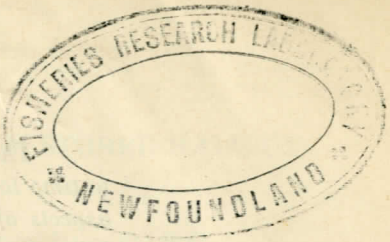
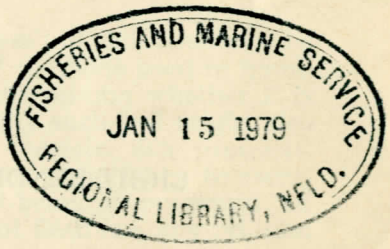


FISHERIES RESEARCH BOARD OF CANADA



PROGRESS REPORTS

OF

PACIFIC BIOLOGICAL STATION

NANAIMO, B.C.

AND

PACIFIC FISHERIES EXPERIMENTAL STATION

PRINCE RUPERT, B.C.

No. 49

DIBB PRINTING COMPANY
PRINCE RUPERT, B.C., SEPTEMBER, 1941

These progress reports are issued from time to time to acquaint the fishing industry with some aspects of investigations which are being undertaken by the Fisheries Research Board of Canada through its Pacific Coast Stations.

CONTENTS

LIGHT-BENDING PROPERTIES OF "DRIP" FROM STORED HALIBUT

By E. P. Sidaway

Pacific Fisheries Experimental Station, Prince Rupert, B.C.

Any rapid and practical test for the "freshness" of fish flesh can be a useful tool for estimating the satisfactoriness of methods used in handling fish from the time they are caught and in determining whether it is possible still further to improve these methods. Any such test might also be of assistance in the grading and inspection of certain fish products. This report records the results of some experiments undertaken to ascertain whether the change in refractivity (light-bending property) of the juice or "drip" that exudes from stored halibut flesh has any relation to the freshness of the flesh.

The degrees to which deterioration can be allowed to proceed before the flesh is judged unpalatable by the consumer has been determined for several of the more important species of commercial fishes, but it is desirable to know at what stages of the holding the different deteriorative steps commence so that precautions may be taken to maintain the freshness at as high a level as possible until the product reaches the customer.

A rough and ready method for estimating the freshness of whole or dressed fish is to inspect the brightness of the eye, redness of the gills, firmness of flesh and odour of the belly cavity. More subtle changes, however, are taking place in the flesh resulting in an alteration of its chemical and physical properties. Fairly successful endeavours have been made to relate changes in chemical properties with post mortem age of the flesh by determining the amount of some definite constituent, such as one of the ammonia-like methylamines, that is generated as deterioration progresses to the stage of actual spoilage. Such methods are now used in commercial practice but at best are apt to be time consuming and to require the services of skilled operators.

Searches have also been made for some simple alteration in the physical properties of the flesh, preferably one capable of rapid quantitative measurement by a relatively unskilled operator. A certain amount of success has attended these efforts and an instrument for measuring freshness by electrical means is in use commercially. The experiments now described deal with an optical effect.

In the course of some tests on freezing and thawing of halibut muscle it was observed that after storage, the fish which had lost the greatest amount of drip had an appearance different from those which had lost only a small amount. The cut surfaces of the former were less translucent and more friable and in most cases had an iridescent appearance. This was particularly true of larger fish and of those with a tendency to be chalky. This difference in appearance suggested an investigation of the optical properties of the exuded drip.

Transparent substances possess the property of bending rays of light which enter them from another medium. A corresponding bending takes place when the rays emerge from the substance. This property explains such diverse phenomena as the action of lenses, the twinkling

of stars, and why a fish under water is not where it appears to be if an attempt is made to spear it from above the water. The degree of bending is known as the refractive index of the substance and can be measured very simply and accurately in the case of liquids by means of an instrument called a refractometer. The refractive index alters with the composition and temperature of the liquid.

In a previous study at this Station Brocklesby (1937 unpublished), working with juice that had been **mechanically** expressed from fish muscle, showed that after the flocculated proteins had been removed, the amount of remaining soluble protein was proportional to the refractive index of the juice so long as no decomposition of the proteins occurred. A steady decrease in refractive index was found to accompany changes in the composition of the stored juice up to the sixth day, when the value dropped much more rapidly due to decomposition of its proteins.

The present determinations were made on the drip, or juice which exuded **naturally** from slices freshly cut from time to time off halibut stored whole in ice at 32°F. Storing the fish in this way approached commercial practice more nearly than storing the expressed muscle juice and it was hoped that the refractive index measurements might form the basis of a quick method of gauging the age or freshness of the fish.

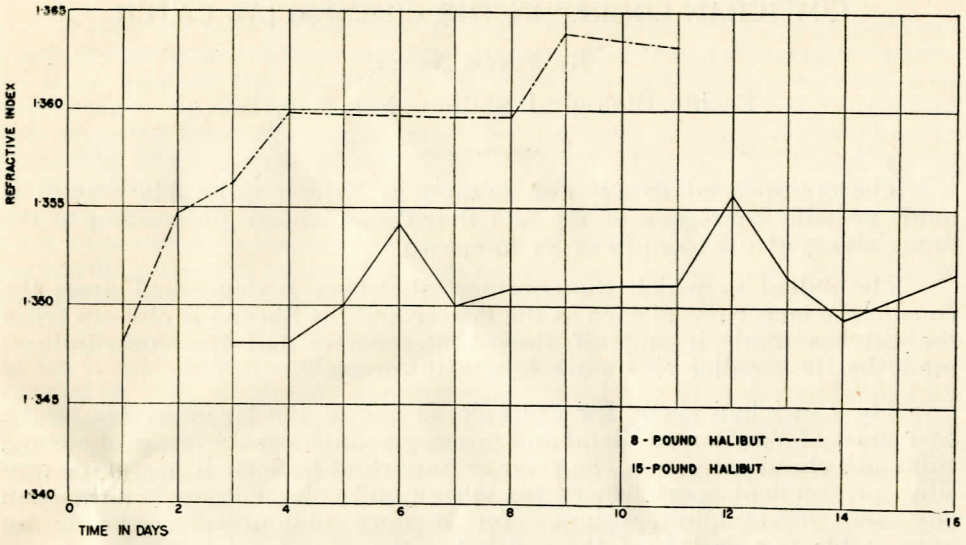
Method—Two freshly caught halibut weighing 8 and 15 lb respectively were used. The fish were dressed before storing in the crushed ice.

