

FISHERIES RESEARCH BOARD OF CANADA

PROGRESS REPORTS

OF THE

PACIFIC COAST STATIONS

PACIFIC BIOLOGICAL STATION

P.O. BOX 6
NANAIMO, B.C.

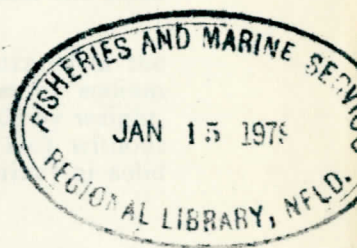
AND

PACIFIC FISHERIES EXPERIMENTAL
STATION

898 RICHARDS STREET
VANCOUVER 2, B.C.

No. 94

MARCH, 1953



These Progress Reports are published under authority of the Fisheries Research Board of Canada. They are issued quarterly to acquaint the Canadian fishing industry with some aspects of investigations conducted by the Board through its Pacific Coast Stations situated at Departure Bay, near Nanaimo, B.C., and at Vancouver, B.C.



PROGRESS REPORTS NO. 94

CONTENTS

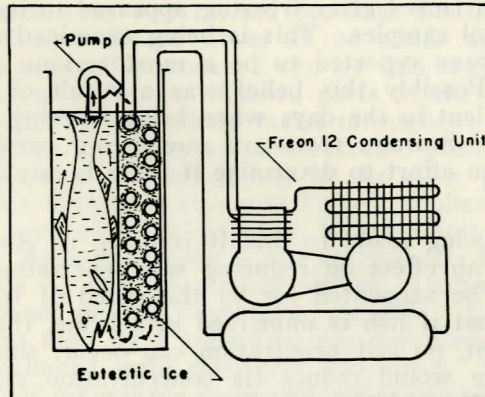
Brine Freezing of Fish	J. S. M. Harrison and S. W. Roach	3
Seasonal Variation in Exploitation of Skeena River Sockeye Salmon as Indicated by Tagged Fish Recoveries	K. V. Aro	5
Daily Seawater Observations Along the Central British Columbia Coast	H. J. Hollister	8
The Stephenson Collapsible Crab Trap	T. H. Butler	16
Oceanography of the Strait of Georgia		
II. Temperature Distribution	Michael Waldichuk	19
Fatty Acid Composition of Fish Oils		
II. Herring Oil	Lyle A. Swain	24
The Nutritive Value of Fish Meal and Condensed Fish Solubles		
VII. Herring Autolysates, Fermentation Products, Condensed Solubles, and Meal as Supplements for Chick Starter Rations	H. L. A. Tarr, Jacob Biely and B. E. March	27
The Appearance of a New Commercial Shrimp in a Newly Developed Shrimp Fishery	T. H. Butler	30
Recent Publications Issued by the Fisheries Research Board of Canada		31

MARCH 1953

BRINE FREEZING OF FISH

Investigations are under way at this Station on the application of brine freezing to the freezing of fish at sea. The need for freezing at sea as a means for improving quality has been stressed in other reports of this Station's activities (these Progress Reports, No. 88, October 1951) but brine freezing has not previously been investigated although it is the oldest known method of artificially freezing fish and is used to a considerable extent in fish freezing. The aim of our present investigation is to find a method of applying brine freezing suitable for conditions on the British Columbia coast with regard to species of fish, type of vessel and the form in which the fish are marketed.

The work done to date has been with the apparatus illustrated in the accompanying figure. The brine used is an eutectic solution of sodium chloride (common salt), *i.e.*, one containing 23.3% sodium chloride by weight, which freezes at -6°F . to a homogeneous material (eutectic ice) without preliminary separation of either water ice (as from a weaker brine) or solid



salt (as from a stronger brine). The operating sequence consists of first cooling the brine to its freezing point, then freezing a considerable quantity of eutectic ice onto the evaporator. The fish is then immersed in the brine and frozen. The circulating pump operates throughout and maintains the brine temperature at -6°F . except for a few minutes when the fish is first introduced. There are several reasons for freezing brine on the coils. Firstly, it permits cooling the brine to its freezing point, whereas in conventional brine coolers some margin of safety must be left to avoid freezing and plugging the heat exchanger. Secondly, it provides a reserve of refrigeration which prevents the rise of brine temperature when the fish is first introduced and gives up heat at a rate exceeding the capacity of the small condensing unit. Thirdly, it allows the condensing unit to operate in periods of no load or part load, providing refrigeration in the form of eutectic ice, for future use.

Considerable work has been done to examine the extent of salt penetration into the fish in order to assess whether it is a serious detriment to brine freezing of the types of fish likely to be frozen here. Three possible

adverse effects are: acquirement of too salty a taste, impairment of a glaze that may be applied after freezing, and promotion of rancidity. The table below shows typical analyses for salt in different species of fish.

Species	Salt content (% of total weight)			
	In skin	First $\frac{1}{8}$ in. under skin	Second $\frac{1}{8}$ in. under skin	Central portion
Spring salmon	1.29	0.15	0.15	0.15
Chum salmon	6.29	0.27	0.28	0.28
Grey cod	3.37	0.66	0.38	0.23

The variation in skin salt content recorded is probably due to the fact that the fish were all rinsed in fresh water, immediately after freezing, to remove adhering brine. However, it can be seen that the salt content of even the first layer under the skin is well below the generally accepted level for palatability, which is usually taken at 1%. Glazes on brine-frozen fish which had been rinsed after freezing appeared to be as good as those on air-frozen control samples. This is being examined further in storage tests since it has been reported to be a most serious drawback to brine freezing of fish. Possibly this belief was a result of the high storage temperatures prevalent in the days when brine freezing was commercially tried in this area. Storage tests are now being carried out on brine-frozen samples in an effort to determine if there is any acceleration in the effects of rancidity.

Attempts are being made to find if freezing at close to the eutectic freezing point has an effect on reducing salt penetration beyond that reduction which can be accounted for by the speed of freezing. A theory has been offered that if fish is immersed in a brine, the brine being held at its freezing point, no salt penetration can occur, since the removal of salt from the brine would reduce its concentration and hence raise its freezing point which would in turn freeze the brine, stopping the action. Freezing at the exact eutectic freezing point cannot be accomplished but it may be that freezing in close proximity to the eutectic freezing point will retard salt penetration. Results of our tests indicate this is true but they are not as yet conclusive.

If brine freezing proves practical it could provide a very compact and efficient freezing system for small craft. For example a tank 16 by 30 by 36 inches operated by a 5-hp. condensing unit could freeze 100 lb. of fish per hour. Little structural alteration would be needed and the condensing unit would require few automatic controls and would operate with a minimum of attention.

Pacific Fisheries Experimental Station

J. S. M. Harrison
S. W. Roach

SEASONAL VARIATION IN EXPLOITATION OF SKEENA RIVER SOCKEYE SALMON AS INDICATED BY TAGGED FISH RECOVERIES

During the years 1944 to 1948 sockeye salmon tagging experiments were conducted in the commercial fishing areas of the Skeena River in order to obtain information on the extent of commercial exploitation, the seasonal variation in catch, the time of migration of sockeye through the fishery, the speed of upriver travel, the extent of capture in the upriver Indian fisheries and the ultimate spawning ground destination. The fish were caught by purse-seine in the commercial fishing areas, tagged and released. Tags from recaptured fish were collected from the commercial fishermen and from the upriver Indians.

Results of each year's tagging have been reported annually by Dr. A. L. Pritchard (Pacific Progress Reports, issues Nos. 61, 65, 70, 75) and Dr. D. J. Milne (issue No. 80). In the present report all years' results have been brought together and the percentage recoveries recalculated to conform to the same dates each year.

Commercial Fishery

The tagging each year was carried out near Smith, Lelu, Ridley and Kitson Islands and near Morse Cove, all of which are well within the commercial fishing area. The sockeye run by this time had already been subjected to fishing in the more offshore parts of the gill-net area. The degree of inshore and offshore fishing varies throughout the season. At the beginning of the season the boats are concentrated offshore whereas during the latter part they tend to concentrate in the river proper. Therefore, the percentage return of tags, as shown in Table I, applies only to the inshore fishery and should vary with the increased fishing effort in the river as the season progresses. Because tagging is carried out after the fish have passed part of the hazards of the commercial fishery, estimates of commercial fishing intensity based on tag recoveries are low. Estimates of Indian fishing intensity are high by a somewhat smaller amount. In 1948 jacks (precocious male salmon) were especially numerous. These were tagged in proportion to their occurrence in 3½-inch-mesh seine hauls but could not be caught effectively in 5½-inch gill-nets. Estimates of intensity of commercial fishing for that year are accordingly low.

TABLE I.—The tag recoveries in the commercial fishery expressed as a percentage of total sockeye tagged each week in the years 1944, 1945, 1946, 1947 and 1948.

Week	1944	1945	1946	1947	1948	Average for all years
June -23		11.8	5.7	2.5	2.5	5.6
24-30		17.6	25.1	18.6	14.7	19.0
July 1-7		39.4	18.5	20.8	44.6	30.8
8-14	23.6	36.7	38.1	17.1	34.4	30.0
15-21	46.5	30.8	36.3	25.8	28.6	33.6
22-28		28.9	32.4	16.9		26.1
29-		27.3				27.3
Total tag recovery	40.9	25.5	30.1	18.8	21.8	27.4

As has been mentioned, the early portions of the runs arriving in the river proper were fished only lightly. The percent exploitation, as indicated by tagged sockeye recaptures, varied in June from 2.5% to 25.1%. Thereafter fishing intensity increased, reaching a peak during the first three weeks of July. Fishing pressure fell off in late July.

Indian Fishery

Table II shows the percent tag returns by the Indian fishery from the total tagged each week in the years 1944 to 1948. The tag returns from the Indian fishery should be considered with caution for it is believed that the Indians in some localities, such as Moricetown Falls, fish selectively for tags. Some of the tags from the Indian fishery may actually have been tags caught in the commercial fishery but taken upriver. Table II shows that in all years, with the exception of 1947, the Indian fishery exploited the early portion of the run most heavily. This heavy exploitation of the early runs, followed by a steady decrease throughout the summer, may be due partly to a desire to procure fresh fish supplies.

Commercial and Indian Fisheries

In Table III are given the tag recoveries for both commercial and Indian fisheries computed as a percentage of the total tagged each week in the years 1944 to 1948.

TABLE II.—The tag recoveries in the upriver Indian fishery expressed as a percentage of the total sockeye tagged each week in the years 1944 to 1948.

