

CONFIDENTIAL

FISHERIES RESEARCH BOARD OF CANADA

ARCTIC UNIT

Montreal, Que.

Annual Report
and
Investigators' Summaries
1956



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In Charge

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REPORT FOR 1956-57 OF THE
ARCTIC UNIT, MONTREAL, QUE.

by H. D. Fisher, Scientist in Charge

The primary objectives of the Arctic Unit are to assess the marine resources of the arctic regions in the light of present utilization, and to carry out detailed biological studies on species of special importance either directly to the living economy or to the general productivity of the region. Marine mammal studies are extended south on the Atlantic side to include whaling and sealing problems in the Maritimes and Newfoundland area. Late in the year, responsibilities for liaison with the Department of Fisheries regarding seal control on the east coast was transferred to the Unit from the St. Andrews Station.

Liaison is maintained with the Department of Northern Affairs and National Resources regarding investigations touching on the role of marine resources in the human living economy. The dependence of many native groups on non-marine wildlife, as well as on marine animals, calls for occasional joint planning with that Department, which is responsible for such wildlife through the Canadian Wildlife Service. Liaison is maintained also with the Atlantic Oceanographic Group at St. Andrews, so that hydrographic work carried out by the Unit can fit as closely as possible into their arctic program. In addition, collection of biological material from arctic cruises of H.M.C.S. "Labrador" is arranged through this group.

Fisheries Investigations

Mackenzie Delta. Work in fisheries for the past two seasons has been concentrated in the region of the Mackenzie River Delta, N.W.T., between Herschel Island and Tuktoyaktuk. Fishes in this area, especially the anadromous species, are relatively abundant. Here especially are possibilities of greater utilization and increased efficiency in fishing methods.

Boat facilities for our work in the Mackenzie Delta have been very limited to date. Our own boats are an out-board launch and a dinghy. We are working very closely with the Royal Canadian Mounted Police in this area, however, and have been able to pool much of our fishing effort to mutual advantage.

Shore-based fishing operations by the investigators began at Whitefish Station, just west of Tuktoyaktuk, on July 7 and were carried on continuously to September 15. Fishing was carried out at the mouth of the Firth River,

opposite Herschel Island, from July 27 to August 10, and at King Point Harbour, just east of this, from August 12 to August 30. Gear used for the most part consisted of gill-nets, though a small trawl was tried off the Firth River, and beach seines and several types of traps were used for collecting.

At Whitefish Station, 10,000 fish of 15 species were taken by the research crew. The majority were Coregonids. At the mouth of the Firth River, Coregonids and arctic char made up the bulk of a sample of 1,000 fish of seven species. The arctic cod Eleginus gracilis, an important food fish in the Soviet arctic but unused in Canada, also was taken off the Firth River mouth.

Pelly and Garry Lakes, Back River, N.W.T. A preliminary survey of fish stocks, in cooperation with the Canadian Wildlife Service, was undertaken during August in Pelly and Garry Lakes, in view of starvation conditions among the caribou-dependent Eskimo population there. The lakes were found to be shallow (20-30 feet), well mixed, with temperatures up to 14.6°C. The most abundant fish species taken were common whitefish, lake trout and round whitefish. The stocks would permit organized fishing in these lakes.

Marine Mammal Investigations

Harp seal. Work has been confined to tooth sampling of southward migrants along the north shore of the Gulf of St. Lawrence for age-composition data, and sampling of stomachs at the Magdalen Islands for cod-worm incidence studies being carried out elsewhere. During the last three years an increase of younger age-classes (one to three years) in the southward migration may prove to reflect the cooling trend in Greenland waters, in which some immature harp seals have been known to winter, or to lag behind the main migration. Annual changes in the age composition of the stock continue to indicate that the high pup kills of 1951 and 1955 were excessive. Twenty-four ships, including 13 from Norway, prosecuted the fishery in March, 1957.

Bearded seal. The bearded seal fills special economic needs in the arctic. Material collected incidentally to other studies has permitted a preliminary study of the biology of this species. The teeth are useless for aging, but annular bands on the claws have been found to be valid age indicators. Food habits concentrate on bottom organisms, particularly on clams. Both males and females reach sexual maturity at about the seventh year. The main features of the reproductive cycle have been clarified.

Ringed seal. Incidental to the major biological study of this seal, which has been completed, has been a

taxonomic study based chiefly on the skull collections which have become available during the work. Many races have been described for this circumpolar species. Russian workers have substantially reduced the number of north Pacific and Siberian races. Our studies throw much doubt on the validity of a Beaufort Sea race and a Nettilling Lake (Baffin Island) race described in 1942.

On Herschel Island, a seven-inch mesh nylon fish gill-net was found to be four times as successful in netting ringed seals as the traditional larger mesh, heavy cotton twine nets.

Harbour and grey seals. Identification of jaws for bounty claims, formerly confirmed at the St. Andrews Station are now left entirely in the hands of the Department of Fisheries, whose examining officers have become proficient in this. Arrangements have been made for this Unit to examine the bounty kill data once a year to assess its effect on the stock of harbour seals. Collections of grey seal material from the Maritimes were made from St. Andrews to round out material for a biological study of this little understood but important species. Active field work on both harbour and grey seals has been suspended, at least until the material and data on hand can be analyzed and reported upon.

Walrus. Field work was conducted in northern Foxe Basin from the M.V. "Calanus" and from a whaleboat and Peterhead vessel at Southampton Island. The basic reproductive cycle has been established. Laboratory studies this past year have concentrated on the establishment of an accurate aging method, essential to a study of growth and maturity. Cemental layers on the molariform teeth are clear in the male, and have been satisfactorily shown to be valid age indicators. More intensive studies on zonation of cementum in the female are necessary before the annuli can be interpreted correctly after three years of age. Sexual maturity in the male occurs at about seven years of age. Males up to at least 28 years of age are sexually active. The distribution of walrus in Foxe Basin to a large extent depends on the movement of sea-ice. There is a southern summer movement from the Igloolik area to the central part of Foxe Basin and perhaps further south, with a return north when heavy ice enters the Basin through Fury and Hecla Strait in September.

White whale. Three aerial survey flights were made out of Churchill, Manitoba, in cooperation with the Department of Fisheries, for aerial counts and studies on grouping and calf presence. There is no evidence of any decline in overall numbers since 1950. There is some evidence of a shift of animals from the Churchill River, where commercial hunting takes place, to the Seal River, 50 miles north, where it does not. Clear growth zones in the dentine of the teeth were

carefully studied as an aging method, and it is felt that conclusions on the seasonal groupings of the zones can soon be made.

Pilot whales. In 1956 the commercial catch of pilot whales in Newfoundland reached nearly 10,000 animals. The recent great increase in exploitation has led us to give special attention to population studies. During September, marking and aerial survey methods were explored on a trial basis. With the cooperation of the Newfoundland Department of Fisheries and Cooperatives, marking was attempted from one of their catching vessels. It was found that free-swimming whales normally remained out of range of the crossbow used to fire the marks. Further experiments are planned.

A trial aerial survey over Trinity and Conception Bays was successful in locating not only pilot whales but other Cetacea as well, mostly fin whales and white-sided dolphins, from altitudes of up to 1,500 feet. The inshore waters of Newfoundland and Labrador have a Cetacean composition similar to that of the Labrador Sea. A tentative comparison has been made of relative numbers of large rorquals and pilot whales observed from research and weather ships, hence of biomasses. Taking into consideration the known potential yield of large rorquals at North Atlantic land stations and data fertility and natural mortality, the comparison suggests an upper permissible limit of 15,000 per annum for the catch of pilot whales.

Invertebrate studies and hydrography.

Foxe Basin. The motor vessel "Calanus" wintered in 1955-56 at Igloolik, with two men aboard who carried out biological and hydrographic studies. The vessel was unable to break free of winter ice until the last day of July, 1956. Particular attention then was given to walrus studies, but collection of hydrographic, plankton and bottom samples was carried out. Hydrographic sections were run across Fury and Hecla Strait, and between Jens Munk and Koch, Koch and Rowley, Koch and Baffin, Baffin and Bray, and Bray and Rowley Islands. Water temperature, salinity, oxygen and phosphate values were determined. One station was occupied 28 times throughout a 12-month period. An analysis is now being made of the physical, chemical and biological annual cycle in northern Foxe Basin from this work. One of the most notable features of the Foxe Basin marine cycle is the lateness in the season of the time of maximum production. A phosphate peak in spring and early summer, and a zooplankton maximum in late September represent a cycle several months later than in marine areas of the temperate region. The production of life, although late in the season and of comparatively brief duration, is great.

Biology of *Themisto libellula*. An intensive study of this pelagic amphipod which is an important part of the

food of ringed and harp seals and arctic char, has been completed. The work includes a review of relevant work on the relation between temperature, metabolism and growth in aquatic organisms. Themisto has a two-year life cycle, at least twice as long as the life-time of pelagic Crustacea of similar body size in temperate waters. Breeding is most intense from March to early June, but another breeding season appears to begin in September-October and may continue all winter. Maturation here appears to be associated with decreasing rather than increasing temperature.

