

**FISHERIES RESEARCH BOARD**  
**OF CANADA**

**1949**  
**ANNUAL REPORT**  
**OF THE**



**PACIFIC FISHERIES EXPERIMENTAL STATION**

**BY NEAL M. CARTER, DIRECTOR,**  
**WITH INVESTIGATORS' SUMMARIES AS APPENDICES**

**VANCOUVER, B.C.**

**DECEMBER, 1949**

PACIFIC FISHERIES EXPERIMENTAL STATION  
VANCOUVER, B.C.

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ORGANIZATION OF STAFF (23 members)  
(As of December 1, 1949)

Administrational

Director	N.M. Carter, Ph.D.
Director's Secretary, Clerk Gr. 3	Miss E.B. Norris
Supervising Clerk (Executive Assistant)	Mr. J.W. Kilpatrick
Secretary and Stenographer, Clerk Gr. 2A	Miss P. Tweedale

Investigational Staff

(1) Engineering Research

Principal Research Engineer	O.C. Young, M.B.E., M.E.
Associate Research Engineer	A.W. Lantz, B.Sc.
Assistant Research Engineer	J.S.M. Harrison, B.A. Sc.
Assistant Research Engineer	S.W. Roach, B.A. Sc.
Assistant Technician, Gr. 3	E.G. Baker

(2) Bacteriology and Microbiology

Bacteriologist	H.L.A. Tarr, Ph.D.
Junior Bacteriologist	Miss B.A. Southcott, B.S.A.

(3) Biochemistry

Biochemist	B.E. Bailey, Ph.D.
Assistant Technician Gr. 1	Miss I.M. Porter
Volunteer Worker for Ph.D.	M.R. Khan, M.Sc., M.A.

(4) Chemistry

Associate Chemist	L.A. Swain, Ph.D.
Associate Chemist	N.E. Cooke, M.A. Sc.
Assistant Chemist	P.J. Schmidt, B.Sc.
Assistant Technician Gr. 1	Miss A.C. Corrigan
Assistant Technician Gr. 1	Miss S. Kristjanson
Assistant Technician Gr. 1	Miss I.R. Smith

Library

Assistant Technician Gr. 3 (half salary)	B.E. Maxwell
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Maintenance

Maintenance Supervisor Gr. 2	F.C. Freeman
Caretaker Gr. 1	H.G. Irwin
Cleaner and Helper Gr. 1 (part time)	Mrs. M.L. Spowage

VANCOUVER STATION

	Approx. Expen. 1926-49	Actual Expen. 1948-49	Anticip. Expen. 1949-50	Revised Estim. 1950-51
Administration	---	15,229	16,600	17,664
Library (incl. printing)	---	5,241	5,600	3,785
Maintenance	---	9,119	10,200	8,754
Fish handling & refrigeration	213,000	29,253	13,700	17,931
Canning	{ 149,900 }	4,705	4,100	4,600
Curing		4,131	4,000	4,900
Bacteriology and preservation	83,800	7,744	8,100	15,269
Chemistry and biochemistry	320,800	20,603	16,400	17,652
Utilization of waste products	87,700	10,651	15,510	19,968
Freshwater fish technology	18,300	8,229	8,900	3,000
Trouble shooting & minor researches	64,000	6,534	5,700	8,087
TOTALS	937,500 (partial)	121,439	108,810 **	121,610

\*\*As of December 1, 1949.

Salaries	68,543	73,211	75,005
Wages	2,379	845	1,620
Printing, Stationery, Office Equip.	2,157	2,564	1,950
Travel	4,378	5,485	7,000
Material and supplies	20,741	8,655	10,500
Equipment	13,477	7,700	13,785
Repairs and upkeep, building mtce.	{ 7,198 }	{ 7,740 }	3,750
Laboratory maintenance			4,200
Sundries	2,566	2,610	3,800
TOTALS	121,439	108,810 **	121,610

\*\* As of December 1, 1949

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FISHERIES RESEARCH BOARD OF CANADA

PACIFIC FISHERIES EXPERIMENTAL STATION  
VANCOUVER, B.C.

DIRECTOR'S REPORT

1949

Neal M. Carter

This Report covers the period from December 1, 1948, to November 15, 1949.

BUILDING AND EQUIPMENT

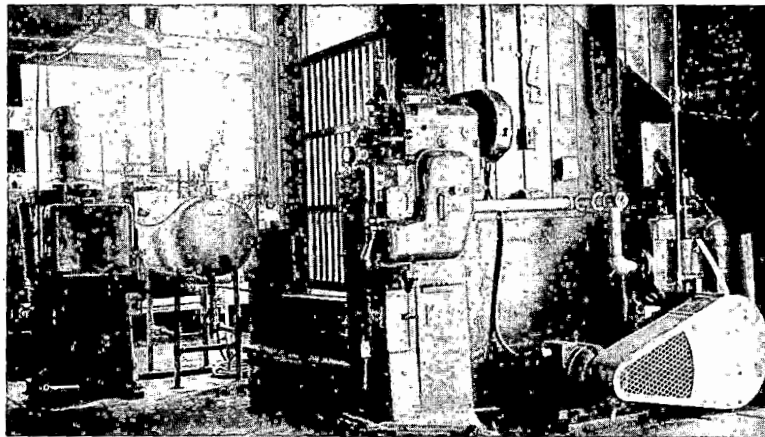
No structural alterations to the Station building were made. The report of the Building Committee has recognized the rapidly-approaching exhaustion of remaining working space and facilities for accommodating additional staff and experimental equipment within the building and that enlargement of the premises could be undertaken only by disproportionately expensive alterations in the present structure, or by acquiring adjoining property and erecting an addition thereon. Therefore, while this Station's turn on the waiting list for new or expanded quarters is being awaited, its work and services can be maintained in quality, but further expansion in quantity must soon be curtailed except for some restricted fields. This was reflected in the Estimates for 1950-51 recently submitted by the writer; a revised total of \$122,210 has been requested, representing an increase of only some 12.8% over the allotment for the current fiscal year.

Acquisitions of equipment during the period reviewed included:

- (a) The second of the two U. S. Thermo Control refrigeration units for the railway refrigerator car project, and addition of dual automatic-control devices as installed at the U. S. Thermo Control shops in Minneapolis.
- (b) A Foxboro 10-inch recording thermometer for control work on engineering research equipment.
- (c) Finned cooling coils for air-conditioning in the fish smoking or drying tunnel.
- (d) Fluorescent lighting in the general office and Director's office.
- (e) One 4-hole and one 8-hole electric water baths.
- (f) A can-seam gauge for the cannery.
- (g) A Thor bench grinder for the workshop.
- (h) A dial-reading Chainomatic balance for biochemical investigations.

- (i) A Nelson vacuum pump with motor.
- (j) A heat-pump concentrator built to specifications for pilot-plant scale investigations on utilization of fish wastes and other materials (see Summary No. 55).
- (k) A re-designed and enlarged lyophilizer (for freeze-drying) constructed largely from the one described in last year's Report and installed in a safer and more convenient position. (See Summary No. 52 and illustration).
- (l) Modifications of the rotary flesh and bone separator described in last year's Report, to adapt it for washing fish (see Summary No. 67) and for sorting of shrimps (see Summary No. 66 and illustration).
- (m) A new carriage for the copying camera, allowing ready conversion through mirror reflection to give direct-reading white-on-black prints, or white-on-black negatives permitting printing of black-on-white positives (constructed by Mr. Freeman).
- (n) A  $1\frac{1}{2}$ -ton Hein Werner jack.
- (o) A Remington Rand typewriter with copyholder.

The gradual increase in amount of necessitated permanent equipment and of other apparatus and equipment employed in investigations or for demonstration has particularly resulted in congestion of the space on the ground floor used for engineering research. The accompanying illustration in conjunction with that in Summary No. 14 showing the Station's smoke tunnel and the one in Summary No. 23 give a general idea of the space available for such experimentation other than work in the cold rooms. It still appears desirable for



Smoke producers and air conditioners for smoking tunnel; washing and filleting tables; hot water and steam producer (under test only); cannery retort; vacuum closer with pump (on lease).

convenience and safety to continue housing the station wagon on the remaining floor space in this area.

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The development of pilot-plant-scale equipment for work on utilization of fish wastes and other materials (see Summaries Nos. 51, 53-55) had led through lack of space in the Station to the necessity of making an arrangement with the Chemical Engineering Branch of the University of B.C. for space in which to carry out such work. In return for steam, water, electricity and other facilities provided by the University, the equipment will be used under adequate supervision for student instruction purposes. Demonstrations to the Industry will be carried out under our own supervision.

#### STAFF

A list of staff employed at the Station during the period under review follows immediately after the present Report.

The present staff consists of twenty-five persons - the same number as employed at this time last year - including one typist temporarily employed for preparation of this Report, and two half-time workers. One voluntary investigator is given part-time accommodation.

Alterations in the scientific staff were the resignation of Mr. D. H. Taylor, Assistant Research Engineer, who accepted a position with the U. S. Thermo Control Co. of Minneapolis, and the resignation of Miss P. W. Ney, Junior Bacteriologist, who married and whose position was filled by appointment of Miss B. A. Southcott.

Mr. N. E. Cooke, Assistant Chemist, was promoted as from January 1, 1949, to Associate Chemist.

Mr. B. E. Maxwell, Assistant Technician Grade 3 (Librarian) commenced on October 1 a course of studies leading to the M.A. degree at the University of B. C., and was granted half-time salary for half-time services.

Mr. M. R. Khan, at present a volunteer investigator completing a Ph.D. thesis for the University of B. C., was granted a nominal salary for five months because of the interest of his thesis ("Studies on the lipoxidase system of fish tissues, with particular reference to those of B. C. herring") to the Station and the Board. Part of his investigational work is being continued at the Station. Other temporary staff indicated in the above-mentioned list were required for assistance in an investigation of utilization of certain organs in fishes and whales (Mr. G. T. Campbell, Summaries No. 60 and 61), for assistance in designing pilot-plant equipment (Mr. A. R. P. Patterson, Summaries 51, 53-55), and for relief work during holiday leave of various technicians (Miss E. D. A. Young). Mr. R. Tomlinson acted as volunteer investigator assisting in field work and calculations relating to the investigation described in Summary No. 6. Mr. C. C. Sun (a Chinese student) rendered volunteer technician service to several of the staff during the afternoons in return for instruction.

The writer desires at this point to pay tribute to the splendid co-operation shown by all members of his staff during the year, and to mention particularly recognition of the services of those whose work does not receive specific recognition in Investigators Summaries or other portions of this Report. Specific reference is due to Mr. F. C. Freeman, Maintenance Supervisor Grade 2, for his enthusiasm in carrying out the varied duties assigned to him in connection with the maintenance of the building and construction of apparatus

and equipment that would otherwise have to be performed at considerable additional cost by outside firms with attendant inconvenience in our supervision of detail.

#### PUBLICATIONS

A complete list of staff publications that appeared during the period under-review follows the list of Staff in the present Report.

Three issues of Pacific Progress Reports (Nos. 78-80) were published under the editorship of the writer. Issue No. 80 contained an author and subject index to issues Nos. 61-80 inclusive, as required by the Board. These indexes were compiled jointly by the writer and Dr. Hart of the Nanaimo Station. A fourth issue (No. 81) is planned to appear before the end of 1949.

Separates of leading articles in the Pacific Progress Reports have been printed at time of publication for the past few years. Experience has shown that in acceding to requests for specific Progress Reports articles, it is more economical to supply such separates than to supply a copy of the complete issue.

The mailing list for Pacific Progress Reports at present totals 1440, made up of 830 individual names and 610 companies, schools, libraries, etc. This total is exclusive of the copies sent to Board repositories or Board Stations. The distribution to 30 countries is shown in the accompanying table:

Country	Individuals	Non-individuals	Country	Individuals	Non-individuals
Canada	456	495	Germany	2	-
Brit. Isles	56	13	Greece	-	2
Africa	7	11	Iceland	4	1
Australia	12	6	Italy	1	-
Ceylon	-	1	Mexico	1	1
India	12	1	Japan	-	2
Malaya	1	-	Netherlands	2	1
New Zealand	19	1	Norway	10	3
U.S.A.	203	74	Philippines	2	-
Alaska	2	1	Poland	1	-
Hawaii	4	-	Russia	2	2
China	3	1	S. America	13	3
Denmark	1	-	Spain	1	-
Finland	1	-	Sweden	1	-
France	1	-	Yugoslavia	2	1

The mailing list for the Pacific Progress Reports has grown considerably since the year following the end of the war; during the past 12-month period some 225 new names have been added, practically all through request. In addition, some 100 requests for change of address have been received. The press run was increased from 1600 to 2000 copies.

The two mimeographed Industrial Memoranda issued (see items 22 and 23 in List of Publications) were circulated to selected Canadian parties concerned

and were not intended as publications for general distribution.

Various staff publications were reprinted in whole or part by other publishers, sometimes under altered titles that in some cases might lead to the impression they were contributions that should appear in the List of Publications. Such material has not been included in that list.

Two articles submitted for publication in the Board's Journal are scheduled to appear in No. 10 of Vol. VII, and two additional articles were submitted for the Journal. The first five chapters of the revision of Bulletin 59 on the chemistry and technology of marine oils have been sent to the University of Toronto Press and the balance of the typescript is ready except for last-minute checking of minor points (see Summary No. 37). Mr. Young, as one of some 25 authors invited to contribute to the compilation of a revised edition of "Marine Products of Commerce" (being edited jointly by Tressler and Lemon), submitted a 42-page typescript article entitled "Transportation of Commercial Fishery Products by Sea, Land and Air". The revised book is expected to appear early in 1950. Dr. Tarr and Mr. Cooke submitted a paper on enzymic browning of fruits to "Food Technology"; Mr. Cooke, one on a theory of vitamin A metabolism to "Biometrika"; and Dr. Carter, one on fisheries technology to the "Proceedings of the Seventh Pacific Science Congress".

#### TRIPS

Mr. Young, Dr. Bailey and Mr. Cooke accompanied the writer to the Board meetings and those of the Canadian Committee on Food Preservation at Ottawa in January. Dr. Bailey and Mr. Cooke then visited the Halifax Station and other Eastern points of scientific contact, as described in Appendices A and B of the minutes of the March meeting of the Pacific Sub-Executive Committee.

Mr. Young remained in Ottawa through January in connection with the Department's development plan, and made similar trips East in March and September in the same connection (see Summary No. 74); his services have been requested in December for a fourth trip. During periods in February-March and June-July he (with Messrs. Taylor, Harrison or Baker) accompanied the railway refrigerator car on trial trips, and in August-September visited Minneapolis and La Crosse relative to refrigerator car studies (see Summary No. 7).

The writer was away for eight weeks commencing the middle of January to attend the Seventh Pacific Science Congress in New Zealand as a private delegate sponsored by the Canadian National Research Council, and visited fishery centres there, in Fiji and Honolulu. A scientific paper was presented at the Congress, and defrayment by the Board of certain expenses incurred on the trip is gratefully acknowledged. In June he attended in Halifax the Annual Conference of the Chemical Institute of Canada, which was followed by a Fishery Research Board Executive Meeting and visits to the Halifax, Ellerslie, St. Andrews and Gaspé Stations. A Board Executive meeting at Ottawa in October was also attended.

Dr. Tarr went in July to the San Francisco meeting of the National Institute of Food Technology, which was followed by visits to several California research laboratories. A trip to Seattle early in November is mentioned in the following section.

Messrs. Lantz and Schmidt during the first half of June made a trip to Winnipeg, Prince Albert, Big River, Saskatoon and Hay River Townsite (Great Slave Lake) in connection with their investigations on technology of fresh-water fisheries (see Summaries Nos. 20, 34, 56, 71). Mr. Lantz made short trips to Prince Rupert in September and November to give advice on a commercial installation of a fish smoking tunnel developed from the Station's experimental tunnel (Summary No. 14) and to demonstrate the shrimp sorting, fish washing and scaling devices reported in Summaries Nos. 66 and 67. The Fish and Wildlife Service Technological Laboratories in Ketchikan were visited during the latter trip.

Dr. Swain introduced Dr. Vandenheuvel of the Halifax Station to Pacific coast whaling operations at Coal Harbour and to the liver oil industries in Prince Rupert during the latter's first trip to this coast. Mr. Cooke also visited the whaling plant in the course of Mr. Campbell's collection of pancreas and other materials there (Summary No. 61).

Messrs. Harrison, Roach and Taylor made trips to the Nanaimo Station to give assistance in connection with services for the new building (Summaries Nos. 12 and 77). Other members of the staff attended various meetings at that Station.

#### SCIENTIFIC, INDUSTRIAL AND OTHER RELATIONS

Most of the trips mentioned in the previous section allowed stimulating contacts with centres of scientific research, and several attendances at meetings were specifically authorized by the Board because of officership or membership in scientific societies held by the staff concerned.

Dr. Tarr was requested to organize and act as Chairman of the Fishery Discussion Group at the annual meeting of the National Institute of Food Technologists he attended in San Francisco, where he presented the already-mentioned paper on the use of carbonyl enediols as antioxidants for frozen fruits; at Seattle he was invited to deliver five lectures at the University of Washington School of Fisheries and an evening lecture to the Seattle branch of the Institute of Food Technologists.

The writer attended the Halifax conference of the Chemical Institute of Canada as a member of the Board of Directors and Councillor "A" for the western region, but has been unable to attend the numerous intermediate Council and Executive meetings held in the East. After being a member of the Board of Management of the B. C. Research Council since its inception in January 1944, his term of office expired this year.

Dr. Swain was elected Chairman of the Vancouver Section of the Chemical Institute of Canada and Vice-President of the B. C. Academy of Sciences, and organized the chemistry programmes of that Section and the three Northwestern Sections of the A.A.A.S. at the Third Annual Conference sponsored by the Academy. Mr. Young was appointed as a member of the Scientific Advisory Council of the Refrigeration Research Foundation (U.S.A.). Dr. Bailey became a Committee member of the B. C. Food Technologists. In addition to such posts, the staff maintain continued association with various scientific organizations.