Week	1944	1945	1946	1947	1948	Average for all years
June -23		11.3	14.6	7.6	15.5	12.3
24-30		10.9	8.8	10.2	11.0	10.2
July 1-7		7.7	11.0	12.5	7.6	9.7
8-14	10.2	10.0	7.1	13.8	10.7	10.4
15-21	5.8	5.6	3.4	10.5	9.0	6.9
22-28		3.3	2.7	15.3		7.1
29-		3.0				3.0
Total Tag recovery	6.9	9.0	6.5	12.5	11.1	9.2

TABLE III.—Total tag recoveries in the Skeena River fisheries expressed as a percentage of the sockeye tagged each week in the years 1944 to 1948.

Week	1944	1945	1946	1947	1948	Average for all years
June -23		23.1	20.3	10.1	18.0	17.9
24-30		28.5	33.9	28.8	25.7	29.2
July 1-7		47.1	29.5	33.3	52.2	40.5
8-14	33.8	46.7	45.2	30.9	45.1	40.4
15-21	52.3	36.4	39.7	36.3	37.6	40.5
22-28		32.2	35.1	32.2		33.2
29-		30.3				30.3
Total season's tag recovery	47.8	34.5	36.6	31.3	32.9	36.6

From a low level in the latter part of June, largely due to presence of the fishing fleet in more outside areas, exploitation in the river increased rapidly, reaching a peak in early or mid-July. Thereafter fishing effort fell off. In other words, the early and late runs to the Skeena received least exploitation and the greatest fishing pressure was exerted on that portion of the run immediately previous to the peak.

Pacific Biological Station

K. V. Aro

Marked Spring and Coho Salmon

The 1952 season produced the first returns from the large double-fin clipping experiments conducted on spring and coho salmon in various streams of Washington, Oregon and California under the co-ordination of the Pacific Marine Fisheries Commission. No spring and coho salmon have been marked in British Columbia or Alaska in recent years. The distribution and abundance of these fish of known origin is obtained by an extensive coastwise sampling of the troll catches. The British Columbia sampling is arranged by the Pacific Biological Station through Dr. D. J. Milne. Returns by fishermen are not encouraged and no rewards are offered because it is necessary to know the ratio of marked to unmarked fish in the catches.

The three States examined more than a half million fish and recovered over two thousand marks. In British Columbia 45,660 coho salmon and 35,625 spring salmon were examined from the landings at Vancouver, Prince Rupert and Victoria. Although similar sampling programs will have to be continued for the next few years before the final results can be stated, the following preliminary observations are given for the 1952 recoveries in British Columbia.

For coho salmon only 4 double-fin and 25 single-fin marks were found. Over 85% of these fish were recovered off the west coast of Vancouver Island. A few were found in the Strait of Georgia. Approximately two-thirds had been marked in streams of Washington and one-third in streams of Oregon.

For spring salmon 36 double-fin and 41 single-fin marks were found. Over 95% of these fish were recovered off the west coast of Vancouver Island. About 85% of these marked fish originated in Washington, 5% in Oregon and 10% in California.

No marked salmon of either species were found off the northern part of British Columbia or off Alaska. More single-fin marks were found, especially in coho salmon, than could be expected from the small size of these experiments, so probably the lack of only one fin on some of the fish is not an authentic mark.

DAILY SEAWATER OBSERVATIONS ALONG THE CENTRAL BRITISH COLUMBIA COAST

Introduction

One of the principal programs being conducted by the Pacific Oceanographic Group is that of the daily seawater observations. Observers at eleven lightstations situated on the Pacific Coast of Canada record the water temperature and take a sample of the seawater once a day at the time of high tide. The seawater samples are sent to the Pacific Biological Station to be analyzed for their salt content (salinity). These daily observations provide a continuous record of the changing conditions of water temperature and salinity in the coastal waters of British Columbia.

This is the last in a series of articles describing the geography and seawater conditions at these lightstations. Previous articles have been published in these Progress Reports: No. 81, December 1949, pp. 75-79; No. 86, April 1951, pp. 6-11; No. 91, June 1952, pp. 3-9. The data are presented in mimeographed volumes which may be obtained free on request to the Director, Pacific Biological Station, Nanaimo, B.C.

The three stations described here: Ivory Island, Pine Island, and Cape Mudge, are widely separated in location (Fig. 1) and also experience different extremes of weather conditions. Each station is located in an important fishing area. The daily seawater observations measure the physical changes in the sea which chiefly affect the life habits of the fishes—water temperature and salinity. Correlated studies of both the seawater data and fish catch records should assist in explaining the large fluctuations which sometimes occur in the productivity of these fishing grounds.

Ivory Island

Ivory Island lightstation (Lat. $52^{\circ} 16' N.$, Long. $128^{\circ} 24' W.$) is built on Robb Point, which is a small islet at the southwestern end of Ivory Island (Fig. 2). High tides separate the Point from the larger island but they are connected by a bridge. The light indicates the northern side of the entrance to Seaforth Channel. It is a guiding beacon for fishing boats returning from the Milbanke Sound grounds.

Seawater data collected at Ivory Island probably indicate general ocean conditions affecting herring migration in this section of the coast. There is good salmon troll fishing in Milbanke Sound and Seaforth Channel. The fish are packed to several canneries located on the shores of the extensive waterways further inland. The Emmaline Banks, a few miles southwest of Ivory Island, support a worthwhile halibut fishery.

Ivory Island has very little shelter from the sweeping winter storms that occur in Queen Charlotte Sound. Except in the summer when the westerly winds prevail, the winds are generally from the east and southeast. Southeast gales up to 30 m.p.h. are experienced practically every month of the year. During the winter, these gales bring up such rough seas that the lightkeeper must take the daily seawater observation from the bridge mentioned. Ivory Island is located in an area of heavy precipitation (annual average is 94 inches). The climate is cooled by the prevailing winds, the average summer air temperature being only $57^{\circ}F.$

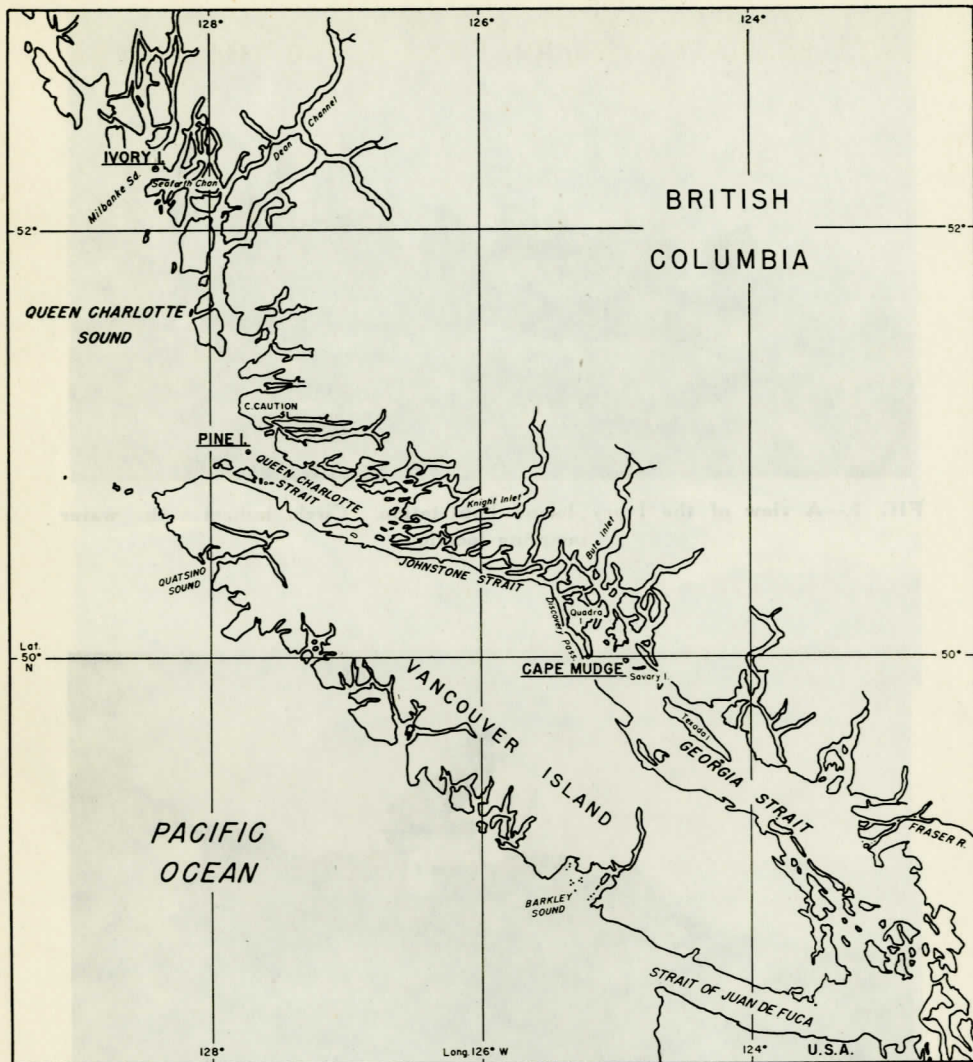


FIG. 1.—Chart showing the location of Ivory Island, Pine Island, and Cape Mudge lightstations.

Mr. Harold L. Campbell, along with his wife and three young sons, has been stationed at Ivory Island since February 1944. His lightkeeping duties include making complete climatological observations for the Meteorological Division. The lighthouse tender visits the light only once every three months, but mail is frequently delivered by the Patrol vessels of the Department of Fisheries.

Pine Island

Pine Island light (Lat. $50^{\circ} 58' N.$, Long. $127^{\circ} 44' W.$) is located on the southwestern extremity of a small wooded island in the centre of Queen Charlotte Strait. Because of the precipitous shores, a boat can be launched

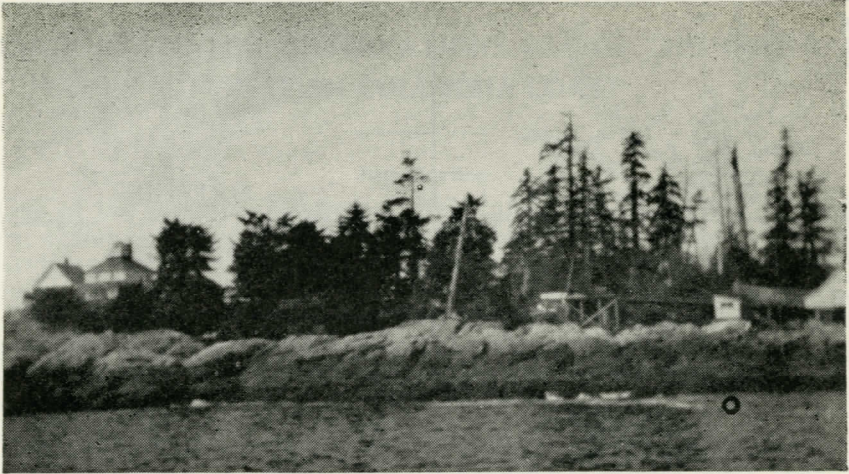


FIG. 2.—A view of the Ivory Island lightstation. Circle indicates the water sampling location.

