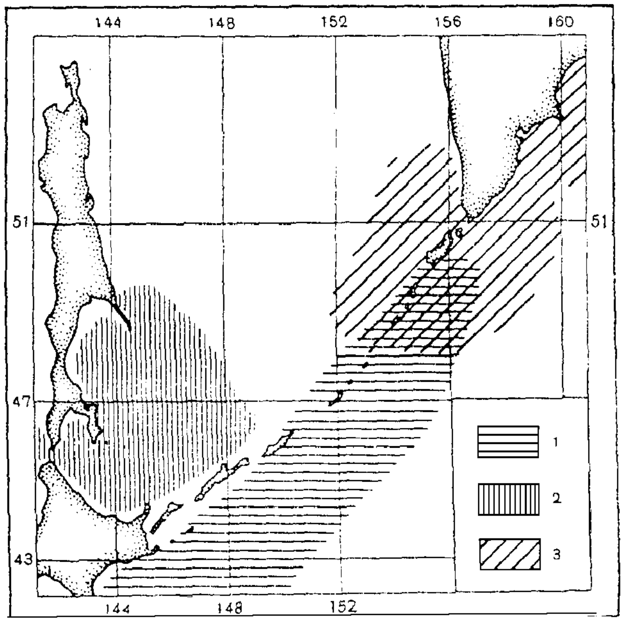

Figure 27. Range of the local stocks of fin whales (*Balaenoptera physalus*) of the Asiatic population. (1 - Japanese-Kuril stock; 2 - Okhotsk-Japanese stock; 3 - Kamchatka-Commander stock).

We observed a similar pattern of sympatric distribution of right whales and accumulations of copepods in the Kuril Island waters. Here the right whales were always seen in the Pacific Ocean opposite the channel of Urup, where in the upper 100 meter layer of the water column a concentration of *Calanus plumchrus* was discovered with a biomass of more than 1000 mg/m^3.

All these data once again confirm the existence of an unquestionable connection between the distribution of right whales in the North Pacific and concentrations of Calanoida. Because of the right whales' evident ability to feed selectively on *Calanus plumchrus*--this will be shown in the part dealing with the feeding habits of right whales--one could hardly expect any other pattern in their summer distribution--the period of intensive feeding and accumulation of energy reserves for winter.

During winter, the period of propagation, when for right whales feeding is of only minor importance (and possibly no importance), the distribution of right whales is determined by other factors--by the existence of doldrums, by the temperature of the surrounding waters, *etc*.

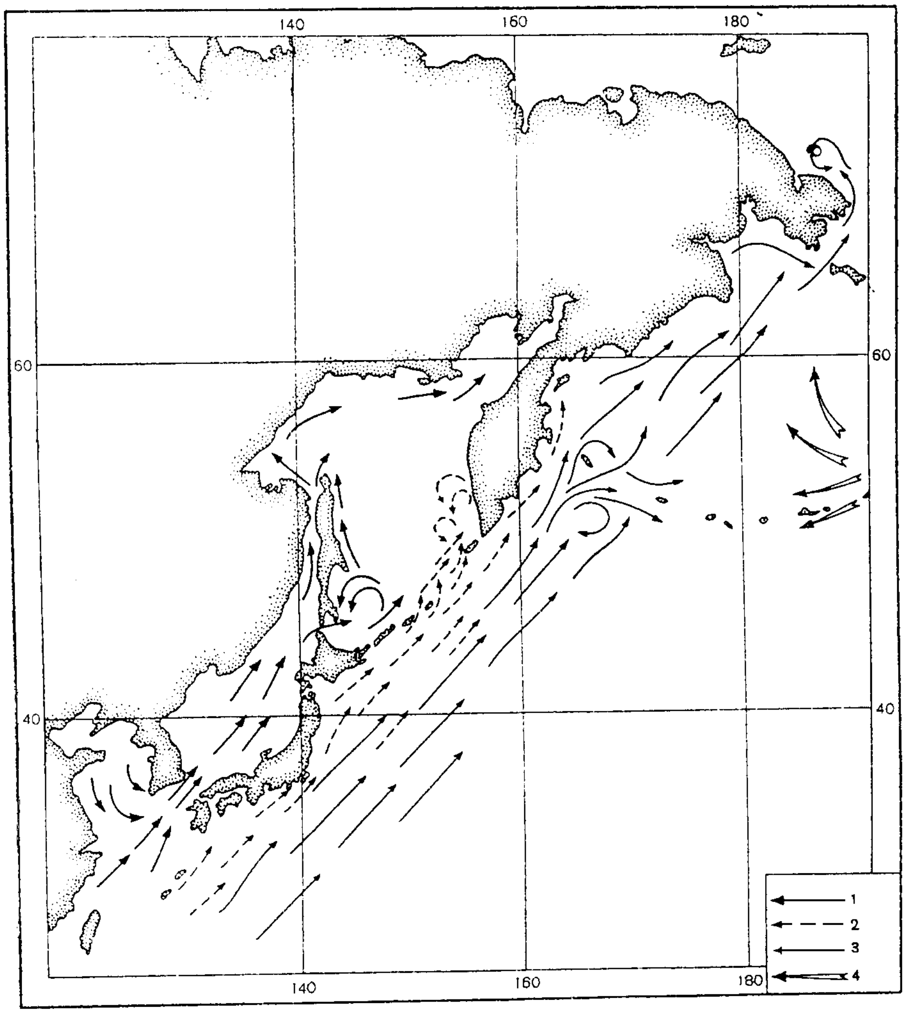

Figure 28. Pattern of spring migrations of fin whales of the Asiatic population.

1 - migratory routes of the Okhotsk-Japanese stock
2 - migratory routes of the Japanese-Kuril stock
3 - migratory routes of the Kamchatka-Commander stock
4 - appearance of fin whales of the American population

Before concluding, I shall mention one more, in my opinion, very important fact. After studying the distribution pattern of fin whales of the Asiatic population that occupies the western North Pacific, I concluded that that population should be subdivided into at least three stocks: one remains in winter in the southern Sea of Japan, in the Yellow and East China Sea, reaching perhaps even the northern part of the South China Sea. In summer, that herd (see Fig. 27, 28) moves north and occupies a feeding area in the northern Sea of Japan and the southern half of the Sea of Okhotsk without going out into the open ocean. According to the data of the Japanese scientists (Maeda and Teraoka, 1956), those fin whales that remained in the Sea of Japan, near the western coast of Hokkaido, were nearly completely exterminated by the Japanese whalers before and during the war. Part of that herd which lived in the southern half of the Sea of Okhotsk has survived, but as a result of the intensive killing it too is not very numerous (see Fig. 27, 28).

The second herd of fin whales has a longer migration than the first one: during winter it occurs in the waters of the North Pacific in the region 20-40°N east from the southern Japanese islands, while in summer it moves north and occupies the waters around the Kuril Islands, reaching to the northern Kuril Islands.

The third stock--namely the Kamchatka-Commander herd--is also located during winter in the Pacific Ocean and apparently in the same waters as the previous herd, but has the tendency to be more scattered in the sea, while in summer it occupies waters adjacent to Kamchatka, the Commander Islands and the south Bering Sea, perhaps reaching as far as the Chukotskiy Peninsula in the case that [the fin whales] in that region [are not part of] an isolated herd of the Asiatic population. Along the Aleutian chain to the east the Kamchatka-Commander herd reaches east to 180°E, while individual whales can be found further east (see Fig. 27, 28).

Comparing the winter and summer distribution of these local herds of fin and right whales in the western North Pacific, and comparing their migratory routes as well (see Fig. 21 and 28), it is not difficult to note their nearly complete coincidence. Studying that problem in more detail, I found an analogy in the distribution of fin whales and right whales to the distribution of many other animals.

It is a well-known fact that fur seals (*Callorhinus ursinus* L.) which summer in the southern part of the Sea of Okhotsk--on the island Tyuleniy [30°N, 144° 38’E], where they establish their rookeries--winter in the southern Sea of Japan. Some individuals pass further south apparently into the southern East China Sea. The migration routes of fur seals from the southern part of the Sea of Okhotsk lead via the La Perouse Channel into the Sea of Japan and further south to Tsusimsk Channel. Thus, the fur seals' summer and winter ranges and migratory routes coincide with those of the Okhotsk herds of right whales and fin whales.

The fur seals which summer every year near the Commander Islands and establish their rookeries there, depart for winter into the Pacific, occupying a quite wide range adjacent to the northern part of the island of Honshu. Migrations of fur seals of the Commander herd take place along the Kuril Islands. Here also is a complete coincidence with the behavior of right whales and fin whales.

Steller's seal lions (*Eumetopias jubatus*) behave similarly to the fur seals. The sea lions that live in the Sea of Okhotsk--on the Yamskiye Islands [59°16’N, 155°25’E], on the islands of St. Iona and Sakhalin--winter apparently in the Sea of Japan, while the sea lions which summer on the islands in the southwestern part of the Bering Sea winter on the Commander Islands, the Kuril Islands, and the Shipunski peninsula in the waters of the North Pacific moving only relatively short distances south.

According to the Japanese scientists (Maeda and Teraoka, 1956), blue whales (*Balaenoptera musculus*) in the western North Pacific form two herds. One herd populates the Sea of Japan; the second herd lives in the Pacific. It is true that what we have here is not a complete analogy with the species mentioned above because blue whales currently do not reach out of the Sea of Japan into the southern Sea of Okhotsk (that herd of blue whales has been nearly exterminated). However, it is possible that previously, when blue whales were numerous in the Sea of Japan, such migrations took place. But even disregarding this possibility, the segregation of blue whales into two herds, one of which inhabits the Sea of Japan and the other the Pacific Ocean, represents a very important fact supporting our position.[25]

The minke whale (*Balaenoptera acutorostrata* Lacepede) also behaves similarly to fin and right whales (Omura and Sakiura, 1956), a point brought to my attention by V.A. Arsenev. When we examine the distributions of dolphins, we find that among them are species with the same characteristic distribution. Moreover, there are similarities among the distribution of other groups of animals to right whales.

The black-legged and dark-back albatrosses (*Diomedea nigripes*, *D. immutabilis*) in their summer distribution are similar to the Pacific herds of right and fin whales.

Among fishes, we can point to cod (*Gadus* spp.), Alaskan pollock (*Theragra chalcogramma* Pallas), saffron cod (*Eleginusgracilis* Til.), and mackerels (Scumbridae), which all form local herds on one side in the Sea of Okhotsk and the Sea of Japan, and on the other side in the waters of the Pacific.

Studying the distribution of many other groups of marine animals, including invertebrates, we can see the same pattern. This pattern has an independent significance and will be explained later.

In this way in the western North Pacific, there are two clearly identified individual zoogeographic groups of various animals among which are included whales. These groups are unified as far as their sympatric winter and summer ranges, migratory routes, and sometimes even by the timing of their migrations. One zoogeographic group of animals inhabits the outlying seas of the Asian mainland, not reaching out into the ocean around the Japanese and Kuril islands. Seasonal migrations of animals of those groups occur within the borders from the Sea of Okhotsk in the north to the South China Sea in the south. The north-south movements are observed only within these boundaries.

Animals of the second zoogeographic group inhabit the open waters of the Pacific behind the borders of the Kuril and Japanese island groups, i.e. from their outward, eastern side, gravitating towards the Asiatic side of the Pacific Ocean basin. During their seasonal movements those animals migrate mainly along the above-mentioned island groups from 20-40°N in the south to the Bering Sea in the north, reaching only into its southern part.

The formation of the above-mentioned groups of animals apparently was composed at the same time, not gradually, and it was combined with the geological processes, as well as with accompanying changes of conditions in the environment.

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25 An exception consists of a smaller group of male blue whales which remains near the Commander Islands in winter.

QUANTITY OF PACIFIC RIGHT WHALES

The complete prohibition of killing right whales which was established initially in 1936 and later reinstated by the International Convention for the Regulation of Whaling in 1946 led to the fact that as the years pass the number of right whales in the western North Pacific gradually, although slowly, increases. Studying observation journals from the whaling ships of the fleet *Aleut* between 1936-1940, we have found that right whales were seen only as a rare exception. The whaling ships operating around the Kuril Islands in 1948 and 1949 found right whales only in a very small quantity. However, beginning in 1950, and especially during the most recent years, right whales were observed more frequently. According to information I received from the Commandant-Director of the 2d Far East whaling fleet, N.N. Martynov, one of the captains of that fleet reported that he saw a group of approximately 30 right whales at one time.[26] On 7 August 1957, captain of the whaling ship *Cyclon*, Mr. Panov, reported by radio to the flagship that during the last days of July and first seven days of August he observed more than 60 right whales in separate groups of 2-3 individuals in waters adjacent to the northern Kuril Islands of Onekotan, Paramushir, and Alaid. Those whales were observed less close to the islands on the Sea of Okhotsk side, and close on the Pacific side.

In the waters around the Kuril Islands, the sightings of right whales were generally of lone individuals, sometimes smaller groups of 2-3 whales, and only rarely up to 5 individuals together. A group as large as the 30 whales mentioned above was seen only once.

As shown in Table 2, between 1951-1957, 323 right whales were observed in the waters around the Kuril Islands between April and November. Of course, these data do not represent in any degree the total population size of the herd, and are far from complete. As noted above, during 1953 and 1954 we had data of observations from only three whaling ships [and from only] parts of the whaling season.

Because catching right whales was prohibited, sightings of these whales were often not recorded in the ship's log. For this reason, the actual number of right whale sightings between 1951-1957 near the Kuril Islands was, of course, much larger than appears in Table 2. As to what the population of the whole herd is, currently we do not have even tentative estimates.

It is necessary to mention that right whales have their own favorite places, where it is possible to meet them nearly always, as confirmed by the captain of the whaling ship *Uragan*, V.K. Vystavkin. The first such places are the areas in front of the Friese Channel [Proliv Friza] and the Bussol Channel [Proliv Bussol], in both cases on the Pacific side. The right whales remain here during nearly all the months of the whaling season, beginning approximately at the end of April and lasting through September. The second area is in the waters of the Sea of Okhotsk in the vicinity of Alaid Island and the western coast of Paramushir Island. The right whales reach this area approximately in June and remain here until September when the fall migration starts and they move south. The whales that are seen in this region in October belong to the numbers of the

[26] Since I was not told the date or even the approximate location of this sighting, it is impossible to include these data in Table 2.

last passers-by. During the summer months (June to September) the right whales can often be observed also quite regularly from the Pacific coast of Paramushir Island, although in smaller numbers than observed in the waters of the Sea of Okhotsk.

That characteristic can be explained by two causes: the distribution of the plankton used as food (the determining role is played here by the quality of the composition and quantity of plankton) and those feeding regions which are occupied annually by individual right whales of the Pacific herd. In this respect the conservatism of right whales, and of cetaceans in general, manifests itself very clearly (Klumov, 1955). At the present time we are in possession of new data that confirm this general characteristic of whales.

In this way during the last years we can observe a certain increase in the number of right whales in the waters around the Kuril Islands on both the Pacific and Sea of Okhotsk sides. It is absolutely necessary not only to maintain a complete prohibition of hunting these whales during the next few years, but also to exclude all illegal poaching of these whales, even if only a few whales are so killed. The slow rate of recovery of the populations of both herds at present can be explained by the relatively small number of individuals in the populations, [and] will undoubtedly increase when there are more whales. I am convinced that the day is not so far off when it will be possible to issue a license for the killing of 20-30 right whales, and maybe even more, on their summer feeding grounds.

To the above should be added that Omura (1958) presents a table summarizing all the data collected on right whales during 11 years of study (1941, 1948-57). The entire Japanese whaling fleet in the North Pacific observed 227 right whales during these years. Of these, 89 were observed in the coastal waters of Japan and 138 were observed in the regions used by the pelagic whaling industry near the Aleutian Islands. As can be seen in Figure 26, the Japanese found a great number of right whales in the eastern Bering Sea near the Aleutians. If we combine these data with those published by Gilmore (1956), one can definitely say it has been established that the population of North American right whales, as well as our two stocks, is beginning to become re-established. Therefore, it follows that prohibiting the hunting [of right whales] along the North American shore has had a positive effect, even though the North American population of right whales was brought to the very edge of extinction by the whaling industry.

According to Gilmore (1956), at the time whaling for right whales was interrupted, the population consisted of only a few individuals, which formed the basis for the population's recovery.

BEHAVIOR OF PACIFIC RIGHT WHALES

We did not conduct special observations of behavior of the Pacific right whales in the sea, and therefore, we do not have any new interesting information. However, whenever we encountered right whales, we observed some of their particular modes of behavior, for example their movements, their surfacing and diving behavior, and their pattern of breathing. First, it is necessary to say that right whales are slow moving animals, far slower than rorquals (Balaenopteridae). Right whales behave calmly even when a ship approaches. They do not make any efforts to avoid a ship that follows them; they do not seek to avoid ships by diving, as do other whale species. For these reasons, it is not very difficult for the whaler in a whaling ship to overtake them.

Chittleborough (1956), when he describes his observations of two right whales (a female and a young whale) near the west coast of Australia, mentions that they both lay quietly on the surface, and when the observers in a launch came nearer to the whales, the latter "...started to move lazily at the speed of some two knots..." The right whales that were observed near the Kuril Islands moved a little more energetically, but not faster than 5-6 miles per hour.

According to our observations, right whales dive for relatively short periods of time under water. They dive for 4-6 minutes, sometimes even 9 minutes, but not more. It was reported to me by radio from a small whaling ship *RS-5230* leaving Kasatka Bay (the Pacific side of Iturup Island) on 3 August 1955, that a right whale was encountered two miles from shore resting under water for a long time. However, it was not possible to measure the length of the dive more precisely.

According to our observations, when surfacing, right whales blow their double spout four to five times at relatively short intervals, and then dive. Sometimes the blows were not clearly noticeable; they were low and weak. At other times the double spout, characteristic of this species of whale, was very visible.

Chittleborough (1956) writes that while he was observing a female right whale with a calf from a small boat, he managed to get very near to both animals, and determined that the female dived for 2-3 minutes then spouted four times at intervals of 63, 42, and 28 seconds, then submerged again for 2-3 minutes. The calf spouted more often than the female, but sometimes even it submerged for two minutes.

It has been mentioned in the literature (Chittleborough, 1956) that right whales, despite their massive and unwieldy body, often appear in shallow water less than 3.5-5.5 m deep. E. Clark (1958) reports the appearance of one right whale on 15 June 1957 in a channel of Cape Cod (Massachusetts, USA) which was 12 m deep.

Those observations do not contradict our data, because in our far East waters right whales also approach the coasts and appear even in shallow waters 6-8 m deep. Lindholm (1888) described this in the last century.

As our observations show, right whales surface after diving in a characteristic manner. After staying submerged for 1-2 minutes, they emerge nearly parallel to the surface, with nearly the whole head breaking the surface at once [see Figure 29, 30] and even part of the back. If their dives were longer--6-7 minutes--then they surface more swiftly and at a steeper angle, with the rostral end part of their head appearing first [see Figure 31]. Diving again, right whales often (but not always) show their flukes (see Figure 32). Our observations of right whales and accompanying photographs taken by a worker of the expedition, L.B. Kliashtorin, show a great similarity to the characteristic behaviors of Australian right whales described by Matthews (1938). We can see in particular a great similarity when we compare the drawings of Matthews (1938, Table XVII, Figs. 1-9) with our photographs [Fig. 31, 32].

One can safely assume that the habits of right whales of all three populations (North Atlantic, North Pacific, Southern Hemisphere) are the same.

True, it is necessary to mention, that Gilmore (1956), when he observed the behavior of right whales on the coast of southern California from a motorboat at close

Figure 29. Surfacing of right whale when resting. Sea of Okhotsk, 1955. Photo by L.B. Kljashtorina.

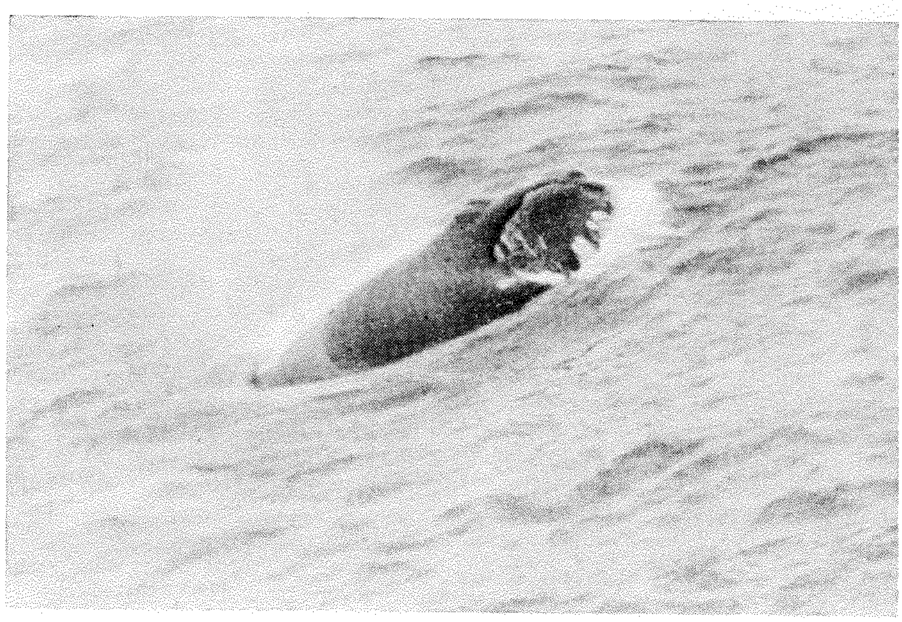

Figure 30. Spout of a right whale when surfacing. Sea of Okhotsk, 1955. Photo by L.B. Kljashtorina.