The entire scientific staff participated in giving the usual fall-term weekly lectures and demonstrations to the fisheries technology class of the University of B. C. Fisheries Course. These classes were held at the Station,

with seven students attending. The writer, as Honorary Lecturer in the University Department, supervised the setting of the examination paper which will be marked by the Station staff. Facilities of the Station library are made available to various students undertaking research relating to essays or theses. Sometimes a line has to be drawn, however, as in the case of a repetition this year of last year's receipt of about twenty individual written requests from school students in a small town in Washington. Typical of such requests is the following:

"Dear Sir - Would you please send me any information you have on hand about fish. If you would, I would be very grateful, because fish is my major topic in Washington history. Thank you, Sincerely yours," etc.

Despite letters to the school principal and reference to Washington State fisheries educational institutions, these requests continue to be received, usually "postage due". Mr. M. R. Khan (see List of Staff) was granted facilities for continuing certain portions of his Ph.D. thesis laboratory work at the Station under the writer's supervision, as last year. Reference has already been made under Building and Equipment to the University's collaboration with the Station in offering to provide working space and to supply services for pilot-plant investigations. The writer gave a lecture on work of the Station, publications, etc. to a class of twenty-three students taking one of the Fisheries courses at the University of B. C., also one on fisheries by-products to a large group of fishermen as part of a course offered by the University Extension Department. Messrs. Taylor and Cooke of the staff completed successfully their respective courses on heat transfer and statistics, taken at the University of B. C.

The writer has been acting on a committee delegated to prepare material on problems of the fisheries industries, to be presented at the Third Resources Conference (B. C.).

Industrial relations have continued to be most encouraging and mutually helpful. References to projects undertaken or continued at the request of the Industry or seriously interested individuals are mentioned in the following section of this Report and in the Investigators' Summaries. Specific examples not mentioned particularly elsewhere have been: (a) The invitation to Mr. Young (unfortunately not able to be present) and to Dr. Carter (present) to attend the official opening of the second large unit of the B. C. Ice and Cold Storage Co. plant in Vancouver. This plant operates on the "jacketted-wall" principle investigated and published by Mr. Young from this Station some sixteen years ago, but adopted for the first time on a large commercial scale in Canada by this company when building its first unit in 1947 in consultation with Mr. Young. (b) The unexpected interest shown by the Industry in a system of pressure cooling during retorting of canned fishery products, devised by Messrs. Harrison and Roach and published by them in Pacific Progress Reports No. 79. (c) The anticipation shown by many investigators and institutions in connection with the forthcoming publication of the revision of the out-of-print Bulletin on chemistry and technology of marine oils. Credit for this revision belongs largely to Dr. Bailey, with assistance from Dr. Brocklesby (editor of the former Bulletin), Dr. Swain and the writer. There is not room to itemize more than a few of the very large number of requests for industrial information that occupy a very considerable portion of the writer's and his staff's time in interviews, plant visits and correspondence. The extent and scope of such work, plus the

degree of appreciation shown, have warranted including in the Estimates for the past few years a separate item headed "Trouble-shooting" since this properly describes the varied and unexpected nature of the problems that so arise.

Relations with the Department during the past year have been many. Mr. Young made three trips east, as already mentioned, to assist in surveys of cold stores for frozen fish and in other aspects of the Department's programme (Summary No. 74). The writer has directed submission of information and samples for an Army fish ration for use in Arctic manoeuvres, submitted comments on other Army fish rations referred to the Department, and with the assistance of his staff has prepared various memoranda relating to Departmental programmes. The Department's local office and the Station frequently exchange information of mutual interest, and the personnel who were given courses at the Station often drop in to chat over problems or to use the library. We were again asked this year to perform our test on a sample of fish seized by the local inspectors for determination whether or not it had been frozen. We wish to express our appreciation of the publicity accorded to the Station by the Department, and through it, by the Film Board of Canada (see three credited illustrations in this Report).

The Civil Service Commission (Vancouver office) requested the writer on several occasions during the year to act as a scientific examiner in screening applicants for eligibility lists.

The usual number of visiting scientists and other persons interested in the Board's and the Station's work were received and arrangements were frequently made for them to see representative aspects of the fishing industry, usually accompanied by a member of the staff. A predominance of visitors from India and Scandinavian countries is noted. It was a distinct pleasure to have Mr. Castell and Dr. Vandenheuvel of the Halifax Station visit our Station during the summer.

### INVESTIGATIONS

Investigators' Summaries in the Appendix that follows are grouped under ten general subject headings, prefaced by an index of contributors, subject-matters and of fishes and other marine animals mentioned. General and in some cases detailed aspects of investigations prosecuted during the period reviewed have appeared in the thirteen Progress Reports articles and four Board Journal articles published during the same period. Consequently, the writer's resume that follows is brief and refers liberally (by numerals in parentheses) to the Summaries themselves. His report now being prepared for the Board's printed Annual Report covers the investigations more fully, since Investigators' Summaries will probably not be available for reference therein.

#### Biochemistry and Microbiology

The discordance between the often-demonstrated lesser value of the "trimethylamine test" for freshness when applied to most B. C. fish flesh, as compared with its application to Atlantic coast fishes, again received attention (1). Although the action of other agencies is not excluded, it appears that the tendency of the flesh of B. C. fishes such as red cod, lingcod and salmon to remain appreciably acid on storage at 33 to 38°F. for 6 to 10 days causes the development of trimethylamine to be less pronounced than in the Atlantic products. Hence for these species (and as previously shown for

B. C. halibut) this test does not give a satisfactory measure of bacterial spoilage. It is certain that development of rancidity is just as important as, or possibly more important than, formation of trimethylamine in causing quality deterioration in non-frozen B. C. fatty fishes. In frozen fish, rancidity also develops slowly; investigations on antioxidants for delaying its development have been described in previous Reports and the use of ascorbic acid commercially for this purpose is growing (13). A thesis investigation (4) of the lipoxidase enzyme system catalyzing peroxide formation and eventual rancidity of the dark muscle of B. C. herring is underway at the Station.

The rotary-screen de-scaler (67) developed and described in Progress Reports No. 77 proved also to be an efficient fish washer. Bacteria counts on fillets prepared in various ways from beheaded and dressed fish so washed (3) showed that addition of a buffered, mildly acid bacteriostat to the washing water was a doubtful improvement over clean water. With this machine, as with the use of the machines developed at the Halifax Station or any of the efficient washing devices now used in many commercial plants, it is again shown that treatment of fresh fish with lots of clean water is after all one of the primary considerations in ensuring good keeping quality.

Other bacteriological investigations included mild curing some bacterially-contaminated (stale) sides of salmon to ascertain whether bacterial growth at around 32°F. would result in generation of sufficient heat to accelerate the growth (18). No significant heating was observed. This experiment was performed to test certain claims made in connection with alleged spoiling of a shipment of B. C. mild cured salmon during transport to a Scandinavian port; our experiments did not substantiate the claim that spoilage was due to spontaneous heating. Commercially-canned fried fish cakes were examined bacteriologically to ascertain the cause of "swells". It was demonstrated that in efforts to avoid discoloration of the cakes by the Maillard reaction (26) during retorting of the cans, insufficient processing was being given (25). A safer processing was worked out.

Summaries 27 to 32 inclusive deal with the results so far obtained in a new investigation commenced early in 1949. The significance of a factor (or factors) known as "animal protein factor" (APF), fairly abundant in fish protein materials and essential for adequate functioning of certain livestock and poultry, is rapidly attaining commercial importance in the fish meal and condensed fish soluble (concentrated stickwater) trades. A synthetic crude "vitamin B<sub>12</sub>" (APF) is on the market for fortification of meals and condensed solubles, but the probable multiple character of its activity as compared with that of a pharmaceutical crystalline vitamin B<sub>12</sub> is not fully elucidated due to uncertainty regarding the specificity of assay methods. Hence the economic aspects of availability of the synthetic product as competing with the residual content of naturally-occurring APF in processed fish feeds is of considerable importance (27).

Our experiments have been directed toward utilizing the most recent microbiological assay methods to assay some 41 samples of widely differing marine protein materials (flesh, liver, meals, stickwater, condensed solubles, etc.) for their B<sub>12</sub> content. The values expressed on a dry-weight basis varied greatly (28); since that summary was written, sockeye salmon kidney was shown to indicate extraordinarily high values, with B. C. little-neck clams coming second highest. A preliminary account of this phase of the investigation appeared in Progress Reports No. 79. Several B<sub>12</sub> assays of submitted samples of feeds have been performed as a service (78). Since in some assay methods fictitiously high B<sub>12</sub>

values may be possible through inclusion of deoxyribosides in the result, various types of assay methods were investigated from this standpoint. A chemical treatment of the materials (29) was not satisfactory; of two very new microbiological methods tried (30), one was satisfactory only for high concentrations of B<sub>12</sub> while the other (more promising) one has not yet been fully tested. Preliminary tests of a physical method (paper chromatography) indicate it may be the best.

It would appear that unless many commercial condensed fish solubles are shown to contain as yet unrecognized essential nutritional factors in addition to vitamin B<sub>12</sub>, some means of increasing their content of this vitamin may be desirable. This can perhaps be effected by fortification with crude vitamin B<sub>12</sub> (APF) alone, but some exploratory experiments were made (31) to ascertain if the production of increased amounts of B<sub>12</sub> and possibly other B<sub>12</sub>-active substances (APF ?) is feasible through inoculation of the fish materials themselves with suitable soil bacteria. Eighty cultures, including 44 from B. C. soils, have so far been tested. Eight of the most active cultures were grown on sterilized herring and salmon offal stickwaters and in several instances additional vitamin B<sub>12</sub> was apparently produced in amounts approximating the best values already found in commercial stickwater concentrates tested as described in (28). A third possibility of increasing the growth-factor content in marine products is to prevent the partial destruction of the factors during manufacture of the products. Since some of the factors are unstable toward heat, a number of whale liver meals are being prepared by freeze-drying (35,52) for assay, and if the results are attractive, these and other materials as produced by the commercially more feasible spray-drying process (53) will be assayed to determine the relative degrees of conservation. A collaborative programme to relate the biologically-determined growth-promoting activity of fish meals and condensed solubles towards chicks with the microbiological assays for B<sub>12</sub> and B<sub>12</sub>-active substances in the same materials is planned (32).

The experiments commenced last year on the utilization of certain salmon wastes for feeding young trout and salmon in hatcheries, and which indicated there may be an as yet unidentified growth factor in such materials, were continued (6). The results so far were summed up in Progress Reports No. 80 as follows: The growth-promoting factor or factors appear to be particularly concentrated in the roe and milt but not in the digestive tract or liver; the digestive tract contains some factor which depresses the growth and causes a high mortality; the growth factor can be extracted from the roe by water or methyl alcohol but not by light petroleum; the methyl alcohol extract does not contain appreciable amounts of the factor which causes a high mortality.

Other types of biochemical investigations carried out during the year are mentioned in the later sections "Nutritive Value of Nitrogenous Fish Tissues" and "Utilization of Wastes (B) Materials".

#### Refrigeration of Frozen Fish

The most important refrigeration project during the year has been the continuation of tests with the mechanically refrigerated railway car. The two further tests, one under heating conditions (with apples from Kelowna, B. C. to Montreal in February) and the other under cooling conditions (with frozen fish from Prince Rupert to Montreal and from Halifax to Vancouver in June and July) received considerable publicity, were described in Progress Reports Nos. 78 and

79 respectively, and are reviewed in Summary No. 7. Performance on these trips showed the equipment to be fully capable of producing desired temperatures, but there was some criticism on the part of the railways that this performance might not be realized if the car were not accompanied by technical observers. Therefore, at the request of the U. S. Thermo Control Co. the car was sent to their shops in Minneapolis for overhaul and installation of a number of improved automatic controls and safety devices to the equipment purchased from them for the car. Of the estimated \$6500 cost for these newly-developed improvements, they are willing to assume some \$3500. A number of the improvements have resulted from observations made on similar cars built in the U. S. after hearing of our preliminary road tests in November 1948. Some resistance to the whole idea of mechanical refrigeration is evident in railway circles, and a full discussion of the subject will take place in December at a meeting of the Canadian National Research Council Committee on Food Preservation, Sub-Committee on Engineering, which Mr. Young will attend. Meanwhile, plans are progressing for a fifth road test to take place early in January 1950.

Considerable interest is being shown by a Vancouver firm in the possibilities of "Dry-Ice" as a refrigerant for railway refrigerator cars. We have followed their plans with interest, and have offered the use of the experimental car for trials of their method, believing that Dry-Ice may prove a suitable refrigerant for transportation of frozen fish at 0°C. or lower, providing adequate control can be achieved and that cost and availability of the refrigerant can be made economical at point of shipping and en route. The company's efforts along these lines are being awaited; there is still the problem of heating the cars for non-frozen shipments in winter, a problem that is already solved in our system described. Another Vancouver firm has proposed an ammonia split-absorption system of refrigeration that has some attractive features and several consultations with us have been held. This system also has the disadvantage of providing no ready heating facilities.

Refrigeration and insulation of fish vessel holds has been a subject of interest to this Station in past years, as will be seen by referring to former Reports. Definitiveness of plans has been restricted, however, by a B. C. Provincial regulation that a vessel equipped with facilities for freezing fish can freeze only fish caught by that vessel, and cannot freeze fish delivered to it by other fishing vessels. Consequently, work to date has been confined mainly to experiments and consultation in respect to insulation of holds to conserve ice, systems of refrigeration to keep bait frozen, and to the relatively few instances where interest has been evidenced in vessels freezing their own catch. We have available pertinent information on the principles and equipment suitable for freezing catches, but as pointed out in Summary 79, we sometimes have difficulty in following up the results of enquiries received. At any time the Department's programme calls for definite action, we are ready to give every assistance possible. In the meantime, an experiment was conducted collaboratively with a local firm interested in the use of Dry-Ice as a refrigerant for bait (8). Here again the present cost of the refrigerant remains as a stumbling block.

One feature of refrigeration of fish holds that is at present open to application in B. C. is that of reducing the temperature of the fish from the 32 to 35°F. ordinarily achieved by melting of ordinary ice to 29.8°F., just above the true freezing point of fish flesh (Progress Reports No. 76, 1948). This slight reduction in temperature gives disproportionately great benefits in the subsequent keeping qualities of the flesh, and can be achieved by the use of "Flake-Ice" produced from sea water, or by mechanical refrigeration to supplement

the removal of heat of the fish through contact with melting freshwater ice by subsequent further chilling below 32°F. without freezing. The benefits accruing from this slight lowering of temperature have recently been emphasized in a report from the Halifax Station.

Refrigeration continues to be one of the principal topics on which the engineering staff of the Station is approached for advice. The official opening this year of a second unit of a Vancouver cold storage plant embodying the jacketed system of cold rooms developed some 15 years ago at this Station included some very complimentary remarks on the collaboration of the Station in assisting in the designing of both units; the performance of the cold rooms is being followed by us with interest (10 C). Assistance given to the Department in its programme for freezing and cold storage of fish is covered in Summary 74, and other consulting services in Summaries 11 and 12.

The application of antioxidants in retarding rancidity in cold-stored fish (13) has already been mentioned.

#### Smoking, Drying and Curing

The modifications made and reported last year in connection with the Station's experimental air-conditioned smoke tunnel and smoke producers resulted this year in two commercial adoptions of the principles involved. One B. C. fish processing industry ordered from a local firm an upright modification of the experimental horizontal tunnel (14). Since that Summary was written, the mentioned trip to Prince Rupert for purposes of assisting in trials of the commercial equipment has been made and the results were mutually satisfactory. The second commercial installation involved another modification to suit the requirements of a local company canning smoked anchovies (15). The installation of the equipment was completed rather late in the season, but from trial runs, the management was very satisfied with its performance. Enquiries from Canada, United States, South Africa, New Zealand, Australia, India, Scandinavian countries and elsewhere concerning details of this smoking equipment continue to be received (16), and experiments are now under way to assess the factors related to smoke penetration and nature of the phenolic constituents absorbed by the smoked products (17).

An investigation of alleged spoilage in mild-cured salmon (18) has already been mentioned; certain cured (21) or smoked (22) canned products are mentioned in the section on "Canning" that follows, and collaboration with Army in producing a dehydrated and/or smoked Arctic ration is referred to later under "Nutritive Value of Nitrogenous Fish Tissues".

#### Canning

As part of the programme for assistance in the utilization of freshwater fishes, several further processings of such fish were carried out on samples submitted (20). In most cases, a proportion of the samples canned at the Station were retained for some time to assess the results of storage on the contents and can.

The utilization of whale products is mentioned under several headings of this Report, and among the various investigations undertaken, the production of a canned "corned" whale meat analogous to corned beef, as well as other means of producing interesting products from whale meat, were tried (21). Information

on the commercial applications of these experiments is as yet incomplete, but there are indications that there may be a demand for them in the Belgian Congo.

Improvement in quality and of production efficiency in manufacture of kippered snacks from herring came under consideration (22). One of the innovations in the experimental procedures was the use of a bank of infra-red lamps for removing excess moisture after steaming and before smoking (19, 22), thus shortening the smoking time. Infra-red lamps are now used commercially in so many industrial processes (though few for fish processing) that it was thought desirable to investigate their efficiency in this case. It was shown that the use of lamps or glassless strip heaters would result in a distinct saving of time in the processing, allowing it to become continuous.

Canning of oyster soup and oyster stew (23) and of lingcod roe (24) were investigated. The canning of smoked anchovies (15), whalemeat (21) and fish cakes (25) have already been mentioned.

#### Nutritive Value of Nitrogenous Fish Tissues

Investigations on the vitamin B<sub>12</sub> content of various marine products (27-32) have already been described under the heading "Biochemistry and Microbiology".