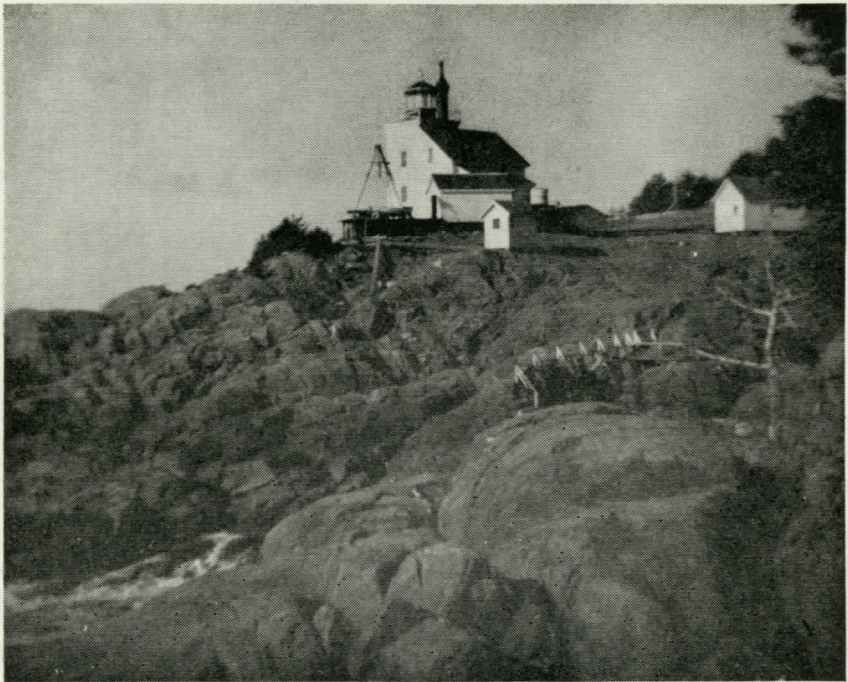


FIG. 3.—A view from the boat landing of the light tower at Pine Island lightstation.



FIG. 4.—The landing cove at Pine Island, where the daily seawater samples are taken.

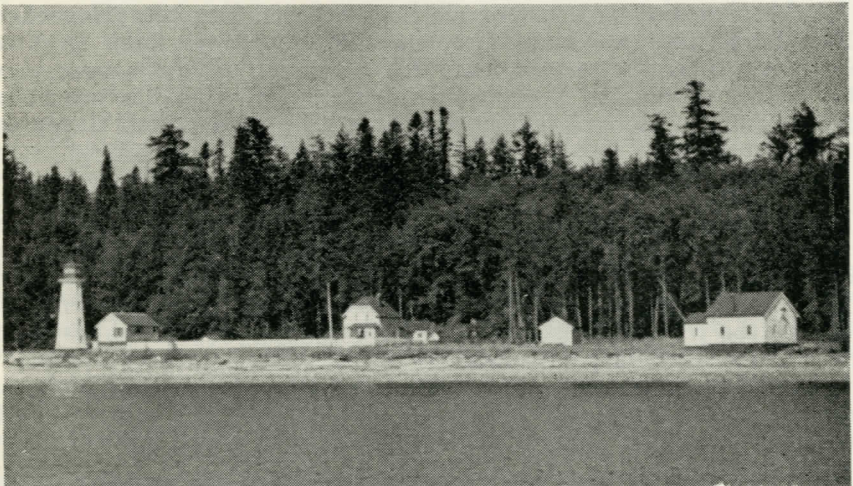


FIG. 5.—A view of the buildings at Cape Mudge lightstation, taken from mid-stream Discovery Passage. Note the rocky and sloping beach.

from the lighthouse only by running it down a cable attached to an "A" frame 80 feet above the landing cove (Figs. 3 and 4). The daily seawater samples are taken from the landing stage shown in Fig. 4.

Seafarers use the powerful beam from Pine Island to steer clear of the many rocks and reefs in the northern half of Queen Charlotte Strait, which is an important coastal shipping lane.

Pine Island is located in one of the most productive salmon fishing areas on the B.C. coast (Statistical Area 12). This salmon fishery is located in Johnstone Strait and the salmon move into this area through the waters surrounding Pine Island. Salmon trollers, cod fishermen, and trawlers all operate extensively in the immediate vicinity of Pine Island. Large fish camps located at Bull Harbour and Cascade Harbour handle the considerable tonnage of fish caught in these fisheries.

During the autumn and winter months the winds in Queen Charlotte Strait are southeasterly. Gales up to a maximum velocity of 70 m.p.h. have been recorded at nearby Bull Harbour meteorological station. The huge seas driven up by these gales have sometimes reached the Pine Island dwelling house which is 43 feet above sea level. Fresh westerly winds predominate during the summer afternoons, with calm periods in the mornings. This region of Queen Charlotte Strait is notorious for its many days of foggy weather.

From 1945 to 1952 Mr. James Thomson took the daily seawater observations at Pine Island. He came to Canada in 1927 after having served in the Scottish lighthouse service since 1911, with a break for war service in 1914-18. On retiring from the Canadian lighthouse service in August 1952, he became associated with the Marine Medical and Shantyman's Missions at Thetis Island.

The seawater observations are now taken by Mr. A. J. Swanson, who came out to British Columbia from Nova Scotia in 1939. He is assisted in the lightkeeping duties by his son who is a licensed air pilot. Housekeeping on Pine Island presents many problems different from those in Victoria, where they previously resided, but Mrs. Swanson still finds time to carry on her hobby of making very beautiful rag rugs. Supplies are delivered to Pine Island by the light tender or are picked up from Port Hardy during the summer months.

Cape Mudge

Cape Mudge light (Lat. 50° 00' N., Long. 125° 11' W.) is situated on the southwestern tip of Quadra Island. The town of Campbell River is two miles distant across the swift waters of Discovery Passage. The Cape is flat and heavily wooded. A considerable area of foul ground extends southward from the white clay cliffs. The shore in front of the light is a sloping beach covered with large boulders (Fig. 5). The lightkeeper must wear thigh gumboots in order to wade out a sufficient distance at high tide to obtain the water sample at the three foot depth. The winter southeast winds bring in a large amount of floating seaweed which hinders his water sampling duties.

Meteorological observations were made for a number of years (1938-44) at Cape Mudge by the lightkeepers. The wind either blows up Discovery Passage from the southeast or down from the northwest. The northwest winds in the summer can often change during the day to southeast, bringing cloudiness and heavy rainfall.

The flooding tidal streams that rush southward through Discovery Passage often attain a speed of 6 knots in the vicinity of the light. Off Cape Mudge, and between it and the Vancouver Island shore, there is a heavy race on the south-going flood streams. When there are opposing easterly or southeasterly winds this race can become quite dangerous to small vessels. Several marine tragedies have recently occurred in this locality. Savary Island, 12 miles southeast of Cape Mudge, is the point where the flood streams coming through the northern passages meet those which have progressed up through Georgia Strait. Extensive tide rips are formed and the waters are well mixed from top to bottom. The northward-flowing ebb stream in Discovery Passage is usually slower than the flood stream, and carries with it considerable debris picked up from the waters of northern Georgia Strait.

At Cape Mudge light the tidal streams reverse direction approximately one hour earlier than the high and low water by the shore. The lightkeeper takes the daily seawater observation one hour before the time of high water which is also the time of the slack water that occurs after the streams have completed their southward flow but before their direction has changed to the northwest.

In the immediate vicinity northwest of Cape Mudge there are extensive salmon trolling grounds. Blueback salmon fishing in Discovery Passage is usually best on the flooding tide during the summer when the westerly winds prevail. The nearby town of Campbell River is world famous as the centre of the tye salmon fishing on this coast. The lingcod fishermen make good hauls on the bank which runs southwest from Cape Mudge across to the Vancouver Island shore. Dogfish trawlers conducted extensive operations on this bank when dogfish liver was valuable.

Mr. O. S. Dean has been taking the seawater observations at Cape Mudge since February 1943. The grounds surrounding the buildings at the light are very neatly kept by Mr. Dean and his assistant. Mrs. Dean keeps busy with the flower and vegetable gardens. Leisure hours are profitably spent in boat building. There are only a few neighbours at Cape Mudge, but the Deans occasionally take a trip in their auto to the nearby settlement of Quathiaski Cove to pick up supplies and mail. They are highly respected by the people of Quathiaski Cove for their kindly nature and their active interest in the civic affairs of this small community.

The Seawater Records

Figure 6 illustrates the varying seawater conditions that are observed at these three stations. The annual water temperature cycles are similar in form but the variations from minimum to maximum differ. The salinity cycles are determined chiefly by the geographic locations of the Stations.

The water temperatures at Ivory Island and Cape Mudge show considerable parallelism, except that the maximum temperature for Cape Mudge occurs about one month earlier, during July instead of August. This early maximum temperature has been noticed for the total period of observations at Cape Mudge.