At regular intervals a cross-sectional slice was removed, beginning immediately behind the poke (belly cavity) and proceeding towards the tail. These slices were then cut in two pieces and placed in shallow glass dishes. When enough juice had exuded its refractive index was determined with the refractometer.

No difference was observed between the refractive index readings of juice from different parts of the fish, i.e., between head end and tail end, or white side and coloured side.

Further refractive index determinations were made on the drip from slices of halibut being used in freezing and thawing experiments. This drip was collected daily where possible at the same time as the slices were weighed. The samples were from different sized fish ranging from 16 lb to 81 lb in weight and were stored in moisture-proof pliofilm bags at 32°F. Previously they had been subjected to various freezing and thawing treatments while fresh controls were stored in a similar manner. These freezing and thawing experiments will be described in another report.

Results—The results of the first part of the experiment are shown in the accompanying figure. As will be noted, there was no definite relation between refractive index of the juice and time of storage of the fish from which it came. The refractometer readings fluctuated from day to day in a most erratic manner. These fluctuations are assumed to be due to varying amounts of protein in the juice. By this method the protein in the juice cannot be controlled and on some days it may contain more than on others, especially after deterioration of the flesh has advanced.



The results of the second part of the experiment were equally erratic and the curves prepared from the data are not shown in this report.

There was no apparent relation between the rate of freezing and thawing or length of storage period of the fish slices and the refractive index of the drip collected from them.

Conclusion—These results indicate that refractive index of the drip from either fresh or frozen halibut muscle is apparently of little use as a measure of the post mortem age or "freshness" of the fish, due to the difficulty of obtaining uniform samples.

Glass Model of Ammonia Refrigerator Used in Investigations at Prince Rupert Fisheries Experimental Station

In the course of an investigation concerning the operation of ammonia evaporators, Mr. O. C. Young, Research Engineer at the Pacific Fisheries Experimental Station, Prince Rupert, has made a section of two types of evaporators, one similar in design to those used in recent sharp freezers installed on this coast, and the other embodying modifications introduced with the object of improving the operation of the evaporator when subjected to a sudden heat load.

The models made for this investigation are on a small scale, and an interesting feature is that the tubes are composed of pyrex glass so that the action of the ammonia in changing from the liquid to the gaseous phase can be observed. Pyrex tubing is also used in portions of the feed and suction lines so that the flow of liquid and gas can be followed visually.

The apparatus is set up in the basement of the Station's building No. 2, and is open to inspection by any who may be interested in this type of equipment. At opportune times, Mr. Young can arrange to demonstrate the operation of the two types of evaporators to cold storage designers and operators.

COWICHAN COHOES IN THE COMMERCIAL CATCH

By Ferris Neave

Pacific Biological Station, Nanaimo, B.C.

The commercial fishery for salmon in British Columbia waters is made possible by reason of the fact that these fish are proceeding to the many rivers of the coast in order to spawn.

The extent to which the commercial fishery is dependent upon the runs to the larger rivers such as the Fraser and the Skeena is obvious from the catches made inland off these watercourses but the contributions made by the smaller rivers are less well known.

The Cowichan river, for example, is one of the larger rivers of the east coast of Vancouver island and possesses quite sizeable runs of spring, coho and chum salmon. The river is important because it has made possible an excellent sport fishery for spring and coho salmon in Cowichan bay and surrounding waters. Yet it does undoubtedly provide an appreciable population of these fish for the commercial fishery also, a fact which perhaps is not sufficiently appreciated. Certain information has been obtained on this point and it is reported herewith. It is based on records of marked cohoes belonging to the 1937 brood year, that is, the spawning of 1937.

Eggs were taken in December 1937 and January 1938 from cohoes which had entered two small tributaries of the Cowichan river close to Cowichan lake. The resulting young fish were raised at the Cowichan Lake Hatchery, 25,739 being subsequently released in the upper part of the Cowichan river in the fall of 1938 and the spring of 1939. All were marked by removal of the adipose and left ventral fins.

Before the return to fresh water in 1940 (cohoes normally mature in their third year) fifty-eight fish bearing the proper scars were reported from salt water, in addition to three cases in which the evidence appeared to be doubtful. Eight of these fish were caught by anglers in Cowichan bay within a few months of the time when they left the river, all being under 13 inches long. Of the remaining fifty fish, all caught after January 1940, twenty-two (44%) were taken in commercial fishing operations. These captures were made at various localities in the Straits of Georgia and Juan de Fuca as far west as the Swiftsure banks and off Cape Flattery. The records can be summarized as follows:

Locality	Date (1940)	No. of Fish
Cape Mudge and vicinity	June 29, Aug. 6, 7, 15	4
Deep bay and vicinity	August, September 22	2
Lasqueti I. and vicinity	June 10-14, July 1,4, 29, 30 August 5	7
Dodd narrows	August 14, 19	2
Maple bay	September 24	1
Sooke	October 22	1
Cape Flattery	July 31, August 21, 23, 26	4
Swiftsure banks	August 21	1

It may be pointed out that though the number of records received from commercial catches was somewhat smaller than the number obtained from anglers, the efficiency with which records were collected was much higher in the latter case. All but one of the twenty-eight marked fish reported from non-commercial catches were obtained in or close to Cowichan bay, where commercial fishing is prohibited. An observer was stationed here to record the number of fish landed and to watch for marked fish. On the other hand, records from commercial fishing areas were obtained only through the initiative of individuals in recognizing and forwarding reports on marked fish or, in several instances, through the co-operation of the Washington State Department of Fisheries.