Figure 31. Surfacing of right whale after a long dive. Sea of Okhotsk, 1955. Photo by L.B. Kljashtorina.

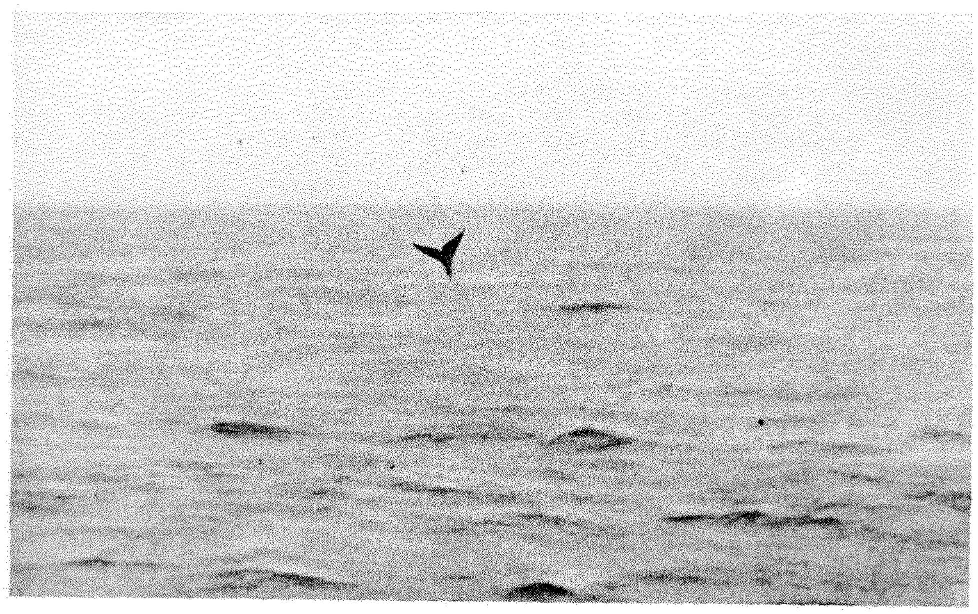

Figure 32. Right whale showing its flukes when diving. Sea of Okhotsk, 1955. Photo by L.B. Kljashtorina.

range, describes in his report how the whale (estimated at 12 m length) breached, appearing with half of its belly out of the water. During this behavior [“it rose slowly and majestically out of the water”] “...with flippers outstretched like barn doors...” and “fell back with a tremendous shower of spray and white water. It was an extremely impressive show of size and power...” To document his description Gilmore presents several photographs of the right whale breaching with approximately two-thirds of its body length out of water. We have never observed such breaches by right whales in the waters near the Kuril Islands, and we have not heard about them from the captains of the whaling ships. Gilmore (1956) is convinced the whale performed such breaches because it was disturbed by the approaching motorboat. Two series of breaches were observed: the first set included 5 breaches, the second 3 breaches.

The same author also mentions the disappearance of the whale which, when followed by the motorboat "...took off to the southwest, without visibly surfacing...Such evasive or furtive swimming tactics are common to whales when frightened. At such times, they expose only their nostrils to breathe, without showing either the head or back. The breath is released so slowly that it does not condense into a visible spout." We have not had similar experiences.

FEEDING OF PACIFIC RIGHT WHALES

Data available about the feeding habits of right whales (Balaenidae) are extremely scarce. This situation can be explained by the fact that during the period of the maximum development of the whaling industry in the 17th to 19th centuries, the marine fauna was still insufficiently studied, and the feeding habits of whales were not given much attention. Therefore, I feel that it will be of interest to summarize here all available data (Collet, 1909; Matthews, 1938; Omura, 1957 and others) on feeding habits of right whales in general and compare it with the data which we obtained when studying the feeding habits of the right whales (see Table 3).

In earlier works (Magnus, 1558; Fabricius, 1780; Scoresby, 1820, Eschricht, 1849, and others) in the best case there are anecdotes only of a general character about the feeding habits of whales. Even this information from the late 19th century suffer from many inaccuracies, and often the data do not allow positive identification of the species the author was describing. For instance, characterizing the region of intense whaling for right whales in the Sea of Okhotsk, V. Zbyshevski (1863, page 229) writes: "...whales eat mainly mollusks which can be found in great quantities in all places where the mixing of freshwater and seawater occurs. In some places in the Sea of Okhotsk, the density of these mollusk can be so great that a seven knot wind will not ripple the surface of this 'jelly'. From the early spring, the streams of alluvial Amur water from the Tatar channel nourishes the mollusks at Iona Island and near Cape Maria and Cape Elizabeth (Sakhalin). In that place in May and June one can meet the first whale hunters..."

It is ambiguous to which species that quotation refers. Is it a reference to pelagic mollusks (Pteropoda), or is it a reference to crustaceans? We can hardly imagine that during the last 100 years (from 1861 to 1958) the hydrological conditions of the Sea of Okhotsk have changed so much that large concentrations of Pteropoda have disappeared. However, we have not observed them there during the last decade in such high densities described by V. Zbyshevsk. On the other hand, concentrations of Crustacea can be observed in that region up to the present, and it is probable that V. Zbyshevski's data refer to concentrations of Calanoida. In the literature there are large inaccuracies in the descriptions of the anatomy of the prey found in the whales' stomachs.

Since the right whales were practically exterminated by the end of the last century, and since hunting them is absolutely prohibited, we do not have enough data to establish comprehensive lists describing the food habits of whales. The existing materials were summarized in Table 3 without segregating the data by whale species. In this table, information for the North Atlantic includes data referring to both bowhead and Atlantic right whales (*E. glacialis glacialis*), and information about the Antarctic and adjacent waters refers to feeding habits of the Australian (southern) right whale *(E. glacialis australis)* and perhaps to *E. glacialis antipodarum*, if such a subspecies exists. As far as the North Pacific is concerned, we rely mainly on the data we obtained in 1955 when operating in waters adjacent to the Kuril Islands, from 10 Pacific right whales (*E. glacialis sieboldii*) and the data from two whales of the same species that were obtained by Japanese whalers (Omura, 1957).

Table 3. Prey species of right whales around the world.

Antarctic	**North Atlantic**	**North Pacific**
Euphausia superba	*Calanus finmarchicus*	*Calanus plumchrus*
Grimothea	*Clione limacina*	*Calanus cristatus*
(post-larvae *Munida gregaria*)		*(Calanus glacialis)*
	Limacina helcina	*(Calanus pacificus)*
		Parathemisto japonica
	Thysanoëssa inermis	*Euphausia pacifica*

Note: The plankton organisms are mentioned in each column in order of their importance in the feeding of whales. Two species of *Calanus* in parentheses in column 3 were not found in the stomachs of studied whales. The reasons for including them in the Table is explained in the text.

The principal food for right whales of the Antarctic ocean and adjacent waters is *Euphausia superba*. This [species of krill] is a large form that is found, as is known, in very dense concentrations. Therefore, all baleen whales that come to the Antarctic water for summer feed nearly exclusively on euphausiids. The Australian right whale (*E. glacialis australis*) is no exception in its feeding behavior. According to A.G. Naumov (1959) in Antarctic waters, calanoid [copepods] also occur sometimes in the top 100 m of the water column in densities up to 1,000 mg/m^3. However, generally these dense patches are distributed at deeper levels than the concentrations of *Euphausia superba* which are met mainly in the upper layer of water (0-10 m) and [the copepods] do not make daily vertical migrations which confirms apparently the feeding of Australian right whales just on this species [*E. superba*].

Near the coast of Patagonia in the stomachs of southern right whales according to Matthews (1938) they found another krill species, namely Grimothea (larvae stages of *Munida gregaria*). Our knowledge of the qualitative composition of southern right whales' food is limited to these modest data. Quantitative data on feeding by these whales are lacking in the literature.

The main food of right whales in the North Atlantic is *Calanus finmarchicus*. This is explained first by the dense concentrations that are formed by the mentioned *Calanus* in the Barents Sea and in the North Atlantic, and second, by *Calanus*'s distribution in the water column.

It is known that right whales do not dive to great depths, remaining usually between 15-20 m and at a maximum 25 m. Within that layer they find food. *C. finmarchicus*, which forms in the North Atlantic 80.5% of yearly average biomass (Zenkevich, 1947), is distributed chiefly in the surface layer of 0-25 m and especially the layer 0-10 m (Bogorov, 1938). At the same time, it does not make noticeable vertical migrations and its biomass in the surface layer does not change during a 24 hour period. This is clearly stated in the case of copepod stages III and IV. V.G. Bogorov (1938) writes: "Studying the 24 hour vertical distribution of *C. finmarchicus*, we observe that the maximum quantity of each stage prefers a specific depth and the movement of maximum quantity from the depth to depth over a 24 hour period is nearly indiscernable." Because of these two facts (dense concentrations and the maximum quantity of krill in the surface layer of water) *C. finmarchicus* is the main food item of right whales in the North Atlantic. Quantitative data on the feeding of right whales for the described regions of the Pacific Ocean are missing. However, from the special calculations done by myself[27], it is possible to assume that the daily food requirement of right whales 16-17m long can reach approximately 3-4 tons. With such a need, the concentrated character of the prey items and ease of their capture (with the minimum use of time and energy) appear to be the main factors that selected for adaptation of right whales for feeding on such tiny zooplankton as copepods.

In an average year, *Euphausia* constitute only 5.3% of the zooplankton biomass in the North Atlantic (see Zenkevich, 1947). This fact partly explains their secondary importance in the feeding of North Atlantic right whales.

On the other hand, also important and perhaps critical, is the fact that the concentration of *Euphausia* takes place mainly in the depths that are lower than 25 and reaching sometimes even 50 meters. In the more southern regions of the North Atlantic the significance of Euphausiids (*Thysanoëssa inermis*) in the biomass, as well as in the feeding of right whales, is slightly greater; it is possible that this is due to the formation of accumulations of *T. inermis* in the upper layers of water at specific times of the year.

Analyzing the feeding habits of right whales in the North Pacific, it is possible to establish a full analogy with the feeding of right whales in the North Atlantic. In the North Pacific, as well as in the North Atlantic, right whales are specialized feeders only on copepods, whereas the specific form of copepod eaten depends on the regions and seasons as our materials show. Of course, the analysis of the contents of stomachs of 12 right whales[28] is insufficient to be used for definitive conclusions, yet the data obtained when compared with existing reports on the distribution of plankton allow us to express a certain opinion.

Studying the qualitative composition of the stomach contents, (see Table 4), we recognized that during the spring, in June 1955 (our data) and in June 1956 (Omura, 1957) in the right whales that were killed in the southeastern Sea of Okhotsk and in the region of the North Pacific southeast from the Small Kuril Ridge and the island of Hokkaido (that is in the region of the influence of

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[27] The calculations that were done show clearly that a whale must eat approximately 35-40g of food every day per 1 kilogram of weight of a whale. The weight of a large right whale reaches 100 tons and sometimes even more. Therefore, the daily food requirement can be as much as 3.5 to 4 tons (see Kumov, 1959, 1981).
[28] Ten whales that were killed by our expedition and two right whales that were killed by the Japanese whaling fleet (see Omura, 1957).

waters in the southeast part of the Sea of Okhotsk and the cold Oya Siwo current) in the stomachs was found *C. cristatus*. At the same time, in the case of whales that were killed during the summer and autumn season (July-October) the basic food item was *C. plumchrus* which, as our observations show, is the main food item of right whales in the western North Pacific and is the largest of all the Calanoids.

Table 4. Analysis of the stomach contents of 10 Pacific right whales killed in Kuril waters in 1955.

No.	Sex	Length (m)	Date	Amount of stomach contents	Species	Helminths	Notes
1	Female	18.3	17 May 1955	-		Analysis not done	samples not taken
2	Male	17.0	1 June 1955	approx. 12 liters	*Calanus cristatus*	not found	
3	Female	16.3	19 June 1955	approx. 75 liters	*Calanus cristatus*	not found	
4	Male	17.06	13 July 1955	approx. 150 liters	*Calanus plumchrus*	6 *Tetrabothrius ruudi* many *Bolbosoma niponicum*	
5	Female	17.4	22 July 1955	-	-	many *Bolbosoma niponicum*	samples not taken
6	Male	10.75	22 July 1955	a little *Calanus*	milk and *Calanus* spp. (*plumchrus*?)	1 *Bolbosoma niponicum* in large intestine	
7	Male	16.6	10 August 1955	13 liters	*Calanus plumchrus* stage V	13 *Tetrabothrius ruudi* and 10 *Bolbosoma niponicum* in small intestine	food only in 3rd compartment of stomach
8	Male	16.6	10 August 1955	no data	*Calanus plumchrus* *Parathemisto japonica*	*Bolbosoma niponica*, in small (4) and large (1) intestine	stomach cut by dissection
9	Female	11.35	11 August 1955	"poorly filled"	*Calanus plumchrus* *Parathemisto japonica*	3 *Bolbosoma niponicum* in small intestine	Harpoon cut through stomach, blood found.
10	Female	17.8	28 August 1955	"poorly filled"	*Calanus plumchrus*	not found	
11*	Female	11.58	23 May 1956	nearly empty	*Calanus plumchrus* *C. finmarchicus*** *Euphausia pacifica*	not found	
12*	Male	12.4	30 June 1956	nearly empty	*Calanus plumchrus*, *C. cristatus*, *C. finmarchicus*	not found	

* from Omura (1957). ** apparently it was *Calanus pacificus*.

Of secondary importance in the feeding habits of the Pacific right whales was *Parathemisto japonica* (Amphipoda), which was found by us in two whales that were killed on the Sea of Okhotsk side of the island Paramushir; one of the whales was killed 12 miles northeast from the island of Atlasovo [Alaida] and the second whale killed approximately 30 miles southwest of the same island. In both cases, *P. japonica* was found in a smaller quantity because the main mass of the feed was formed by *C. plumchrus*. As a passing remark I would like to mention that in July to August the concentrations of *P. japonica* around the island of Atlasovo are constant from year to year, although there are local differences. The food intake of these by the Pacific right whales shows that *P. japonica* remains here in the surface layer, in any case not deeper than 20 meters.

Undoubtedly as an important food component, especially in the southeastern Bering Sea, are *Calanus* that belong to the group (superspecies according to Yashnov, 1955*) C. finmarchicus*. However, until the present time, the planktonologists did not reach consensus as far as the validity of some of the species of that group is concerned, their habitat preferences or the extent of their distribution in the North Pacific. Currently, the following question remains: do the *Calanus* which live in the Bering Sea and the Sea of Okhotsk belong to the species *C. finmarchicus* or do they belong to the species *C. glacialis* as was recently separated by V.A. Yashnov (1955)? Is it even possible that both mentioned species of *Calanus* have their habitat in the Bering Sea and the Sea of Okhotsk?

K.A. Brodskij in his one of his recent works (1959) cites from the article of V.A. Yashnov (1955) that *C. glacialis* "was discovered in all our far-east waters...", and he writes: "The latter requires further research; we assume, that even if that species penetrates into the far-east seas, than most likely it is localized in the northeastern Bering Sea and in the northern parts of the Sea of Okhotsk and the Sea of Japan."

Samples of zooplankton that were collected by our expedition in the southeastern Bering Sea in 1956 were sent for identification to K.A. Brodskij, who informed me (personal. comm. 20 January 1960): "...all samples that you sent me belong to *C. finmarchicus* and not to *C. glacialis*. Is there in the far east *C. glacialis*? That problem needs research, but according to the existing data, *C. glacialis* is limited in its distribution only to the northern Bering Sea and possibly in the Sea of Okhotsk and the Sea of Japan."

In an earlier work, Brodskij (1957, page 184) shows a distribution map of *C. finmarchicus* on which the boundaries of the *C. finmarchicus*'s range are drawn. This range includes all the northern Bering Sea (north of 60° N); southwards it occupies only a narrow coastal strip along the Korjaks coast, the coast of Kamchatka, the Sea of Okhotsk, and the northern Sea of Japan. In the Kuril Island waters, the map shows *C. finmarchicus* is not present, nor in the southeastern Bering Sea where we in 1956 found even in autumn large concentrations of *C. finmarchicus* (*C. glacialis*?). V.G. Bogorov and M.E. Vinogradov (1960) after having processed collections of the zooplankton that were made on the ship *Vitjaz*, and confirming the opinion of K.A. Brodskogo that *C. finmarchicus* can be found only in the coastal regions show a distribution map of *Calanus* near the Kuril Islands, citing its existence nearly along the whole ridge from the southern end of Kamchatka up to the Bussol Channel. The latter authors assume that through the Bussol Channel goes the southern border of the distribution of *C. finmarchicus* behind which further south it does not penetrate. However, the famous Japanese planktonologist C. Nakai (1954) writes that the accumulations of *C. finmarchicus* "are nearly everywhere in the coastal waters of Japan."

Besides that, the Japanese scientists, and especially, R. Marumo, M. Kiotu, and O. Asaoka (1960), in work devoted to research on plankton in the western North Pacific in the summer of 1958, point out that in the large body of water ["aquatorry"] which spreads east from the coast of the northern part of the island of Honshu and the eastern coasts of the island of Hokkaido approximately from 140-165° E and 32-52° N, *C. helgolandicus* was found all the time [as stated in] the works of the Japanese planktonologists [this species is found] in the waters near Japan and the western North Pacific.

V.A.Yashnov (personal communication, 1957) agrees that *Calanus pacificus* occupies the southern part of the North Pacific, mentioning however that that species is a variant of the North Atlantic *C. helgolandicus* with which it is to a great extent sympatric according to many features. It is because of this, says V.A. Yashnov, that the Japanese scientists confuse *C. pacificus* with *C. helgolandicus*. Regarding the borders of its range, *C. finmarchicus* is missing from the North Pacific and in its outlying seas as V.A. Yashnov convincingly proves. Yashnov (1961) gives evidence that *C. finmarchicus* is a surface, subarctic, but not arctic North Atlantic form whose range extends from south of the line of convergence near the Gulf Stream [north] into the Barents Sea [Barentsovo More] and is taken by currents even into the Kara Sea [Karskoye More], but there apparently very quickly dies. *C. glacialis*--is an arctic form which lives in deep and cold waters, it is widely spread in the Arctic basin. In the North Atlantic it can be found only northwards from the line of convergence. This species extends into the Bering Sea via the Arctic Ocean and from there together with the cold current floated southwards along the Asian mainland and the Kuril Islands. In fact, by that circumstance V.A.Jashnov explains the distribution of the "ice" *Calanus* [*glacialis*] in a relatively narrow strip along the western coasts of the Bering Sea, Sea of Okhotsk, and the northern Sea of Japan, as well as along the Kuril Ridge up to and including the strait of Bussol. Consequently, all those places mentioned earlier as places where *C. finmarchicus* can be found--must be occupied instead by *C. glacialis*, while those places where the Japanese planktonologists described *C. helgolandicus* and some *C. finmarchicus* as well (Nakai *et al*., 1954) should be occupied by *C. pacificus*. The last observation was confirmed by other researchers as well, in particular by the materials that were collected by the ship *Vitjaz* and processed by V.G. Bogorov, M.E. Vinogradov, E.A. Lubny-Gertsik and others.

C. pacificus can be found in smaller quantities as far as the Aleutian Islands and the southern Bering Sea, where it is carried off by the sea currents although in those regions it apparently does not survive long and of course does not reproduce.

The dispersal of *C. finmarchicus* from the North Atlantic into the Pacific Ocean via the basin of the Arctic Ocean is considered by V.A. Jashnov impossible because of the natural temperature barrier.

Thus, summarizing all contradictory points of view on the distribution of *Calanus* belonging to the group of *C. finmarchicus* in the North Pacific, we come to the following conclusions:

1. *C. finmarchicus* and *C. helgolandicus* do not exist in the North Pacific.

2. *C. glacialis* has its habitat in the northern part of the Bering Sea and in the coastal zones of the Bering Sea, Sea of Okhotsk, and the northern Sea of Japan, as well as in the narrow strip of the waters near the Kuril Islands along the Kuril Ridge, along both side up to and including the Bussel Strait within the borders of the cold currents [mainly of Oia Siwo].

3. *C. pacificus* has its habitat in the southern part of the North Pacific reaching in its distribution to the north [in each case in the western Pacific] up to the Aleutian Islands and the southern part of the Bering Sea where in smaller quantities it can be carried by the warm currents but where apparently it does not survive.

According to the data that were obtained by our expedition in 1956 one can add to the above that in the southeastern Bering Sea during the summer-autumn season exist every year concentrations of *C. glacialis* always consumed by the right whales of the American population which is apparent from Figures 20, 23, and 26. Besides that our data show that the distribution of *C. glacialis* in the Bering Sea is not limited only to the narrow coastal strip of waters that are adjacent to the Korjaks coast but it involves the central part of that sea as well [see Fig. 33] although here the ice *Calanus* does not form large accumulations.

In light of all that has been said it is very difficult to solve the problem of what species was represented by the "*C. finmarchicus*" found by Japanese scientists in the stomachs of two right whales killed in the North Pacific 200 miles east from the coast of Hokkaido at 39-40° N (Omura 1957). Most probably K.A. Brodskij and V.A. Jashnov are right (personal communication), that considering that the locations the whales were killed, the copepod had undoubtedly to be *C. pacificus*. In fact, it was the reason why I put *C.* [*pacificus*] in parenthesis in the list of food objects of right whales [Table 3 above]--because we do not yet have proof of that [it occurs in this area].