The salinity of the waters at Ivory Island becomes quite low during the summer months. There is an increased freshwater drainage during these months from the rivers emptying into the northern passages adjacent

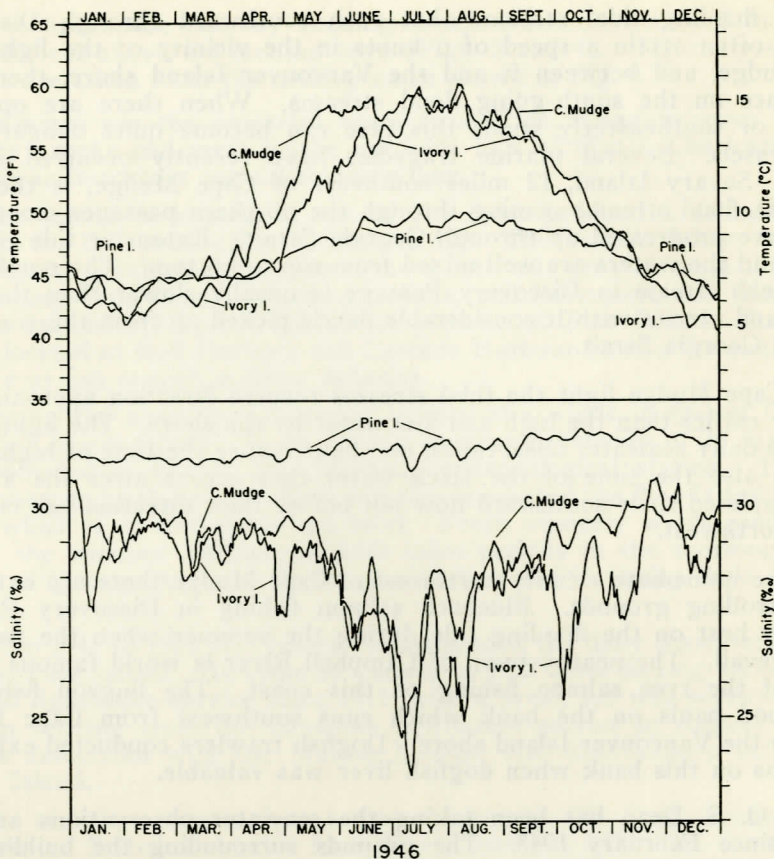


FIG. 6.—Seasonal changes in the surface water temperature and salinity at Ivory Island, Pine Island, and Cape Mudge for 1946.

to Milbanke Sound. This fresh water mixes with the seawater and flows through Seaforth Channel past Ivory Island. During the spring and winter months there are periods of very heavy rainfall in the central coastal area. These downpours result in an immediate freshwater run-off to the inlets, which causes sharp variations in the seawater salinity at Ivory Island for short periods of time. The seawater conditions at Ivory Island are typical of the northern inland passages of British Columbia.

The body of water sampled at Cape Mudge contains varying amounts of water from the northern Georgia Strait plus some from the waters that have flowed southward through Johnstone Strait. The summer freshet from the Fraser River pours large volumes of fresh water into central Georgia Strait. This fresh water mixes with the deep saltier water while it moves slowly northward along the mainland shore and forms a brackish (less salty) upper zone which extends to a depth of 180 feet by the time it has reached the vicinity of Savary Island. The low summer salinities at Cape Mudge are a combined effect of these brackish Georgia Strait waters and the fresh water drainage from the many small rivers which flow into the channels separating northern Vancouver Island from the

mainland. The seawater observations at Cape Mudge can be said to be representative of the average properties of the upper 180 feet of water in northern Georgia Strait which has ebbed and flooded at least once past this station.

Pine Island shows the smallest annual range of water temperature (5°F.) of any of the stations taking daily seawater observations on the Pacific Coast of Canada; this is probably due to the exposed sampling location and the extensive mixing of the cold northern coastal waters with the equally cold deep ocean waters coming in from Queen Charlotte Sound. This mixing also keeps the salinity of the seawater at Pine Island remarkably constant throughout the year and comparable to that of deep ocean water. Minor fluctuations in salinity do occur during the late summer and fall months when there is a flow from the mainland inlets of a shallow layer of brackish surface water similar to that observed at Ivory Island. Only a minor decrease in salinity occurs because this brackish water is mixed with a much greater amount of deep ocean water. This dilution of the seawater during the summer can be shown by the fact that the summer salinities observed at Cape St. James (Progress Reports No. 91, June 1952) are higher than those at Pine Island, but that the winter salinities at both stations are almost the same.

Pacific Oceanographic Group
Pacific Biological Station

H. J. Hollister

Babine Fence Repair

Preparations for reconstructing the Babine fence, through which the salmon runs to Babine Lake have been enumerated and sampled since 1946, were completed in October and November by F. C. Withler and E. Dombroski of the Pacific Biological Station before their return to Nanaimo headquarters. The year-round buffeting of the swift waters has weakened and worn the sills, floor, and pens of the structure to such an extent that repair this winter is necessary to insure successful operation of the fence in 1953. Lumber, equipment, and food have been stored at the Babine fence camp and at Fort Babine for Mr. O. A. Ragsdale and his crew who intend to begin repairs in mid-March, 1953. The remoteness of the site makes detailed planning especially important as all supplies must be on location before winter conditions isolate the camp. The construction work can only be done while water is low during the winter months.

Babine fence operation has been particularly significant during the seasons of 1951 and 1952 when the Babine salmon runs were jeopardized by a slide into the Babine River thirty-five miles downstream. Investigators of the Fisheries Research Board and the Department of Fisheries found themselves in the unique position of being able to count accurately the number of sockeye salmon surmounting the obstacle. In addition, the tagging work carried out by the Department of Fisheries to assess the damage caused by the slide and the effectiveness of the remedial measures was done with the assurance that all fish reaching Babine Lake would be examined for tags and signs of injury.

THE STEPHENSON COLLAPSIBLE CRAB TRAP

The crab trap is an efficient type of fishing gear. One disadvantage is the bulkiness which prevents transportation in small vessels of sufficient numbers of traps to and from the fishing grounds. More portable gear would be useful.

One crab fisherman who thought much about a portable crab trap was Mr. Jack Stephenson of Nanaimo, B.C. Finally he developed one which effectively caught crabs, and could be collapsed for easy handling on a small boat.

Mr. Stephenson showed his model to the writer in October, 1952, and requested that the trap be tested, and a description made available to crab fishermen. The present report describes details of the construction and the results of experimental fishing.

The collapsible trap is constructed in the same way as the regular rectangular type, except that instead of the four corner supports it has one removable centre support. When the support is in position, the trap is expanded and ready for fishing. By one easy motion the support can be removed, and the trap collapsed for transportation. Figures 1 and 2 are from photographs showing the gear in the expanded and collapsed positions.

Details of construction are shown in Fig. 3. The model pictured is larger than the original and has certain improvements in the construction of the centre support. By having a series of holes drilled near the top of the support, through which the pin may be inserted, the height of the trap can be adjusted to compensate for shrinking or stretching of the net covering. This net covering (4-inch stretched trawl web) gives flexibility to the sides. The cost of the whole unit is estimated to be less than \$4.00, which is about the same as of the regular type.

Two collapsible traps and a regular one of the same size were fished in Departure Bay near the Pacific Biological Station from December 17th, 1952, to February 5th, 1953. The collapsible traps were found to fish as well or better than the regular one. Also the collapsible traps stood up well to the hard usage of fishing. The iron frames were painted with a fish-oil base paint which was found to resist corrosion.

The rectangular type of crab trap is not regarded as suitable for intensive commercial fishing or in areas where wind and wave action are great. In these exposed areas a heavy, sturdy trap is required, such as the circular type used in the Queen Charlotte Islands crab fishery. It is believed that the centre support principle as used in the collapsible rectangular trap can be adapted to the circular trap.

Pacific Biological Station

T. H. Butler

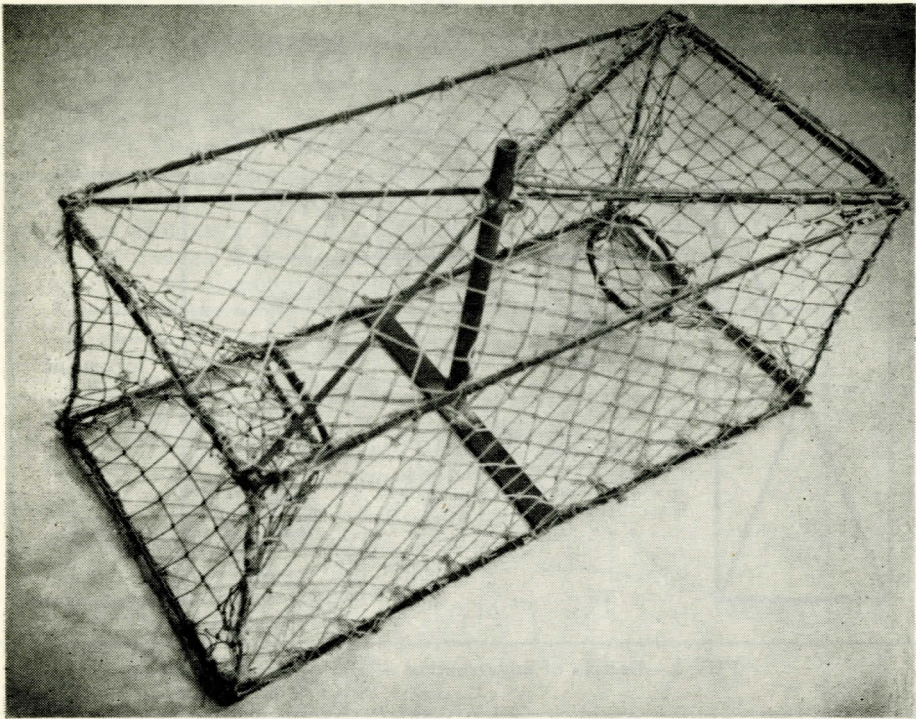


FIG. 1.—Collapsible trap in expanded position.