During the year the project on determination of the distribution of essential amino acids in many B. C. fish protein products, which had continued for several years, was completed at least until some new types of commercial products or new requests arise (33); following the publication of a second Progress Reports article (in issue No. 77), an Industrial Memorandum (No. 11) giving tables of all results secured was prepared and distributed to interested parties and a second paper for the Journal has been accepted. Another project completed for the time being is that of routine analyses of Interior Provinces freshwater fish components in accordance with the programme instituted in February 1948. This year 180 more proximate analyses were made (34) in addition to vitamin A assays and characterization of the oils (39). A second Industrial Memorandum (No. 12) containing tables of results was circulated to parties concerned, and Summaries 34 and 39 give tables of new results that are being prepared for a third Industrial Memorandum. Analyses of several samples of 16 different species have now been fully reported, and an opportunity for interested parties to discuss the significance and use of the results was given during Mr. Schmidt's trip east during the year. The information presented should be adequate for allowing assessment of the value of such species when utilized in a variety of ways.

Summary 36 describes a current collaborative effort to meet with an emergency request from Army to develop a fish protein supplement to an Arctic lunch ration. Samples of various products were quickly prepared to conform with some of the specifications, and at least one type met with approval. An order has been placed for preparation of a substantial quantity of this product at the Station. In addition to the materials mentioned in the Summary, a hard-smoked and dried salmon product and another type of fish cake have been submitted.

Sample liver meals from four humpback and ten sperm whales have been prepared by freeze-drying (35, 52) and are undergoing proximate analysis plus assay for vitamin A and certain B vitamins.

## Fish and Whale Oils (Including Vitamin A)

The securing of final data, specifications on oils (37), illustrations, and the internal editing for the completed revision of the Bulletin on marine oils already mentioned under "Publications" ranked as an investigation. In addition to incorporating some results of other current Station research on oils and vitamin A, special work on iodine values of B. C. herring oil and characteristics of many other oils was completed (38, 45) for inclusion of the results to close up certain gaps in information.

A total of 144 determinations on chemical characteristics and vitamin A potencies of oils from the liver, remaining viscera, and body of ten species of freshwater fishes (39) completed at least for the time being this part of the programme of analyses of such fishes from the Interior Provinces. The results as summarized in (39) are being incorporated along with the proximate analyses of the fish in a third Industrial Memorandum. Some tullibee, inconnu and pickerel livers yielded oils having potencies exceeding 50,000 U.S.P. units of vitamin A per gram, but the percent liver in the fish and the oil contents were rather low for suggesting much commercial value. Some tullibee viscera, even without the liver, might be of commercial value for their vitamin content.

Hydrogenation of fish oils was again revived (49) after a gap of some years since our last activity in this field. Samples of oils having graded iodine values, desired for a biological experiment on goldfish being carried out at the University of B. C., were prepared by controlled hydrogenation of pilchard oil; an investigation still actively in progress is the hydrogenation of B. C. herring oil and determination of the properties of the product in relation to the possibility of its use in margarine. Studies of elaidination (cis- to trans- form) of the fatty acid chains of the oil to confer favoured properties in the hydrogenated material are involved (50). Some margarines prepared from the hardened herring oils were palatable, had no fishy flavour, but were slightly "granular" in the mouth. Improvement of their consistency is progressing.

With the advent of new market conditions and changes in utilization procedures, the vitamin-A oil picture in B. C. is beginning to fade somewhat. Sharp competition from shark livers and liver oils from Japan is being experienced. However, there are several interesting aspects of fundamental problems relating to oils and their unsaponifiable content (including vitamin A) remaining to be solved; and from a technological standpoint, producers of vitamin-A oils continue to have their difficulties, some of which are brought to us.

Dr. Vandenheuvel's process for separating oil from livers as developed at the Halifax Station was demonstrated by him during his visit to this coast, and some experiments with dogfish livers by his method were made by Dr. Swain (41). Difficulties in improving the physical qualities of some industrial vitamin oils were examined (42). Using a vitamin-A stability test described in last year's Report, a further comparison with the air-blowing test was made; bile from gall bladders carelessly not separated from dogfish livers during collection was shown to be possibly an asset rather than a detriment to stability of vitamin A in the liver oil; shaking of dogfish liver oil with cold or hot dilute alkali or alum solutions did not appreciably alter the stability whereas shaking with finely powdered alumina slightly increased it (44).

Resumption of the B. C. whaling industry in 1948 led to commencement of the work on whale liver oil described in the 1948 Report. Commercial utilization of such livers in 1949 made it desirable to carry on certain research in view of several interesting features surrounding the presence of vitamin A in whale tissues. The stability of vitamin A in freeze-dried liver tissue subjected to various exposures was determined (44). Owing to the presence of kitol (which in some respects resembles vitamin A) in whale liver oil, assays for vitamin A alone in whale liver oils by certain methods are subject to vitiation. Four methods (one physical, two chemical and one biological) were compared using humpback whale liver oil (46); the corrected spectrophotometric value most closely approached the rat bio-assay value of 150,000 units per gram. Suitability of various solvents for determining vitamin A and oil content of whale liver samples was also examined. Separation of vitamin A from kitol in the unsaponifiable material of whale liver oil was satisfactorily accomplished on a test scale by means of adsorption-desorption with alumina (45). Attempts to convert kitol to vitamin A by three procedures were either unsuccessful or inconclusive (47).

Miscellaneous observations concerning oils included those on the head and body oil of beluga whale (40), liver oil from an ocean sun-fish brought to the Station as a supposedly rare fish (43), assays of various dogfish liver oils (48), oil from salmon roe (62) and sockeye salmon waste (64). No previously unknown commercially important sources of vitamin A were uncovered.

#### Utilization of Wastes (A) Engineering

Continuation of our programme that has extended over many years in efforts to provide information on possibly better utilizations of fishery materials not commonly used to best advantage seems fully justified in view of the commercial applications of such information made from time to time as described in previous Reports. The 1948 Report indicated that certain projects had reached the stage where pilot-plant-scale investigation of some laboratory results seemed warranted. Considerable progress was made during the period under review in preparing to translate laboratory results to pilot-plant work.

An enlarged and improved lyophilizer for freeze-drying fish tissues and other materials is described and illustrated in Summary 52 which also indicates some of the many uses to which it has already been put; other mentions of its application have already been made herein. The design of a pilot plant intended for general purpose use (51) is more fully described in separate Summaries dealing with its separate components: the spray drier now under construction (53) for rapid drying of slurried or suspended materials at not over 100°F.; a heat-pump concentrator (55) already built and being installed for concentration of liquids at not over 100°F.; and a solid-liquid extractor, of which a model has been built to assist in the construction of the actual unit (54). The necessity of installing this pilot-plant equipment at the University of B. C. due to lack of space in the Station has been described. Sketches, blueprints, data on materials, equipment and plant layouts for utilization of freshwater fisheries wastes, resulting from the last three years' technological assistance to the Prairie Provinces, continue to be in demand and are freely supplied (56).

## Utilization of Wastes (B) Materials

Reference has already been made to data obtained for utilizations of scrap (heads, flesh, entrails, etc.) from freshwater fishes (34, 39, 56), condensed solubles from stickwater resulting from meal and oil production (27,28), whale and fish liver meals (35), milts, roe and viscera for trout feeding (6), lingcod roe for canning (24), etc. Attention has also been directed to the probability of improving the quality and yield of the protamine regularly prepared from B. C. salmon milt for incorporation with insulin; the effects of species, season and locality of salmon catch and cold storage of the milts have been studied with indication that a better product can be made (57). Certain proteins in B. C. salmon milt were also separated (58). Owing to a declared shortage of raw materials for preparing insulin itself, distinct interest has been shown by the Connaught Laboratories of Toronto in the possibility of supplementing supplies through fishery sources. Whale pancreas (61) and insulin-containing islet tissue from halibut (60) are economically available; work was directed toward collecting the material in a sufficiently fresh state and ascertaining the feasibility of getting it to the Toronto laboratories without deterioration of the insulin content. Results of their assays on various submitted samples are being awaited.

Commercial interest in the enzymes available from pyloric caeca of B. C. fish (e.g. salmon) for leather bates appears to be resulting from last year's economic studies of the cost of separating and working up the raw materials (59). Lecithin, an oil resistant to solidification at sub-zero temperature, and an interesting residual protein product were separated from salmon roe for further investigation (62). The pretreatment of herring scales prior to carbonizing them was found to have a distinct bearing on the activity of the resulting decolorizing carbon prepared; alkali pretreatment at a fairly critical pH of 8.5 was most effective (63). It is planned to test the most active preparations, in direct comparison with commercial decolorizing carbons, on a considerable number of different coloured liquids. Unless the fish-scale carbons show greater versatility in their applicability than do the commercial carbons it would not appear worth while to continue work on this project, since none of the fish-scale carbons is as active as most commercial decolorizing carbons. Samples of products prepared privately from salmon waste were analyzed because of the interest shown in production of what appears to be an excellent glue; meal and oil are by-products (64). No information is available on intended scope of production, if any.

## Miscellaneous Processing Developments

A shrimp-sorting machine already described in Progress Reports No. 79 has aroused considerable commercial interest. It has been demonstrated and loaned in Vancouver and Prince Rupert on several occasions (66) and an enquiry concerning it has just been received from the International Food and Agriculture Organization. One of its features is its ability to allow return of most undersized shrimp alive to the sea. This machine was designed to operate on the chassis of the flesh-from-bone separator described in Reports for the past two years that continue to give rise to numerous enquiries concerning its availability and details of construction. Blueprints are available for distribution. By modification of its screens, it is convertible into a de-scaler and washer (67), which also has aroused much commercial interest and is at present on loan for demonstration in Prince Rupert. It was described in Progress Reports No. 77. Patentability of the above three devices was ruled

non-feasible by Canadian Patents Development Ltd. on the grounds that they merely were somewhat novel applications of principles already applied for analogous purposes. Another device developed was a very simple and inexpensively constructed appliance to a beheading and gibbing machine such as used for herring. It simplifies and improves the gibbing operation, particularly in the case of anchovies, for which it was designed (68). Patentability is still under consideration.

An application of ultra-violet rays for assisting in detecting bits of shell to be removed from picked crab meat (69) was quite successful, though not entirely a new idea. Tests were made with a loaned U. S. Navy fog generator modified for rapid production of boiling water through oil-firing (70) and results have led to several enquiries concerning its suitability for use in small, isolated freshwater fish processing and reduction plants in the Interior Provinces.

#### Miscellaneous

The fairly regular submission of samples of supposed ambergris continues (75). One such sample this year was actually ambergris while another was material closely resembling it. An interesting episode was the examination of sealed cans of allegedly live lobsters sent from the Live-Pak Co. on the Atlantic coast to a local firm. Although the lobsters in one can were definitely alive when received, they were dead before the expiration of the time stated for survival under the conditions stipulated; others were dead on arrival. Although the outlay for air shipment of these cans across the continent (packed with cans containing several pounds of melting ice) may be disproportionate to the degree of novelty claimed, the samples were nevertheless enjoyed by members of the staff.

STAFF

STAFF OF THE PACIFIC FISHERIES EXPERIMENTAL STATION

SCIENTIFIC STAFF

N.M. Carter, M.A.Sc., Ph.D., F.C.I.C., F.R.G.S., Director  
O.C. Young, M.B.E., B.Sc., M.E., Principal Research Engineer  
H.L.A. Tarr, M.S.A., Ph.D., Bacteriologist  
B.E. Bailey, M.A.Sc., Ph.D., Biochemist  
L.A. Swain, M.A., Ph.D., M.C.I.C., Associate Chemist  
A.W. Lantz, B.Sc., M.C.I.C., Associate Research Engineer  
N.E. Cooke, M.A.Sc., F.C.S., M.S.C.I., M.C.I.C., Associate Chemist (from  
January 1)  
J.S.M. Harrison, B.A.Sc., Assistant Research Engineer  
S.W. Roach, B.A.Sc., Assistant Research Engineer  
D.H. Taylor, B.A.Sc., Assistant Research Engineer (resigned September 30)  
P.J. Schmidt, B.Sc. (Chem. Eng.) Assistant Chemist  
Miss P.W. Ney, B.A., B.S.A., M.S.A., Junior Bacteriologist (resigned October 31)  
Miss B.A. Southcott, B.S.A., Junior Bacteriologist (from October 1)



Scientific Staff as of Nov. 15, 1949.  
Carter, Young, Tarr, Bailey, Swain,  
Lantz, Cooke, Harrison, Roach, Schmidt

Temporary

M.M.R. Khan, M.Sc., M.A., F.I.R.F.A., M.I.I.Sc., M.C.I.C., Junior Research  
Assistant (from June 1 to September 30); Volunteer Investigator  
(to May 31 and from October 1)

TECHNICIANS

E.G. Baker, Assistant Technician, Grade 3  
B.E. Maxwell, Assistant Technician, Grade 3, (Librarian) (from December 8, 1948  
to September 30. On half pay from October 1)  
Miss A.C. Corrigan, Assistant Technician, Grade 1  
Miss I.M. Porter, Assistant Technician, Grade 1  
Miss I.R. Smith, Assistant Technician, Grade 1  
Miss E.I. Taylor, Assistant Technician, Grade 1 (resigned July 28)  
Miss S. Kristjanson, Assistant Technician, Grade 1 (from July 1)  
Mrs. S.C. McMillan, Junior Laboratory Assistant (resigned December 31, 1948)

Temporary

G.T. Campbell, B.A., Assistant Technician, Grade 2 (May 16 to September 16)  
A.R.P. Paterson, Assistant Technician, Grade 2 (May 16 to September 16)  
Miss E.D.A. Young, Assistant Technician, Grade 1 (June 23 to August 31)

Volunteer

R. Tomlinson (6 months)

C.C. Sun (3 months)

OFFICE AND BUILDING STAFF

J.W. Kilpatrick, Supervising Clerk (Executive Assistant)  
Miss E.B. Norris, Clerk (Secretary) Grade 3  
Miss P. Tweedale, Clerk (Stenographer) Grade 2A  
F.C. Freeman, Maintenance Supervisor, Grade 2  
F.J. Armstrong, Caretaker, Grade 3  
J.H. Thomas, Caretaker, Grade 1 (resigned April 30)  
H.G. Irwin, Caretaker, Grade 1 (from September 16)  
Mrs. M. Fletcher, Cleaner and Helper, Grade 1 (resigned April 30)



Technicians, Office and Building Staff as of Nov. 15, 1949.  
Southcott (scientific staff), Baker, Maxwell, Corrigan, Porter, Kristjanson, Smith,  
Kilpatrick, Norris, Tweedale, Freeman, Findlay, Irwin, Armstrong

Temporary

Miss R. Stringer, Clerk (Stenographer) Grade 2A (May 16 to August 23)  
Mrs. R. Findlay, Clerk (Stenographer) Grade 2B (November 7 to 26)  
Mrs. M.L. Spowage, Cleaner and Helper, Grade 1 (from May 2, part time only)

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PUBLICATIONS

PUBLICATIONS OF THE PACIFIC FISHERIES EXPERIMENTAL STATION

NOTE: For sake of continuity of this list in the mimeographed Annual Reports, certain publications that appeared in print during December 1948, too late to be listed in the corresponding list in the 1948 mimeographed Annual Report, have been included here. Such publications were included in the list given in the printed 1948 Annual Report. Certain publications which are expected to appear in print in November or December, 1949, can not yet be listed here, but will be included in the list given in the printed 1949 Annual Report.

1. Carter, Neal M. Contribution to "Chemistry and the Sea" (Chap. X, pp. 273-279) in "A History of Chemistry in Canada", Chemical Institute of Canada, Sir Isaac Pitman and Sons, Toronto.
2. Science works for Canada's fishermen. Western Business & Ind., Vol. 23, No. 7, pp. 68-74.
3. Carter, Neal M. and J. L. Hart. Author and subject index to Pacific Progress Reports issues 61-80. Prog. Rep. Pac., No. 80, pp. 60-71.
4. Cooke, Norman E. Utilization of fish waste. The economics of the separation of salmon offal. Prog. Rep. Pac., No. 80, pp. 47-49. (See also No. 17).
5. Cooke, Norman E., Frank Pells and Raymond V. Tomlinson. Some observations concerning an unidentified growth factor for young trout and salmon. Prog. Rep. Pac., No. 80, pp. 52-54.
6. Deas, Catherine P. and H. L. A. Tarr. Amino acid composition of fishery products. J. Fish. Res. Bd. Can., Vol. 7, No. 9, pp. 513-521. (See also Nos. 18, 22).
7. Harrison, J. S. M. and S. W. Roach. Pressure cooling cannery retort system. Prog. Rep. Pac., No. 79, pp. 43-44. (See also No. 12).
8. Lantz, A. W. A shrimp sorting machine. Prog. Rep. Pac., No. 79, pp. 41-42.
9. Lantz, A. W. and O. C. Young. An air-conditioned tunnel for processing fish. II. Prog. Rep. Pac., No. 78, pp. 17-20.
10. Ney, Phyllis W. and H. L. A. Tarr. Animal protein factor in fish products. Prog. Rep. Pac., No. 79, pp. 37-39. (See also Nos. 19, 22).
11. Roach, S. W. Ultra-violet rays for detecting shell in picked crab meat. Prog. Rep. Pac., No. 79, p. 39. (See also No. 7).

12. Roach, S. W. and J. S. M. Harrison. Infra-red radiation in processing of fish products. Prog. Rep. Pac., No. 79, p. 44.
13. Swain, Lyle A. Chromatographic analysis of the unsaponifiable matter of marine animal oils. J. Fish. Res. Bd. Can., Vol. 7, No. 6, pp. 389-402, (1948).
14. Herring oil for margarine. Prog. Rep. Pac., No. 79, p. 32.
15. Whale liver oil. Prog. Rep. Pac., No. 79, p. 40.
- Schmidt, P. J. (See No. 23).
16. Tarr, H. L. A. Recent advances in various technological aspects of handling fish and fish products. U. N. Scientific Conference on the Conservation and Utilization of Resources, Sept. 1949. (See also Nos. 6, 10, 22).
17. Tarr, H. L. A. and N. E. Cooke. Control of rancidity in fish flesh III. Carbonyl enediols as antioxidants. J. Fish. Res. Bd. Can., Vol. 7, No. 9, pp. 522-527.
18. Tarr, H. L. A. and Catherine P. Deas. Bacteriological peptones from fish flesh. J. Fish. Res. Bd. Can., Vol. 7, No. 9, pp. 552-560.
19. Tarr, H. L. A. and Phyllis W. Ney. Effect of flesh acidity on bacterial numbers and trimethylamine in spoiling fish. Prog. Rep. Pac., No. 78, pp. 11-13.
- Taylor, D. H. (See No. 21).
- Tomlinson, Raymond V. (See No. 5).
20. Young, O. C. Refrigerator car experiments. VIII. Road tests with a mechanical car under cooling conditions. Prog. Rep. Pac., No. 79, pp. 27-30. (See also No. 9).
21. Young, O. C. and D. H. Taylor. Refrigerator car experiments. VII. A road test with a mechanical car under heating conditions. Prog. Rep. Pac., No. 78, pp. 21-24.