As far as the distribution of *C. cristatus* is concerned, K.A. Brodskij (1950) shows that this species remains in summer "...in the depths lower than 500 meters and when the water becomes colder during winter months it moves up to the upper layers." V.G. Bogorov and M.E.Vinogradov (1955) remark that "...in the waters with the cold intermediate layer which is so characteristic for the Okhotsk and Bering Sea and waters of the Kuril Trench *C. cristatus* reaches its maximum concentration at depths of 25-50 [m], [and is found] in lower densities in the layer of 50-100 meters." The feeding of right whales on *C. cristatus* proves that in May-June period it [this copepod] stays in the surface waters, within the upper 10-15 meters forming there larger accumulations not less than, and perhaps even more than, 1,500-2,000 mg/m^3. Otherwise right whales would not be able to feed on it.

The existence of the *C. cristatus* in the surface waters is confirmed even by the latest research on the research ship *Vitjaz*. So, for instance on her 20th cruise (in spring 1956) the maximum quantity of *C. cristatus* was found in the layer of 10-25 meters at the station which is not far from the coast of Japan (30 April 1956, station 3222, 40° 47'7" N, 142° 58'7" E).

During summer *C. cristatus* was not found in the stomachs of right whales which is confirmed in the reports of K.A. Brodskij (1950) and other planktonologists as far as the depth of the habitat of that *Calanus* during the summer season is concerned. During this period right whales nearly completely switch over to feed on *C. plumchrus* which is widely distributed in the western North Pacific, and in Okhotsk and Bering Seas and forms here dense concentrations. So, for example, in 1956, according to our data in the Kuril Island waters of the Pacific Ocean, in spite of the poor plankton growth, the average biomass of the Far East *Calanus* for the layer of 0-100 meters was very high (>1000mg/m^3).

The ability of right whales in general and of the Pacific right whales especially to [feed] selectively is very clear. Pacific right whales prefer copepods [Calanoida] to all other zooplankton of the Far-East seas. Only in two cases we discovered in the stomachs of those whales pelagic amphipods (*Parathemisto japonica*), and once Japanese scientists (Omura 1957) discovered microscopic remains of several pieces of *Euphausia pacifica* that could have been swallowed incidentally while feeding on *Calanus*.

The following fact is characteristic and confirms the highly developed selectivity ofright whales. In the Sea of Okhotsk near Paramushir Island, a right whale was killed 28 August 1955 in the region of the 4th Kuril Strait [see Fig. 2, whale #10]. In his stomach a small quantity of *C. plumchrus* was found. On the same day and in the same region at nearly the same point a blue whale was killed by another whaling ship and in the stomach of the [latter] whale was a lot of food consisting solely of *E. pacifica*. That fact once again proves the narrow specialization of the right whales and their inability to exploit concentrations of prey at depths lower than 20-25 m where *E. pacifica* primarily occurs. In this way, the feeding spectrum of Pacific right whales in the Northern Hemisphere appears to be severely limited, which enables us to speak about their clearly pronounced stenophagous behavior. Stenophagous behavior in such gigantic animals as right whales with their tremendous need of food could have evolved only when a stable and abundant food source was available. Such a situation occurs in the North Atlantic where copepods form 80 percent of the annual average biomass (Zenkevich, 1947) and in the North Pacific where they provide 87.5% of the biomass (see Mednikov, 1961 and our data for 1951-56 and others).

[Our understanding of] the quantitative characteristics of the feeding habits of North Pacific right whales cannot be called a complete because of insufficient data. Our observations show that the weight of food in the stomachs of right whales at the time of death did not exceed 160kg; according to Omura (1957), two whales that were killed by the Japanese had nearly empty stomachs. However, as noted above, calculations done by myself allow us to assume that given the size and the weight of the animal, the amount of food needed by an adult North Pacific right whale is approximately 3-4 tons of copepods per day. In table 4, all data are summarized from the stomach content analyses of the 10 right whales we killed and the two right whales killed by the Japanese.

To the above discussion, we add only a few words about the young right whale born most probably that same year (whale #5) in whose stomach together with milk we found remains of *Calanus*. There were not many *Calanus,* and most probably it was *C. plumchrus*.[29]

[29] The sample was not identified to species.

One small female (whale #9) which was killed on 11 August was approximately the same length as the male (whale #6) just described. Considering the female in question was killed 20 days later than the male, we can say confidently that both whales were born in the same year. The difference in length was only 0.6 m. However, we did not find in that female's stomach any traces of milk; she was completely weaned. Accordingly, we can assume that young right whales are weaned when they are between 10.5 and 11.5 m. We must mention that the female (whale #9) was obviously not sexually mature which was confirmed by the dissection of her sexual apparatus: the ovaries were very small and not developed (the right ovary was 25x7 cm, weight = 270g; the left ovary was 28x8cm, weight = 420g), the uterus was infantile.

If we assume[30] that the young whales (male #6 and female #9) are in same year-class, and that the 60cm difference in size is the result of the 20 days growth between the time the male and the female were killed, then we conclude that the growth rate of young right whales is very approximately 3 cm/day (60 cm/20 days).

It is necessary to mention that many researchers assume right whale calves have a much more rapid growth rate, to show that the above growth rate is not exaggerated. Using this estimated daily growth rate, we could try to calculate the birth date very approximately if we knew the size of right whales at birth. If we assume the young whale grow at 90 cm/month and extrapolate that growth rate backwards from the size (11.35 m) and date when killed, it suggests that the female was 5m in the beginning of January and 5.9m at beginning of February. It follows that the birth occurred in January while the length of whale at birth was between 5-6 meters.[31]

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[30] I admit that this assumption is not well supported.

[31] Matthews (1938) reports that on 26 August 1926 in the waters off Saldanha Bay, South Africa, a female southern right whale was killed which had a 6.5m newborn calf. Matthews examined both whales and the calf had only milk in its stomach. Chittelborough (1956) reports that on 2 August 1955 he observed in Frenchman Bay, western Australia--two right whales--a female and a 5.5-6.0 m calf. It follows that *Eubalaena* calves are about 6 meters at birth.

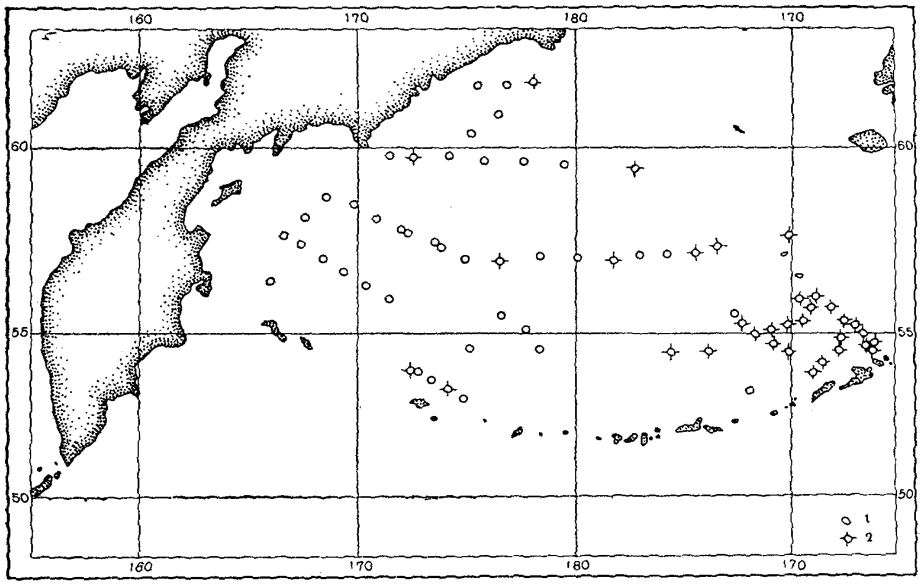


Figure 33. Data collection locations established by our expedition to study North Pacific whales August-October 1956 in the Bering Sea. Samples of plankton were taken at these locations. The map was designed by Ju. Fillippova. 1. Locations at which *Calanus glacialis* was not found. 2. Locations at which *Calanus glacialis* was found.

By this reasoning, weaning of right whales occurs when they are between 10.5-11.0 m at the age of 6-7 months.

However, it is necessary to state again [that these estimates are] very approximate, even though they are consistent with data from other researchers and correspond with data about embryonic growth rates of Pacific right whales.

As mentioned above, adult Pacific right whales 16-18 m in length need approximately 3.5-4 tons of food per day to "maintain normal energetic balance". That amount of plankton can only be found when continuously feeding in the layer of maximum concentration where average densities exceed 2,000mg/m^3 in the top 100m of the water column. It is a known fact that zooplankton is distributed nonuniformly in the water column. Looking at the vertical microdistribution of food organisms, particularly *Calanus,* we find that at certain depths there appear concentrations of plankton. That is, there appears to be a layer of what I call "maximum concentration of plankton." (Klumov, 1958, 1961). The biomass of this layer sometimes reaches very high densities--more than 10 g/m^3.

How do whales find the depths with maximum concentrations of plankton and how do they orient themselves when they move in that layer? Three explanations have been mentioned.

1. <u>By sight</u>. Right whales feed mainly in the top 25m where the concentrations of food are greatest--Calanoids in the northern hemisphere and *Euphausia superba* in the southern

hemisphere. During the day sufficient light penetrates this layer for the whales to find the plankton by sight. However, it is generally accepted that the vision of whales is poorly developed, and it can hardly help them significantly.

2. <u>By touch</u>. The whale's sense of touch is particularly sensitive at its hairs located on the rostral part of its upper and lower jaws. Probably these hairs serve as feelers which allow whales to orient themselves when they move in concentrations of plankton, and to stay within these concentrations even in the dark. It is possible that baleen whales (Mysticeti) sometimes use both vision and touch.

3. <u>By echolocation</u>. I consider this the principal means that both baleen and toothed whales (Odontoceti) orient themselves when searching for food at various depths both at day and in darkness (Klumov, 1957, 1959, 1961). It is important to emphasize that whales have very keen hearing. According the studies of Jamada (1948) whales hear via the surface of their whole bodies, especially their heads.

The layer of the maximum concentration of plankton, especially at high densities, is the layer which absorbs and disperses [sound], and when it is a very dense it even reflects sound waves. After making a sound (and whales in general, and baleen whales in particular, are known to make sounds), a whale perceives the echo from the dense concentrations of plankton. The echo (or lack of echo) indicates not only the existence of concentrations of plankton but also their direction (and possibly the edges of the concentrations); the echoes allow the whale to move in the correct direction to locate food.

Studies of echolocation in animals generally, and in cetaceans specifically (Kellogg, Kohler and Morris, 1953, Griffin, 1953, 1955, and other authors) have explained various observations. For example, some birds that fly in dense fog, by making calls, regulate the height of their flight according to the echoes. It is known also that bats echolocate as they fly at night so they avoid hitting obstacles and injuring themselves (Griffin and Galambos, 1941, Griffin 1953 and others). Kellogg *et al*. (1953) show that certain marine mammals use echolocation like bats to orient with respect to the ocean floor or large obstacles. The observation of McBride (1957) shows that in turbid waters porpoises (*Phocoena*) are able to avoid nets with small holes, but not nets with big holes, which confirms a certain type of echolocation. It shows that in the animal world echolocation is widely used. There is no doubt that whales can use echolocation to locate concentrations of food. In addition, prey animals emit sounds which whales may hear to locate their prey. It is quite clear that even large concentrations of zooplankton, not to mention the schools of squid (*Loligo*) or fish, emit sounds which attract whales. We found that at certain depth the layer of plankton forms a sound barrier, and according to the writing of our ecologists, there are certain conditions for the creation of echoes of the waves. Of course, these conditions are used by the whales for searching for food and for orientation when moving in a concentration of plankton. At the same time, our echolocation equipment does not compare to the precision and range of perception of the hearing of biological organisms, particularly whales, the uniqueness of whose fine hearing had been observed long ago (Jamada, 1948). It is quite possible that whales can determine not only the density of food concentrations, but even the species composition in the concentration by detecting slight differences in the sounds. Otherwise, it would not be possible for a whale to consume 1-4 tons of plankton per day (thinking of all large whales).

In summary, we must consider the right whale's very narrow feeding spectrum--[to be] clearly stenophagous with very high selectivity. In this respect, I cannot agree with I.A. Ponomareva (1949) who writes "We think that the possibility of whales having the ability to select [types of] plankton should be ignored. Undoubtedly, a whale swallows a volume of plankton without selection." Our data do not confirm that view, as shown by the data mentioned above as well as by the selective ability of a blue whale which was established by us. The blue whale is a typical stenophagous species (Klumov, 1959, 1961) which prefers *Euphausia* to all other food, only seldom eats copepods and perhaps never feeds on fish, in contrast to fin whales, sei whales (*Balaenoptera borealis*), small rorquals [minke whale] and humpback whales (*Megaptera nodosa*) all of whom have a much wider feeding spectrum.[32]

The selective feeding of right whales, established during the evolution of the species, is reflected in several principal features: the size of the animals, their robustness, their great weight, their slow speed, and their inability to submerge to great depths, which is why these whales must be considered dwellers of the uppermost zone of the ocean as well as their tremendously high daily food requirements which can only be satisfied by feeding on zooplankton at very high densities.

Table 5. Body and head length of right whales (*Eubalaena glacialis)*.

Whale No.*	Sex	Body length (m)	Head length (m)	Head length/ body length (%)	Note
6	Male	10.75	2.65	24.6	
9	Female	11.3	3.00	26.7	
11	Female	11.65**	3.25	27.3	
17	Male	12.32	3.56	28.9	So. Hemisphere
12	Male	12.40**	3.30	26.6	
15	Male	13.54	3.88	28.6	So. Hemisphere
13	Female	15.23	4.70	30.8	
3	Female	16.3	4.78	29.3	
7	Male	16.6	4.54	27.9	
8	Male	16.6	5.00	30.1	
2	Male	17.0	5.38	31.6	
4	Male	17.06	5.25	30.7	

* (The number of the whale corresponds to Table 11.)
** from Omura (1957)

The need to secure 3-4 tons of food daily, consisting of small organisms, led to the evolution of specific adaptations--the development of a huge head and mouth ("huntsman's bag"), the

[32] It seems to me that the selective ability of blue whales that prefer feeding on Euphausiaids in very deep regions, where they form very large concentrations can be explained by the necessity to get away from the competition in the upper pelagic zone in which there are many more consumers of plankton than in the depths 50-100m.

development of a huge and very efficient filter consisting of baleen plates up to 260cm in length with long, thin fringes (some up to 35cm). No other whale has such a perfect filter.

It is necessary to say that as far as right whales are concerned the size of their heads increases in proportion to their body length as they grow. In other words, the head grows faster, as shown in the data in Table 5 and Figure 34. This could possibly be explained by the whale's need for large amounts of food to maintain its energy balance during rapid growth and sexual maturation.

Data in Table 5 show the relatively smaller head size [proportion of head/body length] of male North Pacific right whales which is apparently related to the robustness of males, as well as the larger head/body length ratio of adult North Pacific right whales [than Southern Hemisphere whales]--more than 30% as well as the relatively larger dimensions of the heads of Southern Hemisphere right whales when compared to North Pacific right whales.[33]

Comparing the data on right whales to that on other baleen whales, we have to state that among other baleen whales the ratio of head/body length is much smaller. For instance, in the case of adult blue whales the ratio reaches 24%, in the case of sei whales it reaches 23%, and with fin whales 25% (see Arsenev and Zenkovich, 1955). It shows that rorquals need less food than right whales. Furthermore, the overall weight of baleen whales is much smaller than the weight of right whales of the same length as shown in Table 6.

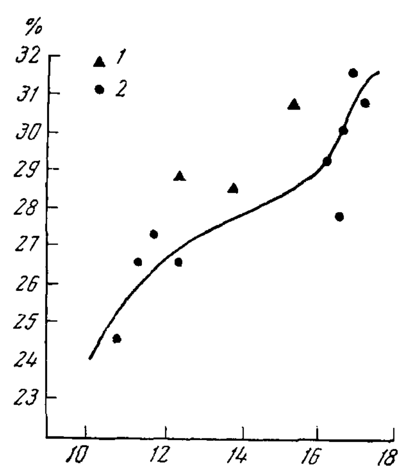


Fig. 34. The length of the head [in %] to the length of the body of right whales. 1 - North Pacific right whales (our data); 2 - Southern Hemisphere [right whales] (Matthews, 1938).

[33] We cannot explain at present the biological significance of that phenomenon and the reasons for its origin because the detailed data on southern hemisphere right whales is missing.

Table 6. Comparative data of the weight of whales of various species of approximately the same dimensions killed in the western North Pacific.

Species	Length (m)	Weight (kg)	Length (m)	Weight (kg)	Length (m)	Weight (kg)	Length (m)	Weight (kg)
Right whale	11.6*	22,866	12.4*	22,247	16.3	58,590**	17.4	106,500
Fin whale	-	-	-	-	16.4	25,342	19.0	51,802
Sei whale	11.9	11,683	13.2	15,521	-	-	19.2	45,075
Sperm whale	11.5	16,017	13.4	22,665	-	-	-	-
Sperm whale	11.9	18,029					18.0	53,364

* From Omura (1957)
** weighing incomplete.

ENDOPARASITES, ECTOPARASITES AND GROWTHS ON PACIFIC RIGHT WHALES

For 9 of the 10 right whales killed, a nearly complete helminthological analysis was conducted by A.S. Skrjabin, a cooperating scientist on our expedition. On 3 of these whales no helminths were found as can be seen in Table 4.

Generally, right whales are less infested with endoparasites than other whales. As can be seen in the survey of S.L. Delamure (1955) which studied the helminth fauna of 14 species of marine mammals, fin whales had 14 species of endoparasites, bowheads had 4 species. For southern right whales, Delamure (1957) mentions only 3 species of helminths: one cestode- *Priapocephalus grandis*, and two acanthocephalans - *Bolbosoma brevicolle* and *B. turbinella*. The above-mentioned cestode was found in the southern right whale and both species of acanthocephalans were found in North Pacific right whales. It is necessary to stress that for the *B. turbinella*, Delamure states only that it was found in the Pacific Ocean, and for *B. brevicolle* only from the Atlantic Ocean and off South Africa and South Georgia Island where, as it is known, *E. glacialis sieboldii* is not found. For this reason, the existence of *B. brevicolle* on Pacific right whales is doubtful and requires more precise identification.[34]

[34]Matthews (1938), after analyzing the internal organs of four Australian whales, found one with *Ogmogaster* spp., and with another whale *Tetrabothrius affinis*. Those helminths were not mentioned in the survey of Delamure (1955).

A.S. Skrjabin (1959) when he analyzed the internal organs of the killed Pacific right whales (lungs, heart, liver, kidneys, stomach, intestines, *etc*.), found one cestode - *Tetrabothrius ruudi* (whales #4 and #7), and one acanthocephalan--*B. nipponicum* (whales # 4-9) which had not been previously described. It was Skrjabin who noted a very weak infestation on North Pacific right whales.

H. Omura (1957) writes that although two Japanese right whales were carefully studied by members of the Institute for the Study of Whales and by workers of the medical faculty of Tokyo University, no endoparasites were found on these whales (see Table 7).

Table 7. Helminthofauna of Right Whales

Antarctica	North Atlantic	North Pacific
*Ogmogaster spp.*** *Priapocephalus grandis** *Tetrabothrius affinis***	Data are missing	*Tetrabothrius ruudi**** *Bolbosoma nipponicum**** *Bolbosoma turbinella**

* Source: S.L. Delamure (1955).

** Source: G. Matthews (1938).

*** Source: A.S. Skrjabjin--these were obtained from analysis of 9 whales killed by our expedition.

When we compare the helminthofauna of North Pacific right whales with the helminthofauna of southern right whales, we can see that there is not one helminth common throughout this area. That is, after all, natural because these populations of whales do not associate with each other and in winter they do not migrate so far into tropical waters as other whales whose winter grounds overlap. At the same time, one must recognize that the right whales live in Antarctic waters and in the North Pacific on the same [summer] grounds with other baleen whales, associate with them, and the right whale's feeding habits being the same (they feed on the same animals) could be exposed to nearly the same "collection" of helminths that are characteristic for that group of baleen whales from various regions of the world. However, as we can see (Table 7) this is not the case, which can be explained most probably by the specific differences in the "internal environment" of those whales as well as their ecology (their feeding in the upper layers of the water column, lack of aggregations, generally low density of those whales *etc.*) but what is most important--their clearly pronounced selective feeding habits.

Comparing the helminthofauna of the North Pacific right whale and of the bowhead whale we also do not find any common species, which once again proves the allopatry of these two species of whales (see Table 8), which was mentioned above in the part describing the distribution of whales.

Ectoparasites of North Pacific right whales were represented only by the whale lice from the family Cyamidae. However, the bulk of the material which was collected about this family has not been processed up to now. Making a very careful inspection, no other ectoparasites have been found on the North Pacific right whales. We did not find *Coronula* spp. or *Penella* spp. or any other living organisms that are characteristic ectoparasites of large whales, including the right whales of Antarctica, which is mentioned by Matthews (1938) in his work.

Table 8. Comparison of the helminthofauna of the bowhead and North Pacific right whale.

Bowhead whale*	North Pacific right whale**
Lecithodesmus goliath	*Tetrabothrius ruudi*
Phyllobothrium delphini	*Bolbosoma nipponicum*
Crassicauda crassicauda	*Bolbosoma turbinella**
Bolbosoma balaenae	

* from Delamure (1955).
** from our expedition.

Attention should be paid to the growth on Pacific right whales of diatom films. It is true that the diatoms were noticed only on one of the killed whales (whale #4), but still this fact represents a great interest because the growth of diatoms on young North Pacific right whales has not been previously mentioned.