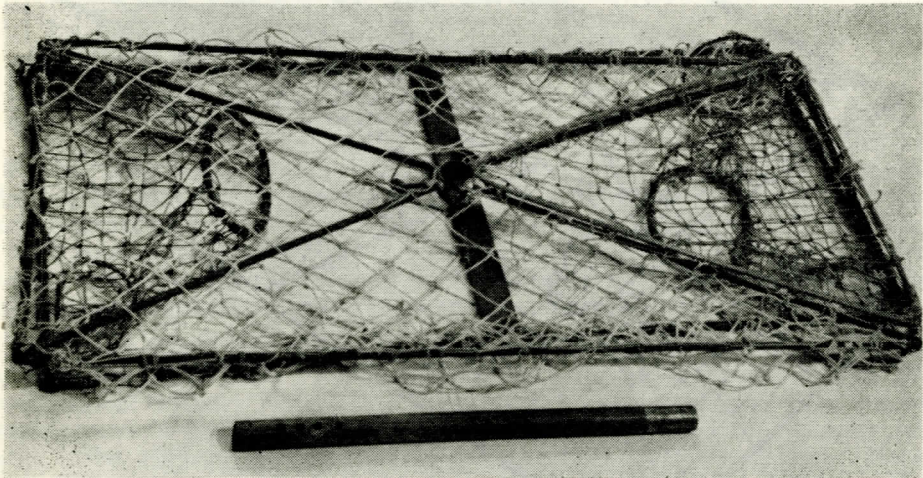
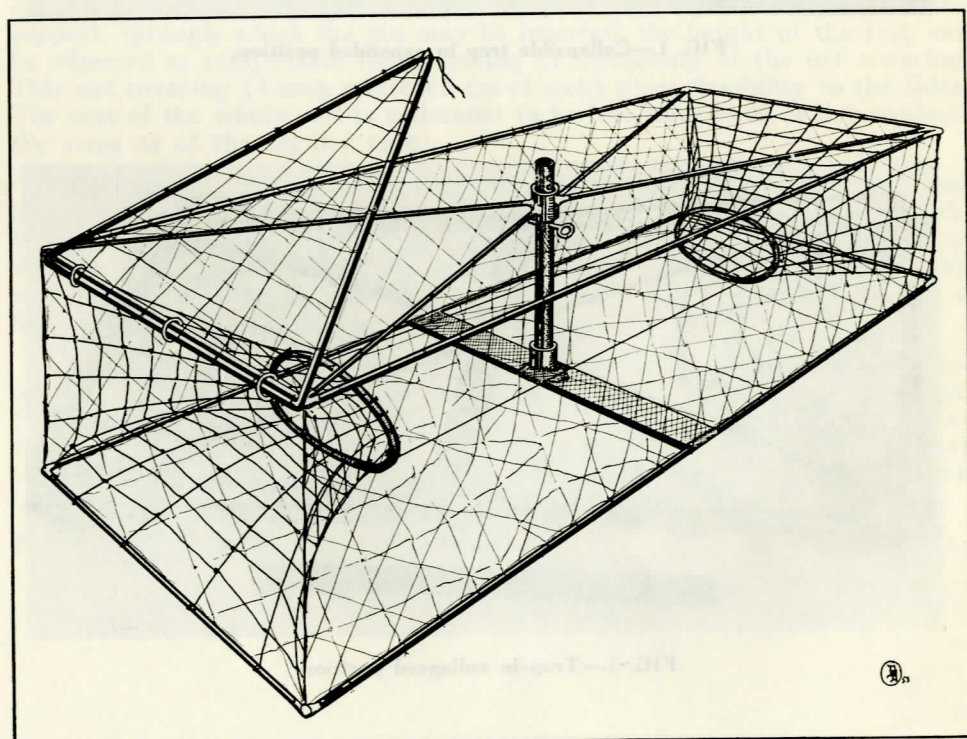
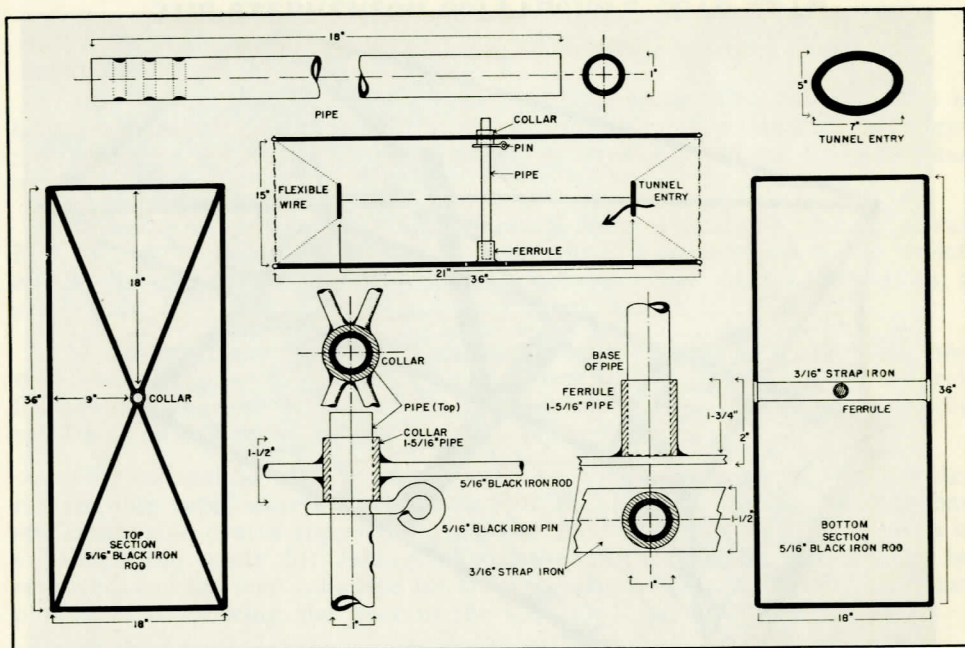


FIG. 2.—Trap in collapsed position.



OCEANOGRAPHY OF THE STRAIT OF GEORGIA*

II. TEMPERATURE DISTRIBUTION

Sunshine dominates the seasonal variation of surface temperature in the Strait of Georgia. Modifying influences such as tidal currents and river inflow are effective only in small portions of the strait. During most of the year a very close correspondence exists between air and sea temperatures at Entrance Island, as shown in Fig. 1 for 1950. Both of these temperature curves follow the general trend in the seasonal variation of daily sunshine at Vancouver Airport.

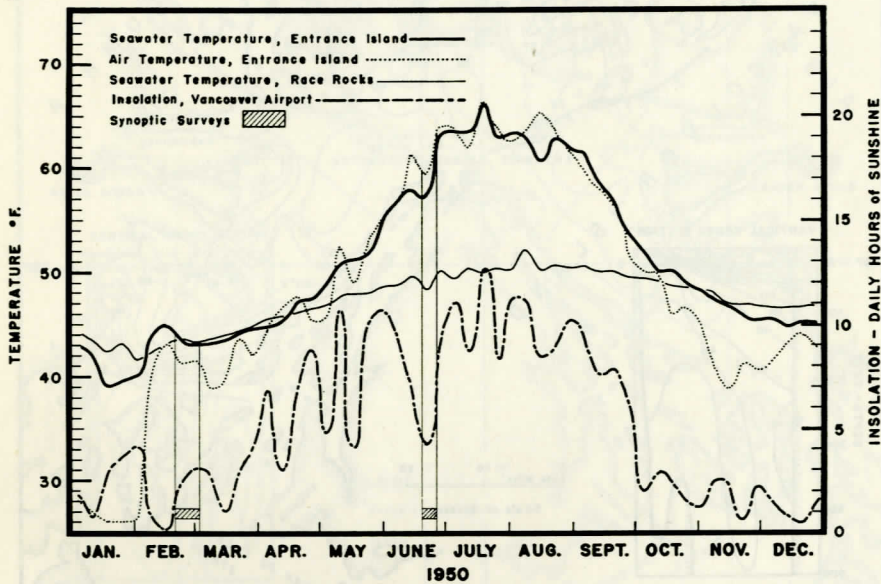


FIG. 1.—Seasonal variation in air and surface seawater temperature at Entrance Island, surface seawater temperature at Race Rocks, and insolation at Vancouver Airport, 1950.

Surface temperatures in the Strait of Georgia for June, 1950 are shown in Fig. 2. The southern strait, where intensive tidal mixing in the channels brings cold, deep water to the surface, exhibits the lowest surface temperatures. Surface water near the Fraser River estuary is cold because of the inflow of snow-fed, fresh water. The vertical section shows the pronounced temperature layering as indicated by the crowding of the isotherms in the upper 50 feet especially in the region of maximum Fraser River influence.

Figure 3 illustrates the surface temperatures in the Strait of Georgia for late February, 1950. Low temperatures can be observed around the Fraser River estuary where the fresh water, cooled by the low winter temperatures of interior British Columbia, has overflowed the warmer sea water. The highest temperature appears just off Entrance Island. Here, wind action has probably brought deep water to the colder surface. The variation in surface temperature throughout the strait at this time of year is about 5°F., or less than half that of the summer distribution. The

* Part I, Salinity Distribution, appeared on pp. 26-29 of the preceding issue of these Reports.

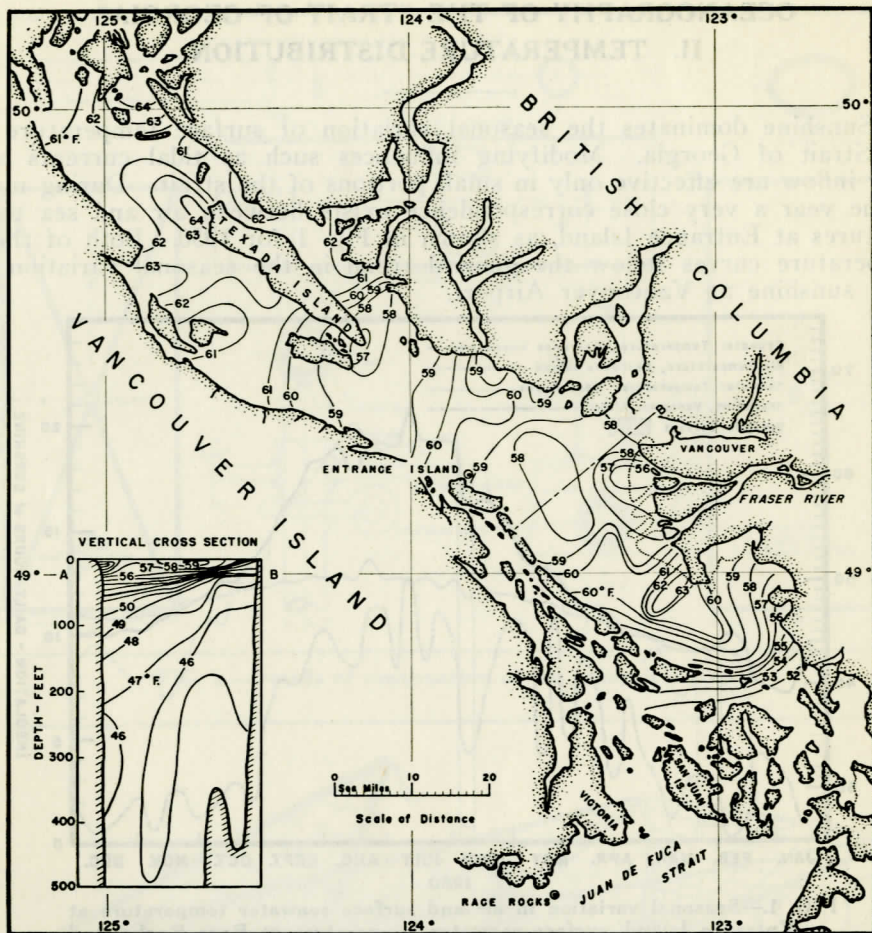


FIG. 2.—Surface temperatures in the Strait of Georgia for synoptic survey, June 1950. Inset: Transverse vertical temperature section.

vertical section shows how the temperature varies from the cold surface water through a warmer intermediate layer down to cold water near the bottom.