Hydrography of the "Calanus" expeditions, 1949-54.
Working up of the hydrographic data of these expeditions, involving the southern part of the eastern arctic, was continued as a special laboratory project. Particular points of interest to date are: (1) At the 50-metre level (below the influence of surface warming and cooling, and freshening) the water of Hudson Bay and western Hudson Strait is about 0.5°C . colder than that of Ungava Bay. At the 100-metre level there is greater spread of temperatures in Ungava Bay, the Hudson Bay water at this depth being normally below -1°C . even in August. (2) Temperatures in Frobisher Bay are of the same order as those of Ungava Bay but show considerably less spread to the warmer side. Ungava Bay waters thus are less stable than those of Frobisher Bay and much less stable than those of Hudson Bay. (3) The higher stability in the surface layers of Hudson Bay causes the surface temperature to rise several degrees above the levels normal for the rest of the eastern Arctic (up to 10°C ., compared to 5.8°C . in Ungava Bay, 4.5°C . in Frobisher Bay). (4) An upturn in the lower ends of the temperature-salinity correlation curves, characteristic for Ungava Bay at the 200-metre level, indicates intrusion of West Greenland water containing an Atlantic element.

STAFF AND ORGANIZATION

(April 1, 1956, to March 31, 1957)

The full-time staff as of March 31, 1957, numbered 12 people: 7 scientific, 1 administrative and 4 technical. In addition, 8 seasonal and 2 part-time people were employed during the year.

Mr. Arthur W. Mansfield joined the scientific staff on April 1, 1956, and Mr. J. G. Hunter on January 1, 1957.

List of Staff

Scientific

H. D. Fisher, M.A., Ph.D.	Senior Scientist, in charge
M. J. Dunbar, M.A., Ph.D.	Senior Scientist, (part-time) Consulting
E. H. Grainger, M.Sc., Ph.D.	Associate Scientist
J. G. Hunter, M.A.	Associate Scientist (transferred from Nanaimo, Jan. 1, 1957)
D. E. Sergeant, M.A., Ph.D.	Associate Scientist
A. S. Bursa, M.Sc.	Assistant Scientist
A. W. Mansfield, M.A.	Assistant Scientist (from Apr. 1, 1956)
I. A. McLaren, M.Sc.	Assistant Scientist

Administrative and Technical

Lois G. McMullon	Stenographer 2 (Group Secretary)
H. N. Andersen	Technician 2 (Captain)
P. June Thompson, B.Sc.	Assist. Technician 3
Barbara M. Barry, B.Sc.	Assist. Technician 3
T. E. Wilson	Assist. Technician 3 (from Oct. 1, 1956)

Seasonal and Term

T. E. Wilson	Technician 1 (July 30-Sept. 30/56)
Margaret G. Gabbutt	Asst. Tech. 3 (June 1-Aug. 31/56)
D. Y. E. Perey	Asst. Tech. 3 (June 19-Sept. 29/56)
J. F. Skidmore	Asst. Tech. 2 (June 22-Sept. 22/56)
Mary Hunter	Asst. Tech. 1 (P.T.)(June 15-Sept. 20/56)
M. E. Riske	Student Assist. (June 15-Sept. 25/56)
J. W. Evans	Student Assist. (May 15-Sept. 22/56)
A. E. Peden	Student Assist. (June 16-Sept. 22/56)
Kathleen E. Beer	Stenographer (P.T.)(Mar. 7-Mar. 29/57)

Organization

In Charge

Senior Scientist H. D. Fisher, Ph.D.

Consultant

Senior Scientist, part-time M. J. Dunbar, Ph.D.

A. Scientific and Investigational Staff

Fisheries

Associate Scientist J. G. Hunter, M.A.

Assistant Technician, part-time Mary Hunter

Student Assistant, seasonal M. E. Riske

Student Assistant, seasonal A. E. Peden

Marine Mammals

Associate Scientist D. E. Sergeant, Ph.D.

Assistant Scientist A. W. Mansfield, M.A.

Assistant Scientist I. A. McLaren, M.Sc.

Assistant Technician 3 P. June Thompson, B.Sc.

Student Assistant, seasonal J. W. Evans

Invertebrate and Basic Studies

Associate Scientist E. H. Grainger, Ph.D.

Assistant Scientist A. S. Bursa, M.Sc.

Assistant Technician 3 Barbara M. Barry

Assistant Technician 3, seasonal D. Y. E. Perey

Assistant Technician 3, seasonal Margaret M. Gabbutt

B. Administration and Maintenance

Stenographer 2 Lois G. McMullon

Stenographer 1, part-time Kathleen E. Beer

Technician 2 (Captain) H. N. Andersen

Assistant Technician 3 (Engineer) T. E. Wilson

Assistant Technician 2, seasonal J. F. Skidmore

SCIENTIFIC STAFF

Arctic Unit, Montreal, Que.

H. D. Fisher, Ph.D. (McGill), in charge.

M. J. Dunbar, Ph.D. (McGill), F.R.S.C. Consultant, part-time.

Fisheries

J. G. Hunter, M.A. (British Columbia). From January 1, 1957.

Marine Mammals

D. E. Sergeant, Ph.D. (Cantab.)

I. A. McLaren, M.Sc. (McGill)

A. W. Mansfield, M.A. (Cantab.). From April 1, 1956.

Invertebrate and basic studies

E. H. Grainger, Ph.D. (McGill)

A. S. Bursa, M.Sc. (Krakow)

PUBLICATIONS

(April 1, 1956, to March 31, 1957)

Dunbar, M. J. The amphipod fauna of Ungava Bay, subarctic Canada, and its zoogeographic significance. Proc. XIVth Internat. Congress of Zoology, Copenhagen, 1953; pp. 454-455, 1956.

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The "Calanus" expeditions in the Canadian Arctic, 1947-1955. Arctic, Vol. 9 (3), pp. 178-190, 1956.

Review of "Man in a Cold Environment" by Bolton and Edholm. Review pub. in: Physics in Canada, 1956.

Fisher, H. D. Review of "Follow the Whale" by Ivan T. Sanderson. Canadian Geog. J., Vol. LIV (1), p. XII, Jan. 1957.

Grainger, E. H., and M. J. Dunbar. Station list of the "Calanus" expeditions, 1953-54. J. Fish. Res. Bd. Canada 13 (1), pp. 41-45, 1956.

MANUSCRIPTS SUBMITTED FOR PUBLICATION

McLaren, I. A. The biology of the ringed seal (Phoca hispida Schreber) in the eastern Canadian arctic.

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Fisheries Investigations

The preliminary survey of 1955 in the Mackenzie delta region was followed in 1956 by intensive studies on either side of the delta. Fisheries work is being developed first in the western arctic because of the relative abundance and variety of fishes in this region, with the possibilities of greater utilization and better organization of fishing. A preliminary survey of fishes in the Back River system, N.W.T., was undertaken in the interests of inland Eskimo economy.

No. 1

Western Arctic

Two areas of fishing were considered in 1956, one at Whitefish Station on the east bank of the Mackenzie River delta, the other west of the Mackenzie River as far as the Firth River opposite Herschel Island.

Fishing operations commenced at Whitefish Station just after the ice went out and was carried on continuously, except for weather interruptions, from July 7 to September 15. Fishing was done at the mouth of the Firth River from July 27 to August 10 and again at King Point Harbour until August 30.

On a reconnaissance trip into Coppermine September 26 the aircraft was lost on the way home and was missing for 19 days. Complications arising mainly from this situation, with the subsequent transfer of the writer to Montreal, have precluded analysis of the data collected during the summer.

During the fishing season at Whitefish Station 15 species were taken and a total of 10,000 fish was caught. Lengths, weights, scales or otoliths, sex, maturity, stomach contents and parasites were recorded and collected. The majority of fish caught were Coregonids. The catch reached as high as 700 in one day. The nets used were graduated in one inch sizes from $1\frac{1}{2}$ to $5\frac{1}{2}$ inches. The efficiency of the nets was noted and the relation of the catch to the season recorded.

A fine-mesh net was set in a small clear-water lake, situated a quarter of a mile from the Mackenzie River and connected to it during normal times by a very shallow marshy stream. The only fish caught here were stickleback (Pungitius pungitius).

At the mouth of the Firth River seven species totalling about 1,000 fish were caught. Coregonids and arctic char made up the bulk of this catch. Weather hampered operations at both fishing locations during August often making it impossible to keep a net in the water.

A small otter trawl was tried in the sea off the mouth of the Firth River but the drifting ice prevented access to water more than 10 feet deep. The restricted fishing allowed produced small cod (Eliginus gracilis). These fish were forming the main diet of the Arctic char being caught.