The processing of a sample taken by myself which was undertaken by the worker of the expedition L.B. Kljashtorin disclosed the existence of only one species of the diatom, *Cocconeis ceticola* f. *typica*.

The distribution of the diatoms on the whale was uneven. A slightly greenish, very thin and very fine thin film was more apparent on the lower jaw, in the region of the chin, on baleen plates, on the lower surface of both pectoral fins, on the back, around the place where the dorsal fin would be, and on the sides near to that place. In addition, the diatom film was found on the peduncle at the base of the flukes.

In light of the latest research on growths on North Pacific whales (see Usachev 1940, Nemoto 1956), it is quite interesting to note that together with the described *Cocconeis ceticola* var. *arctica* in the North Pacific (described by P.I. Usachev, 1940) there is a second form, *C. ceticola typica* which was noted also by T. Nemoto (1956), considering it as the main zoophyte which grows on cetaceans in this region. It is necessary to mention as well that T. Nemoto did not know about the work of P.I. Usachev.

ON REPRODUCTION AND GROWTH OF PACIFIC RIGHT WHALES

There are very few data available about the cycle of reproduction and growth of North Pacific right whales. So, A.G. Tomilin (1957) in the most recent summary about cetaceans writes: “as the analogy with other species of baleen whales we can assume that the pregnancy of the Pacific right whale is not longer than a year and that birth takes place in warm waters during winter.”

Out of the ten Pacific right whales which we killed five were females; two whales--one female and one male--were immature, two females were pregnant and two were lactating. In spite of a very little amount of factual material on the birth and growth of embryos I allow myself to present a first and very preliminary hypothesis.

Females

As is shown in the data in Table 9, female whale #1, taken on 17 May 1955 was found with an embryo of 190 cm length. With female #10, killed 28 August of the same year, a 440 cm embryo was extracted from the right horn of the uterus. The difference in length of these two embryos was 250 cm.

If we assume that the mating of [right] whales, and thus conception, occurs during a short period of time --and such assumption I consider to be valid and reasonable because data on other baleen whales show that the mating and birth seasons have clearly defined peaks of short duration[35], then we can assume that the difference in the length of embryos is the result of the growth of the second embryo during the time between the dates the first and second females were killed, that is between 17 May and 28 August (103 days). In this way, if we accept the above assumptions, the average increase in length of the embryo during that (summer) period would be: 250 cm [divided by] 103 days = 2.42 cm/day.

[35] It is necessary to stress that Collet (1909) in the work which was conerned with North Atlantic right whales, writes that 12 pregnant fremales that were killed in June and July 1907 in the Hebrides had an embryos of more or less the same dimension -- from 1 to 1.5m. That fact confirms the existence of a synchronized breeding season among those whales as well.

Table 9. Data about female North Pacific right whales killed in 1955 near the Kuril Islands.

Whale # (from Table 1)	Date Killed	Length (m)	Sexual state, lactation	Embryo length (m)	Notes
1	17 May	18.3	pregnant, left ovary = 68x38cm, weight 8725g, corpus luteum on it.	1.9	
3	19 June	16.3	lactating	-	
5	22 July	17.4	lactating, right ovary = 4.5kg, left = 6 kg. corpus luteum 10x9 cm on left ovary, size of ovary = 63x35 cm..	-	nursing male killed, length 10.75m. see Table 11, whale #6.
9	11 August	11.35	immature, right ovary = 25x7 cm, weight 270g; left ovary 28x8cm, weight 420g, uterus infantile.	-	
10	28 August	17.8	pregnant. large corpus luteum on right ovary. embryo in the right horn of uterus.	4.4	

The average size of sexually mature females = 17.45m.
Average size of all female whales = 16.22m.z

This figure is very close to that which we found when calculating the growth of newly born North Pacific right whales while nursing--3 cm[/day]. Even considering that in our specific case there could be a difference of several days in the dates of mating, we must admit that the coincidence of the figures is noteworthy, showing the closeness to the real values of the embryonic and post-embryonic growth of these whales. The growth of embryos in the case of whales (and other mammals as well) during the whole period of their development goes undoubtedly at a nonuniform rate (in absolute values). It is known that during the first period after conception, the growth of an embryo is slower while later it increases. Of course, on average, the embryonic growth of cetaceans can be somewhat slower than the growth of the newly born during the first period of their nursing.
Using this derived figure of the daily increase in length of embryos we shall now try by means of extrapolation to determine the dates of mating of North Pacific right whales for both our cases.

For the first embryo we receive: 1,900 mm [divided by] 24.2 mm/day = 78 days. Counting back 78 days from 17 May (the date the female was killed) we find that the mating of a female and the conception of the embryo fall at the end of February.

In the case of the second embryo we obtain 4,400 mm [divided by] 24.4 mm/day = 181 days. Counting back from 28 August (the date the female was killed) 181 days we find that conception also falls at the end of February. Assuming that during the first period of embryonic development its growth was slower, and for this reason it did not equal 24.2mm in a day, we can assume that in fact the mating took place a little earlier, probably in December-January.

As far as mating is concerned, it is obvious, the estimated range of dates is more or less correct because it confirms our calculations extrapolating backward from both the dimensions of embryos and the size of newly born. As far as the birth seasons is concerned here we can see certain differences of opinion..

If we accept that calves are born at the length of 6 meters, and for this we have several reasons (observations in nature of right whale calves size 5.5-6 m in size and near-term embryos of approximately 6 m long) and need not rely on the "inverse" extrapolation which we used in connection with embryos and the neonates; but by calculating the length of the birth seasons, departing from the further growth of embryos we can get a somewhat different picture.

Let us take the embryos of 1.9 and 4.4 meters (from females #1 and #10 from Table 9). If the average daily growth of those embryos equals 2.42 cm and if newborn whales are 6 m long, then the first embryo of the 1.9 m length should be born 169 days after the day when we took our measurements (17 May): 600 cm - 190 cm = 410 cm; 410 cm [divided by] 2.42 cm[/day] =169 days, in other words, the birth date should be in the middle to end of November.

Our second embryo at the moment of the killing of a female 28 August was 440 cm long. Using the same method described for the first embryo, we came to the assumption that this embryo should be born after 66 days, that is the beginning of November.

In this way, taking into consideration calculations made, we get for North Pacific right whales two birth seasons--November and January and one season of mating--December--January. It seems to me that those findings are very close to each other. The problem is that the "daily growth rate" is a value which is somewhat variable. As was said before, during the embryonic growth rate is not constant and regular. It relates especially to the absolute increase in the linear size of the embryo which was slower at its beginning stage of development which is confirmed by the known data on other mammals. Taking this into consideration then when we calculate the average daily increase of the embryo we take the summer season, that is the second half of the period of pregnancy of the Pacific right whale, when the development of the embryo progressed at a faster rate and when the pregnant female was eating very well (contrary to the beginning stage of pregnancy which took place in winter, in conditions of either complete or nearly complete fasting), we must presume that the figure which we obtained as an average daily increase in length (namely 2.42-3.0 cm) appears to be somewhat high. Adjusting for this apparent bias, then the calculated dates of mating and birth of North Pacific right whales coincide very well. Probably, we shall not make a mistake if we state that North Pacific right whales are born in November-December (and not in January) while mating falls into December-January, the term of pregnancy being 11 to 11.5 months.

The calculations which I made on the growth of fin whale embryos killed in the western North Pacific with a much larger sample give for the summer period the same figure of daily increase of embryos and of the newly born during the period of the nursing--from 2.6-3.1 cm. This coincidence is not accidental and it seems to us it confirms to a certain degree data about the embryonic and post-embryonic growth of Pacific right whales, although based on smaller amount of material. Quite analogous data that completely coincide with ours were obtained by the Norwegian scientist I. Ruud (1937) who proved that the average daily increase in the newly born fin whales during the period of nursing equals slightly over 3 cm and the daily average increase in weight reaches 60 kg.

It is necessary to emphasize again, that the above hypothesis should be looked upon only as the first and preliminary working hypothesis for at this stage of research the material was insufficient for reaching final conclusions.

Out of five Pacific right whale females killed in 1955, one was immature and four females were adult, two of which were pregnant, and two were lactating.

Most probably, this is how the reproductive cycle occurs in North Pacific right whales: mating takes place in December-January, pregnancy lasts 11-11.5 months, birth falls within the months November-December, the young are nursed for 6-7 months (to July or August). After the young are weaned, the female rests for several months) (until December-January) which is a period of no feeding, and preparation of organism for the new pregnancy. In this way we can only presume that the right whales give birth to one calf once in two years and that they do not differ as far as their cycle of reproduction is concerned from other baleen whales (Mysticeti).

When we consult published data, we find that Matthews (1938) reports near Saldanha Bay on the coast of southwestern Africa, a female Australian right whale was killed with a calf on 26 August. The calf was also killed and was a 6.5 m female with only milk in its stomach. Matthews shows that the calf had only recently been born.

As it is known, the Antarctic whales migrate north into warm waters from the Antarctic feeding grounds at the end of March and April. It follows that birth occurs in the warm waters (of southern right whales) in the southern subtropical regions during the Antarctic winter, that is during June-July.

Chittleborough (1956) observed on 2 August 1955 a female Australian right whale with a calf on the coast of western Australia (at Frenchman’s Bay, near Albany). The whales were very calm and allowed the ship to approach them closely. According to Chittleborough’s measurements, the calf was 5.5-6.0 m long. Allen (1980) describes the embryo which was taken out of a female right whale as being 6.0 m.

These facts again confirm that the birth of right whales takes place in the warm waters during winter, and that calves are born at the length of 5.5-6.0 m. As far as the season of reproduction is concerned, there are no differences between right whales of the southern and northern hemispheres; both populations produce their young during winter: whales in the southern hemisphere in June or July, whales of the northern hemisphere in November or December. At the same time, there are no differences in the dimensions of the newly born calves. The observations done on newborn southern right whales 5.5-6.0 m long confirm my assumptions about the length of newborn North Pacific right whales, as well as the calculations of their daily growth in the neonatal period during the period of nursing from birth until July or August, *i.e*. 6-7 months. Later, when the calves are weaned, their growth slows sharply. This assumption is based on the following data. On 22 July 1955, a right whale was killed by our expedition; it was 10.75 m long (whale #6), and it was in the process of being weaned. In its stomach were both milk and a small amount of *Calanus*. The male calf killed by the Japanese on 30 July 1956 (Omura, 1957), 11 months after our whale was killed, was 12.40 m. Considering that the mating and birth of right whales occurs mainly during the short period established above, it follows that we can assume that both killed calves were of the same year-class--both born in the winter of 1955. Accordingly, the growth in length for 11 months after weaning made altogether only 165 cm, or 15 cm a month.

At first glance, such a sharp decrease in the growth rate (from 90 cm/month to 15 cm/month) seems to be somewhat improbable. However, it is necessary to take into consideration that these 11 months include all winter months (November - March), when the whales do practically no feeding (Klumov, 1955). That period also includes the spring months (April and May) as well when the growth of zooplankton in the western North Pacific was far from maximum and the productive feeding of whales [in summer] has not begun after the winter fast. For that reason I considered it possible to accept that calculation as an initial working hypothesis. It seems to me clear that during winter the whales do not grow. In general, the growth of whales takes place during the period of maximum feeding, that is in summer (June- October).

Ch. Ash (1953) reports that, on average, humpback whales that live in summer in the Antarctic, gained weight at a rate of up to 150kg/day between 1 January and 17 February, that is in the 48 days of intensive feeding! It is without any doubt that such increase occurred not only to the body length, but also to the weight and thickness of the blubber, that is to the accumulation of energy reserves for the winter fast in warm waters.

Returning to the question of the reproductive cycle of North Pacific right whales, I would like to mention that the materials we collected on the morphology of the ovaries have not been analyzed yet. However, one observation should be mentioned.

The immature female right whale (#9), 11.35 m long, was apparently being weaned only in July (see section on feeding *infra*.), had ovaries sharply differing one from each other both with respect to their dimensions as well as their weight (see Table 9). The asymmetry of ovaries of cetaceans is a well known feature, and was described in the literature (Nikolskij 1936 *et al*.). However, in the case of North Pacific right whales it is here recorded for the first time. As it is apparent from the data that were given in Table 9, the asymmetry of ovaries appears not only in the immature female (#9) but in the adult one (#5) as well, although in the case of that female on the larger ovary a large corpus luteum was found which prevented the determination of the extent of the asymmetry.

Ovaries of female whales of the southern region that were killed by our expedition were within the range of 25x7 cm up to 68x38 cm, and their weight ranged from 270-8,725g, that is dimension nearly three times (2.7 times) and in weight more than 30 times bigger.

According to the data of our expedition that I processed, in the case of fin whales killed near the Kuril Islands, the ovaries ranged from a minimum of 11cm to a maximum of 47 cm, approximately a fourfold increase; the smallest ovary was 50g and the largest 1,500g. It is apparent that the weight of the ovaries of immature and adult females was at a ratio of 1 to 30.

The data for Odonotocetes fall within approximately the same range of values. For example, sperm whale ovaries were within the range of 10-32 cm length (see Chuzhakina, 1955), that is a threefold increase, and the weight had a range of 10X from 85 to 860g. In 1955 and 1956, ovaries were found in several females that were heavier than had been previously recorded, one female was 1050g and two females were 950g each and one female was 910g. If we take the maximum according to these females, then the difference in the weight of the ovaries between adult and immature individuals will fluctuate 10-12 times.

With immature beluga females (*Delphinapterus leucas*) the dimensions of the ovaries fluctuate within the following limits: in size from 5-7cm, and in volume from 5-10cm^3; with the adult females: in size from 7-15cm and in volume from 15-135cm^3 (Nikolskij, 1936). In other words, in size maximum three times and in volume 27 times.

In this way we can find a certain regularity in the dimension and weight of ovaries of cetaceans. The maximum dimensions of ovaries of adult females are 3-4 times bigger than the minimum dimensions of ovaries of immature females, while in volume (or in weight) they are 1-30 times bigger. Within these ranges fall even the North Pacific right whales.

As our fin whale data show, the puberty of female baleen whales (Mysticeti) takes place, more probably at the length and weight of ovaries lying somewhere around the mean of the maximum and minimum weights and sizes. For female North Pacific right whales it [puberty] will occur when the ovaries are approximately 40 cm long and approximately 2kg in weight, at a body length of 14-14.5m; for fin whales according to our data it [puberty] will occur when the ovaries weigh between approximately 500-550g and are about 25-27cm long, and the whale is 18.3-18.6 m long.

Males

As is apparent from the data in Table 10 we had five male right whales at our disposal, including one immature animal.

The average length of the four sexually mature males was 16.81m , *i.e* somewhat less than the average length of the four adult females--17.45 m. The average length of the five males was 15.6m, *i.e*. smaller than that of the five females whose average length reached 16.22m (see Table 9). The above are consistent with the data on all other baleen whale where on average females are always somewhat bigger than males.

<u>Table 10. Dimensions of the testes of male right whales killed in 1955 near the Kuril Islands.</u>

Whale No. (see Table 1)	Date Caught	Total length (m)	Testes				Notes
			Size (cm)		Weight (kg)		
			right	left	right	left	
2	1 June	17.0	-	-	-	-	
4	13 July	17.06	177x75	173x70	300	294	
6	22 July	10.75	36x11	-	0.820	-	weight without epididymis
7	10 August	16.6	210x73	205x73	317	200	
8	10 August	16.6	-	-	255	-	weight without epididymis

The average size of adult males (4 individuals) = 16.81 m.; Average size of all males = 15.60m.

After dissecting the 10.75m male (#6), we found there was still milk in his stomach. It follows that it was a suckling born that year, obviously an immature whale. The dimensions of testes were 36x11cm, and the weight of one testis was only 820g. That testis was 365 times smaller than the weight of one testis of a 17.06 m adult male mentioned in Table 10 (#4).

As is apparent from Table 10, males that reached the size of 16-17 m were sexually mature; the size of testes of these animals were nearly 200 cm (on the long axis) or more (up to 205-210 cm) and approximately 75 cm in cross-section; as far as the weight is concerned, they were nearly 300 kg each. Two testes had the weight of more than half of a ton.

If we summarize the data found in the literature we can compile the following list of males (from the Pacific) for which there are clear data that confirm their sexually immaturity:

10.75 m - our data
12.40 m - Omura (1957)
12.49 m - Matsura (cited in Omura, 1958)
13.60 m - Matsura (cited in Omura, 1958)

We can assume that the puberty of male North Pacific right whales starts when they reach the size of 14-15 m. It is apparent that at that time the size and weight of testes greatly increases, approaching the length of 150 cm along the long axis and a weight of 150-200 kg

Hystological analysis of testes of right whale #7, killed in August 1955, showed that the process of spermatogenesis was quite active that month. It is true that other materials (as far as the testes are concerned) have not been processed yet, and we do not have preparations at our disposal that were prepared from the right whales killed in June and in July.

To my knowledge, spermatozoons of North Pacific right whales have not been described anywhere in the literature, and for this reason Figure 35 is presented from which we can evaluate their form and structure. The figure was drawn according to the preparation that was done by I.A. Zelenova from a dissected piece of testes taken from right whale #7 killed 10 August 1955.

Figure 35. Spermatozoon of North Pacific right whale.

While analyzing all data obtainable about right whales which I had at disposal, looking through literature and the factual material as well as my own journals and records that were made during our work in the field by the expedition, I reached a specific impression that the right whales of all three local stocks that populate the North Pacific (the Okhotsk, the Pacific Ocean, and the North American stocks) are much bigger than their nearest relatives--right whales of the southern hemisphere and North Atlantic. Among the 10 right whales killed on our expedition in 1955 were three whales longer than 16 m; four whales longer than 17 m, and one whale longer than 18 m. And once, when the scientific research was being done from the expedition ship *Krylatka*, we observed at sea a huge right whale which, according to all whalers and scientists present on the ship, was at least 20 m long, and possibly it was 21-22 m long.

Comparing these data with [data on] the length of whales killed in the North Atlantic (see Collet, 1909), we find that the biggest [North Atlantic] males reach 14.3-14.6 m and females reach 14.9-15.2 m. In addition, those large individuals were the largest examples while the [average length] of all the 44 whales described by Collet (1909). The average length of males (n=24) was 13.64 m, and of females 14.08m (n=20). Collet reports one case of a large female killed in the waters of Iceland in 1903 which was 16.4m long.

Two other large North Atlantic right whales have been described: one female 16.15 m long (True, 1904), and one female 16.46 m long (Andrews, 1908).

Matthews (1938) studied five southern right whales. One whale was a newborn 6.5m long and other whales were: males - 12.32, 13.54 m; females - 14.4 and 15.23 m. The latter female was apparently old - on one of her ovaries were 7 traces of corpora lutea and on the other 6 corpora lutea, including one large one. That female was accompanied by a newborn calf.

Chittleborough (1956) observed a female right whale with a calf on the Australian coast which he visually estimated from the boat as being "...approximately 55 feet..." *i.e.* approximately 16.5m long.

Neither in the North Atlantic nor in the Antarctic, has anybody killed or observed right whales as large as[the ones] we killed or had the opportunity to observe in the Pacific Ocean: 16.6, 17, 18 and even 20-21 m.[d]

It is quite natural that North Pacific right whales must be larger than whales from the North Atlantic or the southern hemisphere during puberty. In any case, we have certain basis on which to insist on such an assumption.

Collet (1909) stated that all 12 females killed in the Hebrides in June and July 1907 were pregnant. The size of those females was as follows: 13.4, 13.5, 14.0, 14.3, 14.4 (two whales), 14.6 (two whales), 14.7, and 14.9 m. The dimensions of embryos in the case of all the females were approximately the same--ranging from 1 to 1.5 m. It means that mating of all those females took place at the beginning of 1907. In this way, the North Atlantic female whales were already sexually mature at a length of 13 m or slightly greater, which in no way coincides with our data. We presume that North Pacific right whale females reach sexual maturity and are able to reproduce when they are no less than 14-14.5 m long for females and 14-15 m for males.

BODY PROPORTIONS OF NORTH PACIFIC RIGHT WHALES

All ten whales killed for research in 1955 in the Kuril Islands, as well as the embryos, were measured by the researchers mentioned in the introduction of this study and by the author. The results of the measurements of whales are listed in Table 11, and the proportions of the separate parts and the length of the body of right whales is shown graphically in Figures 36-38.

In the beginning, we accepted the scheme developed by the Discovery Committee, but this scheme was modified by [adding] further measurements, as is apparent from Table 11.

In addition to our own materials, we used the data on two North Pacific right whales killed by Japanese whalers (Omura, 1957) close to the coast of Japan. For comparative purposes, data from Matthews (1938) were used as well, namely his description of right whales killed in the Southern Hemisphere. Also used were the measurements on whales killed in the North Atlantic published by True (1904).

The comparison of all these data showed that North Atlantic and Southern Hemisphere right whales lack sharp differences in proportions. However, the geographic isolation of those whale populations, formation of local stocks by each population inside this range (for example, in the North Pacific, the two stocks within the waters adjacent to the Asian mainland), and some ecological and morphological differences enable us to consider those geographically individualized populations as geographic subspecies. In this respect I do not differ from the view

[d] [ed. – note that the larger animals referred to are based on shipboard estimates of living animals. No dead right whale has been observed longer than 18.3 m, see Tables 11 and 12.]

of J. Kellogg (1940) or Tomilin (1957) who divided right whales of the genus *Eubalaena* into three species (Kellogg, 1940) or subspecies (Tomilin, 1957): *E. glacialis glacialis* (North Atlantic), *E. g. sieboldii* (North Pacific),

Figure 36a. Length from tip of rostrum to front edge of blow hole [as a percentage of the whale's overall length].