The sea receives virtually all its heat from the sun. This heat energy may reach the sea surface by direct radiation from the sun or by radiation and conduction from the atmosphere. Cloud cover, time of day, latitude and season will obviously play an important role in determining the amount of radiant energy which reaches the surface of the sea.

On June 21 (summer solstice) the sun has its greatest noon elevation at latitudes north of the Tropic of Cancer. The effective amount of daily sunshine received in these latitudes is consequently large at this time of year. This is a result of longer days and a comparatively large amount of radiant energy received per unit area, as illustrated by Fig. 4. During the winter solstice the opposite condition holds and the northern hemisphere receives a minimum of effective sunshine.

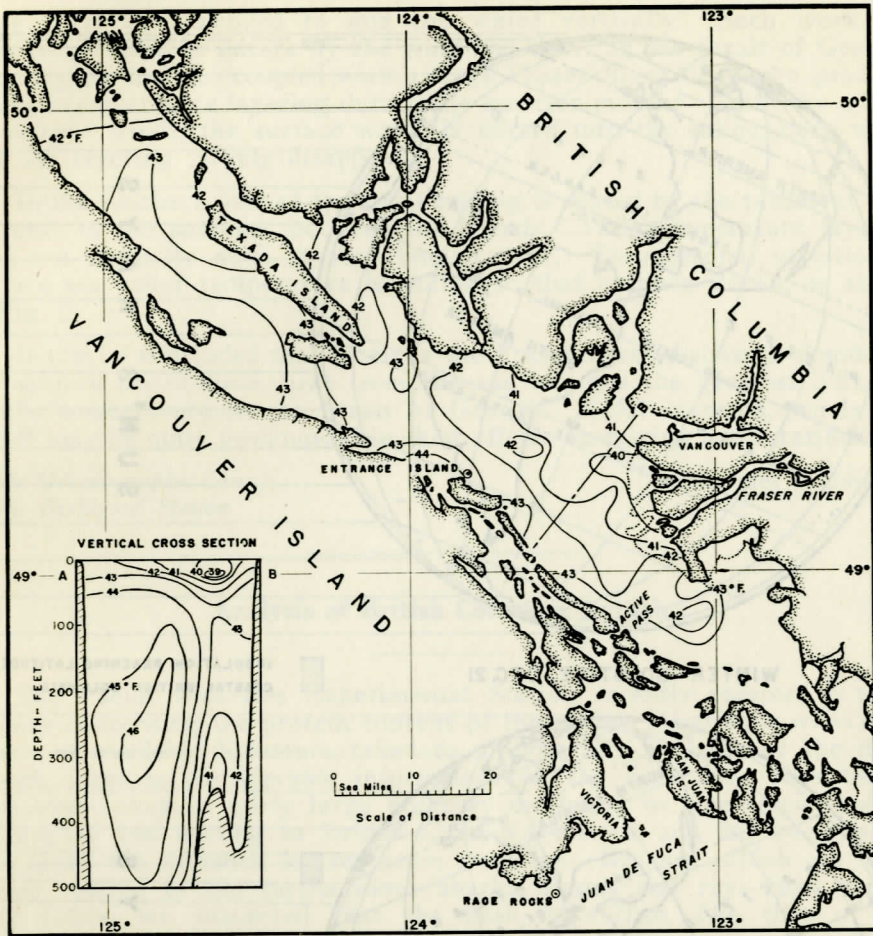
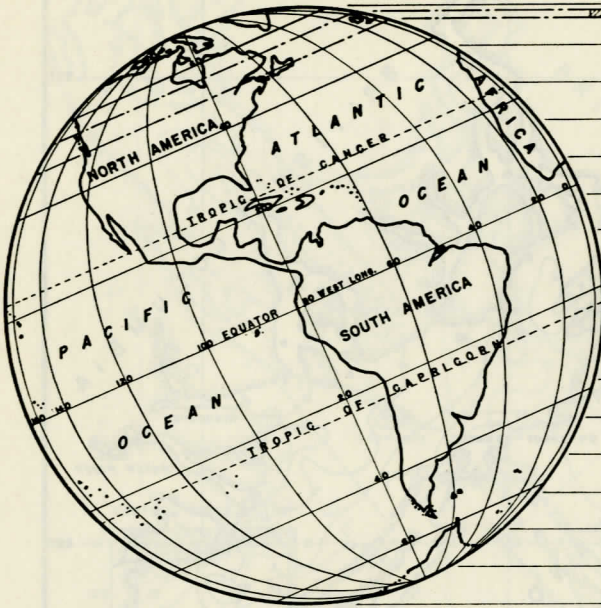


FIG. 3.—Surface temperatures in the Strait of Georgia for synoptic survey, February 1950. Inset: Transverse vertical temperature section.

Normally heat flows from a warm body to a colder one. Accordingly, the sea returns large quantities of heat to the atmosphere by back radiation and conduction during the early winter months when the atmosphere is already cold and the sea still retains much of its summer heat. Cooling of the sea is further increased by evaporation.

Temperature equilibrium between the sea and atmosphere is not reached until some time in March. At this time there is no net loss of heat by the sea to the atmosphere or vice versa. As the season progresses the trend in the air temperature is upward (Fig. 1) and the flow of heat once again takes place from the atmosphere to the sea.

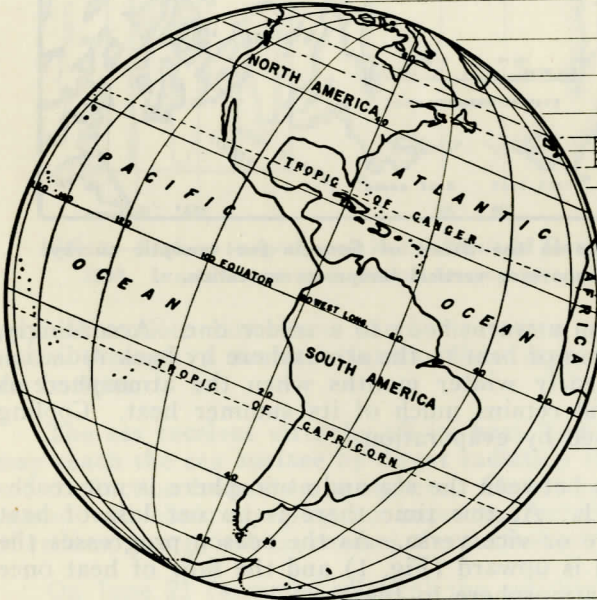
Heating by the sun occurs largely in the upper few feet of the sea. As the fresh water from the Fraser River flows over the denser sea water, it becomes even lighter as it is warmed by the sun. A large decrease in density from the cold, deep water to the warmer surface water is developed and a very stable water column results. In other words, much



SUN'S RAYS

WINTER SOLSTICE, DEC. 21

 INSOLATION REACHING LATITUDE OF COASTAL BRITISH COLUMBIA



SUN'S RAYS

SUMMER SOLSTICE, JUNE 21

FIG. 4.—Position of the earth with reference to the sun's rays and relative insolation at latitude of coastal British Columbia during the solstices.

work must be expended to mix the water vertically. Such work can only be provided in nature by the wind and tide. In the Strait of Georgia, warming by the sun coupled with a large Fraser River discharge produces marked temperature layering during the summer months. With the advent of autumn winds, the surface water is stirred into the saline, deep water and the layering largely disappears.

In the southern part of the strait mixing is caused by the turbulent tidal currents in the passages between the islands. Thus temperature layering does not normally exist at any time of year. The seasonal variation in surface sea water temperature is similar to that at Race Rocks, as shown in Fig. 1.

It can be concluded that whereas the Fraser River discharge dominates the salinity distribution, heat from the sun imposes the greatest influence on the temperature in the Strait of Georgia. Tidal currents, winds and runoff may be quite pronounced in their effects on mixing and stratification.

Pacific Oceanographic Group
Pacific Biological Station

Michael Waldichuk

Analysis of British Columbia Ratfish

The Pacific Fisheries Experimental Station recently received a trade enquiry concerning the protein content of the ratfish (*Hydrolagus colliiei*). A search of available literature failed to disclose any analyses of the flesh, though there is considerable information on the liver oil. This fish is sometimes taken in fairly large numbers incidental to commercial fishing for dogfish and herring in British Columbia waters, and has been mixed with these fish intended for reduction purposes. Because ratfish are more closely related to the cartilaginous sharks, skates and rays than to the bony fishes, we suspected that the flesh of ratfish, like that of the cartilaginous fishes, might contain enough urea (nitrogen content 46.7% as compared with about 16% in proteins) to give rise to artificially high results in a regular protein assay of a fish meal from herring mixed with ratfish. Consequently, Mr. P. J. Schmidt of this Station made analyses of a representative sample of six ratfish having a total weight of 17.3 lb., with the following results (summarized):

Protein (corrected)	11.6%	Urea	1.22%
Mineral matter	1.2%	Ammoniacal nitrogen	0.05%
Fat	18.1%	Urea and ammoniacal nitro-	
Moisture	69.6%	gen, calculated as protein	3.74%

A usual protein assay, uncorrected for urea, would indicate about 15.3% protein in the raw whole fish, a value misleadingly high. Because urea is very soluble in water, much of it passes into the stickwater during fish meal manufacture, though enough sometimes remains in the meal to cause discrepancies in calculated protein values, allowance for which is made in assays of dogfish meals. Further data from these analyses, and the relation of urea to animal feed values, will be reported later.

FATTY ACID COMPOSITION OF FISH OILS

II. HERRING OIL

The molecular still now used at the Pacific Fisheries Experimental Station in the separation of the fatty acids of fish oil was described in the previous issue of these Progress Reports. Analyses have now been completed on two British Columbia commercial herring oils, and the results are given below.

The first herring oil examined was obtained through the courtesy of B. C. Packers Ltd. It had been prepared in January 1952 from herring caught six days earlier in Thistle Pass, near Prince Rupert. The second, from the same company, had been prepared in the summer of 1952 from herring caught off southern Vancouver Island. Both samples contained a small quantity of free fatty acids which was removed by alkali refining. The refined oils were filtered, dried, and stored at -13°F . in a number of 1-lb. bottles under an inert atmosphere of nitrogen.