The marked fish, of course, represented only a very small proportion of the Cowichan river cohoes resulting from the 1937 brood year. During the fall of 1940, as already mentioned, a record was kept of fish landed by anglers at Cowichan bay, where all the fish were presumably about to enter the Cowichan river or the smaller Koksilah river. Twenty-three marked fish were reported from a total of 1,960 landed, that is, about one fish in eighty-five was a marked one. If this is a fair index of the ratio between marked and unmarked fish in this particular year class, the twenty-two marked fish caught by commercial fishermen would represent a total of 1,870 Cowichan cohoes.

It is impossible to estimate how many marked fish were caught without being reported, but it may be pointed out that the twenty-two records listed above were due to only half a dozen men. Judging from this fact and from the experience of observers in the field, it is probable that only a relatively small minority of the marked fish were reported, in which case Cowichan river fish would appear to be of considerable importance to the salmon trollers and the industry generally.

Further lots of marked cohoes, and also spring salmon, resulting from the 1938 and 1939 Cowichan runs are now at large. It is hoped that fishermen and others connected with the industry will find an interest in helping to trace the migrations of these fish and in supplying evidence as to the effect which a comparatively small river may produce in the general catch.

Dogfish Tagging

Early in the summer of 1940, an experimental tagging of dogfish was undertaken. The objective of the tagging was to trace the migration of dogfish in the Strait of Georgia, but before commencing any large programme a test was made of a suitable tag.

Coloured celluloid disks were affixed to the snouts of 100 dogfish, one below and one above. Anyone catching a dogfish whose snout is adorned with one of these disks is requested to remove the disk and send the numbered one to the Pacific Biological Station at Nanaimo. Any particulars as to the condition of the tag or the snout of the fish will be appreciated, especially information as to whether the tag is loose or tightly pressed against the snout, whether the skin of the snout is worn, etc.

A reward of fifty cents (50c) will be paid for each numbered tag sent in, if accompanied by information as to date and place of capture and other remarks.

A DIRECT METHOD FOR COUNTING BACTERIA IN FISH FLESH

By H. L. A. Tarr

Pacific Fisheries Experimental Station, Prince Rupert, B.C.

Spoilage of foods is most frequently a direct result of the growth of minute or "micro"-organisms (bacteria, yeasts or moulds) on them, and consequently the number of these organisms found on a given product has frequently been depended upon as a more or less reliable index of its state of freshness. This is especially true in the case of animal flesh products (fish and meats), dairy products, etc.

Two general methods are normally employed in order to count these micro-organisms which, for the sake of simplicity, will be merely referred to as bacteria in this report. In one method the number of bacteria capable of growing on a nutrient medium is determined ("viable count"); in the other the actual bacteria are counted directly with the aid of a high-power microscope ("direct count") in a preparation made from the product.

In the viable count method the food to be tested, or more frequently a watery extract prepared from it, is thoroughly mixed with portions of sterilized water to give a series of suitable dilutions. Measured amounts of these dilutions are then mixed with a warm, fluid "culture medium" in which is incorporated a substance (agar or gelatine) causing it to solidify to a jelly on cooling. In order to make the medium cover a fairly large area when it solidifies it is either poured into a covered glass dish, or is distributed round the inside walls of a glass culture tube by rolling (" roll tube method"). On incubation at a suitable temperature (e.g. for 4 or 5 days at about 70°F. when fish are being studied) the living individual bacteria or clumps of bacteria grow and multiply to form "colonies" which are readily visible to the naked eye. By counting these colonies the number of bacteria capable of growth originally present in the sample of food can be roughly ascertained. Technically speaking this is a "colony count" and is usually recorded as the "number of colonies of bacteria per gram" of food (one gram equals about 1/28 ounce). Sometimes the count is stated on the basis of a cubic centimetre of the food (one cu. cm. equals about 1/16 cu. in.).

There are two general methods whereby bacteria may be counted directly. One method involves placing some of the liquid containing the bacteria in a minute, carefully standardized, glass counting chamber, so that an extremely thin and uniform layer is obtained. By counting the bacteria present in a number of different regions of such a layer when viewed under a microscope, the total bacterial content of the liquid can easily be calculated. This method can readily be used for liquids which contain no suspended matter other than bacteria, but it is obvious that it is liable to be of little value where the contrary is the case. For liquids which contain much suspended material such as pieces of ground-up tissue, protein particles, etc., the alternative method of preparing a dried, stained (dyed) film seems to offer the greatest possibilities. A procedure of this type has therefore been adopted for counting bacteria in fish flesh and details of the process employed are hereby outlined.

The method used is identical in most respects with that which has been so extensively used in the bacteriological grading of raw market milk—the so-called "Breed Direct Count." The sample of fish is finely minced under conditions which do not permit the access of foreign bacteria. Some of the flesh, selected at random, is added to three times its weight of sterilized distilled water, the weight of fish added being determined indirectly by measuring the volume of water it displaces. The resulting mixture is transferred to a strong glass test tube containing some fine sand. The contents of the tube are then stirred very rapidly for about a minute by means of a bent glass stirring rod rotated by a small electric motor. After standing for several minutes in order to permit the sand and coarser flesh particles to settle, the upper layer of rather cloudy liquid can be used for making the direct count and, if desired for purposes of comparison, the viable count as well.

The actual count is carried out on a small accurately measured drop (0.01 cubic centimetre or about 0.0006 cu. in.) of the liquid, which is placed on a clean glass microscope slide and spread over a marked-off definite area of one square centimetre (0.155 sq. in.) with a fine needle. The resulting thin film of liquid is dried on a level surface in air at about blood temperature. The slide is then placed for one minute in strong (90-95%) grain alcohol, drained, transferred to a solution of a blue dye (Loeffler's alkaline methylene blue) for about 30 seconds, rinsed very gently with tap water, and the so-stained film finally dried in warm air. In such preparations the bacteria are dyed a very dark blue while the background (consisting chiefly of fish muscle protein) is only a very pale blue. The bacteria seen in a selection of separate regions ("microscopic fields") on this film as viewed under the microscope are counted, and from the result it is possible to calculate the number of bacteria in a given weight of fish. The result is expressed as the total number of bacteria per gram.