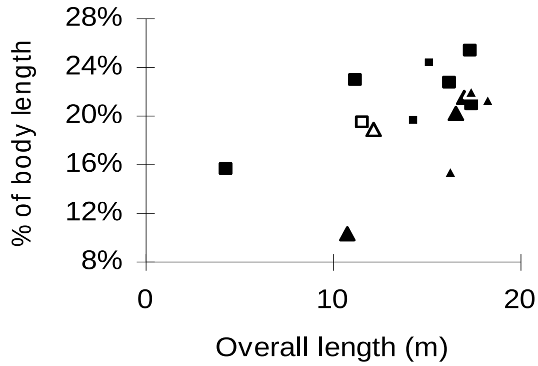


Figure 36b. Length from the tip of rostrum to corner of the mouth.

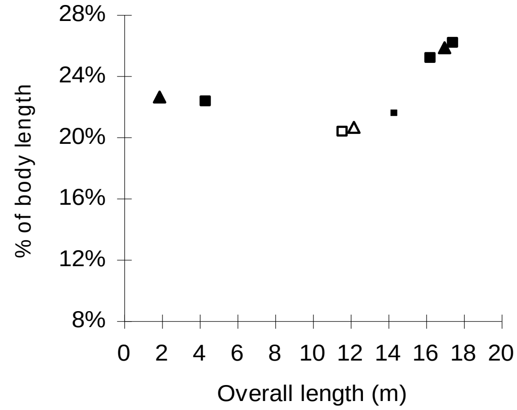


Figure 36c. Length from the tip of rostrum to center of the eye.

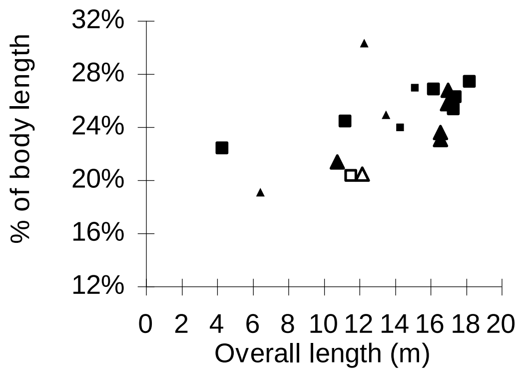


Figure 36d. Length from the tip of rostrum to the end of the pectoral fin.

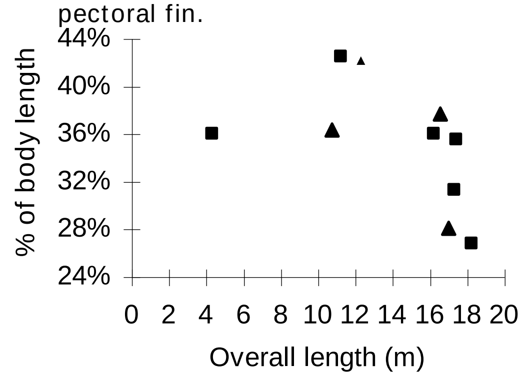
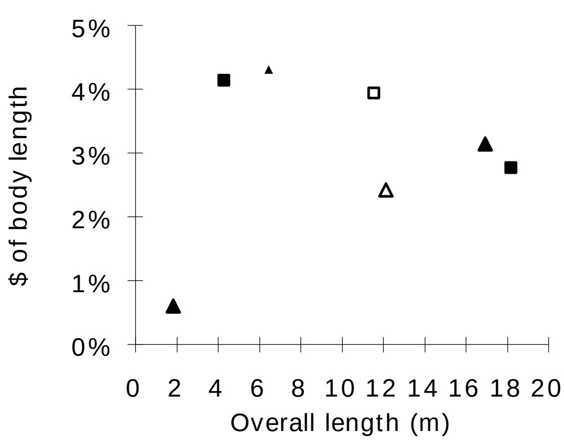


Figure 36e. Length from the center of the eye to the center of the ear.



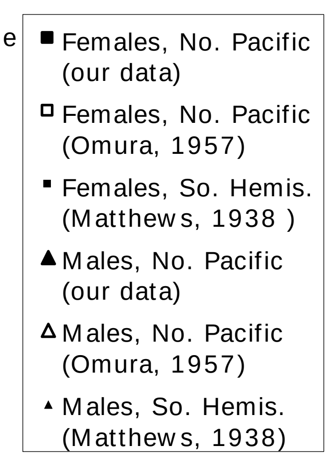


Figure 36f. Width of the eye .

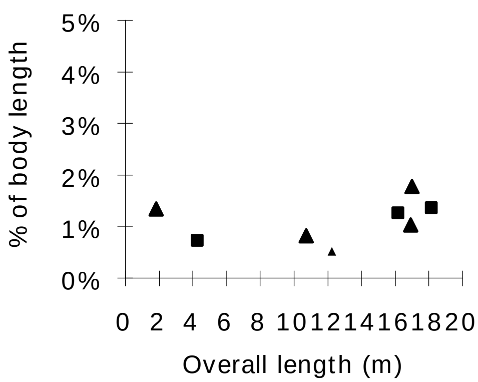


Figure 36g. Length of the nostril

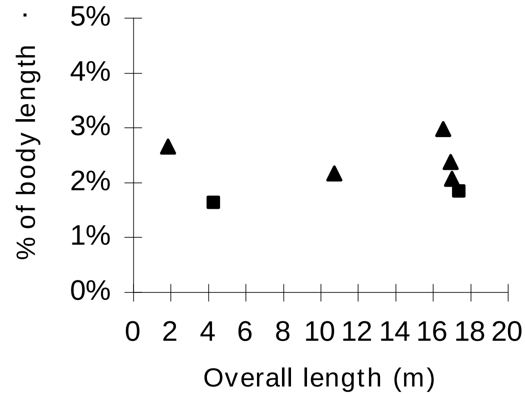


Figure 36h. Maximum distance between nostrils (anterior).

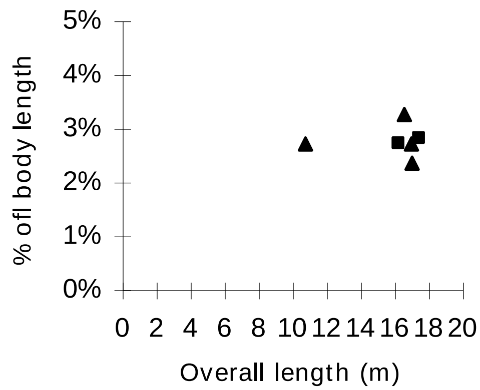


Figure 36i. Length of separated head from tip of rostrum to the occipital condyle.

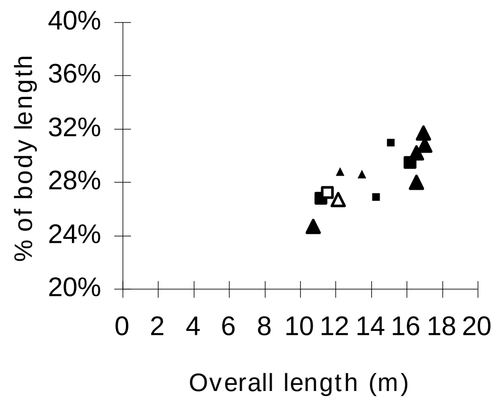


Figure 36j. Maximum height of the whalebone plates.

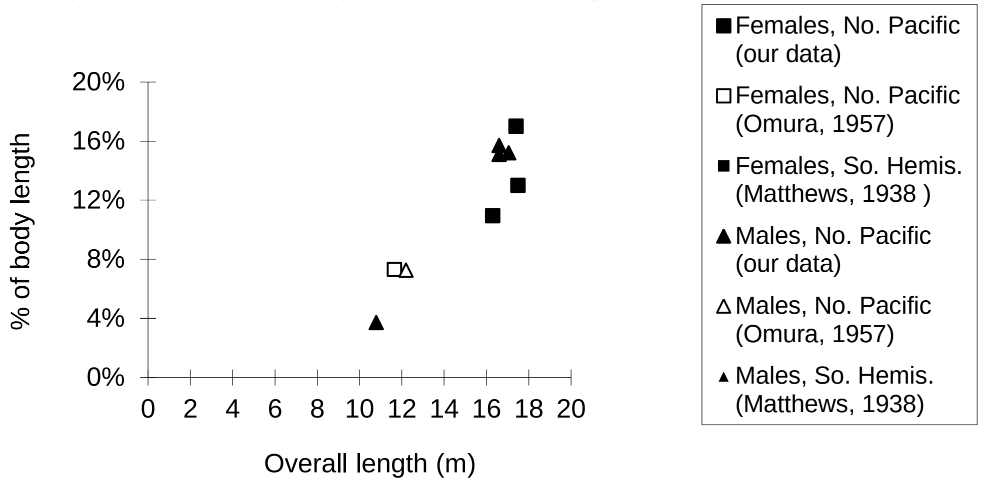


Figure 37a. Length of the pectoral fin from pit to the tip.

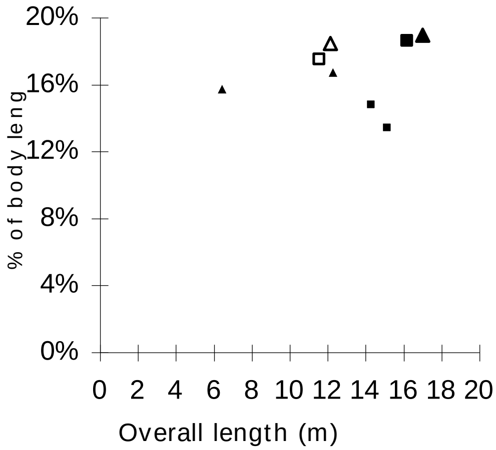


Figure 37b. From the front lower edge of the pectoral fin to its rear edge.

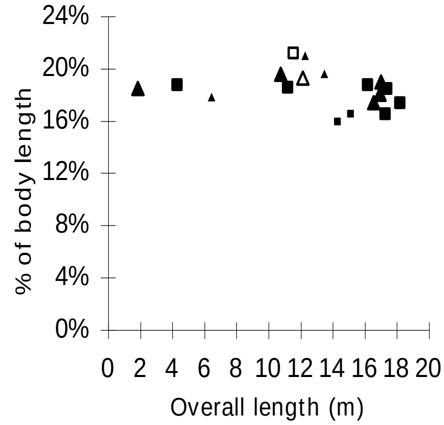


Figure 37c. Length of the lower edge of the pectoral fin to tip.

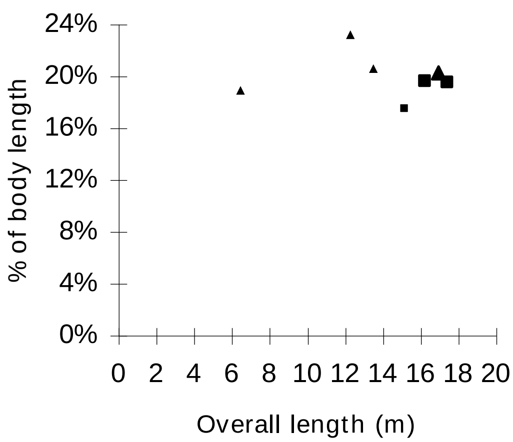


Figure 37d. Maximum width of the pectoral fin.

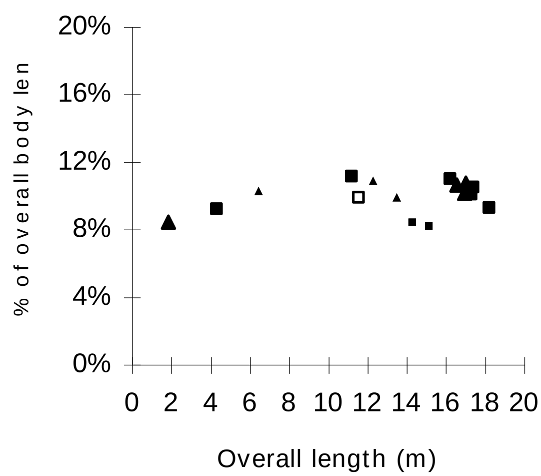
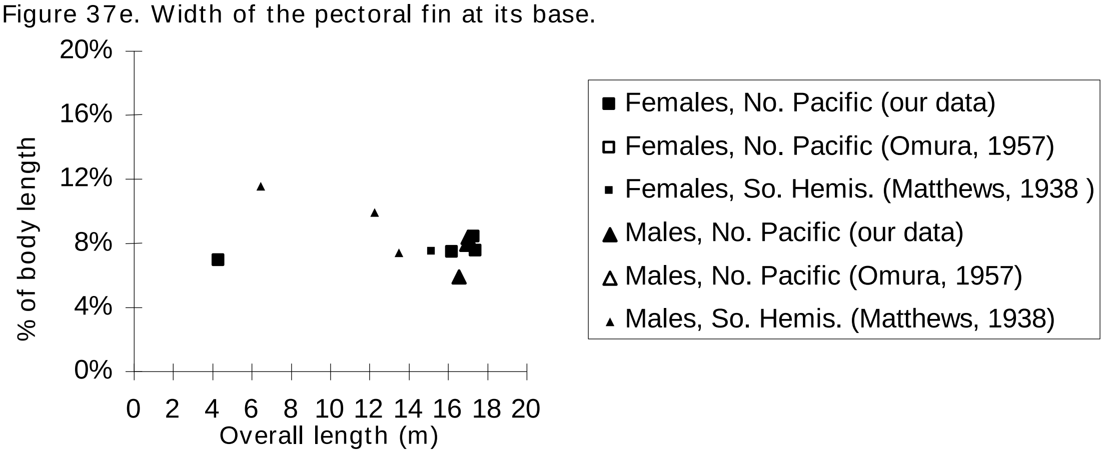


Figure 37e. Width of the pectoral fin at its base.



and *E. g. australis* (Southern Hemisphere). As far as the validity of such species as *E. antipodarum*, it is possible that this whale is identical to the Australian right whale (*E.g. australis*), but the populations of Southern Hemisphere right whales are apparently

divided into two local stocks that do not mix with each other. However, at present we do not have any data for the final resolution of this issue.

Recognizing the described split of right whales into three subspecies, I would like to stress that there is no need that each of these populations has a full taxonomic name [*i.e.* classification as a full species] to separate it from the representatives of other populations of that species. These are "geographic" or "ecological" subspecies that developed as a result of the [different] conditions of their habitat [with] only minor differences from each other--characteristic ecological features and slightly different, but distinct, morphological features. These populations are distinguished also by their biological rhythms and by other peculiarities. However, those differences have not evolved to the point that each of the three populations should be considered a "good" species, as it is considered by R. Kellogg (1940) because similar environmental conditions and apparently only recent isolation [from the other populations], have not yet caused sufficient adaptations. But still, putting aside the above mentioned similarities, some differences can be discerned.

For example, Matthews (1938) wrote that soft palate of Southern Hemisphere right whales is of a light pink, whitish pink, or even white color. [However,] not a single one of the 10 right whales killed in this expedition in the western North Pacific, nor the two North Pacific right whales studied by Omura (1957) was observed with either a pink or white palate. In the case of all our right whales, the palate, at least its rostral portion was of a thick black color. This observation is equally true for young and adult individuals. In general, it is necessary to mention that the soft palate is a good systematic criterion for all baleen whales (Mysticeti) because it varies in color and form only inter-specifically. Within one species, I have never observed any deviations from the established form and coloring although I paid special attention to that feature.

As was already mentioned, the existing data about the body length of North Atlantic, North Pacific, and Antarctic right whales show that North Pacific whales are the largest. In a similar manner, the three populations have other noticeable differences.

Starting from the above example, we assume that if any researcher manages in one season to study carefully the coloring, dimensions, shapes of separate parts of the body and other morphological signs of newborn and immature right whales of the North Atlantic, the North Pacific, and the Southern Hemisphere and at the same time obtain new biological materials in connection with the feeding, reproductive periods, dimensions of whales during puberty, distribution, formation of local stocks, body proportions, coloring, behavior and other signs, as well as [making] the new observations, that such a researcher would find many smaller differences between the above mentioned three subspecies.

The results of analysis of proportions of the separate body parts of right whales enable us to divide obtained indices into three categories:

(a) proportions of the body that change with sex (sexual dimorphism);

(b) proportions of the body, that change in connection with growth, and

(c) proportions of the body that stay approximately constant between sexes and between age groups.

To the first group belongs the smallest number of measurements, associated mainly with changes in the proportions of the head. As was already shown, the head of right whales grows faster than overall body length (see tables 5, 11 and Figure 36i). At the same time there little difference in the growth of the heads of males and females, [although] with males the head is proportionately slightly smaller than with females. Quite clearly, although admittedly based on a very small sample, a difference can be observed between males and females regarding the ratio of the distance from the center of the eye to the center of the ear to the overall body length (see Table 11, measurement 7, Figure 36e). Noteworthy changes in proportions occur as well. In the case of an embryo male, 1.9 m long, that index was 0.58%, whereas in the case of an immature young male it increased fourfold (up to 2.4%) and with a 17 m adult male it increases sixfold (up to 3.1%). We observe a different picture in the case of female whales: with the 4.4 m embryo the index is at its maximum and reached 4.3%; with the young immature 11.65 m female, the index slightly decreased to 3.9%, while with the fully developed adult female it fell even further--to 2.7%. In other words, with female whales, to a greater degree than with male whales, the front part of the head (rostrum) --the lower and upper jaw and the size of the mouth grows faster, the explanation of which was given already above in the part dealing with the feeding habits of whales.

The observed pattern of growth of the right whale's head is confirmed [both] in the ratio of the distance from the tip of the rostrum to the front edge of the blowhole [:body length] and also [in the ratio of the distance] from the tip of the rostrum to the eye: body length (see Table 11, measurements 3 and 5, Figures 36a and c). The growth rate of the head is smoother [i.e. more constant] for females than males, the latter grow slower and one can observe a sharp increase in that ratio only after adolescence (see Figure 36c). A similar pattern is found in the increase of the ratio of the length from the end of the muzzle to the end of the pectoral fin to the overall body length (see Table 11, measurement 6, Figure 36d). The relation of that index to the growth of the body only once again confirms the irregular increase of the front part of the head in comparison with the trunk of the whale. As is apparent from Figure 36d, even according to that criterion there is a smaller difference in the growth and relative dimensions of the head with males than females of the whales described.

One proportion of the whale's body varies with [the individual's] sex: the distance from the center of the anal slit to the center of the genital slit (see Table 11, measurement 27, Figures 38d and e. In females, that proportion does not change as they grow remaining relatively constant; but in males, the genital slit increases in length and to a certain extent extends towards the anal slit as a result of the development and rapid growth of the testes, as well as the growth of the penis (see Table 11, measurement 30), which in adult animals reaches huge size (up to 3m) (see Figure 38e). In female whales, this ratio remains constant (see Figure 38d) during embryonic development (4.1%), during the postnatal period in immature (4.7%) and in adult individuals (4.3%, 4.5%).

To the second group of body proportions that change with the growth of whales belong the previously mentioned proportions of the head (see Table 11, measurements 3,

Figure 38a. Span of the flukes.

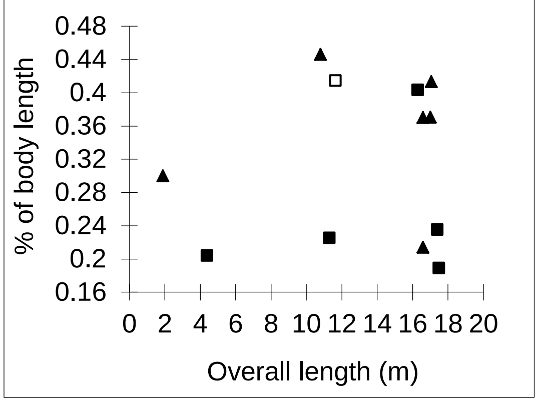


Figure 38b. From the center of the anus to the fork of the flukes.

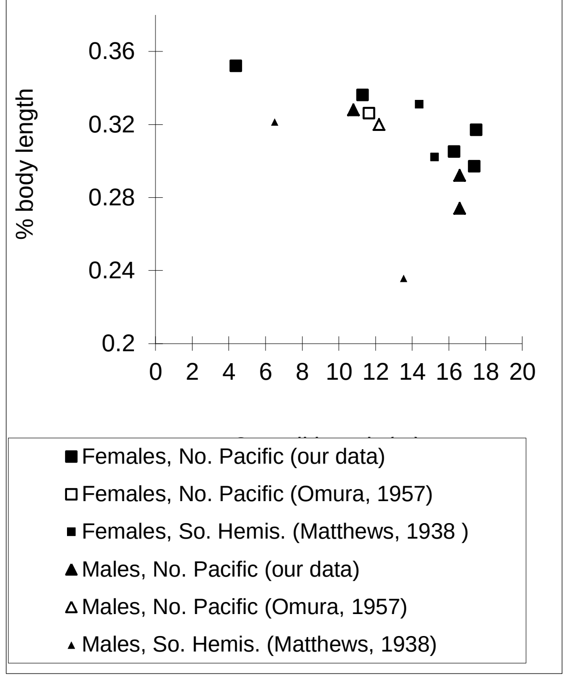


Figure 38c. From the navel to the fork of the flukes.