King Point Harbour is simply an indentation in the coastline forming a small bay (about 0.25 square miles). It is protected from the sea by an extensive sand spit leaving only a small entrance into the area. Approximately 2,000 fish were caught here by the R.C.M.P. this year in the course of four days. Continued equal fishing effort for the succeeding 15 days produced less than 400 fish. This isolated population was not receiving a recruitment from outside waters adequate to withstand the fishing intensity applied. A narrow band of fresh water from the Mackenzie River often extends along the coast and it was reported that in 1954 when the wind changed, altering the salinity picture, fresh water cod or burbot (Lota) died in large numbers and were found distributed along the beaches. No burbot were caught this year however. Seven cod (Eliginus gracilis) measuring from 38.5 to 48.5 centimetres were caught by gill-nets in King Point Harbour this season.

J. G. Hunter.

No. 2

Back River System, N.W.T.

On Garry Lake, of the Back River, are situated some 40-50 inland Eskimos who are primarily dependent on barren-ground caribou for their livelihood. A recent sharp decline in caribou numbers in this region has led to starvation conditions in this group, with attendant problems for the Department of Northern Affairs. They use fish very little, and have no organized method or good gear for fishing. During August, a trip was made to the area with Mr. J. S. Tener of the Canadian Wildlife Service in order to discover the nature of the lakes and the fish stocks in them. Equipment consisted of a 17½ foot canoe, a set of short sunken gill-nets from 1½" to 4" mesh, bottom grab, plankton net, minnow seine and traps, and a Nansen bottle with reversing thermometer.

Fishing began in the Back River 15 miles west of its entrance into Pelly Lake on August 2, in Pelly Lake on August 8, and in Garry Lake on August 19. Extremely bad weather after August 8 hampered operations considerably, and we were unable to get into the main body of Garry Lake. The river and lakes were found to be shallow (maximum recorded depth was 30 feet), and well mixed. The bottom of the river and of Pelly Lake was sand, with a fine silt top cover in

Pelly Lake. The bottom of the west end of Garry Lake was covered with boulders. The water temperature fell from 14.6°C. on August 2 to 7.6°C. on August 23. Pelly Lake is separated from Garry Lake by rapids which had to be portaged in August, but which probably could be run earlier in the summer.

The fishes taken, in order of abundance (other than minnows, fry and sticklebacks) were:

1. Common whitefish
2. Lake trout
3. Round whitefish
4. Cisco
5. Grayling (sampling not carried out in rapids where these should be common)
6. Burbot or loche
7. Sucker
8. Sculpin

The first three were by far the most abundant, and obviously represented a standing crop of old fishes. Young (minnow sized) stages of these fish were taken only in streams and sloughs connecting with tundra ponds, and in such ponds themselves. About 450 fish were sampled for scales, stomach contents, weights, lengths, etc. This data has not yet been fully worked up owing to other commitments.

The preliminary results indicate that the fish stocks are ample to provide good auxiliary subsistence for the human population in the area if fishing could be organized and developed.

Further intensive work on this water system is planned by contract with Dr. D. S. Rawson of the University of Saskatchewan.

H. D. Fisher.

Harp Seal Investigations

The responsibility for harp seal investigations was transferred to this Unit on its formation in 1955, with the transfer of the scientists who had been carrying out this work from St. John's and St. Andrews. There has been no active field work on harp seals since the end of 1953, except for the aerial survey of 1955. Arrangements have been made each year to date for routine sampling of teeth for age-composition studies to follow changes in the stock, and for collection of stomachs for cod-worm studies being carried on

elsewhere. It has not been felt that anything substantially new can be gained by annual trips to the ice with sealing vessels. Aerial surveys will be maintained about every four years, and large-scale tagging, which is important, must wait until resources at our disposal allow this to be carried out.

No. 3

Age Frequencies of Harp Seals

A. Changes in general age composition.

Harp seals migrating south through the Strait of Belle Isle in December-January continue to be sampled at La Tabatière on the north shore. Samples of teeth collected in January of 1954, 1955 and 1956 have now been fully read. Frequency histograms for these three years and also for 1952 are shown in Figures 1 and 2.

It has been known from previous samples that the younger immature year-classes of harp seals are deficient at this time, more animals appearing progressively as maturity is approached at five or six years. (See 1952 sample.) The peak year-class in the frequencies represents the youngest fully or almost fully represented one. It was also known that young seals remained further north, in mid-west Greenland and northern Labrador, until January or even February, thus accounting for the deficiency at the same time in the samples at Tabatière.

The more recent samples show the same trend, but the immatures have become steadily better represented. The peak year-class has shifted as follows:

1952	- five years.
1953	- five years
1954	- four years
1955	- three years
1956	- three years, with two years nearly as well represented.

Tentative conclusions are that some intrinsic factor, perhaps the cooling which is known to have occurred in the last few years in inshore waters of west Greenland, has affected the endocrinological mechanism of the immatures and so brought about their earlier migration.

B. Annual changes in relation to kill of pups.

Figure 2 also shows the kill statistics of pups for the whole area and for the Gulf of St. Lawrence alone. It will be seen that the highest total kill since the war was in