When required, a 500-gram (about 1-lb.) sample of the oil was converted to its methyl esters by warming an ether solution of the oil with methanol (wood alcohol) in the presence of a small quantity of alkali. The glycerol released by this reaction was removed by extraction with water. This left in ether solution the methyl esters of the fatty acids and the unsap. After removal of the ether the residue was fractionated into simpler mixtures of compounds by low-temperature crystallizations from acetone. This was accomplished at about -13°F . and -103°F . In earlier work the fraction crystallizing at -103°F . was further divided into three fractions by molecular distillation. In later work, as facilities became available, this preliminary fractionation was accomplished by crystallization at an intermediate temperature, about -50°F .

Each of the fractions so obtained was then circulated repeatedly in the molecular still at pressures between 5 and 15 microns (about 0.01 mm. mercury) while the temperature was slowly raised, never exceeding 190°F . The distillate was collected in approximately 6-gram (0.2-ounce) portions. On each portion were determined two properties. One was the saponification equivalent, which corresponds to the average molecular weight of the fatty acids in the portion, and so indicates the size (carbon atom content) of the fatty acid molecule. The other property measured was the iodine value, which indicates the unsaturation of the portion.

The data so collected were then converted, by methods of calculation developed by investigators in England, into figures representing the composition of the oil in terms of the size of the fatty acids contained in it, and their unsaturation. Some of these figures are shown in Table I—for two samples of the January-caught northern British Columbia herring oil, and for two samples of the summer-caught southern British Columbia herring oil. These data seem to indicate no great difference in composition between the oils collected at these two places and times, a conclusion in agreement with the data shown in Bulletin 89 of this Board (page 315). Comparison with the analyses of oils from a different species of herring, given in the same table, shows these oils to be quite different in composition.

TABLE I.—Fatty acid composition of herring oil (% by weight).

Sample	Carbon atoms per molecule	Saturated					Mono-unsaturated					Unsaturated*					
		12	14	16	18	20	12	14	16	18	20	14	16	18	20	22	24
A. From January herring caught in northern B.C. (<i>Clupea pallasii</i>)																	
	1	0	1.9	9.5	3.1	0.1	0	0.4	3.5	8.0	1.4	5.4	22.0	30.0	11.5	2.0	
	2	0	1.7	11.5	5.7	0.1	0	0.2	4.2	6.0	2.3	7.8	18.5	23.2	13.4	5.4	
B. From summer herring caught in southern B.C.																	
	1	1.0	2.8	11.4	4.8	0.4	tr.	0.3	4.4	4.3	1.3	5.2	21.3	24.0	17.5	0.6	
	2	0	3.4	12.3	4.9	0.2	0	0.6	4.5	5.0	0.2	5.6	25.8	31.2	6.4	0	
C. From spent October herring landed in England (Lovern) (<i>Clupea harengus?</i>)																	
		6.6	13.7	0.5								0.2	4.9	16.3	28.7	29.1	
D. From July herring landed in England (Lovern)																	
		8.3	12.1	0.3								0.5	6.4	21.0	28.3	23.1	

* In A and B some portion of mono-unsaturated acids is present in these fractions.
In C and D all unsaturated acids appear together.

In Table II an attempt has been made to indicate the unsaturation of some of the fractions obtained in the crystallizations and distillations. The deficiency from saturation, expressed in hydrogen atoms per molecule of fatty acid, is indicated by the figures in parentheses.

TABLE II.—Unsaturated fatty acids (as % of total fatty acids) in certain fractions of herring oil methyl esters.

Carbon atoms per molecule	16	18	20	22
	From January herring in northern B.C.			
Crystals at -105°F.			4.5 (3.5)*	2.5 (3)
Mother liquor at -105°F.	6.3 (3)	15 (4)	11.3 (7)	3.0 (8)
	From summer herring in southern B.C.			
Crystals at -105°F.		4.8 (3.5)	7 (3)	6.7 (3.5)
Mother liquor at -105°F.	5.0 (2.5)	17 (4.5)	11.6 (7)	3.8 —

* Figures in parentheses represent the approximate hydrogen atom deficiency (unsaturation, or cause of iodine value) in the fatty acids.

Nearly half the fatty acids in British Columbia herring oil contain 20 or more carbon atoms per molecule. About 15% of the fatty acids are highly unsaturated, containing three or four double bonds per molecule (hydrogen deficiency 6 to 8), and they fall in this long carbon chain group. It is these big, highly unsaturated fatty acids that are found primarily in fish oils, and upon which emphasis should be placed in attempting to make fish oils a product of unique value.

Pacific Fisheries Experimental Station

Lyle A. Swain

Appointment of Dr. D. R. Idler to Staff of Pacific Fisheries Experimental Station

Dr. D. R. Idler, a graduate of the University of British Columbia with Ph.D. from the University of Wisconsin, joined the scientific staff of the Vancouver Station of the Fisheries Research Board of Canada in March. His academic research experience has included much work on the isolation and structure of animal and plant sterols, and he will be engaged at the Station in basic and applied research related to the organic chemistry of fishery products and by-products. Following a brilliant record with the Royal Canadian Air Force as navigator, with award of the Distinguished Flying Cross and attainment of the rank of Flying Officer, Dr. Idler held a research assistantship at the University of Wisconsin and was recipient of the Babcock Fellowship for graduate research.

THE NUTRITIVE VALUE OF FISH MEAL AND CONDENSED FISH SOLUBLES

VII. HERRING AUTOLYSATES, FERMENTATION PRODUCTS, CONDENSED SOLUBLES, AND MEAL AS SUPPLEMENTS FOR CHICK STARTING RATIONS

Reports from Denmark have indicated that lactic acid bacterial fermentation of fish materials, containing added sugar- and starch-containing substances, yields products of high nutritive value for livestock feeding. In the present work two such products have been prepared and compared with typical commercial flame-dried herring meal, commercial condensed herring solubles, an acidic enzyme autolysate of whole herring, and whole blended raw herring as supplements in an all-vegetable protein chick starting ration. All the products, with the exception of the condensed solubles, which was a typical 1951 commercial sample, were prepared from the same lot of November 1951 herring in order to avoid possible differences due to variations in the raw material. The herring meal and the whole herring had been stored at about -4°F . for several months prior to use.

Whole herring were blended in a silent cutter. An enzyme autolysate was made by blending concentrated hydrochloric acid slowly into the fish until the mixture attained an acid reaction (pH 3), and then permitting the mass to undergo self digestion for 2 days at 98°F . The resulting liquid, which had a pH of 4.1, was found to be quite stable and resistant to bacterial attack when stored at about 32°F . Two lactic acid bacterial fermentation products were prepared as follows. Blended herring (3610 gm.), cane sugar (200 gm.) and soyabean meal (160 gm.) were mixed together and acidified with hydrochloric acid to pH 5.0. One half of the above material was inoculated with a mixture containing equal amounts of three pure laboratory cultures of lactic acid bacteria (*Lactobacillus plantarum*, *L. casei* and *L. shermannii*) and the other half with a fresh culture of a Danish lactic acid bacteria preparation designed for fermentation of fish materials ("LKC." culture). The first preparation was incubated for 5 days at 86°F ., and the second for 6 days at 77°F . At the conclusion of these incubation periods the lactic acid fermentation had caused an increase in the acidity of the samples from the initial value of 5.0 to a final value of 4.5. The preparations were stored at 32°F . for about two weeks prior to their use in the first test. The acidic fermentation products and the acidic autolysate appeared to be stable under these storage conditions.

The all-vegetable protein basal ration used in the chick biological assays had the following composition: ground yellow corn, 63.7 lb.; soyabean meal, 32.0 lb.; bonemeal, 2.0 lb.; limestone, 1.0 lb.; feeding oil (2250A; 300D), 0.25 lb.; iodized salt, 0.5 lb.; *dl*-methionine, 0.1 lb.; choline chloride (25% premix), 0.44 lb.; manganese sulphate, 0.025 lb.; plus 0.16 gm. riboflavin, 0.5 gm. calcium pantothenate and 0.8 gm. nicotinic acid.

In the first experiment several separate modified rations were prepared by adding 2.5 and 5.0% of each of the above fish materials to the basal ration. Each ration was then fed to 42 White Leghorn chicks of mixed sex, and the weights were determined during a 5-week period. The results,

TABLE I.—Average weights of chicks in Test 1.

Diet No.	Supplement to basal diet	Weight in grams
1	None	312
2	2.5% Herring meal	342
3	5.0% Herring meal	354
4	2.5% Condensed herring solubles	358
5	5.0% Condensed herring solubles	341
6	2.5% Ground whole herring	347
7	5.0% Ground whole herring	363
8	2.5% Autolyzed herring	336
9	5.0% Autolyzed herring	334
10	2.5% Herring fermentation product (commercial)	319
11	5.0% Herring fermentation product (commercial)	341
12	2.5% Herring fermentation product (laboratory)	345
13	5.0% Herring fermentation product (laboratory)	345

given in Table I, show that all the fish materials caused an increase in growth as compared with that obtained with the basal ration.

In a second experiment four of the fish materials were tested using the same basal ration as above and also when supplemented with all the important vitamins of the "B complex" with and without an antibiotic (Aurofac A, 4.5 gm. per lb.).

The following amounts of the various vitamins were added to each 100 lb. of the basal ration: folic acid, 0.035 gm.; thiamine hydrochloride, 0.05 gm.; pyridoxine hydrochloride, 0.16 gm.; menadione, 0.018 gm.; alpha tocopherol, 0.15 gm.; *p*-aminobenzoic acid, 4.5 gm.; inositol, 5.0 gm.; biotin, 0.0045 gm.; vitamin B₁₂, 0.0005 gm.

Each ration was fed to 24 New Hampshire cockerel chicks, and their average weights at the age of 33 days are given in Table II. It will be seen that the vitamin supplement caused no appreciable increment in growth with the basal ration, indicating that the ration was complete in the known vitamins. Aureomycin, however, stimulated growth in every instance where it was added. Of the preparations tested only the commercial herring meal gave any stimulation of growth, the fastest rate of growth being attained by the chicks fed the diet supplemented with vitamins, aureomycin and herring meal. It is difficult to account for the failure of the fermentation product, the raw herring, and the autolysate to promote an increased rate of growth, particularly in view of the results obtained in the first

TABLE II.—Average weights (grams) of chicks in Test 2.