Now each of the microscopic fields observed represents only a minute fraction (about one seventy millionths of an ounce) of the original fish muscle. Thus if there were exactly 70,000,000 bacteria per ounce of the original muscle and these were absolutely evenly distributed there would be only **one** bacterium in each microscopic field. So far experiments have indicated that this method cannot be used directly when there are less than about 3,000,000 bacteria per ounce of fish flesh. Greater numbers of bacteria can naturally be counted with a greater degree of accuracy.

It is obvious from the above that this direct count method cannot be applied without some modification to **really fresh** fish, in which the bacterial content is well below 3,000,000 per ounce, and should probably not exceed 30,000 to 300,000 per ounce. Two possible modifications suggested themselves, namely (a) concentrating the bacteria in the extract by rapid centrifuging, or (b) causing rapid multiplication of the bacteria present by incubating the flesh prior to making a direct count.

The second method has been tentatively adopted for certain projected work on freshness of fish, since it will probably be possible not only to relate the numbers of bacteria before and after incubation, but also to give a useful index of the probable length of time the fish will keep. As yet only preliminary experiments have been made, but the results suggest that this modification may be of value. The most suitable time and temperatue for incubating the minced muscle have not yet been worked out. It must be borne in mind that the initial bacterial content of fish muscle is

rather unlikely to bear a very constant relation to the number of bacteria present after incubation. Factors such as the variety of fish, the kind of bacteria, and their stage of growth activity ("lag phase") may all affect the number of bacteria present at the end of the incubation period.

In concluding it is wise to draw attention to the fact that the direct (total) count will probably in many instances give a considerably **higher** and more **variable** count than the viable count. The former takes in to account all bacteria seen, living and "dead"; the latter only those still "living", or capable of multiplying. However, there is no reason to suppose that the results obtained with the considerably more rapid and simple direct count will be of less practical value than those obtained using the viable count.

"Red Feed" in Prince Rupert Harbour

An unusual concentration of "red feed" occurred recently in the waters of the upper part of Prince Rupert harbour, culminating during the week-end of September 13-14. Over an area of about a square mile the water was quite brown and murky for a depth of 3 to 4 feet; near the shore line wave action had further concentrated the feed until the water to a depth of about a foot resembled tomato soup. A sample dipped at random from below the surface near shore was secured by one of the staff of the Fisheries Experimental Station and submitted to examination under a microscope. Many forms of the minute living organisms collectively known as plankton (those that drift) and nekton (free-swimming) were observed. These organisms form the feed of many of the fishes and seashore animals. The class known as the **Flagellata** was most in evidence, the bulk of the material consisting of jelly-like globules about 1/40 inch in diameter (Noctiluca). These animals contribute to the phosphorescence of the sea. Another prominent flagellate was **Ceratium,** a much smaller, delicately-shaped creature that darts about by means of an extremely slender lashing appendage (flagellum). By filtering, it was determined that the organisms were present in the proportion of about 1/30 ounce of air-dried material per gallon of water.

The sudden appearance of large quantities of certain types of red feed in the sea water may give rise to the development of a temporary toxicity of edible shellfish (particularly mussels and sometimes clams) growing in the vicinity, as pointed out in a previous Progress Report (No. 40, pp. 11-13, June 1939).

The Cat Shark, *Apristurus brunneus*

On April 23rd, Fisheries Officer McKinnon of Ladysmith brought to the Pacific Biological Station a specimen of cat shark, **Apristurus brunneus,** 16 inches in length, which had been caught in the Gulf of Georgia off Porlier pass. A number of these fish had been taken by fishermen in this area as well as off Tent island. It is interesting to note that, according to Clemens and Wilby, Progress Reports 23, April, 1935, "the cat shark has been taken but once in British Columbia waters, namely, near Nanaimo in 1907". The range of the species is from Southern California to Cape Flattery.

SLOW-GROWING HERRING FROM SMITH INLET

By R. V. Boughton

Pacific Biological Station, Nanaimo, B.C.