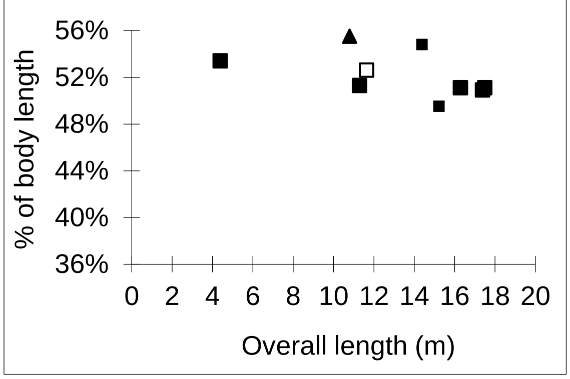
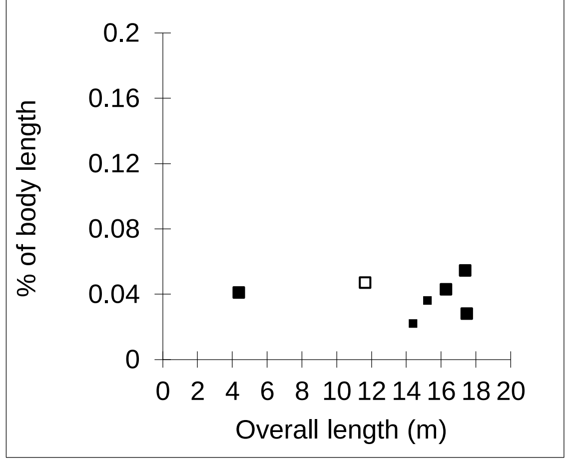
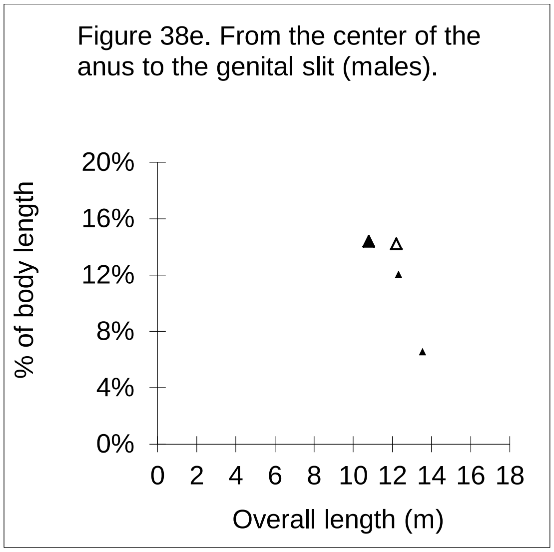
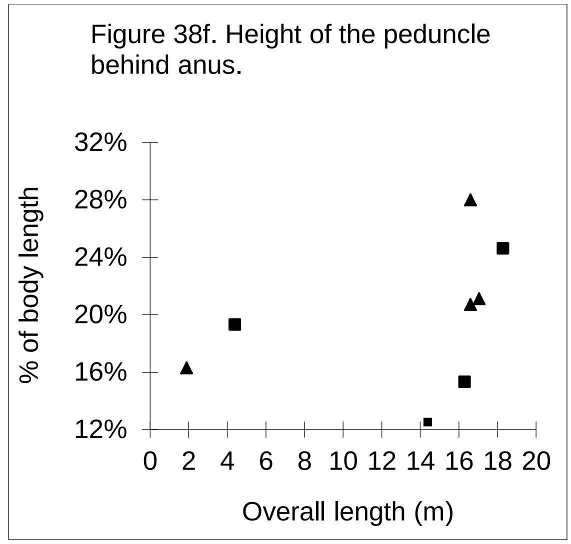


Figure 38d. From the center of the anus to the genital slit (females).







5-7, 16), where there are some differences in the growth of separate sections between females and males and as well several proportions which are not connected in any way with the gender of the animals. Among these are the ratios of the growth of baleen plates that were calculated from the largest plates (see Table 11, measurement 14, Figure 34j). In the growth of a whale from birth, through adolescence to sexual maturity and after that full physical development we see ever a relative increase [in number] and size of baleen plates. But apparently after the beginning of adolescence the growth of baleen stops although the whales go on, even if very slowly, to increase their size until they reach a complete physical maturity. At that stage, during the transition of the whale to full physical maturity--the proportion of the length of baleen plates relative to overall body length begins to decrease as is shown in Figure 36j. In addition, it is necessary to consider that the baleen plates are worn down over time and as a result become shorter.

To the investigated group of proportions belongs even the relation of the overall body length to the height of the peduncle immediately behind the anal slit (see Table 11, measurement 31). Although we have few data, still we can see on the graph (see Figure 38i) quite clearly the increasing value of that index from the embryo to the adult animal.

The third group of proportions that change neither with the growth of whales nor with their gender includes measured and calculated proportions in the whale bodies. To this group belong measurements 10-13,17-21 and others (see Table 11), shown on Figure 36f, g and h, and in Figure 37a, b, c and others. Increasing in its absolute value with the growth of whales the relative value of those indices remains at the same level during the whole life of animals, beginning, as it is depicted in mentioned figures, from the embryo stage and ending with the stage of the complete physical development. Those indices, especially those not that did not vary by sex nor during growth, must have substantial value in studies of the comparative taxonomy of right whales from the North Atlantic, the North Pacific, and the Southern Hemisphere. When we study them, at least some of them (Figure 37c and others) carefully, we can observe the differences in the three mentioned populations of whales, but the material for the generalization is so small that we can hardly make any final conclusion at present.

COLORING OF NORTH PACIFIC RIGHT WHALES AND BODY PROPORTIONS

The coloring of North Pacific right whales is usually of two extreme types with many intermediate types. One type consists of completely black individuals without any white marks on the body, or those with [only] a rather small white spot in the area of the navel. Sometimes two stripes or separate white spots extend from this white spot to both sides (on the belly).

The second extreme type of coloring is characterized by the wide distribution of the white color on the body of a whale where the white marking takes at least half, or approximately half of the body. In that case, the white color is distributed not only over the area of the belly, but goes over even to the sides.

Between these two extreme types of coloring are intermediate types characterized by different degrees of white and black coloring; generally, black whales are found more often than the whales of the second type (those with the wide distribution of white color), but mostly we encounter black whales with a small spot of white color in region of navel. It is this coloring which should be considered as typical for the species [in the North Pacific].

In this paper the description and photographs of two North Pacific right whales are presented. The description was taken from our journals done in the field at the time of observation. One right whale (#4) was delivered for dissection to the Paramushir Island whaling station “Podgonyii” on 14 July 1955. This whale was completely black with a small white spot in the region of the navel. The second whale (#7) was dissected at the same place 11 August 1955. This second whale had the second type of coloring, namely that with the wide distribution of white coloring.

Whale #4 “The general coloring of the right whale is nearly coal black. When one observes right whales at sea it seems that right whales in the water have a sparkling coloring. Whenever these whales appeared above the surface of the water their skin was always glittering like a well-polished shoe. Although the personnel of the whaling station constantly poured water over the whale that was dissected on the flensing platform, its coloring when closely investigated had no glitter and was matte. As a result, it appeared to have a very slight grayish shade. However, that shade depended upon the angle from which the observer viewed the whale, and the lighting played a great role here as well. It was possible [to view the whale] from such an angle that no grayish shade could be observed. The whole whale was uniformly colored, without any variation in color, but on the belly, in the area of the navel, there was a small white spot with the uneven edges adjacent to the front edge of the genital slit.

The growth of diatoms on the whale warrants our attention. We observed on the right whale a slightly greenish, very fine and very thin film, but this film was not found all over the whale and varied in thickness. Mainly, it was observed on the chin, on the lower surface of the flippers, and on the back behind the place where the dorsal fin would be.

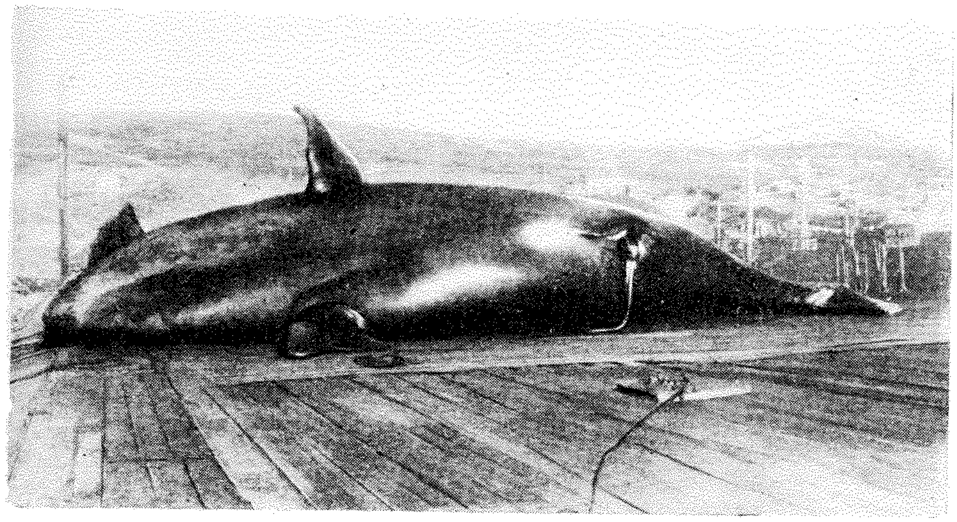


Figure 39. The general view of the North Pacific right whale from the belly side (whale #4, male, length 17.06m, picture by the author.

The greenish film was just visible when the skin of the whale started to dry up, but if the whale is wet then the bloom disappears and does not influence the general coloring of the animal. This description is illustrated by the photograph of the whale (Figure 39).

Whale #7: "The coloring of this right whale surprised us by its unusual shade. Beginning near the line which connects the flippers, down along the whole belly the white color is spread which goes far to the sides of the animal. The border of the white coloring along the whole line is ragged. On both sides of the genital slit are two large, irregularly shaped black spots against the white background. From the right side of the genital slit, around the large black spot, are located three other small dark spots separated from the main one and from each other by white. These spots are very nearly oval in shape. On the left side of the genital slit there are none of these spots. The anal slit is surrounded by the black spot along its whole length narrower on both sides. In front of the anus there is a still smaller oval spot which extends in the direction of the genital slit. Beside this, left from the anus, are distributed several spots that resemble mind the strokes of a fist.

The white coloring covers both sides of the whale's body, extending upwards to the spine then to the line of the genital slit. Towards the head and the flukes it narrows, going down the sides toward the belly. As the black coloring approaches the peduncle, it extends further and further down the sides, displacing the white coloring to the belly. After reaching the peduncle and flukes, the white color is only on the ventral side and distributed in a rather narrow strip along the "keel" to the very fork of the flukes that are colored black on both sides.

The borders of white coloring on the sides of the whale and also on the pectoral part of the lower surface of the body are uneven, ragged. In addition, on the white background there were several black spots of varied shape and size. This right whale could be called piebald.

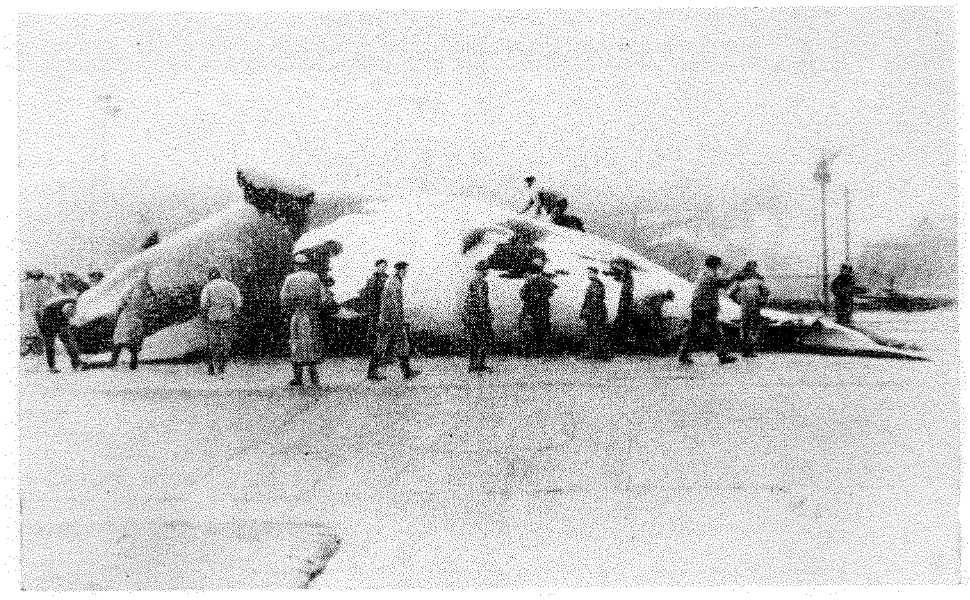


Figure 40. “White-bellied” right whale (#7) male, length 16.6m, picture taken by A.S. Skrjabin]

The head, back, flippers, and flukes are completely black with the exception of the very tip of the lower jaw on which there is a small white spot. A general view of that whale is illustrated (see Figure 40).

The sharp differences in the coloring of the right whales killed in the Kuril Islands confirm the previous comment about the incomplete [knowledge of the] systematics of these animals. It is possible that these variations in coloring do not have a taxonomic value; however, it is very important to continue with the research on this subject. It would be most important to kill several right whales in the region on their winter ground, in the waters of the Pacific Ocean, on the traverse of the southern Japanese islands, at the latitude from 40° to 20°N. In addition, it would be necessary to mark several dozen right whales on their winter grounds in the Kuril Island waters.

I do not here compare the coloring of the North Atlantic right whales with [that of] the North Pacific whales, although there are some data available for this comparison (Collett, 1909 and others). I am prepared to say here only that for both [sub]species there are apparently similar variations in coloring. In the case of the North Atlantic right whales, according to the photographs taken by Collet and according to his descriptions (Collet, 1909) there are both types of coloring as well: completely smooth black coloring of the whole whale without white marks and spots, and alternately a mottled coloring with wide distribution of white along the lower part of the belly of the animal which extending even to the sides. In particular, Collet writes that in the case of only 20% of the right whales killed in the North Atlantic in 1906-1908 the white coloring of the belly surface could be noticed and all the other whales were black. Collet concludes: “...the unified black coloring which covers the whole body of the whale without any variations in the shades--should be considered a typical one.” However, he mentions at the same time that although most individuals are all black, there could be found as well [others with] quite a number of white bands on the belly that were located along the belly in all directions. We did not find such coloring with the North Pacific right whales. We did not come across flippers of marbled coloring.

Matthews (1938) also mentions the existence of white-bellied individuals among the southern right whales killed in South African waters and off South Georgia, and he illustrates this fact in a photograph.

Among our whales, two of them were completely black without any white marks (#1 and #10). Also of the same coloring was the male right whale killed by the Japanese (Omura, 1957). One right whale was white-bellied with a very wide distribution of white (#7); in the case of the other (#5) the lower surface of the flippers had white spots; while all other whales were black and had white spots only near the navel. Those spots were of various dimensions. In the case of some whales they were of quite small (whale #4, see Figure 39); with others they could be found over the rather large area up to 3-4 m2. The female whale killed by the Japanese was colored black and it had a small white spot near the navel (Omura, 1957).

From all the above discussion, we can see that white-bellied [whales], as well as completely black whales, are only rarely met. Out of the twelve whales killed in the western North Pacific, three were completely black, one was white-bellied, and eight whales were black with a white spot on the ventral surface. It follows that this [latter] coloring for *Eubalaena glacialis* should be considered a typical one.

I would like to stay a little longer with the problem of coloring of eyes and of the tongue. The color of the North Pacific right whale is dark gray, a color we called “mouse-shade”. The irises of both eyes were the same color. There was no differences in the color of eyes between individuals.

Matthews (1938) writes that the tongue of Australian right whales is “...white, with lateral gray-blue spots.” The tongue of North Pacific right whale is of a nice gray color, or one tone without any spots.

As a conclusion to the part dealing with the coloring the North Pacific right whales, I would like to mention the irregularities in the description of the coloring of these whales that appeared in the review of A.G. Tomilin (1957), and the quite incorrect pictures of N. Kondakov published in the same review. North Pacific right whales have neither “a white spot on the neck”, nor a “gray belly”, nor “white mottled areas from above.” In fact, even the dimensions of North Pacific right whales mentioned by Tomilin (1957) do not coincide with the facts. As is shown in our data, the length of these whales reaches 20-21 m while the ratio of the body length of calves [to adults] is as low as 30-31.5%.

There are very few descriptions of the shape of separate parts of the body of the North Pacific right whales. There are the drawings of Scammon (1874), of True (1904), and others, and the partial drawings of M.M. Kondakov (see Tomilin, 1957), have many shortcomings. For that reason it seemed to me worthwhile to describe certain parts of the body of North Pacific right whales recorded in natural conditions and attach several photographs.

First of all, North Pacific right whales do not give the impression of being dock-tailed animals, as they are often depicted in drawings. The [ratio of the] maximum height of the whale body near the flippers to its length is approximately 1:6 or even 1:7. North Pacific right whales have reasonable proportions (see Figure 39 and 40), but of course are less slim than rorquals in which the ratio of the height to the body length is much higher [*i.e.* 1:>7].

[The right whale's] very robust flippers are at the horizontal location slightly bent upwards in the distal portion; they are not pointed at the tips, as in the rorquals, but have a rounded shape. The lateral edge of the fin is slightly bent (see Figure 41). The dimensions of the flipper of whale #4 (see Figure 42a) were as follows: the length from the "armpits" to the tip (along the straight line near the front edge) was 3.23 m (18.9% of the body length), the maximum width was 1.83 m (*i.e.* 10.7%), the width at the base 1.42 m (8.3%). The weight of one dissected flipper was 1 ton.

The described proportions of the flipper to the length of the body are typical, and as it appears from the data in Table 11, measurement 17, they fluctuate only slightly, remaining approximately at the same level (see Figure 37). An exact drawing of the outline of the flipper which was done by the scientific worker of our expedition A.S. Skrajabin with strict observation of proportions reflecting the measurements is shown in Figure 42a. That fin belongs to whale #10.

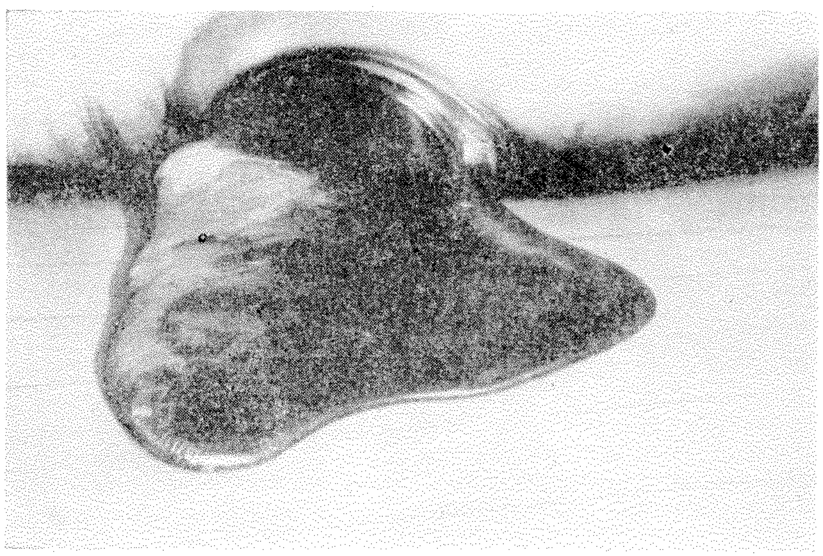


Figure 41. The flipper of the right whale (whale #4) Picture by the author.

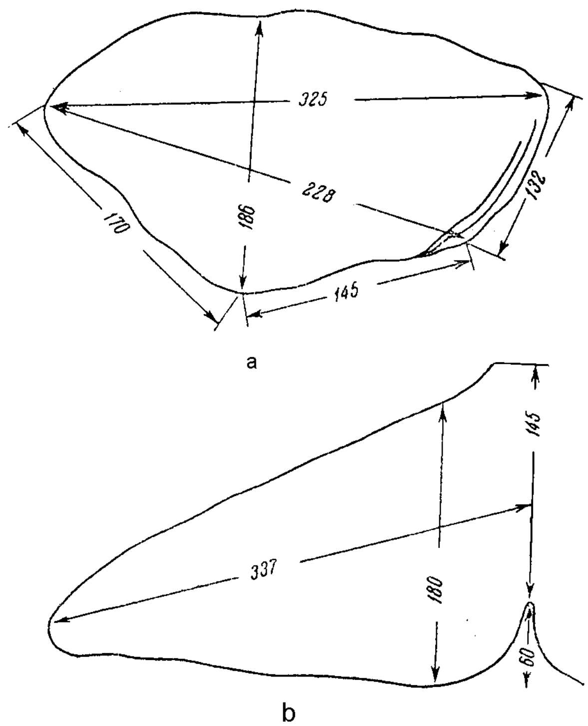


Figure 42. Outlines and dimensions of the flipper and flukes of right whale #10 (cm). Drawing of A.S.Skrjabin from nature.

Comparing ratios of the maximum length and width of flippers to the overall body length of North Pacific right whales to those ratios in fin whales, sei whales, blue whales, and rorquals, we obtain the data in Table 12.

Table 12. The relation of the maximum length and width of the flipper to overall body length among different species of baleen whales (in percent).

Species	Ratio of maximum length of flipper to body length	Ratio of maximum width of flipper to overall body length	Remarks
No. Pacific right whales	1:18.9	1:10.7	Our data (whale #4)
Blue whales	1:10.4	1:3.6	Arsenev and Zenkovich (1966)
Fin whales	1:8.2	1:2.7	“
Sei whales	1:8.5	1:2.7	“
Rorquals[e]	1:9.0:1	1:3.6	Omura and Sakiura (1956)

[e] [ed. – humpback whales are also rorquals, but with much longer flippers.]