MIMEOGRAPHED INDUSTRIAL MEMORANDA

22. Catherine P. Deas, Phyllis W. Ney and H. L. A. Tarr. Essential amino acid distribution in various fish products. Pac. Fish. Exptl. Sta. Ind. Memo. No. 11, pp. 1-6.
23. Schmidt, P. J. Analyses of freshwater fishes from Canadian Interior Provinces (Cont'd.) Pac. Fish. Exptl. Sta. Ind. Memo. No. 12, pp. 1-10.

APPENDIX A. INVESTIGATORS' SUMMARIES

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SMOKING DRYING AND CURING

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NUTRITIVE VALUE OF NITROGENOUS FISH TISSUES

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Liver (see also Vitamin A) ..	28;51	Trout .....	6;20
Meals .....	27-28;33;35	Tullibee .....	17;20;34;39
Milts .....	6;52;57-58	Whitefish .....	17;20;34;39
Other viscera ...	6;28;34;51;59-61	Halibut .....	7;28;35;60;78
Roe .....	6;24;51;62	Herring .....	4;13;17;22;31 37-38;48-50;63;67
Scales .....	63	Jewfish .....	45
Scrap .....	34;56;64	Lingcod .....	1;3;24-25;28;60
Quality .....	1;3;4;18;20;25-26;78	Oyster .....	23
Rancidity and antioxidant .....	4;13;78	Pilchard (oil) .....	49
Refrigeration .....	7-13;74;79	Salmon .....	1;3;6;13;18;31;35-36 49;51;57-59;62;64;67
Smoking and smoked products .....	13-19;22	Sharks (see also Dogfish) ...	42;45;48
Specialty products .....	21-25;36;78	Shrimp .....	66;78
Spoilage .....	1;3-4;13;18;25;78	Skate .....	45
Stickwater and condensed solubles ...	27-28;31-32;55;64-65	Sun-fish (Pacific) .....	43
Vitamin A .....	5;39-41;43-48	Sunfish (Atlantic) .....	45
Vitamin B <sub>12</sub> and A.P.F. ...	6;27-32;35;78	Whales (Pacific) ...	21;35;44-47;61;75
		Beluga (Atlantic) .....	40

BIOCHEMISTRY AND MICROBIOLOGY

## BIOCHEMISTRY AND MICROBIOLOGY

Note: A later section of this Appendix, under the heading "Utilization of Wastes from Marine Products", also contain certain Investigators' Summaries dealing with biochemistry of fish products. Such Summaries have been so grouped because of the separate nature of that programme. See also under the section "Nutritive Values".

### SUMMARY NO. 1

EFFECT OF FISH FLESH ACIDITY ON BACTERIAL NUMBERS AND TRIMETHYLAMINE IN SPOILING FISH

H.L.A. Tarr  
Phyllis W. Ney

It has been realized for some years that flesh of certain prominent varieties of B.C. commercial sea fish is usually of rather low pH after rigor mortis and moreover that it does not often rise very rapidly during the early or even later stages of bacterial spoilage. This fact has been brought out in certain scientific papers published from this Station during the last ten years, and has also been shown in unpublished reports (mimeographed Annual Report of this Station, pp. A14 and A18-19, 1941). It seemed possible that trimethylamine would not form so readily in acid medium as at pH values near the neutral point. Tests were made using lingcod, red spring salmon and red cod, the flesh being carefully adjusted to various pH values between 6 and 7 (ie. to values normally encountered in fish flesh).

In certain instances the flesh or fillets were stored at their natural pH. The results of storage experiments at 0.5 and 3°C., showed that, in several, but not all instances, trimethylamine formation was not nearly as marked in the more acid flesh. This was not true for all samples. However, it is probable that a more marked difference might have resulted if longer incubation with a greater rise in pH, had been employed. Bacterial development was never as rapid in the acid samples. The results have been summarized in a Progress Report, and it is intended that they be published more fully. It is certain that the trimethylamine test would not prove a satisfactory measure of bacterial spoilage in B.C. fish of the species examined.

In connection with this work it is interesting to note that, since the above findings were published, workers at this Board's Halifax Station have found that there is a sharp drop in the pH-activity curve of the triamine-oxidase system between pH 7 and 6.4. This might serve to explain the above results. It would be interesting to ascertain why the pH value of certain Atlantic fish appears to rise rapidly to about pH 7 during bacterial spoilage, while this is generally not the case with B.C. fish.

### SUMMARY NO. 2

THE ACID-SOLUBLE PHOSPHORUS COMPOUNDS OF FISH SKELETAL MUSCLE

H.L.A. Tarr

In Summary No. 3 of the mimeographed Annual Report of this Station for 1948, reasons were given for the initiation of this investigation, and also an account of results of the early experiments.

(No. 2 Cont'd)

Unfortunately this work was severely hampered by lack of adequate facilities, for work of this type should be carried out where this is available a supply of live fish, kept, preferably, under controlled conditions. In the present work the only convenient source of material was a local private sea water aquarium where no control of feed or other conditions was possible. The experiments must be looked upon as purely exploratory. The results give a general picture of the distribution of acid soluble phosphorus compounds in fish skeletal muscle, and no attempt has been made to determine the influence of various conditions on this distribution. Since the results are recorded in a short scientific paper which has been accepted for publication in the Board's Journal, no mention of them will be made. From the standpoint of pure research, the field of fish muscle biochemistry offers interesting possibilities.

### SUMMARY NO. 3

EFFECT OF WASHING FISH PRIOR TO FILLETING ON THE  
SUBSEQUENT KEEPING QUALITY OF FILLETS

H.L.A. Tarr  
A.W. Lantz

It is patently obvious that fillets or steaks which are cut from well-washed fish under clean conditions will normally contain considerably fewer contaminating bacteria than those cut from unwashed slimy fish under unsanitary conditions. Thus during the course of some experiments carried out 8 years ago at this Station, which led to the development of a rapid direct count method for determining bacteria in fish flesh (mimeographed Annual Report of this Station for 1941, pp. A10-A12), fillets with very low initial bacterial counts (a few thousand bacteria per gram of flesh) were obtained by thoroughly cleansing fish prior to cutting them. Recently, work at this Board's Halifax Station has demonstrated the desirability of employing a mechanical washer for fish for use before filleting or steaking them, and it has been shown that the initial bacterial counts can be very significantly reduced by such treatment.

Washing of fish intended for filleting or steaking is by no means a new departure as far as the west coast fishing industry is concerned. Thus mechanical scalers for salmon accompanied by washing of the fish have been used for some years. One local company has used a rotating drum machine equipped with pipes which spray the fish with water. Also the salmon canneries have used scrubbers for fish because salmon used for canning are very often slimy and must be washed. This Board's Halifax has recently designed a new type of washer for fish.

The machine used in the present work was one which has been designed at this Station, and with different modifications can be used for several purposes one of which includes that of washing fish (see Summary No. 67). This machine has one advantage over that of the ordinary scaler in that the fish are kept largely immersed in water during the brief washing process.

It was thought that improved washing might be obtained if an alkaline phosphate or silicate detergent were used. Tests showed that fish slime tends to swell and become more viscous in diluted solutions of such materials. The possibility that a buffered slightly acidic solution might loosen or coagulate the slime and tend to lower the bacterial contamination was considered and tested in two of the following experiments. Three tests have been made, and these will be described only briefly since it is intended to report them more fully elsewhere.

Headed and dressed fresh brills (flounders) and lingcod were used in the first two experiments. The fish were divided into three lots as follows: (1) fish unwashed and fillets cut on slimy unwashed boards, (2) fish washed one minutes in cold (46°F.) water and the fillets cut on clean boards under very clean conditions and (3) fish washed as in (2) but in a freshly-prepared solution containing 0.1% each of  $\text{NaH}_2\text{PO}_4$  and  $\text{NaNO}_2$ . The fillets were wrapped in cellophane and stored at 33°F., or 39°F. Representative packages were withdrawn at intervals and direct bacterial counts were made.

A third and similar test was made with very slimy fresh chum salmon, the  $\text{NaH}_2\text{PO}_4$  -  $\text{NaNO}_2$  wash being omitted and the fillets being stored at 39°F. The results, tabulated herewith, show that washing has a markedly favourable effect on bacteriological keeping quality, but that it is doubtful whether much is to be gained by using a mild acid-bacteriostat wash instead of water.

Days stored	Bacteria per gram of flesh (direct count) in different treatments							
	Brills			Lingcod			Chum salmon	
	1	2	3	1	2	3	1	2
5	$7.2 \times 10^6$	50,000	50,000				560,000	13,000
6				$14 \times 10^6$	300,000	150,000		
8	$15 \times 10^6$	$2.5 \times 10^6$	150,000					
9							$12 \times 10^6$	80,000
12	Putrid no count made	$4 \times 10^6$	$6.9 \times 10^6$					
13				$24 \times 10^6$	$6.9 \times 10^6$	$3.4 \times 10^6$		

SUMMARY NO. 4

STUDIES ON THE LIPOXIDASE SYSTEM IN THE FLESH  
OF BRITISH COLUMBIA HERRING

M.R. Khan  
(part time)

Satisfactory success in controlling rancidity during storage of frozen fish with application of chemical antioxidants stimulated the present studies of the factors responsible for rancidity with a view of finding more effective means for controlling the same. This investigation is being carried out at the Station in partial fulfilment of the requirements for the degree of Doctor of Philosophy at the University of B.C. It was earlier reported by various investigators that herring muscle contained an enzyme "lipoxidase" which catalyzed the peroxidation of unsaturated fatty acids. In the present studies attention was focused on this lipoxidase and attempts were made to determine its nature and characteristics.

Herring was chosen as a representative fish because of its high fat content and particularly of the composition of the fat which is rich in unsaturated fatty acids. The enzyme was reported and was actually found to be concentrated in the black strip of muscles along the lateral lines of the fish and as such, these black strips were used as raw material.

Activity of this enzyme by decolorization of carotenoid compounds could not be measured since this enzyme apparently fails to induce oxidation of those compounds.

Other methods of estimating the peroxide formed from known amounts of unsaturated fatty acids either (i) iodometrically or (ii) by oxidation of ferrous ion to ferric ion and subsequent estimation of the ferric ion by FeCNS method; are laborious and time consuming. Ultraviolet absorption by the hydroperoxides formed under the action of lipoxidase from unsaturated fatty acids containing di- or tri-ethenoid bonds in their molecules, served as a good criterion for standardizing the activity of the enzyme. Besides, the method is accurate and quick.

The enzyme was extracted in the cold from defatted tissue with buffers of various pH. Best extraction was obtained with a buffer at pH 5.6. This extract was fractionated with various concentrations of  $(\text{NH}_4)_2\text{SO}_4$ , alcohol and by change of pH. By subjecting the preparation at various stages to dialysis and subsequent vacuum drying, a concentrate was thus obtained which is over 200 times as active as the raw material. Attempts for further purification resulted in the separation of two fractions, one of which is the enzyme proper and the other serves as an activator. Both of these fractions are non-dialyzable and the activator is heat stable whereas the enzyme is heat labile.

Preliminary tests indicate that the activator is an iron-containing porphyrin whereas the enzyme proper is a protein.

Although conclusive studies on the characteristics of the enzyme, namely, optimum temperature, pH, substrate and enzyme concentration, Michaelias constant, activators and inhibitors are being delayed until electrophoretic purification of the two fractions is effected, exploratory attempts indicate that the optimum pH lies between 6.7 and 6.85 and the optimum temperature is at  $15^\circ\text{C}$ . Haemin, haematin and haemoglobin all activate the enzyme to different degrees. However, inorganic ferrous or ferric ions fail to activate. Cyanides, and carbon monoxide inactivate the enzyme while iodoacetic acid and heavy metals do not; indicating that the reactive group in the enzyme proper is not a (-SH-SH-) group.

Investigations are being continued in order to ascertain with greater degree of conclusiveness the chemical and physical nature of the enzyme and its activator. Attempts will also be made to crystallize them.

#### SUMMARY NO. 5

A MATHEMATICAL THEORY OF VITAMIN A  
METABOLISM

N. E. Cooke

Subsequent to last year's mimeographed Annual Report (Summary 2) a paper on this subject has been submitted to the Board's Journal for publication. In view of the fact, however, that considerably more samples are needed to place the theory on a statistically significant basis approximately 1,000 individual brill livers have been obtained with the help of Mr. George Campbell and are now in refrigerated storage.

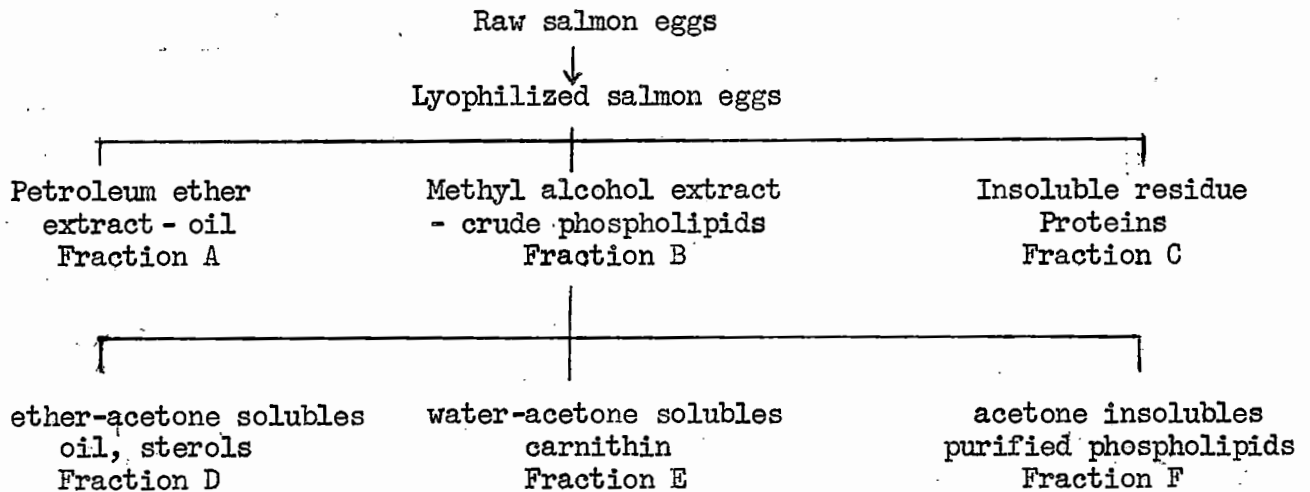
SUMMARY NO. 6

A GROWTH FACTOR IN SALMON VISCERA  
IN TROUT DIETS

N. E. Cooke  
R. Tomlinson

As mentioned in last year's mimeographed Annual Report (Summary No. 56) an investigation was underway to ascertain something of the nature of the growth factor, for young trout and salmon, present in salmon viscera. The results of last year's experiments were reported briefly in Progress Report No. 80 (pages 52-54). A more comprehensive paper is in preparation for publication in the Board's Journal.

Since it was found that a growth factor occurred in the methyl alcohol extract of salmon roe, work this year consists of testing diets prepared with further fractions of this material. The diagram below shows the fractions which have been or are being tested.



The basic diet this year consists of

1675	parts	vitamin extracted casein
450	"	corn starch
375	"	lard
100	"	salts
2400	"	water
50	"	washed agar

A vitamin supplement of the proper amounts of the following vitamins was added: thiamine, riboflavin, niacin, pantothenic acid, para-amino-benzoic acid, inositol biotin, folic acid, choline, ascorbic acid, and vitamin A.

The test diets are based on this diet plus a supplement. In general the supplement corresponds to 810 parts of fraction B. This amount is designated as 1 unit.

<u>Diet</u>	<u>Supplement</u>	<u>Diet</u>	<u>Supplement</u>
A	None	G	Methyl alcohol Extract of Salmon Milt
B	$\frac{1}{2}$ unit Fraction B	H	Synthetic Animal Protein Factor
C	1 " Fraction B	J	$\frac{1}{2}$ unit Fraction B + Synthetic Animal Protein factor.
D	1 " Fraction D	K	None and lacking vitamin A supplement
E	1 " Fraction E		
F	1 " Fraction F		

REFRIGERATION  
(A) ENGINEERING  
(B) MATERIALS

## REFRIGERATION OF FROZEN FISH

### A. ENGINEERING

#### SUMMARY NO. 7

REFRIGERATOR CAR STUDIES -  
MECHANICAL REFRIGERATION

O. C. Young  
D. H. Taylor  
J.S.M. Harrison  
E. G. Baker  
A. W. Lantz

It will be recalled from last year's mimeographed annual report, Summary no. 9, that with funds from this station a Canadian National overhead type refrigerator car was remodelled and fitted with jackets and two gasoline driven cooling and heating units.

In February of this year a road test with this car under heating operation was conducted from Kelowna, B. C., to Montreal, P. Q., with a carload of apples. This trip is described in Progress Reports of the Pacific Coast Stations No. 78, pp. 21-24, where the results in some detail are given. For convenience, a few of the data will be repeated here.

The duration of the trip was about  $7\frac{1}{2}$  days (182 hours) during which the outside temperature varied between  $43^{\circ}$  F. and  $-10^{\circ}$  F., the mean being  $16.2^{\circ}$  F. The inside temperature was maintained at about  $34^{\circ}$  F. with a maximum difference between warm and cold points in the car being  $4^{\circ}$  F. The mechanical units ran approximately  $3\frac{1}{2}$  hours altogether and consumed about  $5\frac{1}{2}$  Imperial gallons of gasoline (estimated).