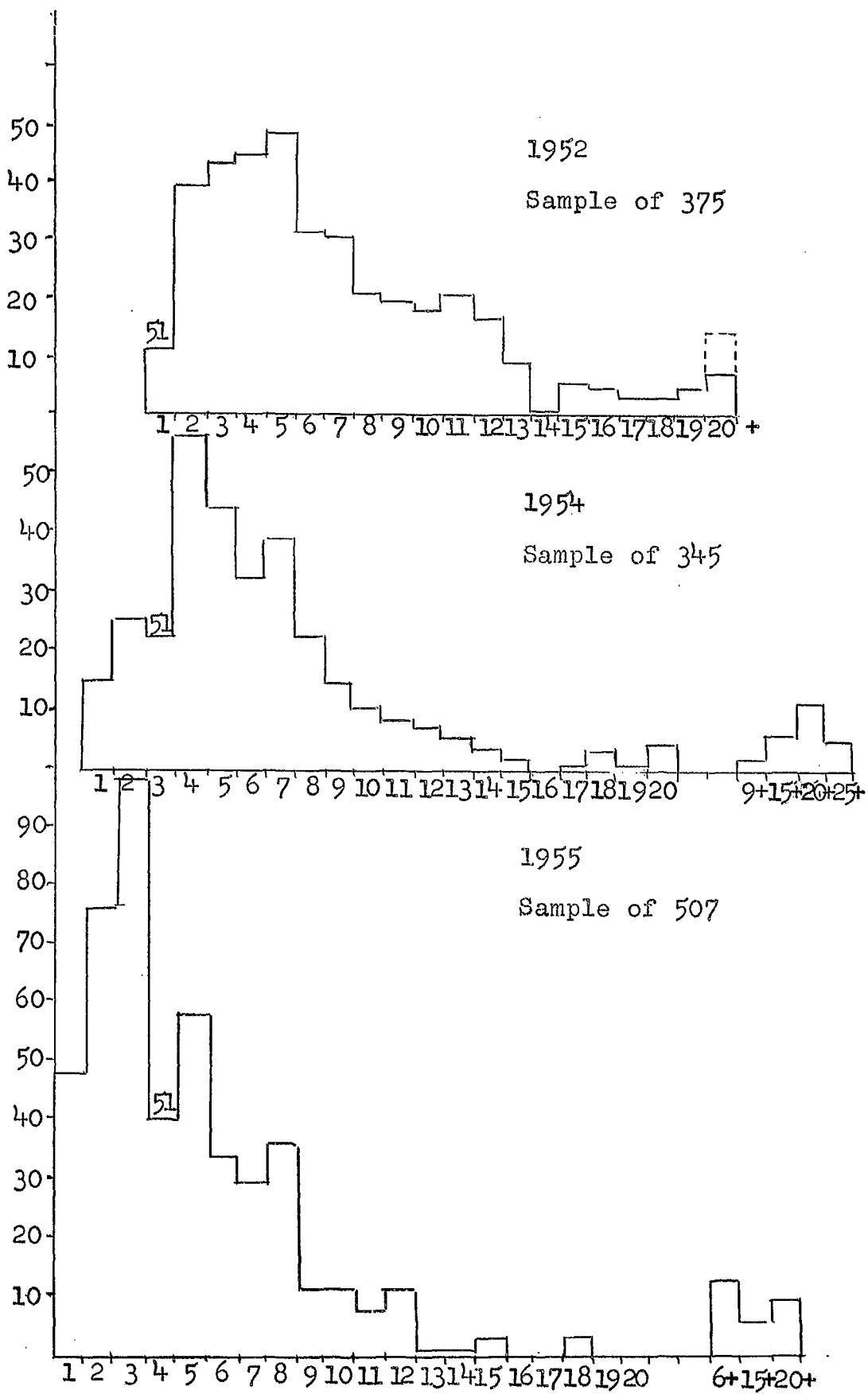


Figure 1. Age Frequencies of Harp Seals

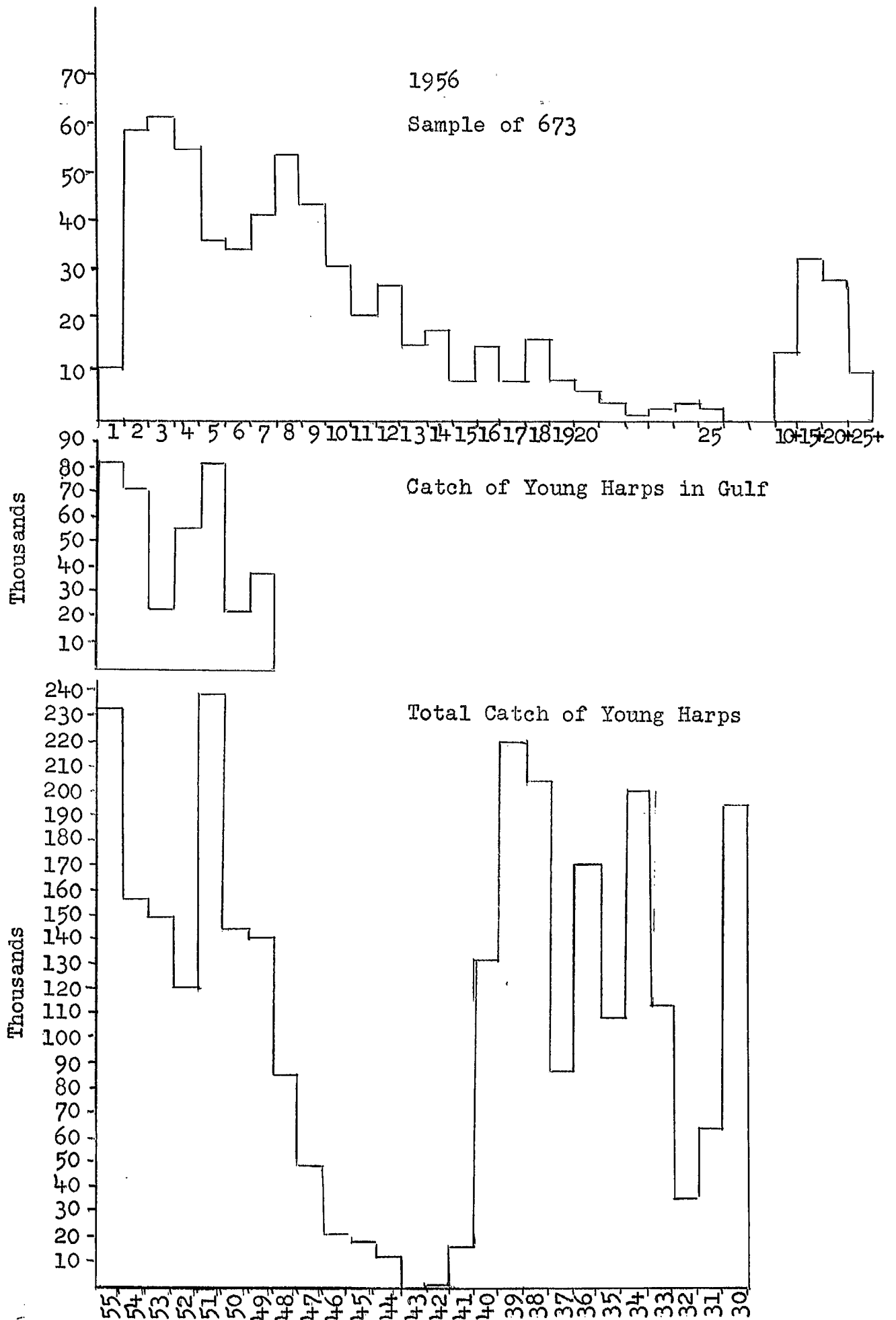


Figure 2. Age Frequency and Catches of Harp Seals

1951, followed closely by that made in 1955. Gulf kills, for which data are less precise (since it is difficult to obtain 'ships' kills by areas), also shows peaks in 1951 and 1955, with a fairly heavy kill in 1954. However, these catches are believed, from aerial surveys in the Gulf, to be light in relation to the number of young produced; the kill at the Front, east of Newfoundland, being proportionately heavier.

The low survival of the 1951 year-class is shown in all samples up to date. This can be related to the heavy overall catch in that year. The 1954 year-class shows no such scarcity. Comparison of the 1956 and 1952 samples, made in each case one year after a peak catch, shows that the 1955 year-class is lower than it should be, which suggests that the 1955 kill of young seals, too, was excessive. In general our histograms suggest that the La Tabatière age composition reflects changes in total catch better than catch at the Gulf, implying that migrants passing La Tabatière in the fall are a mixture of seals which separate later to breed either at the Gulf or the Front.

The total kill in 1956 was evidently higher than in 1951, though full statistics have not yet been obtained. Unfortunately, severe weather caused the nets to freeze at La Tabatière in December, 1956, resulting in a low catch and poor sample of jaws. Increased efforts are, however, being made to obtain samples from the commercial ships at the "Front" in 1957. Samples from this area were obtained between 1952 and 1954, and showed evidence of the high 1951 kill as early as the following year. Consequently it should be possible to determine during the coming year what effect the heavy 1955 and 1956 catches have had on the survival of those year-classes of harp seals.

D. E. Sergeant,
P. June Thompson,
H. D. Fisher.

The Bearded Seal

Analysis of material collected from 85 bearded seals (Erignathus barbatus) is almost complete, and will be published shortly as a preliminary study of this animal. The bearded seal fills special economic needs in the arctic. The thick hide, e.g., is used for boot soles and dog lines.

No. 4

Biology of the Bearded Seal

Growth. This seal grows from about 120 cm. in standard length at birth to a final adult size of about 235 cm. Little variation in size is exhibited, adults ranging from 220 to 250 cm., and there is no evidence of geographical differences in size attained, as has been found in the ringed seal.

Aging. The teeth of the bearded seal are quite degenerate and are useless for aging purposes. The pulp cavity is closed after the first year of life, and the tooth may be replaced by a strip of connective tissue in older seals. The claws, on the other hand, have been found to be valid indicators of age. A light band, generally marked by an encircling ridge, is formed in the spring and summer. Wearing at the tip obliterates the first year's growth after the ninth to fifteenth year thus old seals cannot be aged accurately.

Feeding. At least 36 organisms have been identified in stomachs from several areas. These include a wide variety of epifaunal elements, chiefly Crustacea, and other burrowing forms, of which Cardium spp. and Mya truncata are abundant.

Reproduction. Both males and females of this species appear to mature in the seventh year. The pup in the eastern Canadian arctic is born in April or May, on pack ice. Mating occurs shortly after this time as the testes of males taken in June and early July have passed the peak of spermatogenetic activity. The female bearded seal has been supposed to produce only one pup every two years. In fact, the female is apparently capable of breeding annually, but the incidence of successful impregnation seems low. The bearded seal is solitary throughout the year and does not aggregate during the breeding season. This behaviour may contribute to the low reproductive rate. There is a delay in implantation of the embryo of about two and one half months. The spread in implantation time may be over two months, probably reflecting a rather prolonged breeding season. There is good evidence, from embryo sizes, that the species breeds later in the eastern Canadian arctic than in the Okhotsk Sea, where the Russians have carried out some studies.

I. A. McLaren.

The Ringed Seal (Phoca hispida)

Field work by the investigator in charge of ringed seal studies was cancelled last year to enable him to devote a full year's continuous attention to writing up the work. A substantial manuscript as a result has been submitted to the editor as a bulletin of the Fisheries Research Board. After a study to clarify the taxonomic status of the species, now well advanced, work will be confined to routine collections in areas where the animal is an economic problem, to assess abundance and hunting depletion.

No. 5

Taxonomy of the Canadian Ringed Seal

Russian workers, in considering the great variability of this species, have eliminated a number of north Pacific and Siberian races, retaining a few forms which are isolated in lakes and in the Baltic Sea, and four others of the Russian arctic and subarctic coasts. One race is supposed to inhabit the Barents Sea and northern Russia, another is found in the area of the New Siberian Islands, another in the Bering Sea and eastern Siberia, and the fourth inhabits the Okhotsk Sea.

The Canadian ringed seal was divided into three races by R. M. Anderson in 1942, Phoca hispida hispida, of the eastern Canadian arctic, P. h. beaufortiana of the western arctic and Alaska, and P. h. soperi of Nettilling Lake, on Baffin Island, and adjacent Foxe Basin. His and the type specimens have been considered against a series of 77 skulls collected in southwest Baffin Island and 87 skulls from various localities housed in the National Museum of Canada.

The type skull of P. h. beaufortiana is unfortunately from an exceptionally large male, and all the peculiarities of this subspecies are based on this skull. No consistent differences between eastern and western arctic skulls are demonstrated in the large series now available for study.

P. h. soperi is based on five skins, three incomplete and two complete skulls from Nettilling Lake, and a few skulls from Foxe Basin. Two more Nettilling Lake skulls are now available. Of the many criteria which Anderson felt would "consistently separate" the Nettilling Lake seals, only differences in the palate may distinguish them from southwest Baffin Island seals. Three of the four Nettilling Lake skulls have proportionately longer and narrower palates, their measurements lying outside two standard errors of the regression line derived from southwest Baffin Island skulls.