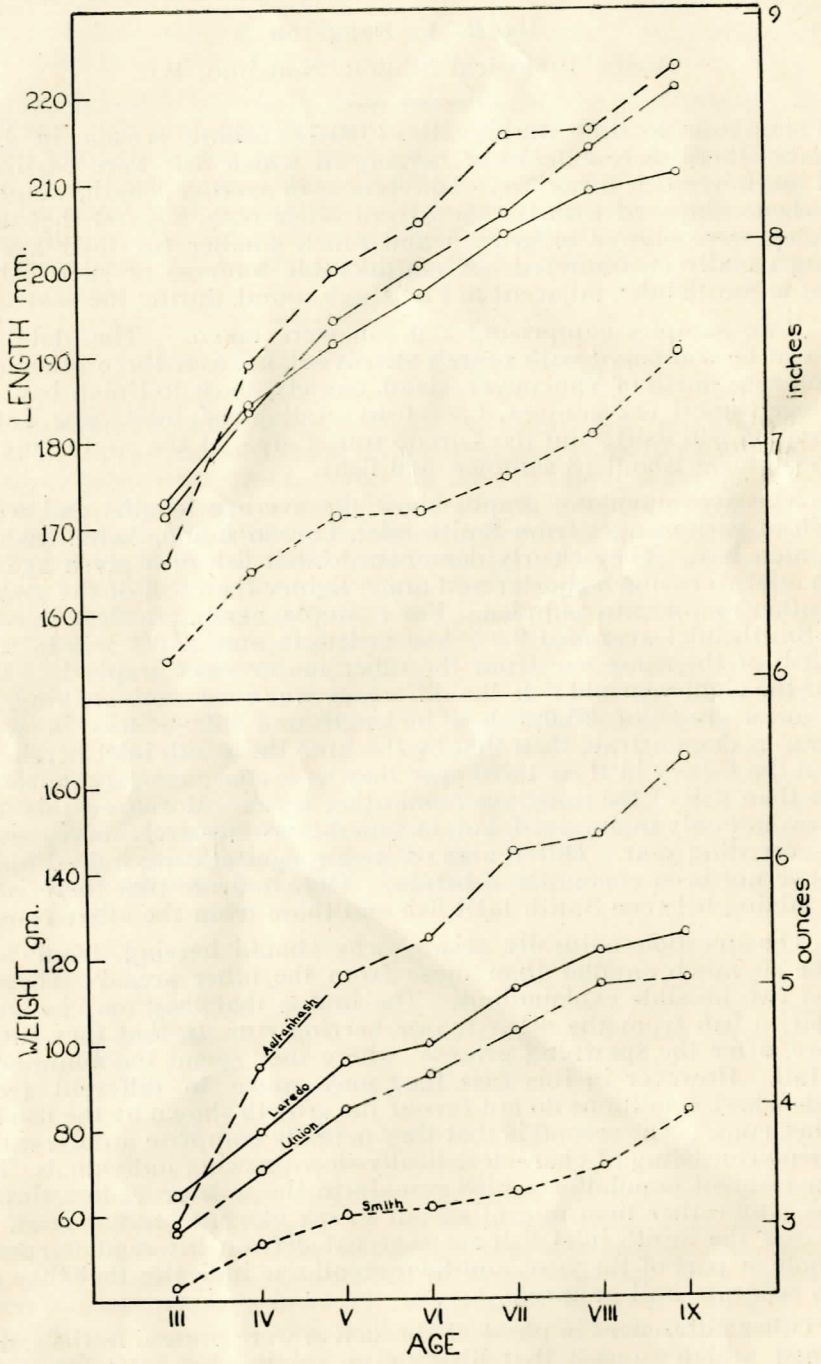
From time to time during the 1940-41 fishing season in British Columbia there were catches of herring in which fish were particularly small but nevertheless mature. Differences in average length, weight and age, when compared with the data from other runs, suggest that in general they were slower in growth and much smaller for their age than herring usually encountered. A considerable tonnage of such fish was caught in Smith inlet, adjacent to Fitz Hugh sound, during the past season.

Two samples comprising 220 fish were taken. The data from these can be compared with more extensive data from three other major herring runs north of Vancouver island, namely, those to Union bay, north of Prince Rupert (12 samples, 1,300 fish); Aaltanhash inlet, near Butedale (8 samples, 840 fish); and the Laredo sound area, at the southern end of Princess Royal island (8 samples, 840 fish).

The accompanying graphs show the average lengths and weights for fish of various ages from Smith inlet, Laredo sound, Aaltanhash inlet and Union bay. They clearly demonstrate that fish of a given age from Smith inlet were much shorter and much lighter than fish of the same age from other major runs sampled. For example, herring in their third year from Smith inlet averaged 9.0% less in length and 27.0% less in weight than fish of the same age from the other major runs graphed. In the case of the eight-year-old fish the difference was even more striking, there being an average of 15.0% less in length and 42.0% less in weight. The graphs demonstrate then that by the time the Smith inlet herring had entered the fishery in their third year they were conspicuously shorter and lighter than fish of the same age from other areas. Moreover, this difference was not only maintained, but, in general, progressively increased with each succeeding year. Differences of such magnitude are indeed unusual and have not been encountered before. They indicate that there is little or no mixing between Smith inlet fish and those from the other runs.

The question naturally arises—why should herring from Smith inlet be so much smaller than those from the other areas? There are at least two possible explanations. The first is that they may be similar in habit to fish from the other major herring runs in that they migrate offshore, after the spawning process, where they spend the summer and early fall. However in this case they may move to different feeding grounds where conditions do not favour the growth shown by the fish from the other runs. The second is that they actually comprise a different race of herring consisting of characteristically slow-growing individuals. These form a resident population which remain in the inshore waters throughout the year rather than migrating out to sea like the regular runs. In either case the Smith inlet fish are segregated from the regular runs for the whole or part of the year, and their small size indicates that they comprise a separate unit or group.

Other differences in physical characters were present in the samples examined, which suggest that little or no mixing has ever taken place between Smith inlet fish and those from the other major runs under discussion.



Average lengths and weights of herring of various ages from Smith inlet, Laredo sound, Aaltanhash inlet and Union bay.

THE CONCENTRATION OF VITAMIN A BY ADSORPTION

By L. A. Swain

Pacific Fisheries Experimental Station, Prince Rupert, B.C.

At the present time vitamin A is a nutritional factor whose necessity in the human diet is becoming increasingly evident to the general public. Any means of improving methods of its production are worthy of consideration. Utilization of the phenomenon of adsorption (the attraction that a solid surface may exert on the components of a solution in contact with it) is one possible means, and has been discussed in a previous report in this series (No. 46, pp. 12-13, Nov. 1940). Attention has been drawn in a still earlier report (No. 36, pp. 14-15, June 1938) to the loss of vitamin A occurring because of its adsorption on the soaps formed during the alkali refining of a fish oil. This same force of adsorption has been used in various laboratories to concentrate vitamin A from fish-oil unsaponifiable matter, the material remaining after the fatty constituents (triglycerides) of the oil have been removed by conversion to soaps.

A study has been commenced at these laboratories to ascertain the feasibility of using this force of adsorption to concentrate vitamin A from fish oils in which it occurs in small concentration. This is a more difficult task than its adsorption from unsaponifiable matter because of the presence of the triglycerides and because the vitamin is usually in a less easily adsorbed form (chemically combined with fatty acids) before saponification. In such oils, e.g. herring oil, the vitamin is of little use pharmaceutically because of the large amount of oil in which it is dissolved. In the various industrial applications to which the oil may be put, the vitamin is probably not utilized. If adsorption could be successfully applied it would be possible to recover the vitamin from the oil in a more or less pure form and then to use the oil in the same industrial processes as before.