It is apparent from the data in Table 12 that right whales have the longest flippers as in relation to overall body length. [Because of the right whale's relatively] massive body and its lesser flexibility compared to rorquals, [a right whale] must have such large flippers to keep maneuverability and balance in water.

The width of the right whale's flukes appear to be the largest both in size and in proportion to overall body length compared to other whales--for example, rorquals or sperm whales. We do not find with other whales either such proportions or such absolute size (with whales of the same overall size). As is apparent from Table 11 (measurement 23) and Figure 39a, the ratio of the width of the flukes to overall body length of right whales fluctuates insignificantly around 40% (38-44%), while with sperm whales that value reaches only 14.2% (see Ivanova, 1955), with fin whales - 22% (Arsenev and Zenkovich, 1955), with sei whales - 24.7% (our data), with blue whales 25.5% (Arsenev and Zenkovich, 1955), and with the minke whales around 29% (Omura and Sakiura, 1956). Here, as with the proportions of the flipper, we see the same picture. To be able to move relatively quickly in water, the right whale with its massive, robust, rounded body must have a very strong "engine"--[larger] flukes than the elegantly built rorquals that have much more hydrodynamic shape.

In their shapes, the flukes of right whales differ noticeably from the flukes of other cetaceans. Their distal edge is nearly completely straight with a hardly noticeable curve from the tip of each flipper to the notch of the flukes. In any case, the flukes of right whales are not bent in the shape of a sickle, and do not have the shape of such a butterfly which we observe in rorquals as well as in sperm whales-- which it is less noticeable. An exact drawing of the outline of flukes of whale #10 drawn from nature by the scientific worker of our expedition A.S. Skrjabin, is given in Figure 42b. In Figure 43 the flukes of whale #4 are shown; the length of each flippper from the tip to the notch of the flukes was 3.62 m. On the other photograph (Figure 44) for comparison is shown the flukes of a sperm whale. As is apparent from the photograph, the shape of the tail is completely different.

The flukes of adult right whales on each side of the peduncle have several deep folds, which show, that most probably each tail fluke can move independently upwards and downwards perhaps a very small degree. This is also suggested by the existence in the notch of the flukes a fold of skin which can stretch a considerable amount.

We were not able to observe such folds at the base of the flukes or in the notch of the flukes with any of other species of cetacean. It follows that this feature of right whales is unique.

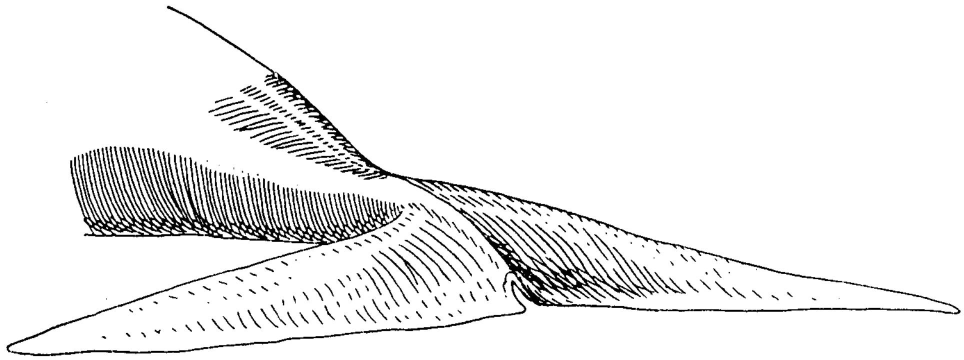


Figure 43. Flukes of the right whale (#4). Drawing of V.M. Gudkov according to the photograph taken by the author.

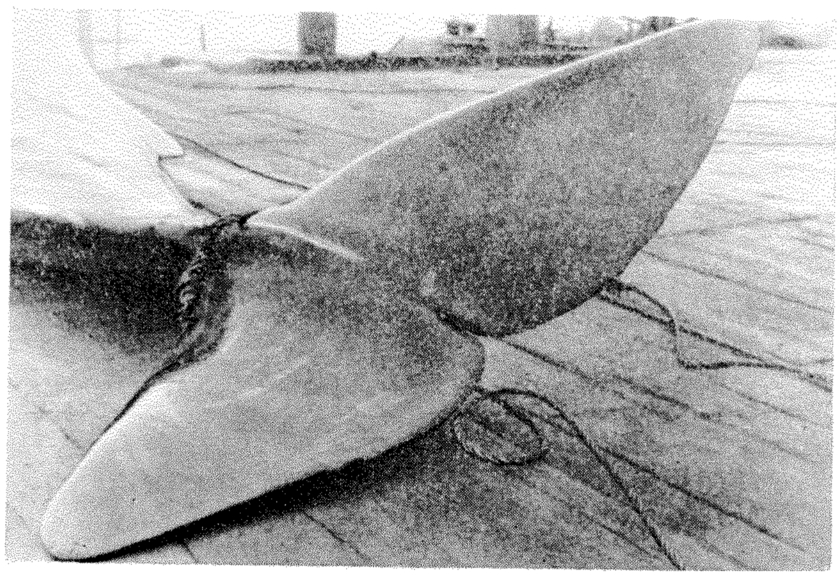


Figure 44. Flukes of a sperm whale. Photograph by the author.

Most probably, this feature has great importance in the movement of whales with such a massive body and such a large volume. Of course, considering the resistance of the water, to handle such a big mass [as a right whale] is more complicated than in the case of a very hydrodynamic rorqual. The possibility of each fluke turning separately to a different "angle of attack" enables right whales (with the help of large flippers that appear to be a distinctive "organ of stability") to have better maneuverability in water.

The penis of the adult right whale (#4), shown in the photograph (Figure 45), measured 2.97 m at rest from the base to the tip. The coloring of the penis was black, and only in the upper third near to the very root from both sides could be observed longitudinal strips of a fine white-pinkish color that were spotted with tiny black spots that are quite visible in the photograph. At the proximal base, the penis was completely round, but from the middle towards the tip it gradually flattened from the sides and already in the lower third it was of flat-oval shape. The very end of the penis looked as if cut off at a very sharp angle. The urethra canal terminates at a small opening, not at the very tip of the penis, but somewhat lower from it on the flat part of the “cut”. The urethra runs near to the upper (proximal) edge of the penis. The penis of the right whale differs greatly from that of rorquals and sperm whales in its great length, smaller diameter, flattened shape of the lower half, and its greater length relative to overall body length (17.4%).

Speaking about the sexual apparatus of the male North Pacific right whale, it is impossible not to touch upon the question of testes. They are oval, from both ends similarly rounded glands the size of which, without an appendix along the long axes, is 175-210 cm and diameter 73-77 cm (see Fig. 46).

Of great interest are the baleen plates of right whales which it seems to me to have taxonomic significance. In Table 13, data on the number and dimensions of baleen plates of 10 whales killed on our expedition, and two whales killed by the Japanese (Omura, 1957) are summarized.

First, what deserves attention is the great difference in the baleen plates of one right whale in comparison with all the rest. That whale (#10), a 17.8 m female, was killed in the northwestern [*sic*.] Sea of Okhotsk on the traverse of the 4th Kuril Strait on 28 August 1955 by the whaling ship *Purcha*. The whale was of a regular black coloring without any white marks. As far as its size and its body proportions it did not differ from other whales except for the number of baleen plates. If this case is an exceptional pathological one or if in the Sea of Okhotsk there live two distinct races of whales (representatives of two local stocks) namely one with the number of over 200 baleen plates on each side of the upper jaw and the other far fewer than 200 baleen plates, only future research can reveal. In either case, the finding is of great interest because all other whales including even those two whales killed by the Japanese (Omura,1957) had in total many more than 400 baleen plates each and some of them had even 500 baleen plates.

The baleen plates which we investigated were nearly black, sometimes with a slightly grayish and sometimes with a brownish color.

Table 13. Characteristics of North Pacific right whale baleen.

No.	Sex	Length (m)	No. of plates		Maximum dimension (cm)			Length of row of baleen (cm)
			left	right	Height	Width at base	length of fringe	
1	Female	18.3	220	205	200	-	-	-
2	Male	17.0	226	225	-	24	34	460
3	Female	16.3	-	214	205	18	22	430
4	Male	17.06	-	230	260	25		-
5	Female	17.4	-	217	260	-	-	-
6	Male	10.75	-	240	40	-	35	-
7	Male	16.6	-	250	220	-	-	-
8	Male	16.6	-	246	260	26	30	-
9	Female	11.35	-	222	-	-	-	270
10	Female	17.8	160	159	237	18	-	-
11*	Female	11.58	238	238	89	11.8	-	-
12*	Male	12.4	259	257	90	14	22.5	-

* Whales 11 and 12 were taken by the Japanese and the data is from Omura (1958).

As is apparent from Table 13, the number of baleen plates does not depend on the size (and consequently even on the maturity) of the whales. The variation in the number of baleen plates (excluding whale #10) is a substantial one--the number varies from 205-257 baleen plates on the right side and from 220-259 baleen plates on the left side. With several whales the numbers of baleen plates counted on the right and left sides of the upper jaw show there is less asymmetry that as far as this character is concerned. The greatest difference was found to be with the right whale #1--namely 15 baleen plates, somewhat smaller; Omura (1957) reported the case of a female killed by the Japanese--8 baleen plates. Other differences were insignificant and fluctuated between 1-2 baleen plates.

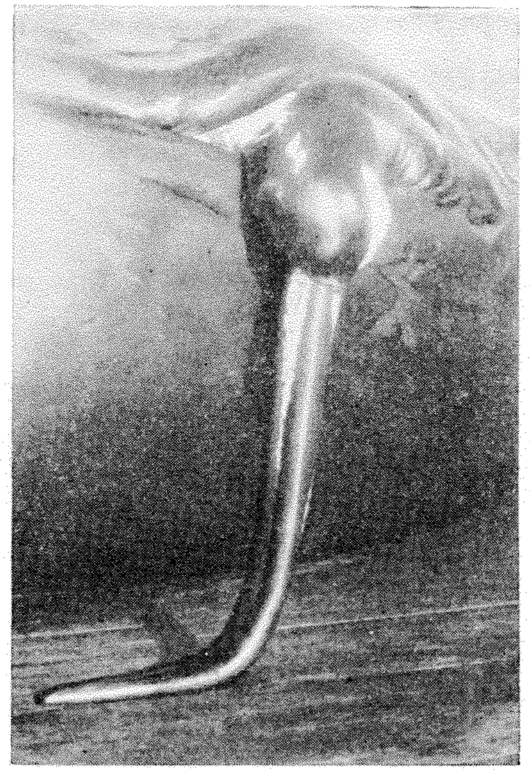


Figure 45. Penis of the right whale (whale #4). Picture taken by author.

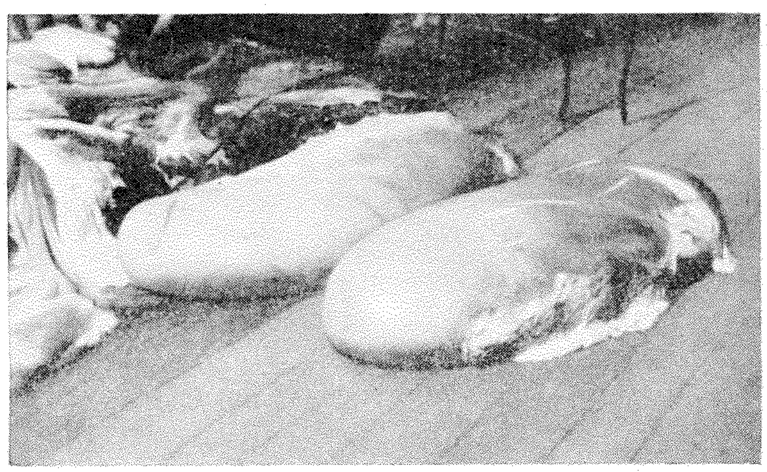


Figure 46. Testes of the right whale (whale #4). Picture taken by author.

Figure 47. Baleen plates of the right whale (whale no. 4). Maximum height 2.6 m picture taken by the author.

The length of the largest baleen plates in adult whales varied from 200 cm (female #1, it is quite possible that in this case there was intensive wear during growth because the size of the female speaks to its age) to the maximum of 260 cm. With the right whale calves of the year, especially in the case of the nursing whale (#6) in the stomach of which was found milk, the length of the largest baleen plate was only 40cm.[43] In the case of right whales killed by the Japanese expedition and apparently yearlings, the baleen plates were 89 and 90 cm in length. It follows that during the first year of life of a right whale the largest baleen plate slightly more than doubles in length.

The width of the base of largest baleen plate was apparently somewhat larger for males and smaller for females as shown in Table 13. It is true that the material at our disposal is still insufficient for the final conclusion, but still we feel that such an assumption is to a certain degree justified.

In the young right whales, especially nursing whale (#6), the baleen fringe was very thin, soft, and, it is possible even to say, silky. In the adult whales, the fringe of the baleen plates was much harder and rougher. However, in comparison with other baleen whales--fin whale, sei whale, humpback whale-- the right whale's fringe differs in having greater fineness and elasticity.

The thickness of several baleen plates measured by myself at the very base with one as well as those adjacent to it on both sides equaled 12 mm. There was no variation in the thickness of those plates. The distance between the baleen plates at the base (the place of the attachment to the palate) was not completely uniform and was 10 mm. In the case of right whale #4 (investigated in

[43] Matthews (1938) shows that in the case of newly born Australian right whales 6.5m long (killed together with the female) and in the stomach of which was only milk the baleen plate was only 17 cm long, the baleen plates "were at the initial stage."

great detail by myself) there were 11 sharply pronounced transverse bands on the baleen plates clearly visible in the photograph (see. Fig. 47). Probably those bands are the annual rings, analogous to [what was found for] other baleen whales, and [by interpreting] them one can establish the age of the animal in question. It is a great pity that the baleen plates were lost during transport, and for this reason any further analysis of this material was impossible.

The length of the row of baleen increase in size as the right whale grows as is obvious from the data given in Table 13.

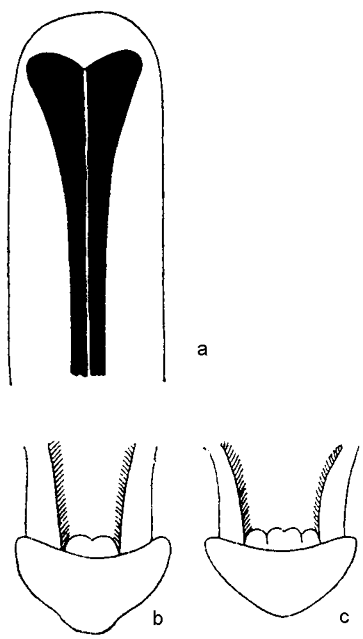


Figure 48. The shape of the soft palate of the right whale. (a) view from above; (b) cross-section; (c) palate of the humpback whale (drawing of V.M. Gudkov according to sketches of the author from nature)

To my mind the right whale's baleen plates represent exceptionally interesting material for further studies about right whales. On one hand, there is no doubt about the possibility of establishing the age of animals from the marks on the baleen plates, on the other hand, most probably the number, coloring, thickness and other peculiarities of the baleen plates can prove to be very good taxonomic signs. For this reason when we study North Pacific right whales in greater depth there is a need to pay more attention to the collection of baleen plates.

I have already mentioned above the significance of the shape and coloring of the palate of right whale for taxonomy. Now, I would like to show two drawings I did from nature which confirm the already mentioned assumption. Figure 48 represents the shape of the soft palate of the North Pacific right whale as seen from above (Figure 48a) and in cross-section (Figure 48b) and as a comparison with shape of the palate of the humpback whale (Figure 48c). The differences are so obvious that further explanation is not necessary.

DISTRIBUTION OF CALLOSITIES ON THE HEAD OF NORTH PACIFIC RIGHT WHALES

The characteristic formations on the heads of right whales, including North Pacific right whale, are strong thickenings of epidermis which are called by various authors: callosities, growths, protuberances, knobs/lumps, warts, *etc.* The biggest callosity, located in front on the upper jaw, the scientists from abroad call a “bonnet”. There is a somewhat regular pattern to the distribution, shape and in the size of callosities. The largest callosities can be found: a) on the front edge of the upper jaw, “supporting callosities” as I call them; c) on both sides of the head over the eyes “above-eye callosity” and d) a rather large callosity in front of the blowhole, the “pre-nose callosity”. As a rule, all these callosities occur on most right whales, and their absence is the exception.

The smaller callosities are distributed on the upper jaw between the bonnet and the blow-hole seldom extending posterior to the blow-hole. The number and distribution of these callosities vary greatly; and even their dimensions vary to a smaller extent. Most often these callosities are located symmetrically in two rows, and never have been observed in one row only. Smaller callosities can be observed as permanent features on both sides of the lower jaws. Here, beginning from the rear edge of the supporting callosities, they extend always in one row in the direction to the corners of the mouth, smaller round lumps, the last of which never reaches posterior to the corner of the mouth while in most cases it reaches it. From these patterns depicted from nature (see Figures 49, 50), it is possible to present some ideas about the distribution of callosities on the head of right whales killed in the Kuril Islands.

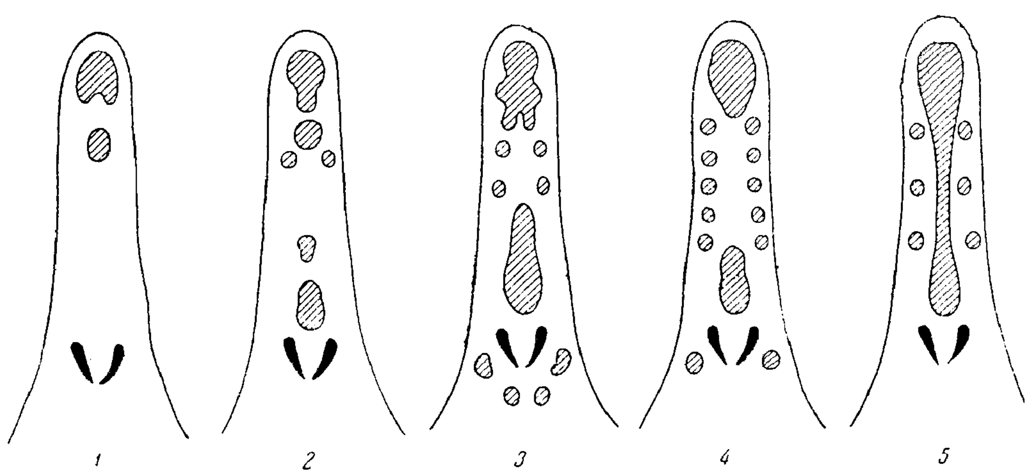


Fig. 49. The scheme of the distribution of callosities on the upper jaw of North Pacific right whales (as viewed from above). (1) whale #1; (2) whale #4; (3) whale #3; (4) whale #2; (5) whale #8.

It is necessary to mention that the bonnet is not simply located always on the front edge of the upper jaw, but on a special protuberance--a very firm knob from the combined tissues usually of

12-15 cm of height. In the case of the adult whales the front edge of that knob is located 50-60 cm from the tip of the rostrum. As was discussed, the general regularity in the distribution of callosities is retained with all right whales but the number of callosities varies greatly. So, for example, in the case of whale #4 (see Fig. 19), the pre-nose callosity consists of two knobs while in the case of whale #3, of but one larger, in the case of whale #10 it is completely missing. In the case of whale #8 the bonnet and pre-nose callosity are fused together, forming a rather massive callosity along the whole surface of the upper jaw. Macroscopic examination of the vertical cuts through the callosities showed that in places of cuts there are strongly developed, well pigmented, epidermal layers, supported by a very thick layer of the connective tissue of exceptional density. Only with a very sharp scalpel was it possible to make a vertical cut through the bonnet. The diagram of the cut gives some idea about the relation and the interdependence of the epidermis and the layer of connective tissue (see Fig. 51).

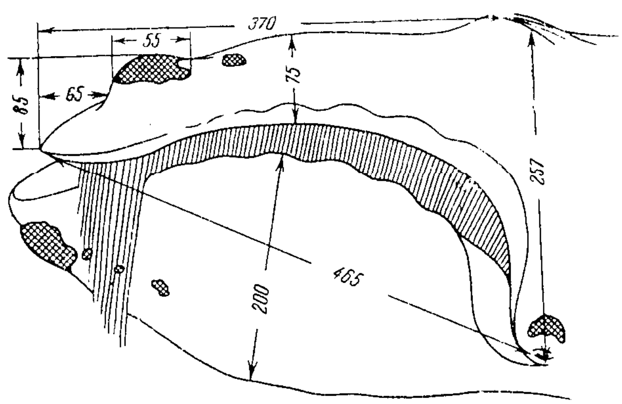


Fig. 50.Distribution of callosities on the head of whale #10 (in cm). (drawing from nature by A.S. Skjabin).

We collected skin samples from several right whales for histological analysis, and handed them over for further processing to V.E. Sokolov who already for a long time has been interested in studies of the skin of marine mammals (see Sokolov, 1961).

The callosities on all right whales served as the principal habitat of whale lice (*Cyamus*). It must be emphasized that the thickening of the epidermis in the above- described places of the head

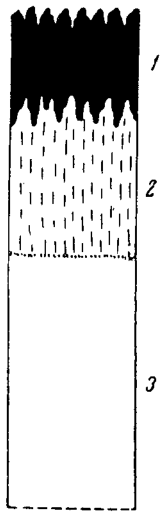


Fig.51. The layers of epidermis of the bonnet of the right whale. (1) pigmented layer of the epidermis. (2) dense connective tissue. (3) blubber. The drawing is by the author.

exists already with the larger right whale embryos which fact has been observed by many authors, and for other right whales as well.

As far as the dimensions of the callosities are concerned, even here there exists a certain constancy.