It is hoped that the study will be extended to include published material and available skulls from Alaska and Greenland, thus complementing the Russian studies in Eurasia and completing the taxonomic picture of this circum-polar species.

I. A. McLaren.

No. 6

The Use of Fish Gill-nets for Capturing Ringed Seals

As an experiment in catching ringed seals, a seven-inch mesh nylon fish gill-net, 150 feet by 10 feet deep, was left with the R.C.M.P. at Herschel Island, Y.T. This net caught 29 seals on the first night, and took a total of 500 during September. The seals were taken in the ratio of four to one compared to equivalent length, larger mesh, heavy cotton twine nets usually used for netting seals. The number taken was about double a normal year's take by the police.

J. G. Hunter.

Walrus Investigations

Field investigations were carried out by M.V. "Calanus" personnel in northern Foxe Basin from October, 1955, until September, 1956, and by the investigator in charge at Southampton Island from May until October, 1956.

No. 7.

Growth and Age of Walrus

The male. Growth of the calf in the first two years is rapid, and the body weight may reach 1,000 pounds by the end of the third summer, from a birth weight of about 130 pounds. At fifteen years of age, the average body weight has increased to nearly 2,500 pounds and there is probably only slow growth after this. There is great individual variation, however, and body weights of up to 3,500 pounds have been estimated for some old bulls.

The first three year-classes are distinguishable by standard length and weight, but there is no clear division between the later year-classes. Length measurements of tusks and bacula corroborate these initial age groupings.

Bodily growth is reflected in eruption of the tusks, for this proceeds at a decreasing rate as the animal grows larger. Thus in the first year the tusk may lengthen by as much as 6.5 cm., whilst in old males the annual increase may be as little as 0.5 cm. Cementum is added to the root as the tusk is erupted, and there is slight evidence of layering, particularly after the first two years. Cementum is also laid down on the molar teeth, but here there is no eruption and the picture is simpler. Examination of the complete dentition of immature animals reveals that there is a similar proportion of cementum added to each tooth in any one year.

In mature males, cementum is laid down in regular layers on tusk roots and molar teeth, broad bands of normal cementum alternating with very narrow bands in which there appear to be no cementoblasts. These layers are well defined, and each molar tooth bears the same number. In old male tusks, pronounced root ridges may be formed, and it has been proved for other species of pinnipeds that these correspond to yearly growth zones. Tusks from only three old males are available in the present series, but they confirm that ridge formation results from a period of markedly reduced growth during and shortly after the breeding season, from March to June. A clear band in the cementum is formed at the end of the breeding season, and occurs simultaneously in both tusks and molar teeth. The cementum layers on the tusk root are necessarily fewer than those found on molariform teeth, for eruption of the tusk causes the earlier formed layers to be extruded from the alveolus. However, in the molar teeth, the cementum layers are added constantly to the tooth, increasing its diameter in a regular fashion. In adult males, if the increase in width of the cementum is plotted against the number of layers present, a typical growth curve results; this falls off to an asymptote at old age. Since the lower values of the curve fit those represented by the first three years' growth of cementum in immature animals, it is assumed that the whole curve correctly expresses the true growth, and therefore the age of the animal.

The female. It is possible to group immature females into three initial year-classes, but subsequent aging is much more difficult. The mechanics of tusk growth and cementum deposition are essentially the same as in the males, but pronounced root ridges are never formed on the tusks. Moreover, many additional narrow zones of clear cementum, lacking cementoblasts, may be formed, and this invalidates the aging method used for males.

A. W. Mansfield.

No. 8

The Male Walrus Reproductive Cycle

Evidence of former spermiogenesis is first obtained in seven-year-old animals, though spermatid formation has been observed in a small number of testis tubules in one six-year-old male. In adult males taken in the period June to late October, spermiogenesis has ceased and all stages of tubule degeneration are observed; few tubules, however, show the true resting condition. Only two specimens are available which show active spermiogenesis: a 24-year-old bull taken on March 21 and a 13-year-old taken on November 30. In both these animals, the epididymal tubules are well filled with sperm. No specimens were taken in April and May, but it is known that in Odobenus divergens spermiogenesis is still active in these months. There is no indication of a relative sterility correlated with increasing age, for bulls of up to 28 years of age show no decrease in tubular activity of the testes.

A. W. Mansfield.

No. 9

Distribution of the Walrus in Northern Foxe Basin

The movement of sea ice appears to be the most important factor affecting the distribution of walrus in Foxe Basin. In winter, in the vicinity of Igloolik Island, walrus are almost invariably seen and hunted in the pack ice. With the withdrawal of the pack ice to the south in the summer, walrus are found and hunted chiefly in the region south of the latitude of Hall Beach (68°45'N). In early September, when a new influx of heavy ice enters through Fury and Hecla Strait, and presses around Igloolik Island and down the eastern coast of Melville Peninsula, the walrus again are found close to Igloolik, presumably having returned to the northern part of Foxe Basin from the south. From then on their distribution with relation to Igloolik depends largely upon winds.

E. H. Grainger.

White Whale Investigations

The main source of supply of material for study to date has been from the commercial whaling operation at Churchill. This fishery is highly selective and there is

no evidence that the present catch is significantly affecting the stock and further collecting there has been discontinued, at least for the time being. A detailed report on maturity, growth rates of different stocks, and other incompletely known aspects of life-history will be made as soon as other commitments allow full analysis. The report will include material collected from 100 white whales by the western arctic fisheries group in the Mackenzie Delta in 1955 and 1956.

No. 10

Population Studies of White Whales

Three aerial surveys were made in the summer of 1956, extending between Churchill and Seal River 30 miles to the north. Resulting estimates of numbers of white whales are shown in Table I, together with similar estimates for both this and more extensive traverses made by personnel of the Fisheries Research Board and Department of Fisheries in previous years.

There is no evidence from the aerial surveys of any decline in overall numbers since 1950. There is some suggestion, however, of a shift of animals from the Churchill River, where hunting takes place to the Seal River, where it does not. Commercial hunting at Churchill began in 1947. In 1951 the catch reached a level of 584 animals, which is close to the average catch from 1951 to 1955. We conclude that this level of hunting has no effect on the stocks, although it may cause the whales to move out of the area hunted.

Visual and photographic studies made on these flights showed an abundance of large animals, usually in groups of from two to twelve within the loose mass of whales in the estuaries. These were probably in the main adult males. Females with calves were usually solitary or in pairs. Since the large animals are selectively taken by the hunters, this is further evidence of the slight effect of the fishery on the stocks.

White whales give birth generally in April and May. On the first flight, made on June 30, yearling calves could generally be distinguished, and a visual estimate was obtained of 22 calves out of 192 animals, or 11.4%. On the last flight, made on August 4, there was more confusion between possible first- and second-year animals; 12 to 20 calves were out of 134 animals, or from 9.0 to 15.0%.

D. E. Sergeant.

Table I. Aerial Estimates of White Whale Numbers in Western Hudson Bay.

<u>Year</u>	<u>Date</u>	<u>River Area</u>			<u>Total</u>
		<u>Churchill</u>	<u>Knife</u>	<u>Seal</u>	
1950	July 19	600+		600-700	1200-1300+
	July 26	700		700	1400
	Aug. 1	988		650+	1638
	Aug. 31	33		Not surveyed	--
1953	Aug. 7	1000	30	80	1110
	Sept. 2	120		Not surveyed	--
1955	July 25	900		1800	2700
1956	June 30	250	125	600	975
	July 14	295	145	650	1090
	Aug. 4	675	73	730	1478

<u>Year</u>	<u>Date</u>	<u>Churchill R.</u>	<u>Within 60 miles North</u>	<u>Nunulla</u>
1948	Aug. 12, out	200	165	125
	Aug. 12, return	131	34	

<u>Year</u>	<u>Date</u>	<u>Churchill R.</u>	<u>100 miles North</u>	<u>Tavani</u>
1948	Sept. 13	--	28	3

<u>Year</u>	<u>Date</u>	<u>Churchill to Eskimo Point</u>
1951	Aug. 31	631

<u>Year</u>	<u>Date</u>	<u>Churchill to Nelson River</u>
1951	Aug. 31	76

Newfoundland Whale Studies

The increased development of the Newfoundland pilot whale industry (1956: about 10,000) has prompted us to give emphasis to population studies, with the ultimate objective of estimating the potential yield. An experimental aerial survey over Trinity and Conception Bays in 1956 was successful in locating not only pilot whales but other Cetacea as well.