In June and July two transcontinental trips were made with the car under cooling conditions. One was from Prince Rupert, B. C., to Montreal, P. Q., with frozen halibut, and the other was from Halifax, N. S., to Vancouver, B. C., with frozen East Coast fishery products. An account of these trips will be found in Progress Reports of the Pacific Coast Stations, No. 79, pp. 27-30. Again for convenience, a few of the most interesting results will be given here.

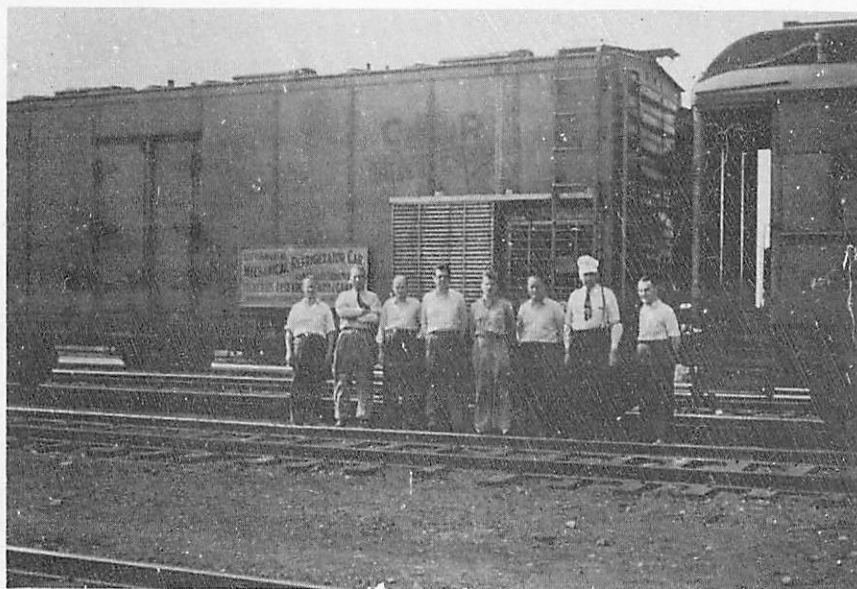
The test from Prince Rupert to Montreal took about  $8\frac{1}{2}$  days (206 hours) during which time the units ran 188 hours, and the evaporators were defrosted 5 times. Approximately 220 gallons of gasoline were consumed and 4 gallons of lubricating oil were used. With the thermostats set at  $-5^{\circ}$  F., the mean temperature in the car was maintained below zero for the duration of the trip even though the outside shade temperature went above  $90^{\circ}$  F. on four successive days.

The test trip from Halifax to Vancouver took 12 days (288 hours) during which time the units ran  $240\frac{1}{2}$  hours, and consumed about  $342$  gallons of gasoline and used 5 gallons of lubricating oil. The evaporators were defrosted 8 times. During this trip also, the interior temperature, with but a few exceptions, was maintained below zero, while the outside temperature went up to between  $70$  and  $90^{\circ}$  F. 7 days out of the 12.

As a result of these three trips a number of modifications to the units and the car itself have been undertaken by the U. S. Thermo Control Company and this station jointly. For this purpose the car was sent to Minneapolis in August, and will return to Vancouver before the end of the year, ready for further tests in 1950.

The tests proposed for 1950 include a West to East trip under heating in January; and West to East and East to West trips under cooling in June and July. These trips should uncover any mechanical weaknesses and indicate the technical feasibility of the scheme. Should the results continue to give encouragement, it would seem that the next phase of the investigation should be an economy study, for which, of course, a single car would be quite inadequate.

The data required for an economy study would include such items as the reliability of the equipment; the extent of repairs and upkeep; the life of the mechanical devices; the time involved in servicing; and the effect of the scheme on train schedules and switching, etc. Obviously reliable deductions could not be made from the performance of one car, therefore the economic phase of the investigation cannot be carried forward very far with the present equipment.



The car en route during the test described above, accompanied by Station, U. S. Thermal Control Co. and railway observers, who travelled in the attached coach

SUMMARY NO. 8

SOLID CO<sub>2</sub> AS A REFRIGERANT FOR BAIT IN FISHING BOATS

D. H. Taylor  
O. C. Young

The following test was planned and conducted by Mr. Charles F. Gorse who arranged for the insulating of the fishing boat; the installation of the CO<sub>2</sub> tanks and ducts; and the securing of the solid CO<sub>2</sub> (dry-ice). One of us (D.H.T.) made the necessary observation with the aid of this Station's equipment to assess the performance of the CO<sub>2</sub> appliances.

It was observed that the experimental bait hold of a halibut boat was insulated with fibreglas of varying thickness and densities in the following manner: the deck and forward bulkhead were insulated with 6 inches of fibreglas of  $2\frac{1}{2}$  pound density; the aft bulkhead with 2 inches of 9 pound density; and the shin of the vessel on each side for the upper two feet next the deck with 4 inches of 6 pound density. The remainder of the shin was not insulated.

Metal tanks of dimensions 45 x 20 x 20 inches were placed one on each side at the top of the hold. The tanks were placed against the insulated walls so that only two faces of dimensions 45 x 20 inches were directly exposed to the air in the hold. A pipe from each tank led to ducts on the ceiling of the hold. From these ducts other pipes led to the outside. The purpose of the ducts was to abstract some specific heat from the gaseous CO<sub>2</sub> evolved in the tanks.

On April 7th, 600 pounds of solid CO<sub>2</sub> was placed in each tank. During the following 8 days the temperature of the hold was below +10° F. At this time 800 pounds of fresh eulachons were placed in the hold, after which the temperature in the hold commenced to rise and reached 33° F. by the end of the third day.

It was estimated that under the conditions prevailing during the test, namely an outside temperature of 60° F. (mean) and a seawater temperature of 45° F., that the temperature of the hold would have remained at 10° F. for approximately 18 days. However, the addition of the unfrozen fish after the 8th day made it impossible to check our calculations. Since there was no way of determining what portion of the load was frozen, heat balance calculations could not be made.

Although we had no control over the above experiment since we were merely asked to make the observations, we did suggest that for further tests, if made, insulation be applied to the hold more uniformly and an attempt be made to control the temperature by shielding part of the dry ice tanks. Then two schemes could be investigated. One would be the holding of pre-frozen bait in the frozen state at about 10° F., and the other would be the holding of unfrozen pre-chilled bait in the unfrozen condition.

Cost estimates for the operation of both schemes have been made but so far our suggestions have not been acted upon. The economic feasibility of the use of dry-ice in this way depends upon the cost of dry-ice, and at the moment the cost of dry-ice in Vancouver makes its use much too costly for the holding of bait. (See also Summary No. 79)

#### SUMMARY NO. 9

#### CONDUCTIVITY OF FISH MUSCLE

D. H. Taylor  
O. C. Young

In last year's mimeographed Annual Report, Summary No. 10, it was stated that an apparatus had been assembled to determine the heat conductivity and surface coefficients of heat transfer of fish muscle.

This apparatus was set up in one of the Station's cold rooms, fitted with the necessary thermocouples and filled with a sample of fish muscle, but no results were actually obtained due to the press of other more important undertakings and the resignation of Mr. Taylor.

SUMMARY NO. 10

MAINTENANCE AND DEVELOPMENT OF STATION EQUIPMENT

E. G. Baker

(A) Maintenance of Existing Equipment

The Station's refrigeration equipment is being given a complete overhaul by the writer. At present the older of the two compressors has been completely overhauled, painted, glands repacked, pistons and piston rings checked. The second compressor is now being done, following which the water and brine pumps will be reconditioned.

(B) Development of New Equipment

Four sets of eight resistance thermometers were made up at the Station for use with the railway refrigerator car. A few modifications have been made to them to increase their flexibility for greater usefulness. This whole set-up is proving exceedingly useful in cold storage work particularly for the taking of temperature measurements requested by local cold storage operators. The cost of similar, factory-made equipment would have been prohibitive with funds available for this purpose this year, but by making the thermometers ourselves, we were able not only to increase the numbers of sets, but to obtain a sensitivity greater than that in the commercial equipment.

(C) Technical Data from New Applications of the Jacketed System of Cooling

It may be recalled that in the recently built Vancouver plant of the B. C. Ice and Cold Storage Ltd., the jacketed system of cooling all rooms was used. We, as well as the management of the firm, are interested in the performance of the cold rooms, as being an application of principles developed at this Station some years ago. Therefore, airflow and temperature measurements have been taken of both full and empty rooms being held at the two temperature levels, namely  $34^{\circ}$  F. and  $-10^{\circ}$  F. Our observations indicate that the amount of occupancy has negligible effect on the temperature distribution in the rooms, since the greatest difference found between the warmest and coldest points in any room tested, did not exceed  $2^{\circ}$  F. Obviously the system is performing exceedingly well.

The observations will be repeated periodically through a whole year's operation in order to note the effect of outside conditions on the temperature distribution within the various rooms.

Observations will also be made on the Finnegan Freezers, to determine the rate of freezing for the different sized packages of products being frozen.

SUMMARY NO. 11

CONSULTING

O. C. Young

The amount of consulting done by the staff of this Station is increasing from year to year in a very gratifying manner. The information given out by the engineering staff includes problems in refrigeration, insulation, vapour barriers, construction of cold rooms, cooling equipment, and freezing and storage of all types of fishery products. Many inquiries come through the mail, but much time is also taken up by personal interviews. For illustrative purposes several examples will follow:

Through a request that went to the Fisheries Department at Ottawa a trip was extended from Ottawa to Halifax to consult with members of the National Sea Products (Halifax) and the Gorton Pew Fisheries (Gloucester) regarding a proposed cold storage plant at Louisburg, N. S. The discussions covered building materials, construction, flow sheets, dimensions, types of freezers and equipment. Arising out of these interviews were contacts with members of a firm of consulting engineers in Montreal, who are now carrying forward the plans discussed.

A partnership firm in Port Alberni, V. I., secured information and advice on the construction of a small ice storage and fish holding plant. The matters of particular concern were means of preventing ice from forming in the earth under the building, and backing one side of the building, and also to construct a room in which flakice could be stored without "caking".

The B. C. Ice and Cold Storage Ltd. of Vancouver received much advice on the planning of the new building just completed. It will be recalled that this firm was the one to apply our ideas on the jacketed system as applied to the storage of fish. The successful operation of the first cold storage unit completed over a year ago, prompted further demands for information and advice from us.

Sable Freezers Ltd. of Clark's Harbor, N. S., have secured considerable information on air blast types of freezers. Information was also supplied on packaging and freezing times for different thicknesses of packages under different air velocities and temperatures.

SUMMARY NO. 12

CONSULTATION: NANAIMO STATION COLD ROOM

D. H. Taylor  
O. C. Young

Dr. R. E. Foerster, Director of the Nanaimo Station, asked for assistance in the designing of a cold room to be set up in the new building now being completed at Departure Bay. After some discussion it was decided that plans and specifications be prepared so that estimates and possibly competitive prices might be obtained.

As a result Mr. Taylor visited the Nanaimo Station and brought back the required data to prepare plans and specifications as suggested. These have been prepared and now are in Dr. Foerster's possession.

## REFRIGERATION OF FROZEN FISH

### B. PRESERVATION OF QUALITY

#### SUMMARY NO. 13

INDUSTRIAL APPLICATION OF ASCORBIC ACID  
AS AN ANTIOXIDANT TO CONTROL OXIDATIVE  
RANCIDITY IN FISH FLESH

H. L. A. Tarr

There are now definite indications that the work on antioxidants (Pages A29-A32 of the 1944 mimeographed Annual Report) initiated by the writer is being applied by the fishing industry on a moderately large scale. Two large local fillet processing plants and two in Prince Rupert have processed, or are processing, salmon and "sole" fillets. One of them has also treated oily Eulachons with considerable success. Another large local firm is considering application of ascorbic acid and is utilizing its own laboratory facilities to ascertain the most desirable mode of application. Unfortunately the plants concerned do not care to disclose the amount of fish treated, though it appears that a large proportion of the salmon and sole fillets intended for freezing will be processed by at least one firm.

In summary No. 12 of last year's mimeographed Annual Report, reference was made to experiments in which whole fish and steaks were either glazed with ascorbic acid solution, or were dipped or sprayed with viscous carriers (e.g. carboxymethyl cellulose or Krimko gel) containing ascorbic acid. No communication regarding the results of these tests has so far been received by the writer from the chemical firms who initiated these experiments. There has been, and still is, an element of secrecy in this work, and it has not been easy to learn the results of such tests.

One chemical firm has been advocating a dip in a solution containing 0.3% ascorbic acid, 0.5% Krimko gel, and 0.001% Tween 81. It has been claimed that they are seeking a U. S. Patent for this procedure. Tween 81 is not used locally as far as can be determined. The company concerned state that this procedure has several distinct advantages over a straight dip in ascorbic acid solution. It is claimed that it is more economical since it retains the ascorbic acid on or near the surface where it is most effective, that a more uniform coating results and that there is no dilution of the solution when a large mass of fillets are passed through a dipping tank. It would seem important that these claims be verified by comparative experiments. If this were done, an unbiased decision could be reached regarding the best mode of application of ascorbic acid, and proper advice be given when enquiries are received concerning the most satisfactory application of this antioxidant to fish. It is intended to conduct such tests shortly.

It is understood that certain United States fish companies are processing Atlantic mackerel fillets with ascorbic acid. So far it has not been possible to obtain any data on the quantity of fish treated, though several indirect reports that the method is successful have been received.

One local firm has requested information on a method of treating smoked herring fillets which are to be frozen and stored after brining and smoking. Some suggestions have been made regarding possible antioxidant treatments.

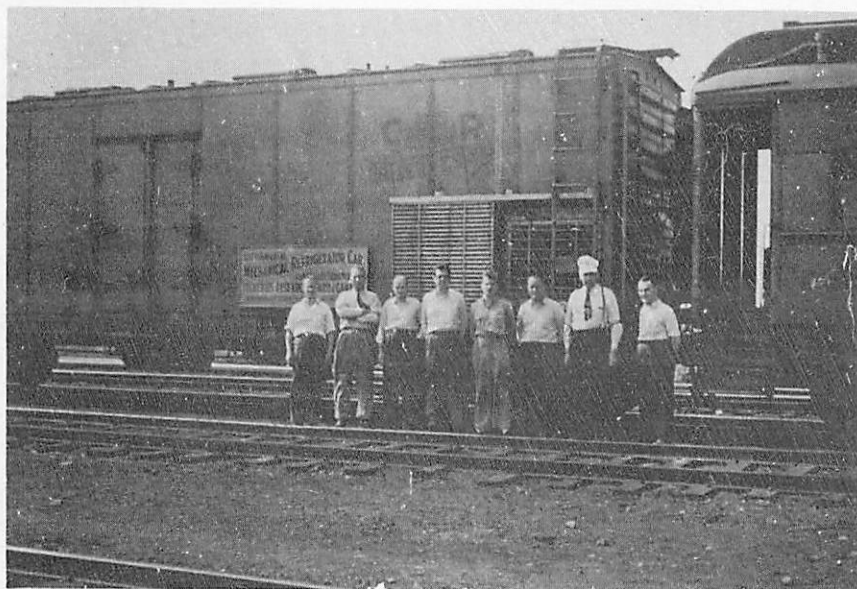
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SMOKING DRYING AND CURING

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O. C. Young

The following test was planned and conducted by Mr. Charles F. Gorse who arranged for the insulating of the fishing boat; the installation of the CO<sub>2</sub> tanks and ducts; and the securing of the solid CO<sub>2</sub> (dry-ice). One of us (D.H.T.) made the necessary observation with the aid of this Station's equipment to assess the performance of the CO<sub>2</sub> appliances.

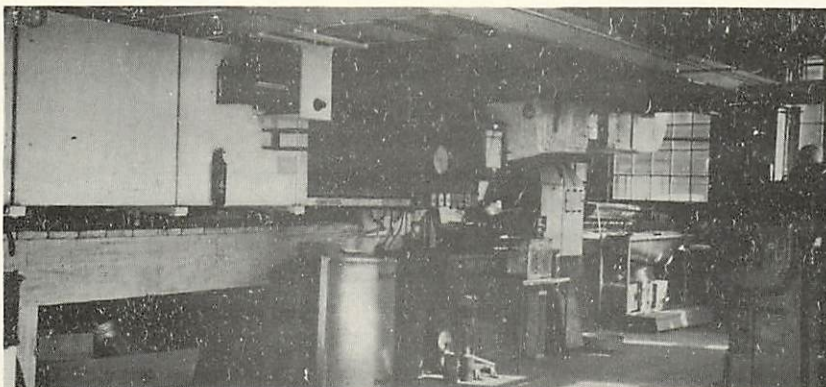
## SMOKING, DRYING AND CANNING

### SUMMARY NO. 14

#### A COMMERCIAL AIR-CONDITIONED SMOKE TUNNEL

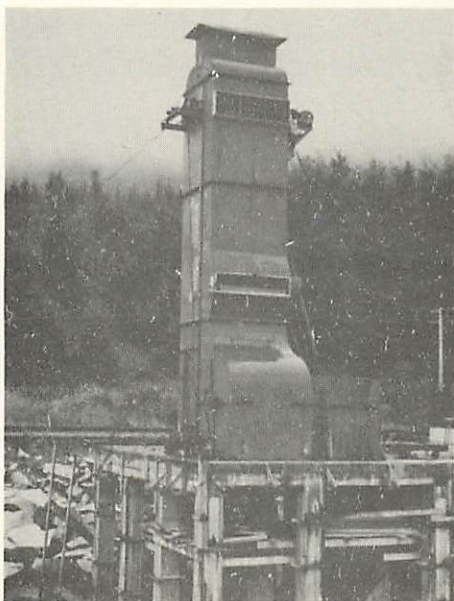
A. W. Lantz

The Prince Rupert Fishermen's Cooperative requested assistance in designing a tunnel for smoking fish, based on the principles of the Station's smoke tunnel. This commercial tunnel is of the conveyor type, set in a vertical position, as opposed to the Station's experimental horizontal tunnel. From Pacific Progress Reports No. 56, pp. 4-5, and the accompanying photograph,



Station's experimental horizontal smoke tunnel

it will be recognized that the conveyor could have been placed in a vertical or sloping tunnel just as effectively as in the horizontal one shown if floor space were at a premium. Many of the modifications (Pacific Progress Reports



The smoke kiln as positioned on the plant foundation

No. 78, pp. 17-20, and Investigators Summaries No. 19, 1948) made to this Station's experimental model were incorporated and adapted to the commercial unit. Fabrication was by Empire Sheet Metal and Western Bridge in Vancouver to assure that blueprinting and construction applied the principles desired.