Smaller callosities--knobs or small plate-like features of a round or slightly oval shape that are located on the lower jaw, on each side in one row near to the lower edge [of the mouth] as well as on the upper jaw in one or more rows (frequently two), were in most cases from 8-25 cm in diameter, their maximum diameter being 30 cm. In no case did we find among those callosities ones less than 8 cm or more than 30 cm in diameter, regardless of the size of the right whale in question.

A detailed investigation of the front end of the lower jaw of right whales, as well as of humpback whales, and of sperm whales shows that in most of these animals the very front tip of the lower jaw shows clear traces of chafing, often an abrasion. a scratched epidermis, and sometimes there can even be a “blister”. This gives us the basis to insist that some whales when feeding on the bottom, place their body an angle of 30-45° in respect to the bottom, and can by this action lean against, and apparently they really sometimes support their jaw or in any case they touch it to the sea floor. While hunting in shallow waters, right whales most probably may sometimes make use of their lower jaw as a support when hunting in the near-bottom layers of water (of course for a very short while) or following just over the bottom of these layers they may touch the bottom with the lower jaw when opening their mouths; they may abrade from its front end skin, the feature I observed even on whales killed in the Kuril Islands (see also reports of Lindholm, 1888 [*ed. – reference is to bowheads*]; Chittelborough, 1956; E. Clark, 1958. Sometimes even the edges of the side callosities located on the front end of the lower jaw are damaged. Such a circumstance allows us to call the above-mentioned callosities “supporting”, to distinguish them from other types of callosities located on the head of right whales. Of course, it is admitted that this name must be considered somewhat conditional for the whales do not touch the sea bottom with the callosities located at both sides of the front end of the lower jaw.

Returning to the size of the supporting callosities, we emphasize that the variation in their size in adult whales is smaller than the variation in the size of the bonnet. According to our data the dimensions [of the supporting callosities] are within the range of 50-70 cm, and their average diameter in the whales killed by our expedition was 55.7cm.

The length of the over-eye callosities was measured only for two whales and was 30 cm in the case of whale #2, and 50 cm in the case of whale #3.

When examining callosities on the 10 right whales killed by our expedition, we found that on each callosity there are hairs, the length and number of which varied among individual whales. In most cases, the length of hairs reached 32-35 mm, while the number of hairs depended on the size of the callosity (from several tens to two-three hundreds). However, the hairs were not distributed strictly in the area of the callosity but in between them on the front part of the lower and upper jaw.

The origin of callosities has not yet been explained. There are several hypotheses. For example, Allen (1908) says that "...the function of that formation (the bonnet) as the nest for the parasitic crustaceans, under whose influence its growth increases, and it may be that those crustaceans are even by the primary reason for the formation of [the bonnet's]..." Matthews (1938) disagrees, taking exception to Allen's conclusion, giving the following explanation: "...the bonnet and other callosities were found already on the newborn whale calves that had not been yet infected with the parasites..." Further on he continues: "...the parasitic crustaceans do not limit themselves in their distribution to the callosities...they can be found even on the body of whales at very different places."

Table 14. Sizes of the callosities and their distribution on the head of North Pacific right whales (in cm).

Measurement	#6 male	#3 female	#7 male	#2 male	#4 male	#5 female	#10 female	#1 female
Overall length (m)	10.75	16.3	16.6	17.0	17.06	17.5	17.8	18.3
Length of bonnet	35	-	98	85	62	82	55	135
Distance from tip of rostrum to the bonnet	-	-	59	-	46	47	65	-
Length of the supporting callosity on the lower jaw	-	50	53	50	-	70	-	-
The length of the callosity over the eye	-	50	-	30	-	-	-	-

Allen's point of view of seems to me to be more acceptable, and I shall try now to give my reasoning.

It seems to me that callosities were initially formed on the body of right whales as a reaction of the whale to the concentration of parasites in local places. Afterwards, the parasites became attached as follows. Where do we find the callosities? Only on the right whale's head, and generally, the biggest callosities are located at the front part of the head: on the front edge of the upper and lower jaws, over the corner of the mouth (that is the above-eye callosity) etc.; i.e. they are all distributed around the mouth of the whale namely in the place where food enters the whale That is the first point.

Second, for the animals that sit on the head of the whale during its gradual movement there is always a permanent flow of water for respiration and for them to obtain food as well by filtering [the seawater].

Third, Matthews (1938) emphasizes that the callosities of right whales were formed where hairs grew and even now a small number [persist] which is confirmed by our right whale materials. Matthews writes in his paper: "There is undoubtedly a certain connection between the formation of callosities and the places where hairs were located. On all those places where the callosities exist we can find hairs. The callosity which was located over the eye of the whale most probably served as the eyebrow, that is in fact where the hairs of eyebrows should grow."

It follows that callosities are distributed on the head of whales only in those places where long ago their ancestors grew hairs which are preserved even now in a smaller number. In those places where hairs used to grow, there were natural small thickenings of the epidermis.

Starting from those three points it is possible to conclude that the whale lice (*Cyamus*) selected the head of the whale as their habitat not by chance but because: first, especially here were the best conditions for respiration as well as for the filtration and feeding from the uninterrupted flow of water which washes over the whale during its movement; second, because especially as a result of the hair on the whale's head there was the means in a simple way to easily attach to the whales during swift movement forward until these crustaceans developed special adaptations in the form of claw-like legs. Because of the conditions of habitat, during evolution of the whale lice adaptations towards symbiosis were developed, the ability of the filtration was lost and at last they went over completely to feeding on the remains of the whales' food while simultaneously developing the described adaptations for attaching to the whale's head (because by now the hair has disappeared).

Originally feeding by means of the filtering seawater, then changing gradually into symbiotic behavior, those crustaceans proceeded in their evolution, apparently now on the way of changing into the typical parasites that feed themselves probably already fully on their "host".

We may assume it is not by chance that the whale lice are so numerous on right whales, humpback whales and gray whales; especially because those whales are slow moving. Very rarely, and only on individual whales, can we find whale lice on rorquals, on sperm whales, on killer whales, on dolphins or other fast-moving cetaceans which lack any callosities to enable the above mentioned parasites to stick to the body during the whales' movement. In this way, the whale lice, distributing themselves on certain limited places of the head of the right whales, caused irritation of the whales' skin, and the responding protective reaction of the organism caused a further strong thickening of the epidermis and the formation of the callosities that persisted (through evolution) as an inheritance. As far as the distribution of whale lice, not only in the areas of callosities, but as Matthews (1938) writes "...over the whole whale body..." then, first, it must be emphasized that similar cases can be found only very rarely (mainly on dead whales), and second, one cannot exclude the possibility that such distribution had originated relatively recently, in any case after the time when with these crustaceans formed specialized, strong, claw-like legs, that allow some of them to attach even on smooth places of whale skin. But as a rule, in a great number of cases, the distribution of whale lice on the body is very narrow, localized and is limited to the callosities on the head and to the folds around the genital slit.

One can assume that the beginning and growth of parasitism in some groups of crustaceans which led to the formation of today's genus *Cyamus* took place mainly on right whales and gray whales or their ancestors as mainly the slowest and most primitive forms. The transition of whale lice to the fast-moving cetaceans (rorquals, billfish and others) took place only recently already after the stage of evolution of those parasites was completed forming most of currently known species of Cyamidae. That hypothesis finds its confirmation in the absence of specific adaptations of whale lice for attaching to fast-moving cetaceans, with the exception of those developed previously, adequate to attach to the body of relatively slowly moving right and gray whales, but clearly insufficient for the task of adhering to the bodies of rorquals, billfish and dolphins. Apparently, this is the reason for the very small number of the whale lice which survive on the above-mentioned fast animals. The cyamids' specialization simply has not reached the necessary level. At the same time, we must emphasize the absence of any callosities or thickenings of epidermis on the bodies of fast crustaceans which would allow parasitic amphipods to create the typical colloidal settlements on the surface of the whales' bodies and adhesion during the movement in water of the host. It is most probable that the family Cyamidae is a progressive one "assimilating" new "hosts"--the fast moving cetaceans and in connection with that acquiring new adaptations. From this point, new forms originate, even new genera. Quite recently Bowman (1955) described a new genus and species of the whale lice living on the [false killer whale] *Pseudorca crassidens*. Giving the name of *Syncyamus pseudorcae*, the author mentions that "...this species is the most specialized of all known Cyamidae."

V.E. Sokolov (1961), who undertook a histological analysis of the callosities of right whales collected by us near the Kuril Islands, points out that "...the histological structure of the epidermis of callosities shows outward pathological signs..."' It seems to me this assumption confirms what was said above, namely that the development of the strong, thickened epidermis is the reaction of the organism to the formation of parasitic colonies (in this case of whale lice) at places where hair was longer. At the same time, as said before, on those places there was possibly a small natural thickening of the epidermis.

However, the final resolution of this question lies ahead. A histological analysis of the head callosities is needed, particularly the bonnet of right whale embryos at different stages of their development. If in the embryonic stage the histological structure of the callosities discloses pathological signs, then this problem could be considered positively solved in the sense it was discussed by Allen (1908) and amended by us in this paper. In the case that the histological analysis of embryo head callosities does not disclose any pathology, then it is necessary to assume that these callosities did not develop as a protective reaction of the organism, but that they originated on the natural protuberances (thickening of the epidermis) of whales where the whale lice found the most comfortable places for their habitat. In other words, the callosities always appear on the right whales as a characteristic, natural feature, but at a certain period in the life of the species they were "adopted" by the whale lice which chose them as supplying the best conditions for their habitat.

WEIGHT OF NORTH PACIFIC RIGHT WHALES

To do a complete weighing of all 10 whales at the coastal whaling stations on the Kuril Islands was an impossible due to various technical difficulties. Therefore, several whales were not weighed at all, while others were only partially weighed. All the material obtained from the weighing has not been worked on to the extent as we would wish, but even in the preliminary stage the data are of some interest. Below is a table showing the results of weighing only four whales--#2, 3, 4, and 7 (see Table 15) and separately is given the results of weighing of whale #5 (see Table 16). Other data will be published later after we work on this material.

Table 15. Weight of different organs and body parts of North Pacific right whales (kg).

	Whale # 2	Whale # 3	Whale # 4	Whale # 7
[total length =]	17.00 m	16.30 m	17.06 m	16.60 m
Blubber	21,288	14,274	19,619	18,200
Internal fat	1,378	1,150	-	1,134
Skull and upper jaw	-	6,042	6,450	-
Lower jaw	5,092	4,260	5,380	-
Tongue	4,014	2,585	3,800	3,680
Flippers (total of both)	2,520	1,731	2,017	-
Flukes	1,127	1,009	1,300	-
Ribs and vertebrae	7,615	8,362	8,842	-
Ribs, vertebrae, flippers and flukes	-	-	-	17,954
Heart	200*	471	484	438
Lungs (both)	514	577	-	460
Liver	200*	540	-	389
Kidneys (both)	-	292	-	329
Stomach	580	374	-	672
Intestines	624*	1,299	-	1,204
Uterus	-	440	-	-
Testes without epididymis	-	-	594	417
Baleen plates alone	-	294*	-	800
Baleen plates with base	1,347	-	-	-
Meat	19,635	11,750	15,000	14,480
Mesentery, tendon, diaphragm and other remains		3,140	-	2,973
Total =	66,134	58,590	63,485	63,130

* Only a part of the organ was weighed.

It is necessary to make several comments in connection with Table 15. The weighing of whales was undertaken by different observers at the various coast bases and by different methods of weighing, and naturally during that process there could occur certain discrepancies. So for example, one observer weighed the lungs after he had cut off the larynx [trachea?] while another one left it with the lungs, the third observer cut off only part of it. In one case the meat was cut away from the bones more carefully, in other case less carefully, *etc*. To follow any uniform method during such operations proved to be impossible. At one whaling base the weighing was done by means of the dynamometer [balance scales?], while at the other base weighing took place on the decimal scales. In the case of right whale no. 2, the upper jaw was not weighed together with the skull, kidneys, testes, and some other organs were not weighed either. In addition, only one flipper (mass 1,260 kg) was weighed and the weight of the second one was just assumed. In the case of the whale #3, only one scapula was weighed, the weight of which was doubled during the totaling, and only one side of baleen plates were weighed.

In the case of whale #4, the internal fat and internal organs were not weighed, while the mass of the meat was determined only from the approximate ratio of the circumference of the whale to its volume--also [by multiplying] the number of carts (of which only the first ones were weighed); thus the weight of meat was most probably somewhat underestimated. In the case of whale #7, the head was not weighed at all--also not weighed were the upper jaw with the skull and lower jaw. By analogy to other whales of approximately the same size, as is seen in Table 15, it would be necessary to add to the mass of that whale (#7) some 10-11 tons. In general, we can consider the whole mass of southern?? whales reaching the length of 16-17m as something between 65-70 and 90-100 tons. These figures are well confirmed by the data obtained from the weighing of whale #5 which was undertaken most fully and carefully by the scientific workers of the Oceanographic Scientific Institute--the technologists L. Shmelkova and N.A. Nikonov. These data are given in Table 16 from which it can be seen that the general weight of the whale was 106.5 tons plus the weight of blood which was not included in that calculation.

From the total mass of 106.5 tons, some 70 tons or 65.72% belonged to the skin and blubber, bones, tongue, flippers and flukes, liver and others; 26.7%, belongs to the meat, while nearly 20% belongs to the spinal filet meat, i.e. edible meat. Therefore, it follows that 80% of the whale carcass represents useful fat and meat of high quality which can be used without waste, and only 1/7 part or 14% of the mass of the carcass can be considered waste, and [even] that can be used in the manufacture of fertilizer.

The mentioned ratio of useful material to waste (7:1), as well as the huge mass of the North Pacific right whale absolutely and in the comparison to rorquals and the sperm whale (see Table 16), shows the very high, and I would say, unique, commercial and economic value of these animals (using that ratio as the criterion).

In addition, the right whales have exceptional social value, incomparable to other whales', because they [right whales] represent a unique zoological object. Until the last few years, it was thought that right whales were disappearing from the face of the earth, and when we consider the fate of bowhead whale that assumption is reasonable. [However,] as far as North Pacific right whales are concerned, our research shows it is not the same case. The population size of these whales is such that there is hope for their recovery. For this reason, at present, as never before, the protective measures of those animals have great importance. Such measures must be accepted, so that not a single right whale is allowed to die, even as a result of an accidental shot of the harpoon gun.

Table 16. Mass of various organs and parts of right whale # 5 (a 17.4 m female, blubber thickness in the standard place = 25.3 cm)

	Weight (kg)	% of total mass
Blubber	25,505	24.05
Internal fat	2,207	2.07
Upper jaw	4,181	3.95
Lower jaw	6,155	5.93
Skull	4,450	4.28
Tongue	7,644	7.37
Flippers (total of both)	2,328	2.19
Flukes	1,247	1.17
Ribs and vertebrae	14,643	13.89
Scapula (both)	586	0.55
Heart	404	0.35
Lungs with trachea (both)	1,038	0.97
Liver	1,053	0.99
Kidneys (both)	336	0.31
Stomach	683	0.64
Intestines	3,396	3.29
Mesentery	335	0.31
Uterus	1,320	1.24
Ovaries (both)	10	0.009
Baleen plates without base	522	0.49
Meat	28,467	26.95
spinal meat	21,016	19.75
stomach and rib meat	7,451	7.0
Total mass of whale =	106,510	100%

CONCLUSION

The observations on the distribution of right whales that were made during the last years (1951-1957) in western North Pacific show from year to year that the number of these animals is without question increasing. It is necessary to mention in passing that the prohibition on killing California gray whales in the North Pacific introduced in 1946 proved to be advisable and very useful, because the number of those whales increased greatly according to existing data. In the same way, it is necessary to admit that the restrictions on killing of whales introduced by the International Whaling Convention already bring their fruit if they are adopted at the right time, that is while the number of whales has not reached such a low level that no measures can help. We can see that in the example of the bowhead whale and the Atlantic right whale, as well as partly on the example of the Okhotsk stock of right whales, the recovery goes much slower than for the Pacific stock.

At present, it is necessary to undertake a wide education program among whalers and especially harpooners, to increase protection all over the world to make this control effective so that the possibility of poaching is completely excluded.

The challenge is now, when the increase in the number of those whales starts to increase geometrically, to not allow the killing of a single whale [to ensure] the much faster recovery to the point where limited culling becomes possible pursuant to regulations. That will allow [scientists] to follow carefully the status of the stock and regulate in proper manner its level, not allowing a decrease in the population and keeping it the target level.

Whalers of the Soviet Union and of Japan can, by combining their efforts, achieve a goal of great economic importance and of great moral value. The example of protection and increases in the stock of right whales in the North Pacific will demonstrate that humane objectives can be achieved on the basis of international cooperation and mutual understanding.

The analysis of data on the distribution of Pacific right whales in the western North Pacific obtained on the basis of personal observation and the comparison with the distribution maps compiled by Townsend (1935) enable us to put forward the hypothesis that there exist two local stocks in this region, namely the Okhotsk stock which has its summer habitat in the western part of the Sea of Okhotsk and its winter ground in the Sea of Japan, mainly along the coast of Korea, and the Pacific Ocean stock with its summer habitat in the Kuril Island waters of the Pacific and Sea of Okhotsk and the southwestern Bering Sea and its winter ground in the Pacific Ocean in the region of the southern Japanese Islands between 20-40° N.

Without doubt, the right whales that have their habitat along the coast of North America are completely separate from our two mentioned stocks (the Okhotsk and Pacific stocks). We are not in possession of any data about the quantity of "American" stocks of right whales. However, taking into consideration that during the last few years there began to appear in literature reports about the appearance of right whales near the coasts of America (Gilmore, 1956, Clark, 1958, Omura, 1958). We can assume that the numbers of these whales are increasing even in the eastern North Pacific.

The increase in numbers of right whales in the North Pacific presents the task to scientists of establishing a planned research [program] on these animals. Especially important in the next years is to determine the borders of the summer and winter ranges and find out their migration routes. Study is needed on questions of the taxonomic status of these whales which seems to us to be still unclear, on their biology, and especially on problems connected with their reproduction. As was said above, unfortunatlely right whales are the least studied of all big cetaceans because the maximum development of the whaling industry on right whales took place in those far away times when biological science were still at the very beginning. This is why at present when the North Pacific stock of right whales is restored, it is necessary to do detailed studies of their biology. The solution of those questions must go hand in hand with cooperation with the Japanese, Canadian, and American scientists.

Perhaps to some scientists and fishing industry workers my views about the possibility of a quick recovery of the population of right whales in the western North Pacific will appear to be over-optimistic and give reason to their skepticism. To those I can only say: all is in our hands! Now we have all the possibilities for a further sufficient rapid population growth of right whales. And if the prohibition on killing of those whales will be strictly observed, then not beyond the mountains is that day when we will be able not only to see, but even realistically to use, the fruits of our mutual efforts.

[END]

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[Copy of the English Summary *verbatim* from the original article]

SUMMARY [ORIGINAL IN ENGLISH]

S.K. Klumov

THE RIGHT WHALES IN THE PACIFIC OCEAN

In 1955, the Institute of oceanology received a special permition for getting ten Right Whales in the North-West Pacific for scientific purposes.

During some seasons of whaling (1951-1957), all whaling and research vessels conducted observations over the distribution of Right Whales. The results of this work are shown in figures 2-10.

The analysis of our own data and data from different sources allowed us to divide Right Whales of the North Pacific into american and asiatic populations. These populations are independent and do not mingle. Asiatic population is divided into two independent stocks: the Ochotsk and the Pacific one. These stocks occupy their own independed ranges and have their own ways of migrations. (fig.12,21).

The observations show that the number of Right whales in the pacific stock is more than in the ochotsk one and the growth of the pacific stock goes faster.

The original data on feeding habits of Right Whales of the northern Pacific are examined in comparison with the data from other regions of the World Ocean (plate 3). Analysis of food showed that Right Whales have in this respect a very good selective capacity and that they are stenophags. The main food of Right Whales in the North Hemisphere is Calanoida and in the South Hemisphere Euphausia superba.

Helminth fauna of Right Whales of the northern Pacific consists of 3 species. There are no common species of helminth of Right Whales in the South Hemisphere and Greenland whales. It was noticed that the invasion of Right Whales in the northern Pacific is very little. (plate 7,8).

Ectoparasites are presented by only one species, Cocconeis ceticola typ. Nels (Diatomea).

The materials about reproduction of Right Whales are not so big. It is possible that puberty of female comes when they are 14-15 m long and the weight of their ovaria is near 2 kg each and the length 40 cm. The mail's body length is 14-15 m. The weigth of their testis is 150-200 kg and its length 150-200 cm.

The mating of Right Whales takes place in December and January; pregnancy period is 11-12 months. The bringing up of the calv[e]s is during 6-7 months. Embryo's average increasly is 24-25 mm per day. During gathering up the calv[e]s' increase is 30-33 mm per day. When the calves are born they are 5-6 m long. All these data are more or less preliminary. When there will be more material it will be possible to check them.

The proportions of Right Whales' body in the northern Pacific do not differ from that in the North Atlantic and in the South Hemisphere. The typical colour of Eubalaena glaciailis is black with white spots on stomach near the nevel.

The weight of grown up whale is more than 100 tons at the length of 16-17 m (plate 16). In comparison with sperm and fin whales of the same size Right Whales give much more production. That is why they are so valuable from the economical point of view.

The author believes that prohibition of catching Right Whales will be very important for the restoration of the stock of these valuable animals. If prohibition is carried out it will be possible that after some years the hunting on this whale will be allowed, but in a very limited scale.

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