No. 11

Aerial Observations of Whales off Eastern Newfoundland

On September 28, 1956, two flights were made in a "Beaver" aircraft over Conception and Trinity Bays, in order to estimate numbers of pilot whales and other species of Cetacea. Weather conditions were bright sun with a westerly breeze force 2. Visual observations were easy up to altitudes of 1,000 feet and estimates made by two observers tallied reasonably well. Aerial photographs were, however, unsuccessful partly because the wavelets caused too much light scattering and partly because the animals dived too deeply for their outlines to be photographed under water. The following was the approximate total of Cetacea observed:

<u>Species</u>	<u>Conception Bay</u>	<u>Trinity Bay</u>	<u>Total</u>	<u>Mean ratio to large whales</u>
Pilot whale, <u>Globicephala melaena</u>	650	360	1,010	72/1
Dolphins, all identified being <u>Lagenorhynchus acutus</u>	150	-	150	10/1
Rorquals, apparently fin whales <u>Balaenoptera physalus</u> (i.e. "large whales")	4-5	9-10	13-15	

The rorquals were feeding in groups in the outer part of both bays, accompanied at times by white-sided dolphins. Pilot whales and dolphins were also associated at times.

In the preceding ten days about 650 pilot whales had been driven ashore in the bottom of Trinity Bay, including a group of 200 driven while the flights were in progress, but not included in our count. Lower numbers of pilot whales were seen in the bottom of Trinity (160) than in Conception Bay (300) as the result of the driving. Several groups were, however, seen in mid-Trinity Bay moving southward. These observations bear out a previously developed concept that as fast as herds are taken out of the bay they are replaced by other herds moving in randomly to exploit the rich stocks of squid found against the coastline.

D. E. Sergeant.

No. 12

The Biomass of Pilot Whales as Compared with Other Species of Cetacea in the Boreal Northwest Atlantic

The totals given in our aerial survey may be compared with figures obtained from observations made from various ships in 1953 and 1954. Observations were made offshore from cutters of the United States Coastguard at Ocean Station "B" situated in boreal waters of the Labrador Sea, and at Ocean Station "D" southeast of Flemish Cap in North Atlantic Current water, and from research vessels of the Newfoundland Biological Station around Newfoundland, as reported by Sergeant and Fisher (1957). Totals of Cetacea observed, and the ratios of each type of small whale to large, were as follows:

<u>Species described as</u>	<u>Station "B" number</u>	<u>"B" ratio</u>	<u>Station "D" number</u>	<u>"D" ratio</u>	<u>Coastal waters around Newfoundland</u>	
					<u>number</u>	<u>ratio</u>
Blackfish (U.S.) or Pothead Whales (Nfld.)	981-1082	34/1	444-459	53/1	395-505	37.5/1
Dolphins or Porpoises	125-145	4.5/1	111-136	15/1	50-60	4.5/1
Large Whales	30		8-9		12	

It is probably better to exclude from consideration the observations made in warmer waters at Station "D", since some of the animals described as "blackfish" there probably refer to species other than Globicephala melaena, and since warm water dolphins were probably recorded also. Not only do the other two areas show a marked similarity in faunal composition (the species of dolphin observed were in each case Lagenorhynchus acutus where indentifiable, and the seasonal movements of the pilot whales were similar), but the actual ratios of the various types of Cetacea were, as may be seen, closely similar. Records kept by individual observers known to be more than usually reliable show this again:

<u>Species</u>	<u>Station "B"</u> July 18-Aug. 3, 1953		<u>Hamilton Inlet Bank</u> Sept. 3-21, 1954	
	<u>Number</u>	<u>Ratio</u>	<u>Number</u>	<u>Ratio</u>
Blackfish or pilot whales (<u>G. melaena</u>)	200-270	30/1	315-395	40/1
Dolphins (<u>L. acutus</u>)	50-60	7/1	35-40	9.5/1
Large whales, species indet.	8		9	

The similarity in species composition and ratios shows that we are dealing with a very similar fauna inshore and offshore. The ratio of pilot whales and dolphins on one hand to large whales on the other in our inshore aerial observations (Appendix No. 11) was higher than elsewhere, but this sample was restricted to the bays, and clearly reflects the tendency of the large whales to remain outside narrow waters.

The mean ratio of pilot whales to large whales observed, excluding the observations in the bays, works out at 35 to 1.

The fin whale is the dominant whale among the larger species in these waters; catches at Newfoundland and Labrador shore stations from 1945 to 1951, the last period of operation at these stations, averaged 86.7% fin whales. We may assume that the majority of sightings of "large whales" refer to this species. With fin whales representing 86.7% of the sightings, the ratio of pilot whales to fin whales observed would be 30 to 1.

To calculate the relative biomasses we must know the relative weights. The average length of fin whales taken at the shore stations in 1945 to 1951 was 60 feet. Following Ash (1952) we calculate the weight of this size of fin whale to be 34.42 long tons or 3497 kilograms. However, allowing a 15% reduction for immature and young whales not represented in the catches, as suggested by Mackintosh and Brown (1956), we may reduce this figure to 2973 kilograms. The mean length of a random sample of pilot whales taken in Trinity Bay, Newfoundland, in 1954 to 1956 was 13 feet, with a mean weight calculated at about 900 kilograms. The ratio of weight of an average fin whale to an average pilot whale is thus about 33 to 1. We conclude that the relative biomasses of pilot whales and fin whales in these waters are approximately $30/1 \times 1/33$ or nearly the same.

No. 13

Comparative Sustainable Catches of Fin Whales and Pilot Whales

We use the maximum sustainable catch of fin whales in Newfoundland and Labrador waters to calculate the same for pilot whales, using the comparative biomasses and our knowledge of the reproductive rates of each. We thus do not attempt to calculate total stocks. For each species we assume a homogeneous population in the northwest Atlantic which is not subject to catching elsewhere.

Catches of fin whales in Newfoundland and Labrador remained fairly steady between 1945 and 1951 with a mean annual catch of 482.3. There was no decline in the catch, but in 1950 and 1951 the catch in waters close to shore was reduced, the catch per unit effort was declining, and the proportion of larger whales, both males and females, began to decrease. It can therefore be assumed that the catch was slightly but not greatly excessive, and that the maximum sustainable catch of fin whales in this area was about 450.

A similar biomass of pilot whales will consist of 450×33 or about 15,000 pilot whales. The reproductive frequency of the pilot whale, which has on average one calf in three years, is about one third less than that of the fin whale, which has one calf in two years. This is probably balanced by a lower natural mortality rate, so that as high a cropping rate should be possible as for the fin whale. The ages at maturity are respectively six years and five years, which will reduce the crop to about $15,000 \times 5/6$, 12,500.

The calculation rests on the accuracy of the parameters given. The ratio of numbers can be improved by further surveys from ships and planes planned for 1957. The omission of minke whales, not caught at the big land stations, will probably lower the proportion of fin whales to total large whales, but minke are inconspicuous compared with the large rorquals and the numbers recorded are probably few in comparison with them. The estimate for a sustainable catch of fin whales cannot be improved until further whaling, and biological studies, can be initiated in Newfoundland and Labrador. It is complicated by the recent discovery that fin whales taken in Iceland have increased in size beginning in 1954. This suggests that the Newfoundland-Labrador stock, not caught since 1951, now contribute to Iceland catches, (Jonsgaard, personal communication). The catching of pilot whales in Greenland, Iceland and Faeroes, which may total about 1,000 a year, is negligible compared with that taking place in Newfoundland. However, in 1948 to 1951, whaling in Iceland took an average of 248 fin whales a year in addition to the 482.3 taken in Newfoundland and Labrador. Consequently, our estimate for the sustainable catch of fin whales in

Newfoundland and Labrador, under hypothetical conditions with no whaling of the same stock elsewhere, has to be raised by an unknown factor with an upper value of 248/482 or about 50%. This would raise the sustainable catch of pilot whales by the same unknown factor, giving an upper limit of 18,750 per annum.

An excessive catch of pilot whales would lead to a slower entry into the bays where whaling is carried out, so that, with present catching methods, the result would be less frequent drives of pilot whales, and greater effort and overheads incurred by the catcher boats searching for them.

The imposition of an annual quota would be complicated by the fact that, in certain years, pilot whales fail largely or altogether to enter the Newfoundland bays. The direct cause is a failure of the squid; the ultimate cause is unknown. Such failures seem to preclude the development of a highly capitalized fishery based, as at present, on inshore whaling alone. Offshore whaling for the small pilot whales would doubtless prove to be expensive and perhaps unremunerative. In these circumstances, regulation may for the time being prove unnecessary.

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D. E. Sergeant.

Invertebrate and Hydrographic Studies

Phytoplankton and subsequent marine production is particularly large in areas of confluence of purely polar and non-arctic waters. Plankton and associated hydrographic studies, primarily from material collected from H.M.C.S. "Labrador" and the M.V. "Calanus", are being undertaken in an attempt to clarify our understanding of purely arctic versus sub-arctic productivity. In view of the painstaking nature of work on this material, field work is being held to a minimum in the coming year in order to get a back-log of data and material processed.

No. 14

Physical and Chemical Annual Cycle in Northern Foxe Basin

Between September, 1955, and September, 1956, at approximately two-week intervals, observations on water temperature, salinity, oxygen and dissolved inorganic phosphate, along with measurements of ice thickness, air temperature and other related features, were made at a fixed station near Igloolik Island, northern Foxe Basin. Data were collected from the surface, 10, 25 and 50 metres, and these permit recognition of the general features of annual change in this marine area with respect to the variables studied.