Mechanical operation of the tunnel was demonstrated to the Industry before shipment to Prince Rupert. Subsequent to operation of the tunnel, a trip was made to Prince Rupert to assist with positioning of the tunnel (see accompanying photo).

A second trip will be made in November to observe initial operations of the kiln.

SUMMARY NO. 15

A CANNERY SMOKE TUNNEL

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

Progress Reports (Pacific) No. 77, December 1948, included an article "Canning of Anchovies" which described a canning process developed at this Station. This was brought about by local interest in anchovy canning and the belief of some marine biologists that the anchovy fishery offers great opportunity for increased exploitation. For example in 1946 the B. C. pack was worth over \$600,000. An early commercial attempt to use this process met with disappointing results and so further work was carried forward at this station to find the cause of the trouble.

The process chiefly concerned the removal of moisture from the fish prior to packing, a reduction of thirty percent in weight of the raw fish being necessary. This was accomplished by steaming the fish followed by smoking in the Station smoke tunnel. Experiments showed that approximately half of the moisture was removed by the steaming and the remainder during smoking. In our experimental packs this had presented no problem as our smoke tunnel, operating on very small loads, could smoke at a very low relative humidity. However, low relative humidity was found unobtainable in any of the local cannery smoke houses when fully loaded, the reason being that smoking for canning differs from ordinary fish smoking in that much greater drying is required with the impartation of much less smoke flavor. After inspecting our experimental packs of anchovies, one packer decided to adopt the process and asked for engineering advice in remodeling his smoke house. This assistance was given to aid in the establishment of a new and potentially large industry. It also gave us an opportunity to experiment in the design and operation of a commercial cannery smoke house at no expense to the Board. This was desirable as many smoking and drying problems cannot be worked out in an experimental model. We were also interested in obtaining data on this type of equipment for the production of kipper snacks (see summary #22).

The design of the tunnel was based on data obtained from tests in the Station smoke tunnel. There, a satisfactory smoking-drying process was found to be one hour at 110° F. dry bulb temperature, thirty percent relative humidity, and with an air velocity of three hundred feet per minute. The production rate required was nine hundred pounds of precooked fish per hour from which fifteen percent of the moisture was to be removed by air drying. A fresh-air fan of six thousand cubic feet per minute capacity, already installed in the tunnel, was to be left unaltered if possible. Calculations showed that this could be done even under the most adverse weather conditions. Data obtained from the Dominion Meteorological Station indicated that the most severe conditions would occur when outside air was saturated at 60° F. These

conditions gave a final relative humidity of twenty-nine percent which was within the design specifications.

The calculation is given below:

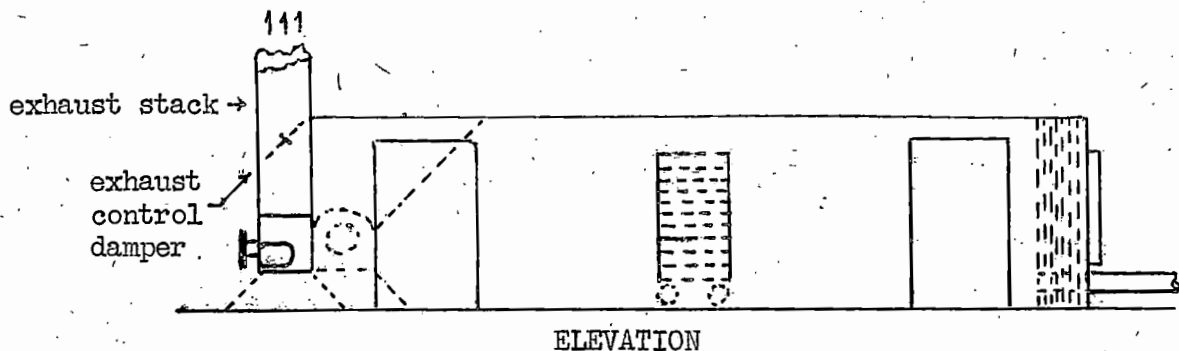
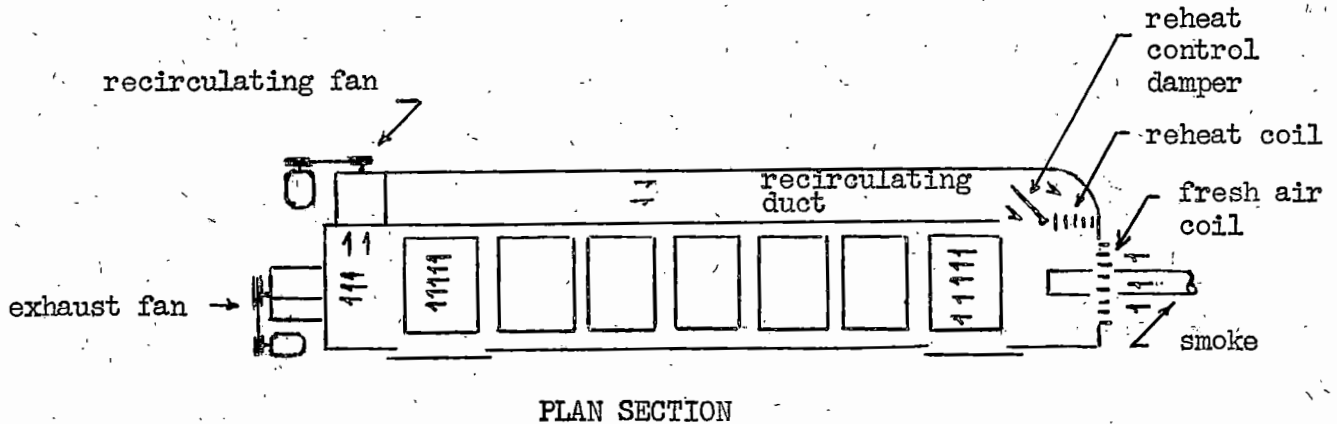
Hourly input of fish in pounds		900
Moisture removal, % of weight		15
Fresh air input, cubic feet per minute		6000
Fresh air conditions, dry bulb temp. °F.		60
relative humidity %		100
Moisture removal, grains per hour	=	900(.15)(7000)
	=	945,000
Fresh air intake, pounds per minute	=	6000(.0740)
	=	445
Moisture pick up of air, grains per pound of dry air	=	$\frac{945000}{60(445)}$
	=	35.4

From psychrometric chart air saturated at 60° F. subsequently heated to 110° and humidified with 35.4 grains of water vapor has a relative humidity of 29%. In order to accomplish this much drying it was calculated as follows that the incoming fresh air must be heated to 132° F.:

Required moisture pick up, grains per pound of air		35.4
Moisture pick up per °F. drop in grains		1.62
Total temperature drop, °F.	=	$\frac{35.4}{1.62}$ = 22
Final air temperature, °F.		= 110
Initial air temperature, °F.		= 132

An air-heating steam coil was selected capable of the above required heating, and a recirculating duct equipped with another 6000 C.F.M. fan. A small capacity reheat coil was installed in the recirculating duct to maintain the same humidity during drier weather than the severe conditions for which the tunnel was designed and thus achieving a higher drying efficiency. Also theoretical considerations tend to show that the recirculating system, in permitting higher air velocities than those which could be used in our experimental work, would allow faster and more efficient drying.

A schematic diagram of the tunnel is shown below.



The tunnel modifications were completed this year, in time for only one day's anchovy canning. The management was very satisfied with the resulting pack. It is expected that in the coming year much useful technical information will be obtained from its operation.

SUMMARY NO. 16

SMOKING

A. W. Lantz  
P. J. Schmidt  
O. C. Young

Requests for information on air-conditioned tunnels from India, South Africa, New Zealand and Australia as well as from Canadian Industry indicate that the general trend in kilns is toward a greater measure of control of factors such as temperature, air velocity, humidity and smoke density. With the increased installations of tunnels of this type it was considered desirable to determine the effectiveness of equipment, particularly with reference to the relation of time to smoke penetration in different fishery products.

The Station's tunnel to which, it will be recalled, modifications were made last year, is suited to studies of this nature (Pac. Prog. Rep. No. 78, pp. 17, 1949; and Investigator's Summary No. 19, Mimeographed Annual Report 1948). A series of experiments have been initiated to endeavor to relate the above mentioned factors to smoke penetration in selected samples of different species of fish. Smoke penetration is being measured by analysis of the samples for phenol content.

## SUMMARY NO. 17

### DETERMINATION OF PHENOLS IN SMOKED FISH

P. J. Schmidt

In conducting experiments with the Station's air-conditioned smoke tunnel (see Summary No. 16) it was found necessary to determine the amount of phenols in smoked fish. The phenol content has been found to be the most satisfactory measure of smoke content. Such a quantitative measurement of smoke concentration is valuable in probing the effects of various factors (e.g. smoke velocity, relative humidity, etc.) involved in smoking fish. A satisfactory method of estimating the smoke content would help to produce smoked fish of uniform quality.

Various reagents and methods were used to determine the phenol in smoked tullibee and whitefish, which are freshwater fishes. The phenol was extracted from 25 smoked fillets using the method of Linton and French. To determine the amount of phenol present, Gibbs' reagent was then used in the manner described by Tucker who used it for smoked meats. This procedure is long and laborious. Extremely small differences in phenol content could not be estimated by this method. Folin's reagent was also used on the same extracts, but was found to be even less sensitive than Gibbs reagent.

It was found that a more satisfactory distillation procedure could be used than the steam distillation method. Using a Kjeldahl distillation unit, 12 simultaneous extractions were possible. It was found that 96% of added phenol could be recovered in this way.

The sulfanilic acid method proved to be the most satisfactory method of estimation of the phenol content of the distillates. It is more sensitive than either Folin's or Gibbs' method and is faster than Gibbs' method. Using this method, a colorimetric determination is made using the Beckman spectrophotometer at a wavelength of 425 mu. The amount of phenols present can be calculated (as phenol) from a standard curve constructed from a series of known amounts of phenol.

## SUMMARY NO. 18

### RISE IN TEMPERATURE IN MILD CURED SALMON DUE TO BACTERIAL AND OTHER ACTION

O. C. Young  
H. L. A. Tarr  
A. W. Lantz

A shipment of B. C. mild cured salmon, worth about \$400 per tierce, had arrived at a Scandinavian port at an elevated temperature (46° F.) and in poor condition. The shipping company involved claimed that their vessels storage rooms had been maintained at about 33° F., and that the high temperature had been caused by heating as a result of growth of microorganisms. The shippers on the other hand thought this idea ridiculous and requested information from this Station. Unfortunately no scientific or exact reports concerning the strength of the brine on arrival, nor of the fish when it was shipped, were available. It may be said that fish of this type is almost invariably treated with every care since it is a very valuable product.

We were unable to find evidence that a temperature increase of the order of 10° F. or more could be induced in mild cured salmon by bacterial action, therefore an experiment was conducted in the Station's storage rooms

with highly contaminated fish. These fish, described in Dr. Tarr's following portion of this Summary covering the bacteriological phase of this investigation, were packed in small barrels holding about 100 pounds each, and stored in rooms (two barrels to each room) maintained at two different temperatures. The temperatures selected were 32° F. and 45° F. and all temperatures, including those of the room and of the fish at the centre and edge of each barrel, were determined by means of thermocouples connected to an automatic recorder.

The storage period was extended to 6 weeks and at no time during that period did the observations indicate that the temperature at the centre of the barrel was significantly above that at the edge of the barrel or that in the room. It was concluded, therefore, that under the conditions of the experiment, which simulated those in a boat hold, bacterial activity did not raise the temperature of the fish significantly above the ambient temperature. Consequently, the high temperature observed by the European consignee referred to above could not have been due to bacterial action as claimed by the steamship company.

(H. L. A. Tarr)

Little information is available regarding "heat of putrefaction" of fish flesh. Active putrefaction in fish flesh at temperatures over 23° C. is accompanied by evolution of heat (Langstroth, Cooper, Tarr, Ms. Reports No. 38, 1929). On the other hand nothing appears to be known regarding heat generated during slow bacterial growth such as might occur in fish immersed in brine at temperatures between 32 and 50° F. An experiment to check this point under practical conditions was carried out. Sides of defrosted chum salmon were stacked and held one day at room temperature in warm weather. The fish at the end of this time were stale. Four, 100 lb. barrels were then packed with these sides in the manner used in preparing mild cure salmon, the fish being dry salted and the barrels filled up with saturated brine. Two barrels were stored at 32° F. and two at about 45° F., thermocouples being inserted in the flesh. Bacterial counts were made on the original fish, and then after 2 days (equilibrium) and after 6 weeks. The counts were made on nutrient agar containing 10% NaCl.

The results of these counts, given below, show that there was initially a decrease in the salt tolerant bacteria. At 32° F. the count remained about constant within probable limits of error, while at 45° F. there was a marked rise and also a very marked putrefactive odour which was much more marked than that noted in the 32° F. fish.

<u>Treatment</u>	<u>Salt Tolerant Bacteria per gram of Fish</u>
Fish before salting	320,000
Stored 2 days at 32° F.	110,000
" 2 " " 45° F.	92,000
" 30 " " 32° F.	32,000
" 30 " " 45° F.	3,000,000

The results from the bacteriological point of view indicate that if mild cure fish is kept at about 32° F., even if it is highly contaminated initially, bacteria will not grow appreciably in it. On the other hand, at

(No. 18 Cont'd)

45° F. there is a definite danger of bacterial spoilage. It is therefore highly unlikely that putrefaction occurring initially at 32° F. would cause a rise in temperature to 46° F. in mild cured salmon as claimed.

Results of tests carried out by Mr. Young regarding temperatures support this contention.

CANNING

## CANNING

### SUMMARY NO. 19

#### INFRA-RED EXHAUST

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

The use of infra-red heat for the drying of fish is described in Pacific Progress Report No. 79 and Summary No. 22 of this report. Further experiments were carried out on its use for exhausting of cans prior to sealing. This method of exhausting was found highly satisfactory in the processing of anchovies and kipper snacks which are ideally suited being already precooked and being packed in  $\frac{1}{4}$  oval cans which are very shallow but have a large surface area. A satisfactory exhaust was obtained in two minutes under 250 watt infra-red lamps: the lamps were spaced  $5\frac{1}{2}$  inches centre to centre.

### SUMMARY NO. 20

#### CANNED FRESHWATER FISH

A. W. Lantz

Investigations into canning of fresh water fish (Investigators Summaries No. 23, 1948) have been restricted during 1949 to a number of small processings, as follow:

#### (A) (i) Whitefish, Inconnu, Common Suckers (Alberta)

A shipment of Inconnu whitefish and common suckers was received from McInnes Products Limited of Edmonton. The fish was treated in various ways, canned and returned to the company for determining quality during storage.

#### (ii) Storage Tests on Canned Alberta Freshwater Fish

First processing using Seafood enamel No. 32 cans was briefly reported in Pacific Progress Reports No. 75, p. 39. Storage tests on 1948 processings were briefly described in Investigators Summaries No. 24, 1948. Further examinations were made in October of this year. Cans of pike, common sucker, trout, whitefish and inconnu were opened. The product was good in all instances indicating keeping quality of the canned fish is very satisfactory.

There was some evidence of corrosion in a small number of the cans containing pike.

#### (B) Canning Pickerel (Manitoba)

During June approximately four dozen cans of pickerel were processed for Mr. Collins of Booth Fisheries (Winnipeg). This company shipped a small quantity of poor quality pickerel to this Station for canning in September 1948, Investigators Summaries No. 23, 1948. Results of this canning were disappointing; therefore the second processing was done to give the company an impression of potentialities.

A request from Mr. Barbour of Booth Fisheries (Winnipeg) for "advice on disposition of the lake mullet" was considered a lengthy research problem which this Station was not in a position to undertake. It was suggested that since "mullet" seems to be a term applied to more than one species of Manitoba fish that some decision be reached regarding common nomenclature. Further it was stressed that this problem should be investigated near the source to assure ample quantities of fresh fish. An outline for an intensive survey of the problem was provided with our offer for continued assistance with technological advice.

(C) (i) Canning Tullibee (Longlake, Saskatchewan)

The investigation into canning of freshwater fish has been concluded upon development of processing methods for canning of whitefish, lake trout, pickerel, pike, inconnu and tullibee.

One of the major problems now faced by the industry particularly in Saskatchewan, is the earthy flavour which is "pronounced" in fish from certain lakes. Tullibee from Long Lake, Sask., was tested at this station and since it has not been reported elsewhere is included in these summaries.

One lot of fish was caught on July 10th, 1947, a second lot was caught July 23rd, 1947, and each lot sharp frozen and shipped to this Station. A third lot was caught Jan. 6th, 1948 (through the ice) sharp frozen and shipped to Vancouver. Each lot was thawed, a small amount canned as a control and the remainder salted in dry salt according to a suggestion in U. S. Commissioners Report 1922 for removing earthy flavour from fish.

After 60 days the fish were reconstituted, canned and stored. After 6 months' storage at room temperature the product was tested. The salting had no detectable effect upon the flavour. Salting did not reduce the earthy flavour and no difference could be detected between fish caught in the summer or winter.

(ii) Storage Tests on Canned Whitefish (Prince Albert, Sask.)

Samples of whitefish canned during the summer of 1947 at the Prince Albert plant have been in storage at this Station. In October of this year cans of the processings were opened and examined. The product has improved with storage in flavour and colour. Corrosion of the cans which was reported in Pacific Progress Reports No. 74, p. 19, is apparent in a few of the cans opened. Corrosion of the cans after two years' storage appears to no greater extent than was apparent after a few months' storage. This concludes the storage tests on the product packed in seafood enamel cans during 1947.