The preliminary part of this investigation deals with the more readily studied unsaponifiable matter and has consisted of a survey of locally available chemicals to determine which showed adsorbent properties for vitamin A. Seventy-one materials have been examined in powdered form directly as obtained, without any attempt at drying or other preparatory treatment which might modify their force of adsorption. Of these, ten showed promise of being usable.

The apparatus used was made of two pieces of glass tubing, 0.5 in. and 0.3 in. inside diameter, sealed together end to end to make a tube 10 in. long, the narrower one being constricted at the free end. The chemical was packed carefully into the narrower tube to a depth of 4.7 in. A wad of cotton inserted against the constriction prevented loss of the chemical. The larger portion of the tube served as a reservoir for the vitamin solution. Many of the materials formed a compact bed through which the solution seeped with difficulty. When it was necessary to hasten the flow the reservoir was connected to a nitrogen cylinder and pressure applied as desired. In all experiments fish-oil unsaponifiable matter containing vitamin A was used, dissolved in low-boiling petroleum spirits, a solvent from which substances tend to be readily adsorbed.

In each experiment 10 ml. (1 ml.=0.06 cu. in.) of this solution was poured into the reservoir and allowed to filter through the chemical. When all the solution had drained out of the reservoir, pure solvent was added to wash the column until it was free of vitamin A. The liquid which escaped from the bottom of the column, known as the "eluent", was caught in separate 2-ml. portions. To follow the passage of vitamin A down the column the blue value (antimony trichloride test for vitamin A) of each portion was determined, using a Lovibond tintometer. It was soon learned that with chemicals which possessed adsorptive properties, vitamin A followed the visible zone of adsorbed pigment as the latter slowly passed down the column. This pigment zone therefore acted as an indicator of the location of the vitamin.

A more useful indicator is the fluorescence of vitamin A in ultraviolet light. When filtered ultraviolet ("black") light is directed on vitamin A in the dark the vitamin gives off a faint yellow light with a greenish cast. The presence and location of the vitamin in the adsorption column can thus be very readily seen. It should be mentioned here that the destructive action of daylight on vitamin A is due to the ultraviolet light it contains. Therefore more than momentary inspection of an adsorption column with this light may result in loss of vitamin A.

Materials vary greatly in their behaviour toward vitamin A. Many show no attraction for it. The first drops of eluent fluoresce as strongly as the original solution and all the vitamin A that is put in can be found in the eluents by determining their blue value. The following materials were found to be of this type:

Aluminium hydroxide
Ammonium carbonate
Ammonium chloride
Ammonium nitrate
Barium carbonate (No. 1)
Barium dioxide
Barium hydroxide
Bismuth subnitrate
Boric acid
Borax, calcined
Calcium acetate
Calcium carbonate
Calcium lactate
Calcium phosphate, dibasic
Calcium sulphate dihydrate
Casein
Diatomite (two samples)
Lactose
Lead acetate, basic
Lead carbonate
Lead sulphate
Lithium carbonate
Lithium sulphate
Magnesium sulphate
Mercuric chloride
Phthalic anhydride
Potassium carbonate
Potassium oxalate
Potassium phosphate, dibasic
Potassium silicate
Potassium sulphate
Sodium acetate
Sodium arsenite
Sodium bicarbonate
Sodium bitartrate
Sodium borate
Sodium carbonate
Sodium fluoride
Sodium hyposulphite
Sodium perborate
Sodium tungstate

Some materials are destructive of vitamin A, possibly because of the oxygen which is already adsorbed on them. The fluorescence of the solution in the reservoir does not penetrate below the surface of the powdered material and the eluent gives a red instead of a blue colour with the antimony trichloride reagent, which is a characteristic of oxidized vitamin A. This behaviour was found with:

Bentonite (2 samples from British Columbia)
Bleaching earth, commercial
Carbon
Carbon, iron-free
Clay, activated
Kaolin, iron-free
Titanium oxide
Volcanic ash (from British Columbia)

Other materials permit vitamin A to pass through, but with considerable loss. This group includes:

Aluminium acetate	Calcium oxide	Magnesium oxide
Arsenious acid	Calcium sulphate, anhydrous	Sodium bisulphite
Barium carbonate (No. 2)	Diatomite (from British Columbia)	Sodium silico-aluminate (two samples)

With those chemicals which showed useful adsorptive properties, the initial eluent or eluent portions did not fluoresce and the column fluoresced only part way down, showing that the vitamin had not progressed through the column as rapidly as the solvent; in other words it was adsorbed. Blue values of the eluents always confirmed this, the first portions giving no blue colour. When the fluorescent zone reached the bottom of the tube, subsequent portions of eluent gave higher values than the original solution, showing that the vitamin had been concentrated. The following chemicals showed this property:

Alumina, calcined	Infusorial earth	Sodium benzoate
Calcium hydroxide	Magnesium carbonate, basic	Sodium sulphate
Calcium phosphate, tribasic	Silicic acid	Sodium sulphite
		Sugar, powdered