Station 719, the location of this work, is slightly more than 50 metres deep. It is within the region of Foxe Basin most influenced by the southeastward flow of water through Fury and Hecla Strait. Winter freezing of the surface water occurred about November 1, following which time the ice thickness increased gradually to about 150 centimetres. First ice melting occurred in early June, and at the end of July the winter ice moved away from the station. Station 719 remained free of ice until about the middle of October, 1956.

Winter water temperatures (Figure 1) followed a regular pattern during the year. From the first occupation of the station in late September, 1955, when temperatures at all depths were close to -0.5°C ., temperatures decreased to about -1.7°C . immediately after freeze-up in early November. From then until early May, 1956, temperatures at all depths remained close to -1.7°C ., the only appreciable deviation from this being a drop to -1.75°C . during April and early May, at 50 metres. The first warming was noticed in mid May at the surface, shortly before mid June at 10 and 25 metres, and in mid July at 50 metres. Until early September, surface, 10- and 25-metre temperatures increased, then fell rapidly. Temperatures at 50 metres increased until soon after mid August, then fell gradually. The warmest surface temperature was $+1.80^{\circ}\text{C}$., the warmest at 10 metres, $+1.55^{\circ}\text{C}$., at 25 metres $+1.18^{\circ}\text{C}$., and at 50 metres, -0.07°C .

Air temperatures at times of station occupation fell from $+30^{\circ}\text{F}$. to -20°F . between late September and the end of November, 1955. They remained below 0°F . until early April, 1956, increased to $+42^{\circ}\text{F}$. in mid July, and dropped to about $+30^{\circ}\text{F}$. in September.

Results of salinity titrations are not yet available.

Oxygen values (Figure 2) at the surface, 10 and 25 metres decreased from about 8 cc./l. in late September, 1955, to between 5 and 6 cc./l. in late April and early May,

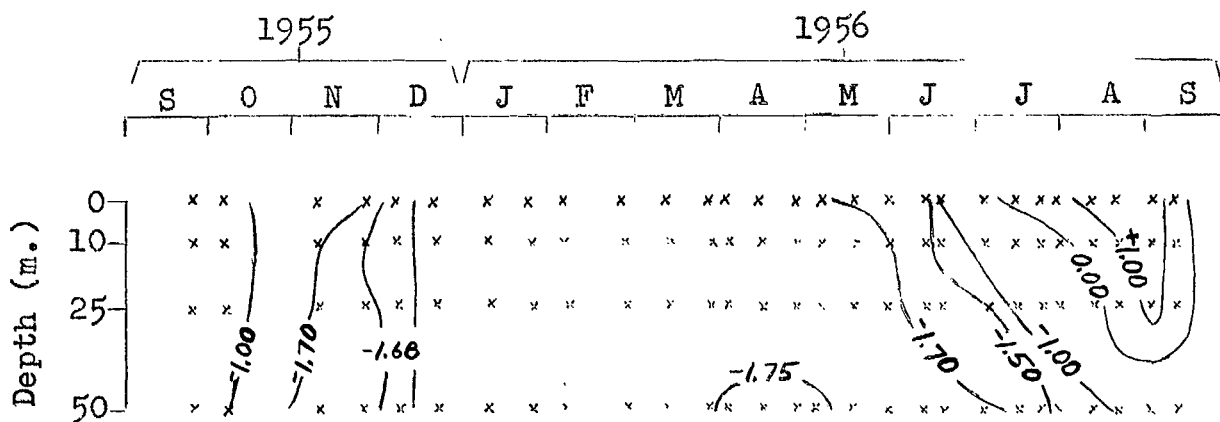


Fig. 1. Temperature (°C.)

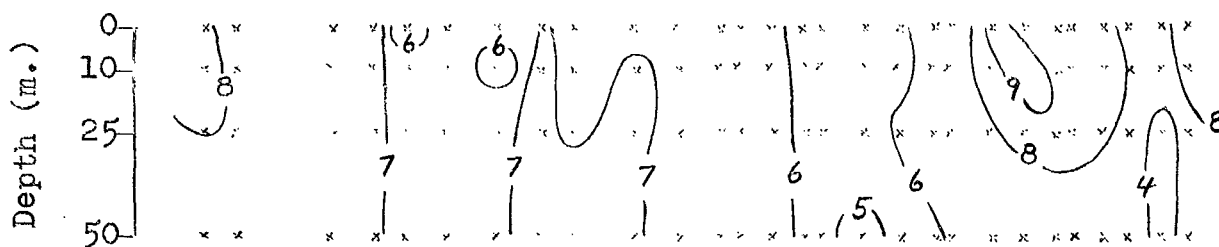


Fig. 2. Oxygen (cc./l.)

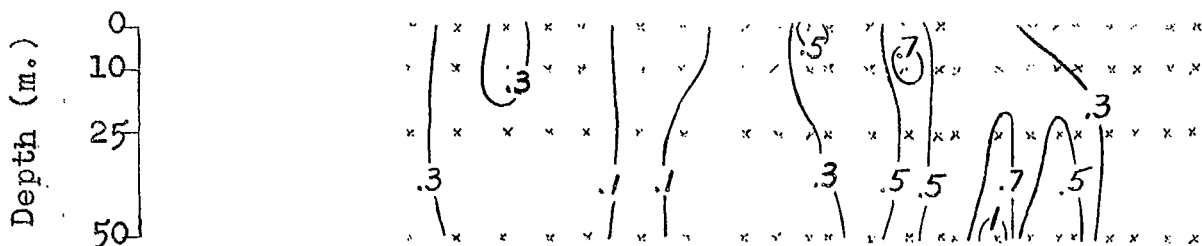


Fig. 3. Phosphate (µg. at./l.)

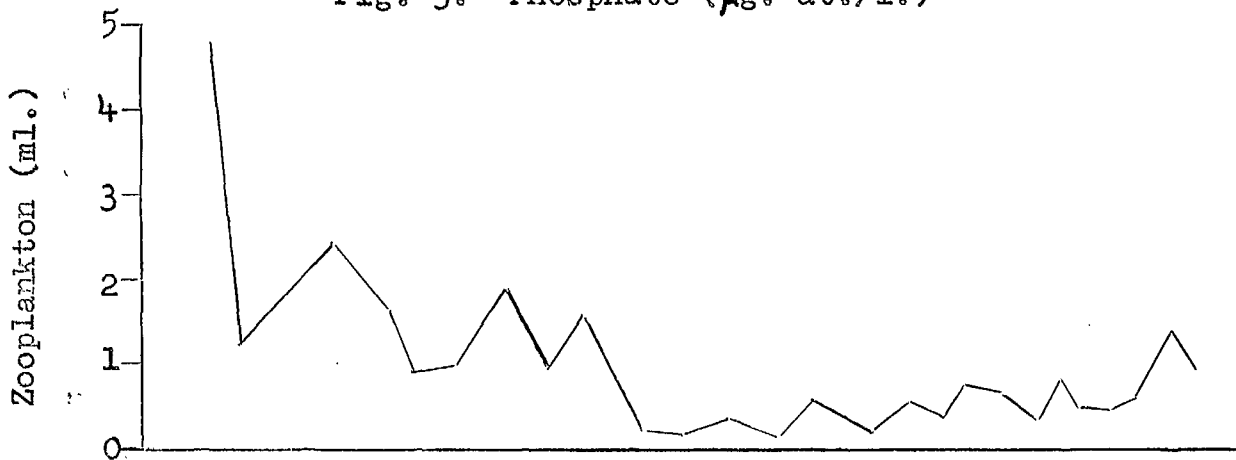
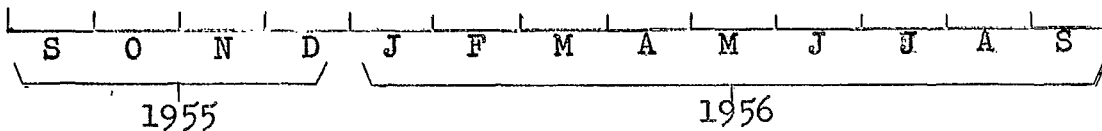


Fig. 4. Total zooplankton (ml. per 50-metre haul)



1956. At 50 metres, values rose from about 6.5 cc./l. in late September to more than 7 cc./l. in November, then decreased, as did values for other depths, until May. Following this, values for all depths rose, the surface to 9.52 cc./l. in early July, 10 metres to 9.23 cc./l. in mid July, 25 metres to 8.80 cc./l. in the first half of August, and 50 metres, showing a much smaller increase, to 7.01 cc./l. near mid September. Of interest was a sharp and short decline in all values in late August and early September, less pronounced at the surface than at other depths, greatest at 50 metres, where the value dropped to 4.08 cc./l. In mid September values at all depths approached closely those found in late September, 1955.