SUMMARY NO. 21

CANNING OF WHALE MEAT

S. W. Roach  
J. S. M. Harrison  
A. W. Lantz

(A) The utilization of whale meat which at present is used only for pet food in British Columbia has been of interest to this Station. It was decided to investigate the possibility of preparing a whalemeat product approximating

canned corned beef. Samples have been prepared with varying success depending on the freshness of the whalemeat. With good meat a product can be made closely resembling corned beef in colour, flavour and texture.

The product is of interest since corned beef accounts for the greater part of canned beef production. It is of further interest since the corning process could be utilized to preserve the meal from the time of cutting at the whaling station to its delivery at a cannery, whereas freezing of whalemeat is difficult because of the large capacity freezer required. The work will be continued if samples of high and uniform quality meat can be obtained to work with. Until this variable is removed conclusive results can not be determined.

(B) A commercial investigator who has developed a method for removing or modifying the unsavoury flavours of whalemeat, requested assistance in developing canned products. Minced beef tendons in varying quantities and minced pork skins in like manner were added to minced whalemeat, each product thoroughly blended and processed. Either pork skins or beef tendons improve the texture and flavour of the baleen meat and result in a product similar to canned corn beef. Pork skins and beef tendons were selected for their binding quality as well as for economy.

SUMMARY NO. 22

KIPPER SNACKS

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

Since the loss of the wartime markets for canned herring, the problem of utilizing herring for human consumption rather than entirely for reduction purposes has been of concern to the fishing industry and has been referred to this Station. In 1946 canned herring production in British Columbia was valued at over six million dollars. This portion of the catch is now being reduced to oil and meal and yields only a small fraction of its former value. The increased production of canned kipper snacks may be one means of returning the marketed value of herring to its former level. To many B. C. canners the production of kipper snacks has one very desirable feature. That is, where canneries have reduction plants fish can be selected from those going to reduction, the fillets removed, and the offal returned to reduction. Thereby prime fillets are obtained for the negligible price of reduction herring. Kipper snacks have been produced in B. C. in considerable quantity. In 1946 for example, their production was valued at one half a million dollars in spite of inefficient production and an inferior product. It was therefore decided that an investigation into possible improvement in quality and production efficiency would be worthwhile.

Improvement of quality was investigated first. From the literature it was learned that Norwegian kipper snacks which are regarded as the standard of quality are steamed prior to smoking. This was tried experimentally and found advantageous in several ways. One advantage is the rapid removal of a large portion of the moisture content. Two hours are required to produce a comparably dry product by smoking alone. The removal of this moisture is necessary to avoid free water in the can after final processing. A second advantage is the elimination of shrinkage in the can during exhausting and processing. This improves appearance as the finished product completely fills

the can rather than leaving voids at either end. Also the cans can be filled to the correct weight rather than being overfilled to allow for the losses in the exhaust box. Other advantages are elimination of the darkening of the flesh during processing, probably due to the Maillard reaction (Tarr, Pacific Progress Reports No. 74); reduction in oil losses and oil deterioration and in the opinion of many tasters an improvement in flavour.

Improvement of production efficiency was next investigated. To improve production it is desirable to have a continuous process wherein the product is conveyed throughout all operations with a minimum of handling. The chief obstacle to this has been the long period required for smoking for a continuous smokehouse which could hold the product for the required time would be costly to build. Since the long period of smoking is required for drying the fillets rather than for imparting colour and flavour it appeared that the completion of the drying after steaming might be done more rapidly by other means than smoking. Infra-red heat was tried since in recent years it has been found very effective in the drying of many products. An apparatus was built employing 250 watt infra-red lamps and the following results obtained:

1. Ten percent of the weight of the fish in moisture was removed in five minutes. This was sufficient drying (after steaming) to produce the desired product.
2. The maximum radiation without scorching was produced by approximately ten watts of input per square inch of product surface.
3. The drying efficiency was approximately fifty percent.
4. A period of fifteen minutes smoking after drying was found sufficient to yield a product of satisfactory colour and flavour.

Similar tests were made using strip heaters (glassless infra-red) which showed that these would probably be equally satisfactory without the danger of lamp breakage.

These experiments have shown the total processing time for kipper snacks prior to canning can be reduced to thirty minutes (ten minutes steaming, five minutes infra-red drying and fifteen minutes smoking). This makes it feasible to carry out the whole operation continuously, using conveyors, and makes possible a far greater production efficiency.

#### SUMMARY NO. 23

CANNING OYSTER SOUP AND OYSTER STEW

A. W. Lantz

The cannery manager for Tulloch Fisheries Limited requested assistance in overcoming curdling during processing of canned oyster soup and oyster stew. Methods recommended by canner associations were procured and tested. The addition of cracker meal and cornstarch appeared to be the most effective method of avoiding curd. The company asked for a method which would yield an unthickened product. Various buffers were tried the most effective being sodium bicarbonate which was added to the unthickened liquor and milk to

maintain a pH of 7.3 on processing. Cans which have been in storage since December 1948, were opened during October and the product heated. Flavour was good, no evidence of curdling could be detected. Cans showed marked etchings on the sides but top and bottom of the cans were fairly clear. There was no evidence of corrosion.

SUMMARY NO. 24

CANNING LINGCOD ROE

A. W. Lantz

A local fish company requested aid in developing a canned cod roe product similar to a Norwegian pack. Cod roe in clusters were canned with only salt added. A small portion of the roe was cured in 60° salinometer brine with 200 p.p.m. of sodium nitrite for three days at curing room temperature (38°F. to 40°F.) prior to canning. This product had a slight pinkish colour but flavour was unchanged.

SUMMARY NO. 25

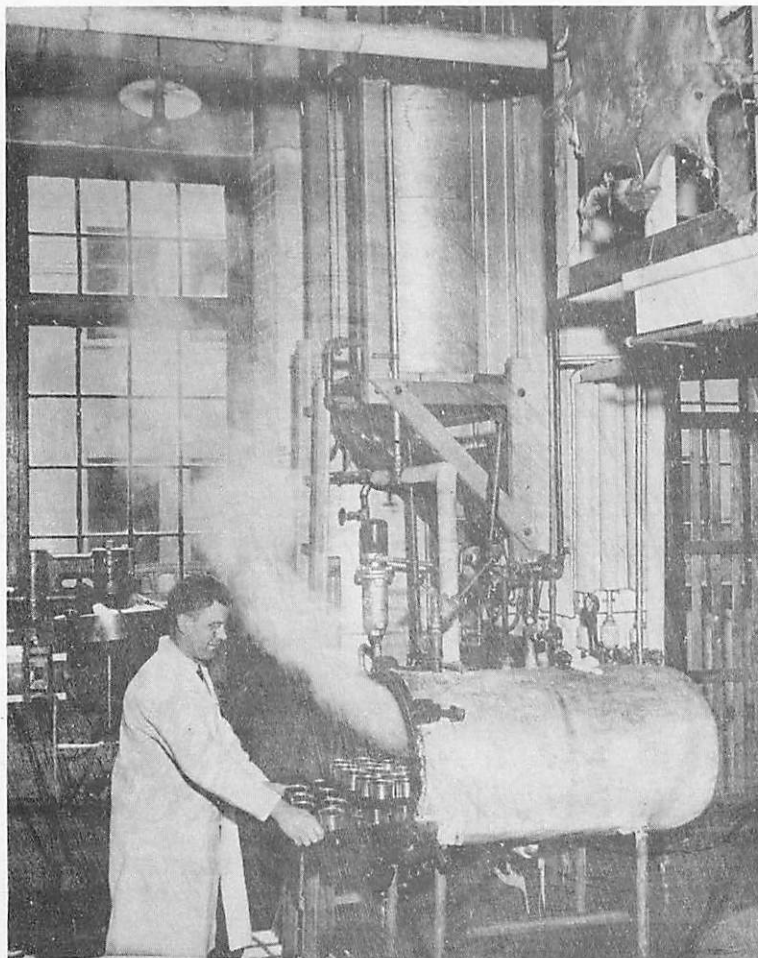
"SWELLS" IN A CANNED FISH CAKE PRODUCT

H. L. A. Tarr

S. W. Roach

J. S. M. Harrison

A request to ascertain the cause of swelling in a local pack of canned fish cakes was received. The product had been placed on the market where it had apparently been favourably received. However, trouble had been encountered for a number of badly swollen cans, representative of several different



batches, had been returned. Examination revealed mass bacterial contamination accompanied by gas and a marked butyric acid odour reminiscent of *Clostridium butyricum*. Enquiry showed that the product was being severely underprocessed (220°F. for 60 minutes). The recommended times and temperatures are 230°F. for 90 minutes, or 220°F. for 120 minutes. The cannery was visited and the process checked.

The product is made from raw lingcod flesh (the fish being used at the time of the visit was in very good condition), canned milk, pasteurized skim milk, high grades of potato flour and ordinary wheat flour, spices

Mr. Lantz, Associate Research Engineer, removing canned sample materials from retort in Station's cannery. Pressure retort cooling system is shown above.

(ginger and nutmeg) and salt. After mixing to a light white pasty mass in silent cutters the cakes are formed and fried automatically in cottonseed oil in a special Norwegian machine. They are then packed by hand into 1 lb. flat cans, a "gravy" from browned flour etc. and extract of the lingcod bones is added by hand and they pass through a vacuum closing machine. There is opportunity for contamination in such a process, though assurance was given that all equipment is thoroughly cleaned and steamed at the end of a run. It seemed possible that the flour, or spices if not sterilized, might have been the source of contamination. Since the inadequate processing temperature and time would appear as the most likely cause of the trouble, no special attempt to trace the source of contamination has been made as yet. Advice that processing for 90 minutes at 230°F. be adopted has been given, but not very favourably received. The product, which is white when cooked, becomes discoloured (Maillard reaction) noticeably even at 220°F., and at 230°F. this is much more marked (see Summary No. 26). It is probable that a 70 minute cook at 230°F. will be adopted, though this would seem somewhat risky.

It must be noted that 24 cans from as many code numbers selected from the original packs were incubated 2 weeks at 38°F., and that no "swells" resulted. The company are going to maintain as sanitary conditions as possible in order to avoid further trouble.

SUMMARY NO. 26

MAILLARD REACTION AND THE NON-ENZYMIC BROWNING OF  
FISH FLESH

H. L. A. Tarr

Due to pressure of other work this problem has been allowed to lapse temporarily. However, a scientific paper covering work so far carried out has been prepared and accepted for publication in this Board's Journal. That the problem is important industrially can be realized from the fact that one local firm has been underprocessing a canned product in order to restrict non-enzymic browning as much as possible (Summary No. 25.). Unfortunately underprocessing is dangerous, and the discovery of a simple chemical treatment which would overcome browning would certainly be of advantage. Browning of this particular product was probably intensified by the use of cows milk which contains lactose, a reducing sugar.

NUTRITIVE VALUE OF NITROGENOUS FISH TISSUES

## NUTRITIVE VALUE OF NITROGENOUS FISH TISSUES

### SUMMARY NO. 27

THE OCCURRENCE AND SIGNIFICANCE OF VITAMIN B<sub>12</sub>  
AND THE ANIMAL PROTEIN FACTOR IN FISHERY MATERIALS

H. L. A. Tarr

During recent years the role of fish meals and condensed fish solubles in supplying a factor, or factors (APF), essential for proper growth of certain livestock and for high hatchability of eggs has become more fully recognized. Though the exact nature of this APF is even yet somewhat obscure, the recent isolation of vitamin B<sub>12</sub> (and B<sub>12a</sub>) in crystalline form has done much to clarify the position. A brief survey of this field has been made in an article published from this Station (Progress Report No. 79, pp. 37-38). At present the evidence in favour of the fact that vitamin B<sub>12</sub> is itself the APF is strong but not entirely conclusive. It can only be said that in many instances vitamin B<sub>12</sub> has been shown to have marked APF activity when added to APF-free diets of chicks or pigs, but that there are some indications that other factors are required. It will undoubtedly take considerable time and much careful experimental work to clear up all the disputed points.

The crystalline vitamin B<sub>12</sub> now being sold for intramuscular injection in pernicious anaemia therapy, and the cruder form intended for inclusion in animal feeds, are the products of the metabolism of certain mold-like organisms of the genus Streptomyces whose common habitat is the soil. The cruder form, which is usually a powder consisting of considerable amounts of kaolin as a carrier, is sold at about \$2.25 per lb. It is manufactured by at least six pharmaceutical firms. The actual price of the vitamin B<sub>12</sub> in these powdered forms would be about \$0.20 per milligram, and at this price would seriously compete with vitamin B<sub>12</sub> from fishery materials if it were definitely shown that this vitamin accounts for all APF activity of such products.

In view of these facts it appeared essential that the exact position of fish materials in contributing APF to animal feeds be determined, with particular reference to the amount present and the possibility of increasing that already present by microbiological action. The results of completed experiments and outlines of projected further experiments in this field are recorded in the following summaries:

### SUMMARY NO. 28

TOTAL APF CONTENT OF FISH MATERIALS AS DETERMINED BY  
MICROBIOLOGICAL ASSAY WITH LACTOBACILLUS LEICHMANNII

P. W. Ney

When this work was started early in 1949 it was somewhat handicapped by lack of much published information regarding methods of determining APF micro-biologically and by the difficulty of obtaining vitamin B<sub>12</sub> as a control substance. Fortunately at about this time details regarding an apparently suitable method were published by the Sharpe and Dohm Laboratories (Skegg method). This method had the advantage that it required only minute amounts of vitamin B<sub>12</sub> as a control, for the assay bacterium used gave growth response in the vitamin B<sub>12</sub>-free medium employed from 0.02 to 0.2  $\mu$ g per ml. of culture medium. This was certainly a determining factor in the continued use of this method even when others became available, for the only source of vitamin B<sub>12</sub> was Merck and Co., who very kindly supplied occasionally 1  $\mu$ g ampules of the

vitamin during the early stages of the investigation. The medium used in this assay is unique in that it contains a tryptic as well as an acid digest of casein. This would ensure presence of streptogenin in the medium so that the possibility of the growth response of the test organism being influenced by this substance in added hydrolysates of fish materials being assayed would be largely obviated.

At the outset certain preliminary difficulties had to be overcome, particularly regarding the method of carrying assay cultures for use, and in hydrolysis of natural fish materials for analysis. Since trypsin (pancreatin) was found to contain considerable APF, papain was used for hydrolysis of the protein materials assayed. The papain was activated with cysteine in the usual manner, and fish meals were soaked for 2 days in water at 0° C., prior to hydrolysis since they are rather resistant to such treatment. The filtered solutions were assayed by the Skegg method with Lactobacillus leichmannii 4797, the acid formed in assay tubes being titrated electrometrically using the apparatus previously employed in the work on essential amino acids (see Summary No. 33).

This Skegg method has been reported by its originators to yield results which parallel closely the APF content of natural materials as measured by their ability to support growth of mice. However, the results obtained probably do not indicate only the vitamin B<sub>12</sub> content of the material, for the assay organism also responds to the four known natural deoxyribosides and to a less extent to deoxyribonucleic acid. It is of interest in this connection that it has been found, using the pyrimidine deoxyriboside thymidine, kindly supplied by Professor Shive of the University of Texas, that about 4,600 times as much thymidine as vitamin B<sub>12</sub> is required to cause a given response by L. leichmannii. Roughly the same ratio of thymidine to vitamin B<sub>12</sub> was found by investigators at the Lederle Laboratories using a different Lactobacillus leichmannii strain (ATCC 313) and a different assay medium.

The results obtained in a number of assays of natural fishery materials are recorded below. Crystalline vitamin B<sub>12</sub> was used as reference standard in these assays.

Material	mg APF/g dry wt.	mg APF/lb. dry wt.
Lingcod liver	380	0.17
Halibut liver	520	0.24
Lingcod liver	880	0.40
Dogfish liver	96	0.044
Lingcod viscera	84	0.038
Lingcod viscera wash water (from alkali vitamin A extraction process)	200	0.091
Red cod flesh	130	0.059
Lingcod flesh	180	0.082
Mink food (Chiefly ground halibut heads)	110	0.050
Little neck clams	2500	1.1
Dried fish liver meal (Washington Lab., U.S.A.)	470	0.21

Material	mg AFF/g dry wt.	mg AFF/lb. dry wt.
Condensed fish solubles (Tuna cooker juice)	460	0.21
" " " (Alaska herring)	660	0.30
" " " (California sardine)	460	0.21
" " " (Tuna)	270	0.12
" " " (Menhaden)	300	0.14
" " " (White fish)	81	0.037
" " " (Norwegian whale)	320	0.15
" " " (Sperm whale, pH 6.8)	170	0.077
" " " ( " " pH 4.5)	85	0.039
" " " (Dogfish)	78	0.035
" " " (Uncertain origin)*	22	0.01
" " " " " *	460	0.21
" " " " " *	200	0.091
Stickwater (Herring; stored 1 year at -20° C.)	180	0.082
" (Chum salmon offal)	540	0.25
" (Pink and sockeye salmon offal)	500	0.23
" (Pink salmon offal)	530	0.24
" ( " " " )	600	0.27
Fish Meal (Pink salmon offal, stored about 2 years)	170	0.077
" " ( " " " " " 2 " )	190	0.086
" " ( " " " " " 2 " )	210	0.095
" " (Chum " " " " 2 " )	520	0.24
" " (Sockeye and pink " " " " 2 " )	260	0.12
" " (Whole herring)	360	0.16
" " ( " " )	1510	0.69
" " ( " " )	1270	0.58
" " ( " " ) (?)	176	0.08
" " ( " " )	300	0.14
" " (Sole and red cod fillet waste)	81	0.037
" " (Fillet waste, solvent extraction process)	69	0.031
Meat meal (50% protein)	170	0.077

\*Stored at least 2 years under ordinary temperatures.

These results indicate great variations in AFF content of fishery materials.

Clams (only a single sample examined) have an apparently high AFF content, and this result should be further explored using different samples of clams, other shellfish and lower forms of marine life. Livers had relatively high AFF values, and the apparently low value for dogfish liver is due to the fact that the high oil content was included in the dry weight. The amount of AFF in fish meals and solubles varied very greatly, and this would indicate that possibly some standardization might be desirable.