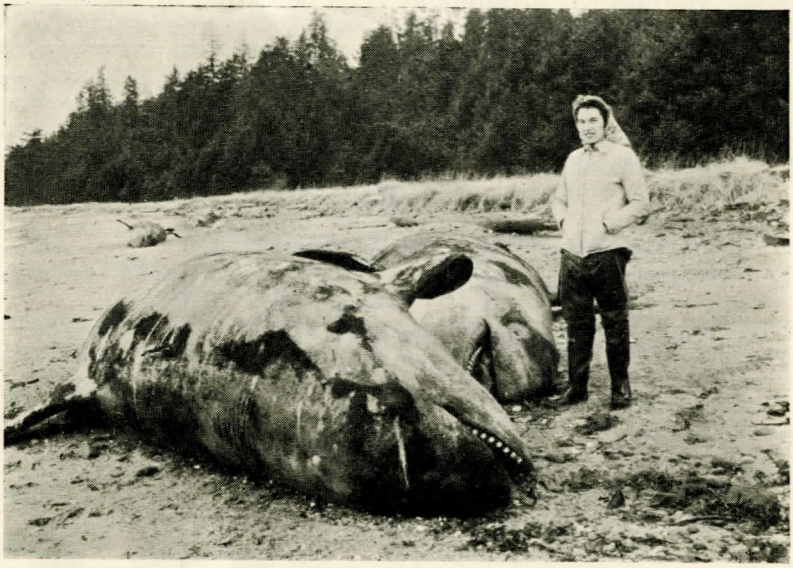
In the accompanying table are given the results of three experiments, illustrating the first, third and fourth types of material described above; the second requires no example. In each experiment the 10 ml. of vitamin solution was followed by 10 ml. of pure solvent to wash the column. The eluents are in 2-ml. portions. The passage of the pigment can be followed by changes in colour of the eluent. The symbols for the intensity of fluorescence of the eluents are only qualitative and are self-explanatory. The blue values, expressed in blue units per portion, probably have an error of less than 10 % of the true value, sufficient to account for the discrepancies between the blue units put in and recovered with the second and third chemicals, but insufficient to explain the discrepancy in the first case, where some vitamin has presumably been destroyed by the sodium bisulphite.

	Non-adsorbent e.g. sodium bicarbonate			Partly destructive e.g. sodium bisulphite			Adsorbent e.g. powdered sugar		
Eluent Portion	Appearance	Fluorescence	Blue units	Appearance	Fluorescence	Blue units	Appearance	Fluorescence	Blue units
1	yellow	++	154	yellow	+	26	faint yellow	+	10
2	"	++	152	"	++	78	light "	++	88
3	"	++	158	"	++	94	yellow	++	96
4	"	++	156	"	++	108	"	++	128
5	"	++	112	"	++	94	"	++	134
6	colourless	+	25	colourless	+	5	colourless	±	2
7	"	–	3	"	±	2	"	–	—
8	"	–	2	"	–	—	"	–	—
9	"	–	—	"	–	—	"	–	—
			—			—			—
	Blue units recovered		762			407			458
	Blue units put in		740			750			490
	(130 minutes at atmospheric pressure)			(42 minutes at atmospheric pressure)			(105 minutes at 1¼ atmospheres pressure)		

Vitamin A is now in considerable demand and is of particular importance in the present emergency. Research on the method of increasing our vitamin A production as outlined in this report is therefore actively proceeding. The next step is to attempt to improve the adsorptive properties of those substances which have shown promise. Water is known to decrease adsorption greatly and the effect of drying at various temperatures will be examined. Since adsorption is a surface phenomenon, the particle size of the material will have a bearing on the problem. The fact that two samples of pure barium carbonate from different manufacturers behaved very differently (one having no effect on vitamin A, the other adsorbing it strongly with some loss) shows the importance of the method of preparing the adsorbent. Because of this, those chemicals which showed no promise in this first survey, but whose nature would lead one to suspect they should have possibilities, will be given further consideration. The foregoing classification is by no means to be considered final.

Sub-executive Committee of Fisheries Research Board Meets

A meeting of the Pacific Sub-executive Committee of the Fisheries Research Board of Canada was held in Prince Rupert on August 30th during a tour of the Board's scenes of operation on the west coast by Dr. A. T. Cameron, Chairman of the Board, and Major D. H. Sutherland of the Department of Fisheries, Honorary Secretary of the Board. Other members of the Board attending were Mr. John Dybhavn, Secretary of the Committee, Dr. A. H. Hutchinson and Mr. R. E. Walker. Dr. R. E. Foerster, Director of the Nanaimo Station, and Dr. N. M. Carter, Director of the Prince Rupert Station, were also present. Matters pertaining to the investigations and operation of the Stations were reviewed and discussed. The officers of the Board then proceeded south for a visit to the Nanaimo Station and scenes of its field work.



Killer whales stranded near Massett.

KILLER WHALES STRANDED NEAR MASSET

By **W. M. Cameron,**
Pacific Biological Station, Nanaimo, B.C.

During the third week in January, 1941, the press reported a number of whales stranded near Masset on the Queen Charlotte islands. At the request of the Provincial Museum in Victoria an examination of the animals was made on January 27th by the writer, at that time stationed at McClinton creek, Masset inlet.

The specimens proved to belong to the species **Orcinus orca,** commonly known as the Grampus or killer whale. This animal is in reality a porpoise, its most characteristic feature being the white markings, a lens-shaped patch just behind the eye and a large trident-shaped patch on the belly. It has a wide range of distribution, both in the Atlantic and Pacific oceans.

The animals had apparently been left stranded by a receding tide, though the reason for this disaster was not evident. They were distributed along the beach at the north end of Sturgess bay, almost due west of Entry Point Light. Eleven in all, they were found within a distance of approximately seventy-five yards.

The sizes of the whales as well as the condition of the teeth suggested that both adult and immature individuals were represented. The lengths, taken from the tip of the snout to the fork of the fluke, were as follows: four males—13.7, 17.3, 20.0, 20.5 feet; seven females—10.4, 12.2, 14.2, 18.3, 18.5, 18.7 feet. The two largest males are pictured opposite.

The assistance rendered by Sgt. A. Dunbar of the British Columbia Police and Mr. R. M. Stewart of Masset, is most gratefully acknowledged.

It may be of interest to note that killer whales are very voracious, well termed "killers". They are recorded as hunting in packs varying in number from two or three to thirty or forty and when attacking large baleen whales their behaviour is comparable to that of a pack of wolves attacking a deer. While they are said to feed on salmon when these fish are sufficiently abundant, such food seems of little significance in comparison with other food items they seek out, namely, whalebone whales, dolphins, porpoises, seals and sea lions. It is recorded that in one stomach of a 21-foot **Orcinus** were found the remains of thirteen porpoises and fourteen seals.