Dissolved inorganic phosphate values (Figure 3) are wanting for the period from late September until December, 1955. Values, similar at all depths, declined generally from about 0.4 $\mu\text{g. at./l.}$ in early December to close to zero (0.02 to 0.04 $\mu\text{g. at./l.}$) in February. Following this time the amount of phosphate increased at all depths until late May (0.6 to 0.7 $\mu\text{g. at./l.}$). Then surface and 10-metre values decreased gradually until mid August, to about 0.1 $\mu\text{g. at./l.}$ while phosphate content at 25 and 50 metres continued to increase until early July (to 0.7 and 1.1 $\mu\text{g. at./l.}$), then fell quickly until August. A slight increase was noted in late August and early September, but the cycle cannot be followed further because of missing data from October and November.

E. H. Grainger.

No. 15

Phytoplankton Studies

Foxe Basin Phytoplankton. The plankton collections made by the M.V. "Calanus" expedition in 1955 and 1956 represent valuable material which permits a study of the entire annual cycle of productivity in the Igloolik area and the northern part of Foxe Basin. Attention was concentrated on quantitative estimates of plankton production. Vertical net hauls taken with a No. 20 net have been examined for diatoms and dinoflagellates. Phytoplankton counts are not yet completed. The final analysis of phytoplankton production cannot yet be finished since there has not yet been an opportunity to make use of recently obtained salinity data. Stations were investigated quantitatively and samples were taken from the surface, 10, 25- and 50-metre levels. In spite of previous information to the contrary phytoplankton growth was found to start under the ice in the beginning of May, reaching a maximum probably in summer. The quantity of diatoms is still large in

September, and gradually diminishes. It is impossible to appreciate yet other factors in action, and the importance of different elements in the area studied, since this work is in a preliminary phase.

A final report on this phase is expected in about one year.

H.M.C.S. "Labrador" Cruise 1954. Ninety-five plankton stations taken from 50 metres to the surface with a No. 5 net have been examined. Particular attention was paid to the study of dinoflagellates, especially Goniaulax species. Special attention was given to definition of this species on the basis of the sulcal plates. Some rare plankton forms were described. All species concern the strong-membraned group which can be preserved in formalin samples.

H.M.C.S. "Labrador" Cruise 1955. The quantitative phytoplankton material collected by the "Labrador", including net plankton in collections of surface samples taken in 1955 from Hudson Strait, will be studied in the near future.

H.M.C.S. "Labrador" Cruise 1956. Phytoplankton stations were examined for fresh plankton species of "naked" dinoflagellates, including a cruise around Baffin Island. The samples had to be examined immediately in the living state, in state, since they are too delicate for preservation. A microscope was mounted on a table aboard ship. A foam rubber base eliminated the effect of ship vibration. This made possible taxonomic observations, including detailed drawings with camera lucida. The naked dinoflagellates of northern seas are little known. Over 60 species have been found in eastern Canadian waters by the author. This study is still in progress, and comparisons are being made with recent intensive work along the same lines in the U.S.S.R.

One hundred and six samples of formalin-preserved material, taken with No. 5 and No. 20 nets, will be used for taxonomic identification supporting sedimentation method.

Phytoplankton stations in coastal waters of Baffin Island, Hudson Strait and Foxe Basin including Fury and Hecla were collected from surface, 10-, 25- and 50-metre depths. As soon as the "Calanus" 1955 and 1956 material is finished with, they will be worked in detail.

A. S. Bursa.

No. 16

Zooplankton Annual Cycle in Northern Foxe Basin

For the assessment of plankton (zooplankton and phytoplankton), nets of three mesh sizes were used in vertical hauls at Station 719, and collections were made at the same time as the physical and chemical observations. Used with $\frac{1}{2}$ -metre conical nets of silk numbers 0 and 6XXX, and Apstein nets of silk number 20. Phytoplankton collections, from the Apstein nets and from closing-bottle samples, are being studied at present (see phytoplankton report of A. S. Bursa). Of the zooplankton collections, only the number 0 net hauls have yet been examined, and detailed work on this has only begun. An approximation of zooplankton biomass has been made by volumetric measurement of total plankton yields, expressed in ml. of plankton per 50-metre vertical haul (Figure 4). Shown by this is a decline in total zooplankton after a late September maximum, a levelling-off during November to January, a further decline to lowest values between late February and April, then a gradual increase, accelerated in September, reaching maximum quantity in late September.

The principal group within the zooplankton is the copepods which show a volumetric variation during the year generally comparable to the total plankton curve. The dominant species are Calanus finmarchicus and C. hyperboreus, which along with several other species were taken to the maximum number of 2,125 specimens per single haul (late September), and to the minimum number of 58 specimens per haul (early May). It is hoped that present material will serve to show something of the breeding cycles and growth of several of the more abundant copepod species in these waters.

Several other zooplankton groups are well represented, often by several species, during much of the year. Among them are the medusae (Aglantha), chaetognaths (Sagitta), tunicates (Oikopleura and Fritillaria), amphipods (Hyperoche, Gammarus, Apherusa), decapod, cirripede, polychaete, isopod larvae, and others.

Several points of relationship between the physical, chemical and biological cycles are apparent. Coinciding approximately with the first apparent temperature increase in the surface waters (early May) was the appearance of the first sign of spring phytoplankton increase and the first rise in oxygen values, following the long, slow winter decline. As water temperatures rose and phytoplankton quantity expanded, oxygen quantities increased, reaching successive peaks at the surface, 10, 25 and 50 metres. Meanwhile, phosphate values in the upper waters diminished, but increased in the lower layers, then fell, in phase with the later oxygen maxima in these depths.

One of the most notable features of the Foxe Basin marine cycle is the lateness in the season of the time of maximum production. The phosphate peak in spring and early summer, and the zooplankton maximum in late September represent a cycle which is several months later than the occurrence of similar phases in marine areas of the temperate region. There is evidence, however, that the production of life, although late in the season and of comparatively brief duration, is great. Attempts to compare total productivity of this area with other regions have not yet been made.

E. H. Grainger.

No. 17

Biology of *Themisto libellula*

(Completed, paper at present being finished.) This is a contribution to the understanding of the factors determining the productivity of arctic and subarctic waters, and includes a review of relevant work on the relation between temperature, metabolism and growth in aquatic organisms. *T. libellula* is a "key industry" form at its ecological level in arctic seas, being a large pelagic Crustacean, feeding chiefly on copepods and other small Crustacea, and itself forming food for ringed seal and arctic char.

The material consists of collections from Ungava Bay, Hudson Strait, Frobisher Bay, Cumberland Sound and Hudson Bay, made in the years 1947 to 1954. This large material has made it possible to go into the growth rate and breeding cycle in much greater detail than in the earlier (1946) study of the same species at Lake Harbour.

Themisto has a well-established alternating breeding cycle, such that two broods co-exist at different stages in the life cycle, the broods being largely or completely separate reproductively. The life cycle almost certainly takes two years to complete, and there is no evidence that individuals spawn more than once. The growth rate of the younger group (young of the year) is slow, the population increasing in mean size from 4-5 mm. in length in late June to 14-16 mm. in late August, in Ungava Bay. The larger (adolescent) group increases from about 24 mm. to 26-30 mm. in the same time. Mature specimens (from seal stomachs) were found in March and April, and the breeding period is probably at its most intense from March to perhaps late May or early June. There is, however, some evidence for a beginning of breeding in October or even late September, in the colder waters studied. It is possible that breeding continues all winter, or that there is a breeding period in the late fall for those individuals which have

"missed" the earlier maturation time. This suggests that maturation is associated with decreasing and not increasing temperature.

A two-year life cycle is at least twice as long as the life-time of pelagic Crustacea of similar body size in temperate waters.

M. J. Dunbar.

No. 18

Physical and Chemical Oceanography of the "Calanus"
Expeditions, 1949-54.

These results are not yet worked out in sufficient detail to warrant a full summary at this time, but the following points of interest may be noted: (1) At the 50-metre level (below the influence of surface warming and cooling, and freshening) the water of Hudson Bay and of the western end of Hudson Strait is about 0.5°C . colder than that of Ungava Bay, and at the 100-metre level there is greater spread of temperatures in Ungava Bay, the Hudson Bay water being normally below -1°C ., even in August. (2) Temperatures in Frobisher Bay are of the same order as those of Ungava Bay, but show considerably less spread to the right (warmer). Ungava Bay waters, in short, are less stable than those of Frobisher Bay and much less stable than those of Hudson Bay. (3) The higher stability in the surface layers in Hudson Bay causes the surface temperature to rise several degrees above the levels normal for the rest of the eastern Arctic (up to 10°C . in Hudson Bay, 5.8°C . in Ungava Bay, 4.5°C . in Frobisher Bay). This heating of course further emphasizes the stability. (4) An upturn in the lower ends of the T-S correlation curves is characteristic for Ungava Bay, at about the 200-metre level. This probably indicates the intrusion of West Greenland water containing an Atlantic element. (5) Density inversions were recorded in 20 out of 48 stations in Ungava Bay, Hudson Strait and Frobisher Bay, in 1949-51; their occurrence appears to be related to the state of the tide in areas of high tidal interval.

M. J. Dunbar.