Supplement to basal diet	None	Vitamin* mixture	Vitamin mixture* plus aureomycin†
None	408	411	477
5% Herring meal	480	476	522
5% Ground whole herring	400	405	463
5% Autolyzed herring	400	394	442
5% Herring fermentation product (laboratory)	381	382	434

* See text.

† 4.5 mg. per lb. (from Aurofac A, Lederle Laboratories).

test. The fact that these products were prepared from raw fish and were not heated suggests that some vitamin-destroying factor such as thiaminase might be responsible. The action of thiaminase itself is not indicated because two of the rations in the second test were supplemented with thiamin and no such effect was noted in the first test in which no supplementary thiamin was included in the rations. It is, however, possible that some essential factor(s) was destroyed since the preparations were stored at 38°F. for 10 weeks between the two tests. From their odour and general appearance the products did not appear to have undergone bacterial decomposition. An explanation of these results will be sought in further experiments.

We are indebted to Mr. Hakon Skafte for supplying samples of Danish "LKC." culture, and to Dr. Nora Neilson of the Department of Dairying, University of British Columbia, for the pure culture of lactic acid bacteria.

Pacific Fisheries Experimental Station

*Poultry Nutrition Laboratory,
The University of British Columbia*

H. L. A. Tarr

Jacob Biely
B. E. March

THE APPEARANCE OF A NEW COMMERCIAL SHRIMP IN A NEWLY DEVELOPED SHRIMP FISHERY

A new shrimp trawling ground was developed during December 1952 and January 1953, in the region of Stuart Channel along the lower east coast of Vancouver Island. The region is known better to trawlers as the Boat Harbour ground. Preliminary statistics released by the Department of Fisheries show that during the months of December and January 66,195 pounds of shrimps were caught in 183 trawling days. Most of the shrimps were landed and processed at Steveston, B.C.

Five species of shrimps have been taken for many years in commercial quantities by British Columbia shrimp fishermen. Observations by Mr. R. M. Wilson, Pacific Biological Station observer at Vancouver, and examination

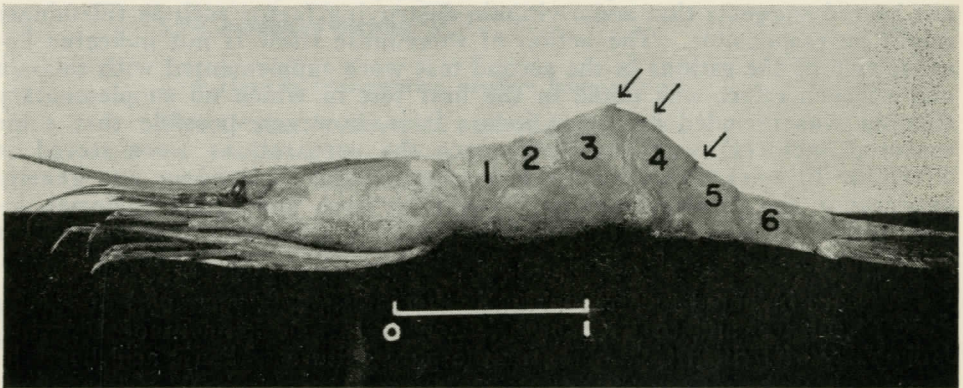


FIG. 1.—The "Pink" shrimp, *Pandalus borealis*. Arrows indicate spines, two on third segment and one on fourth segment of abdomen.

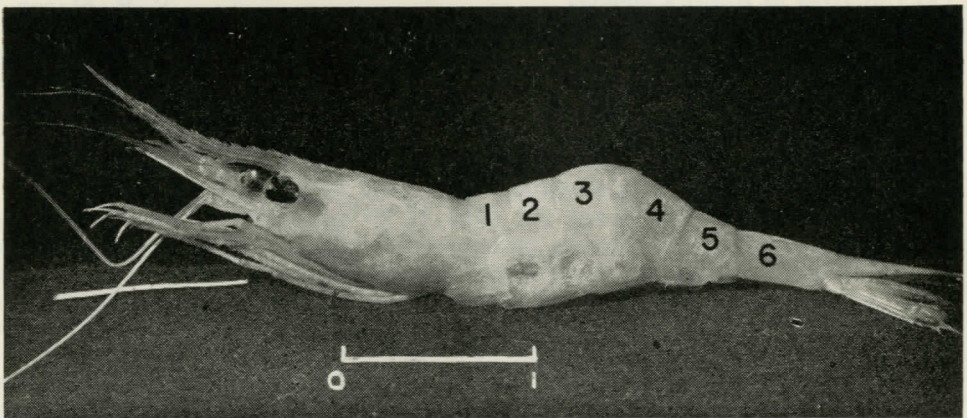


FIG. 2.—The shrimp caught in Stuart Channel, *Pandalus jordani*. Spines are absent from third and fourth segments of abdomen.

of two samples from Stuart Channel indicate that the catch is made up almost entirely of a species not previously taken in any numbers, *Pandalus jordani*. This species looks a good deal like the "pink" shrimp, *Pandalus borealis*, but differs in lacking the characteristic spines on the upper surface of the third and fourth abdominal segments. The accompanying photographs show the difference between the two species.

As yet no common name has been suggested for the new commercial shrimp.

The photographs were taken by Mr. C. J. Morley from specimens obtained through the courtesy of Mr. Eiichi Sakata and Mr. Eric Hart.

Pacific Biological Station

T. H. Butler

RECENT PUBLICATIONS ISSUED BY THE FISHERIES RESEARCH BOARD OF CANADA

Subsequent to the notice appearing on page 24 of issue No. 90 of these Progress Reports (March 1952), the following Board publications have appeared in addition to issues Nos. 91 to 93 of this series. Enquiries relating to these publications should be addressed as indicated:

Progress Reports of the Pacific Coast Stations—Director, Pacific Fisheries Experimental Station, 898 Richards Street, Vancouver 2, B.C., Canada.

Progress Reports of the Atlantic Coast Stations—Director, Atlantic Biological Station, St. Andrews, N.B., Canada.

Bulletins (and other Board publications)—Secretary, Fisheries Research Board of Canada, West Block, Ottawa, Ont., Canada.

Scientific Exchange—Editor, Fisheries Research Board of Canada, Pacific Biological Station, Nanaimo, B.C., Canada.

ANNUAL REPORT OF THE FISHERIES RESEARCH BOARD OF CANADA FOR THE YEAR 1951 (May 1952)

JOURNAL OF THE FISHERIES RESEARCH BOARD OF CANADA Volume IX, No. 1 (June 1952)

The Arctic char of the west coast of Hudson Bay. By Wm. M. Sprules.

Further Ostracoda of the Vancouver Island region. By Verna Z. Smith.

Currents and net transport in Loudoun Channel, April 1950. By L. A. E. Doe.

Volume IX, No. 2 (August 1952)

Station list of the "Calanus" Expeditions, 1947-50. By M. J. Dunbar and E. H. Grainger.

Contribution to the study of the fishes of Ungava Bay. By M. J. Dunbar and H. H. Hildebrand.

Volume IX, No. 3 (September 1952)

The vitamin B₁₂ activity of natural material with particular reference to cod liver protein. By A. Guttman and F. A. Vandenheuvel.

The first record of the smooth lump-sucker, *Cyclopteroichthys ventriosus* (Pallas), in British Columbia waters. By W. A. Clemens and G. V. Wilby.

(Continued on next page)

- The agonid fish, *Pallasina barbata aix* (Starks), from British Columbia.
By W. E. Barraclough.
- The importance of *Flavobacterium* in fish spoilage. By C. H. Castell and E. G. Mapplebeck.
- Improved medium for red halophilic bacteria from salt fish. By H. P. Dussault and R. A. Lachance.
- The distribution of Vitamin B₁₂-active substances in some marine invertebrates of British Columbia. By B. E. Maxwell.

Volume IX, No. 4 (September 1952)

- A comparative study of anadromous and freshwater populations of brook trout (*Salvelinus fontinalis* (Mitchill)). By D. G. Wilder.
- The benthos of Cultus Lake. By W. E. Ricker.

Volume IX, No. 5 (November 1952)

- Current measurements in the Grand Manan Channel. By D. G. MacGregor and H. J. McLellan.
- The biology of the surface zone zooplankton of a boreo-arctic Atlantic Ocean Area. By William V. Kielhorn.

Volume IX, No. 6 (November 1952)

- Temperature tolerance in young Pacific salmon, genus *Oncorhynchus*. By J. R. Brett.

Volume IX, No. 7 (December 1952)

- Vertical temperature distribution in the Great Lakes. By H. B. Hachey.
- Surface temperatures of the Great Lakes. By F. Graham Millar.

Volume IX, No. 8 (December 1952)

- The survival of red halophiles in water and in brines. By C. H. Castell and E. G. Mapplebeck.
- The water transfer in codfish muscle immersed in sodium chloride solutions. By H. Fougère.
- A study of the "lipoxidase" in the flesh of British Columbia herring. By M. M. R. Khan.

Volume IX, No. 9 (January 1953)

- Limnobiology of Cowichan Lake, British Columbia. By G. Clifford Carl.
- Principles affecting the size of pink and chum salmon populations in British Columbia. By Ferris Neave.

BULLETINS OF THE FISHERIES RESEARCH BOARD OF CANADA

- No. 94. Freshwater vertebrates of the Arctic and Subarctic. By V. C. Wynne-Edwards.
- No. 95. A review of the *Trianaophorus* Problem in Canadian Lakes. By R. B. Miller.

PROGRESS REPORTS OF THE ATLANTIC COAST STATIONS

No. 53 (April 1952, 12 pages)

- Fluctuating inshore water temperatures in the autumn. By H. J. McLellan.
- Recent water temperatures along the Canadian Atlantic coast. By L. Lauzier.
- Moisture curves for light-salted cod. By J. R. Dingle.
- Index to issues Progress Reports 34-53.

No. 54 (September 1952, 26 pages)

- The animal protein factor of cod liver. By P. L. Hoogland.
- Absorption refrigeration in the fishing industry. By G. K. Gunnarsson.
- Changes in Digby scallop landings—how and why. By Lloyd M. Dickie.
- Breakage—the bug-bear in clam handling. By J. C. Medcof and J. S. MacPhail.

CANADIAN PACIFIC FAUNA

9. Annelida. 9b(2). Polychaeta sedentaria. By E. and C. Berkeley. (139 pages, 1952).