One unusual feature of killer whales is that the male, attaining a length of thirty feet when fully-grown, is approximately twice as large as the female.

Bottle-Nosed Whale, *Hyperoodon rostratus,* near Estevan Point

On May 25th, Mr. Basil H. Robson, officer-in-charge of the Estevan Point Radio, west coast of Vancouver island, submitted to the Pacific Biological Station a photograph and description of a whale which was identified as a bottle-nosed whale, **Hyperoodon rostratus.** Mr. Robson's description follows: "The length over all was very close to 20 or 21 feet and the color was blue-black with slightly lighter mottled spots on the side facing the picture [the dorsal side], the other side was a dirty white. It washed up at Ho-miss Bay, two miles north of here, on May 10th—or at least when found on that date it was still warm. No teeth were noticeable."

EULACHON CATCH STATISTICS

By J. L. McHugh
Pacific Biological Station, Nanaimo, B.C.

During the past season, the Department of Fisheries has distributed forms to eulachon fishermen and buyers, requesting detailed information on their daily catches. This is not idle curiosity—the reasons behind it are very definite—and the final object is the protection of the Fraser river eulachon fishery.

The eulachon investigation was started in 1939 in response to suggestions made by fishermen and buyers on the Fraser river. Certain fur farmers in the State of Washinghton had applied for quotations on shipments of frozen eulachons to be used as food for fur-bearing animals. It was felt that the increased intensity of fishing necessary to supply the export market might result in depletion of the stock in the Fraser river.

In planning the investigation, the annual records of the Department of Fisheries were consulted in an effort to determine to what extent the catch had fluctuated in the past. In addition, it was desired to know whether or not the catch had tended to decrease over a period of years. Commencing with the year 1877, the marketed value of the eulachon fishery as given for the whole province rose to a maximum of $96,436 in the year 1903, at which time it held fifth place among the fisheries of British Columbia. In 1912 the eulachon was still in fifth place with a value of $78,950 but subsequently the recorded catch and value dropped off very rapidly until in 1938 the total marketed value was given as only $760, and the fishery now holds a position of very minor importance.

What are the reasons for this decline? Records of some of the circumstances affecting the runs of fish and the fishery have been lost in the past and many of the reasons will never be clearly known. The methods of recording statistics have undergone several changes, especially in the early days. A considerable proportion of the eulachon catch is taken by Indians and local residents for personal consumption, and it is suspected that formerly the value of this portion of the fishery was estimated and included in the records, while in later years the practice has been adopted of recording only the commercial catch.

Furthermore, the total catch in any area is governed to a considerable extent by the demand. In the year of a heavy run an abundance of fish may be caught in a short time, and no advantage is gained by fishing long hours if the extra catch cannot be sold. In the case of a light run, by fishing longer hours it may still be possible to keep up with the requirements of the market. The total catch in such cases would give no idea of the relative abundance of fish.

The method of collecting statistics introduced during the past season is designed to give a measure of the catch which can be compared directly from year to year. By means of daily records, information is provided on the length of time each net is in the water, the size of mesh and dimensions of the net, and the weight of fish taken each time a set is made. From these data a unit of fishing effort is chosen—at present this unit is represented by 100 square fathoms of net fished for one hour—and the weight of fish taken by one unit is the catch per unit effort. Since all other variables are eliminated, these weights may safely be compared from day to day or from year to year.

In 1941 fishing on the Fraser commenced on March 16, and the catch per unit effort remained relatively low (below 30 lb) until April 10. By April 20 the value had risen to over 200 lb, and it remained greater than 150 lb per unit effort until May 3. After May 5 the catches were negligible (less than 10 lb per unit).

The average daily catch per unit effort for the whole season was 68.7 lb, and the total weight landed by licensed fishermen was close to 200,000 lb, which is roughly equivalent to 2,500,000 fish.

It must be emphasized that the value of such a system of statistics depends on the continued co-operation of all parties over a period of years. Particularly is it the responsibility of the individual fisherman to provide returns which are as accurate as possible, since the whole value of the results depends on the accuracy of his records. In time it will be possible to trace any changes which may occur in the yearly availability of eulachons in the Fraser river. The knowledge of the habits of the species obtained in the present investigation may then be used in drawing up regulations for the protection of the fishery.

Salmon Stomach Collection and Analysis

In 1939 and 1940 collections of spring salmon stomachs were gathered from fish taken in the commercial catches in many districts of British Columbia with a view to establishing the relationship of the species with other valuable varieties. General summaries of the results for each of these years have been submitted in Progress Reports Nos. 42 and 47 respectively. Copies of these may be obtained by writing to the Pacific Biological Station at Nanaimo.

In the season of 1941 the programme has been expanded to include collections not only in those areas already investigated but also in other districts which have so far been neglected. An effort has also been made to extend the collections into the winter when commercial fishing is at a minimum. At present the following collectors are operating: West coast of Vancouver island—5; Strait of Georgia area including Campbell river, Lasqueti island, Horseshoe bay, Cowichan bay, and Brentwood districts—8; Sooke and Victoria—2; central coast, Queen Charlotte sound to Milbanke sound—3; northern coast including the Queen Charlotte islands—7. The numbers of stomachs obtained for analysis will, of course, depend upon the size of the runs, but it is expected that with the unstinting co-operation of so many fishermen and resort owners, a large amount of valuable data will result.

Linseed Oil for Salmon Gill Nets Tested

Difficulties were experienced at certain B.C. canneries this year in the setting of the linseed oil used for the treatment of some salmon gill nets. Chemical tests of the "unsaturation" of the oils, performed at the Pacific Fisheries Experimental Station, indicated the samples to be inferior in drying quality as compared with commercial grades of linseed oil used in other years. Further investigations on the preservation of gill nets are in progress.