The lower value obtained in the acidified sample of identical sperm whale solubles would suggest that acidification before processing might destroy B<sub>12</sub> active substances.

It must be emphasized that some of the AFF measured in the various products may have been in the form of the various deoxyribosides, so that the values recorded may indicate a fictitiously high vitamin B<sub>12</sub> content.

Since "commercial APF" (microbiological origin) sells for about \$0.20 per milligram, the calculated value of condensed fish solubles (assuming 50% dry wt.) on this basis would only be at the most \$0.03 per lb. Unless these solubles are shown to contain unknown essential nutritional factors in addition to vitamin B<sub>12</sub> then the need for fortifying them in some way with this vitamin is apparent.

SUMMARY NO. 29

ATTEMPT TO DISTINGUISH VITAMIN B<sub>12</sub> FROM  
DEOXYRIBOSIDES BY ALKALI TREATMENT

P. W. Ney

Recent published work has shown that vitamin B<sub>12</sub> is rapidly destroyed by brief exposure to alkali (pH 10) at 120° C. On the other hand thymidine (and presumably the other deoxyribosides) will withstand such treatment for 1.5 to 2 hours in presence of protein. This then would appear to offer a method of distinguishing vitamin B<sub>12</sub> from deoxyribosides in protein materials.

Portions of eight of the papain hydrolysates used to determine APF activity by the Skegg method (Summary No. 28) were heated 2 hr. at 120° C. at an initial pH of 10, and the treated solutions were cooled, neutralized and re-assayed. The results, recorded herewith, indicate that this method will not prove satisfactory for in some instances higher values resulted after such treatment. Whether this is due to destruction of inhibitory bacteriostatic substances by the alkali treatment or to hydrolysis of deoxyribonucleic acid to yield deoxyribosides is not clear.

Sample No.	µg B <sub>12</sub> active substances per gram dry wt.	
	Before treatment	After treatment
21	160	170
26	340	240
30	78	160
33	34	65
35	170	140
41	12	8
42	230	91
44	97	79

SUMMARY NO. 30

ATTEMPTS TO DISTINGUISH VITAMIN B<sub>12</sub> FROM DEOXYRIBOSIDES  
IN FISH MATERIALS BY USE OF SPECIFIC MICROBIOLOGICAL  
TECHNIQUES

H. L. A. Tarr

Certain tissues of animal (including fish) origin (for example thymus, spleen, liver and sperm) contain considerable amounts of nucleoprotein composed of protein in combination with chromonucleic acid (deoxyribonucleic acid, thymus nucleic acid). This chromonucleic acid yields by enzymic hydrolysis (polynucleotidase) four deoxyribosides containing either thymine, cytosine, guanine or adenine linked to 2-d-deoxyribose. These four deoxyribosides, and, to a lesser extent, chromonucleic acid itself, possess vitamin B<sub>12</sub>

activity for certain bacteria used for the assay of this vitamin, and this may complicate the results obtained in such assays. Certain methods have been devised by which it is hoped to overcome this difficulty. Thus Merck and Co. have developed a special cup-plate assay technique based on the "exhibition zone" method used by British workers in their vitamin B<sub>12</sub> work. A confidential memorandum describing the details of this technique was kindly supplied by the Merck Co., and also a small supply of the actual culture medium used. This method is said to be insensitive to deoxyribosides.

A number of tests have been carried out using this method. It was found that almost identical results were obtained with the Merck medium as supplied and a similar medium prepared in the laboratory under the specified conditions only using a different type of acid hydrolysed casein. In common with inhibition and exhibition zone techniques of this type it was found that the growth zone diameters increased linearly with the logarithm of the vitamin B<sub>12</sub> concentration between 10 and 750  $\mu\text{g}$  per ml. of this vitamin. The most sensitive range appears to be between 10 and 300  $\mu\text{g}/\text{B}_{12}$  per ml. of sample. Tests, using thymidine kindly supplied by Prof. W. Shive, showed that there is no bacterial response to 40  $\mu\text{g}$  of this deoxyriboside per ml.

It has been found that this method works reasonably well with materials rich in vitamin B<sub>12</sub> such as commercial "APF" and certain liver concentrates. Results with natural fishery materials have not been very promising. Considerable difficulty has been experienced, because, instead of the clear cut growth zones characteristic of vitamin B<sub>12</sub>, diffuse or "fuzzy" zones are produced. Naturally these zones cannot be measured with any degree of precision. The reason for these results is not clear. However, it is usually necessary to use rather high concentrations of fish hydrolysates, and since the technique is ultimately based on the rate of diffusion of vitamin B<sub>12</sub> into the agar medium, it can readily be seen that substances which affect the diffusion rate will influence the test. Bacteriostatic compounds might also exert a marked inhibitory influence.

More work is being carried out using this method for it has the advantage that it forms a rapid means of determining vitamin B<sub>12</sub> in relatively high concentrations, and offers promise in the work dealing with bacterial production of this vitamin (Summary No. 31).

A further method which offers a possible means of distinguishing vitamin B<sub>12</sub> from other active substances is now being studied. This is one devised by the Lederle Laboratories utilizing a protozoan organism, Euglena gracilis. It reputedly measures vitamin B<sub>12</sub> but not deoxyriboside activity, and is very sensitive to vitamin B<sub>12</sub>. If it proves satisfactory it will be used to check results obtained by the Skegg method. It is also intended to separate B<sub>12</sub> active substances in fish materials by filter paper partition chromatography.

SUMMARY NO. 31

ATTEMPT TO INCREASE THE VITAMIN B<sub>12</sub>-ACTIVE SUBSTANCES  
IN FISH MATERIALS BY MICROBIOLOGICAL ACTION

H. L. A. Tarr

The Streptomyces organisms used in the industrial production of AFP are slow growing and require rather exacting conditions for proper growth. However, it has been shown that certain bacteria commonly present in soil, manure and decomposing organic matter are able to form AFP or vitamin B<sub>12</sub>. It was thought that bacteria of this type might form B<sub>12</sub> active substances in fish waste materials. Organisms of the following genera were obtained from several culture collections: Bacillus, Achromobacter, Chromobacterium, Sarcina, Micrococcus, Proteus, Staphylococcus, Aerobacter, Alkaligenes, Bacterium and Tetracoccus. Also 44 cultures were isolated from 12 different B. C. soils. These were probably largely aerobic Bacilli of the Subtilis-Mesentericus group, but as yet no attempt has been made to classify them. The following procedure is being followed in order to determine which of the organisms form vitamin B<sub>12</sub> active substances. Eighty cultures have so far been tested.

Known cultures were inoculated into Skegg vitamin B<sub>12</sub>-free medium and incubated at 28° C. After 7 days all but one culture gave growth, though several grew feebly. A second transfer was made in the same medium and most of the cultures gave growth, but many grew quite feebly. After 1 week at 28° the vegetative cell cultures were killed by heating at 80° C. for 10 minutes (spore formers destroyed by brief autoclaving at 120° C.) They were then tested to ascertain whether any of them showed vitamin B<sub>12</sub> activity as follows. Skegg medium solidified with 2% agar inoculated with L. leichmannii was allowed to solidify in sterile dishes and 10 mm. cups were removed with a cork borer. The test solution (or vitamin B<sub>12</sub> standards) were introduced into these cups and the exhibition growth zones were measured after 1 day at 38° C. This method was found to be sensitive to thymidine (2 to 40 µg per ml. gave the usual logarithmic response) and to vitamin B<sub>12</sub> (2 to 200 µg/ml.) Unfortunately, as with the Merck cup-plate method previously described (Summary No. 30) the growth exhibition zones, which were sharply defined with pure vitamin B<sub>12</sub>, were usually diffuse and "fuzzy" with the culture fluids. It was found that 14 out of 45 cultures tested produced B<sub>12</sub> active substances by this method. It was not possible to obtain an accurate measurement of the amount formed because of the diffuse zones.

Cultures were isolated from soils by plating using Skegg medium plus 2% agar, and incubating the plates, after inoculation with dilute soil suspension; for 1 or 2 days at 28° F. Usually about 0.001 M. cobalt was added to this medium in order to see whether a purple colour developed in any of the surface colonies. Dr. Lewis of the Western Regional Research Laboratory, Calif., had isolated an aerobic spore former from soil which formed B<sub>12</sub> and gave a purple colour and vitamin B<sub>12</sub> active substances in the liquid growth medium (personal communication). Colonies which developed after 2 days at 28° C. were inoculated into Skegg liquid B<sub>12</sub>-free medium and the resulting cultures incubated 7 days at 28° C. It was found that 20 out of 40 cultures tested formed B<sub>12</sub>-active substances.

Eight of the most active cultures were grown in sterilized neutralized herring and salmon offal stickwater for 14 days at 28° C. Tests were made at intervals for formation of B<sub>12</sub>-active substances using the Skegg cup-plate assay method. There was a definite increase in several instances, and in some cases there seemed to be a slow decrease after the initial increase. Since the Skegg cup-plate method responds not only to vitamin B<sub>12</sub> but deoxy-ribosides as well, the Merck cup-plate method was applied to these samples since it reputedly determines only vitamin B<sub>12</sub> (see Summary No. 30). The results were not entirely satisfactory since with most of the samples rather diffuse growth zones were produced. However, in several instances a definite increase and good compact growth zones similar to those found with vitamin B<sub>12</sub> were obtained, and from 40-75 µg of vitamin B<sub>12</sub> were apparently formed. The highest value would be at the most roughly equivalent to 0.3 mg. of vitamin B<sub>12</sub> per lb. of dry wt. of material. Further work designed to test effect of substrate (material), temperature, aeration and other factors is under way. The experiments are strictly exploratory and are naturally hampered by lack of published information in this relatively new field of investigation.

SUMMARY NO. 32

PROJECTED COLLABORATIVE EXPERIMENTS DESIGNED TO RELATE  
VITAMIN B<sub>12</sub> AND VITAMIN B<sub>12</sub>-ACTIVE SUBSTANCES CONTENT  
OF FISH MEALS AND CONDENSED SOLUBLES TO THEIR VALUE IN  
CHICK NUTRITION

H. L. A. Tarr

Though it is known from published work that there is some general relation between the vitamin B<sub>12</sub> content of animal feeds and their ability to enhance growth of chicks and pigs, it has not been definitely shown that the content in vitamin B<sub>12</sub> active substances as measured by microbiological assay procedures always parallels the growth promoting qualities of such feeds. During a recent visit to this coast by Dr. Clandinin of the Nutrition Department, University of Alberta, several discussions were held, some in conjunction with representatives of local fishing companies, in order to plan some collaborative tests. Tentative arrangements were made to obtain supplies of salmon offal meals, herring meals at different seasons, whale meal and condensed fish or whale solubles which are obtained during reduction of these materials. It is intended that this laboratory carry out microbiological assays, perhaps by two different methods, that the nutritional tests be made by Drs. Clandinin and Robblee at the University of Alberta, and that the findings be compared.

SUMMARY NO. 33

DISTRIBUTION OF ESSENTIAL AMINO ACIDS IN FISH  
PROTEIN PRODUCTS

H. L. A. Tarr  
P. W. Ney

Work on this project (see Annual Report of this Station for 1948, Summary No. 29) has been completed. An industrial memorandum was prepared in order to summarize the results and to enable them to reach those interested prior to scientific publication. A second scientific paper on this subject has been accepted for publication in the Board's Journal.

SUMMARY NO. 34

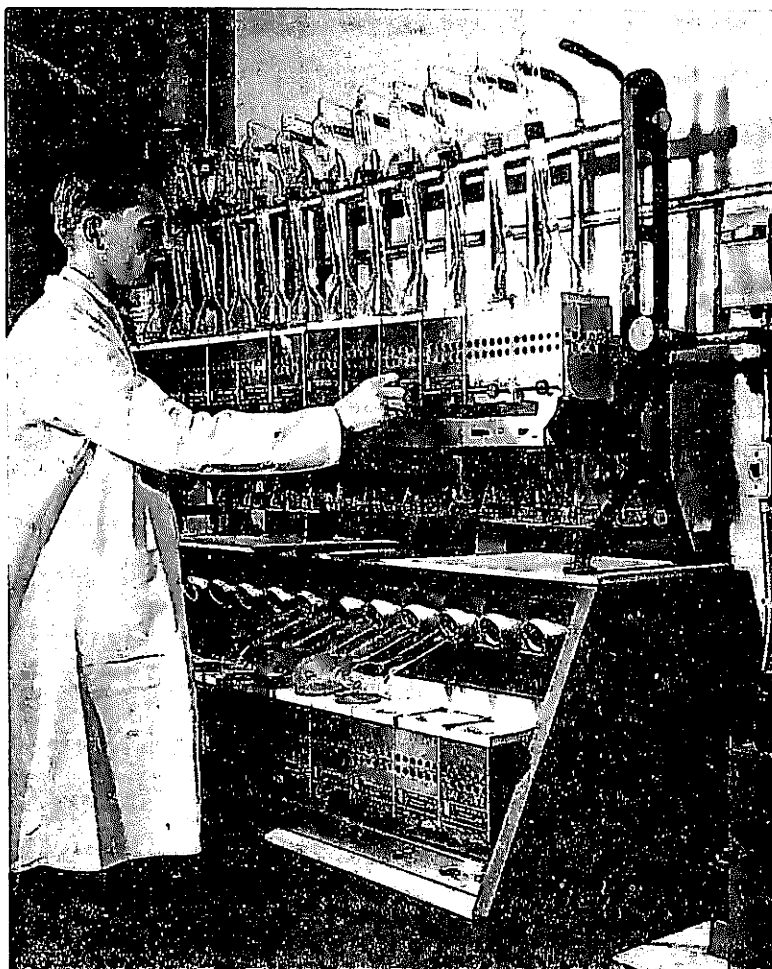
ANALYSES OF FRESHWATER FISHES FROM CANADIAN  
INTERIOR PROVINCES

P. J. Schmidt

The programme of analysis of typical freshwater fishes from the interior provinces, instituted in February 1948 was continued (see mimeographed Annual Report for 1948, Summary No. 28). The results of some of this year's work were described in Industrial Memorandum No. 12. Further data will be issued in a subsequent memorandum.

Proximate analyses were made on the following fishes: Bowfin and ling

from Ontario, jackfish, mullet, tullibee, pickerel and whitefish from Saskatchewan, inconnu from Alberta and goldeye from Manitoba. The proximate analyses were again made on the different parts of the fish (flesh, skin from flesh, head, viscera, residue). A total of 180 analyses were made.



The chemical characteristics and vitamin A potencies of the oils of these fishes are reported in Summary No. 39.

From the data of the separate proximate analyses of the different parts, the composition of the whole fish was calculated and the results tabulated on the following page.

Mr. Schmidt, Assistant Chemist, operating the 12-unit electrical Kjeldahl digestion and distillation apparatus acquired in 1948 to replace the original home-made gas apparatus used since 1928, and to facilitate analyses of interior provinces fishes

- Photo courtesy Film Board of Canada

Species	Scientific Name	Locality	Moisture	Protein	Ash	Fat	Calories per lb.
Bowfin	<i>Ameiurus calva</i>	Ontario	72.2	19.4	3.94	5.21	581
Ling	<i>Lota lota maculosa</i>	Ontario	80.9	15.1	2.56	2.16	372
Jackfish	<i>Esox lucius</i>	Sask.	75.6	18.5	3.31	3.56	495
Mullet	<i>Moxostoma rubreque</i>	Sask.	75.0	16.6	3.95	4.91	516
Tullibee	<i>Leucichthys tullibee</i>	Sask.	77.4	15.9	3.00	4.80	498
Pickereel	<i>Stizostedion vitreum</i>	Sask.	73.1	16.7	3.61	6.86	600
Whitefish	<i>Coregonus clupeaformis</i>	Sask.	74.6	16.0	2.84	7.01	592
Inconnu	<i>Stenodus leucichthys mackenzii</i>	Alberta	72.6	16.9	2.86	8.82	686
Goldeye	<i>Amphiodon alosoides</i>	Manitoba	70.8	16.9	4.80	7.98	650

The range and average value of the composition and the calorific value of the separate components of the separate components of the 16 species of freshwater fish analyzed were calculated and are recorded below:

Constituent portion of fish	Percent of whole fish represented		Moisture		Protein		Ash		Fat		Calories per lb.	
	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
Edible flesh	27.4-51.4	37.2	72.6-82.0	77.8	15.7-19.4	17.4	0.98-2.38	1.25	0.90-9.57	3.38	347-724	467
Skin from edible flesh	5.0-12.5	7.7	57.3-78.6	74.0	16.2-23.5	19.1	0.73-1.28	0.86	1.19-26.8	7.37	428-1431	666
Head	9.11-29.6	21.1	68.3-81.7	73.7	12.5-17.1	14.3	4.25-7.34	5.72	0.86-14.9	6.64	292-880	546
Bones, fins, scales, etc.	13.0-29.9	20.4	57.9-73.7	70.0	15.1-20.7	17.3	4.64-12.8	6.94	1.39-16.5	6.29	366-992	588
Viscera	6.5-21.6	13.6	44.7-80.2	68.3	7.85-25.3	14.6	0.33-2.95	1.47	5.56-46.3	15.4	482-2096	922
Whole fish	-	100.0	68.9-80.9	73.9	14.6-19.4	16.5	2.29-4.43	3.35	2.16-14.7	6.63	372-908	587

The samples analyzed showed a wide variation in oil content. Manitoba whitefish (from Lake Winnipeg) had a higher oil content than any of the other species and the value for the whole fish was approximately twice that obtained for 2 different samples of Saskatchewan whitefish. The oil content of each component of Manitoba whitefish was higher than that for the corresponding components of any other species analyzed. The oil content values for the whole fish was lowest in Ontario ling (2.16%) whose liver contains 25.7% oil.

The variations in calorific values are largely due to the variations in oil content, the protein content being relatively uniform.

SUMMARY NO. 35

INVESTIGATION OF WHALE AND FISH LIVER MEALS

N. E. Cooke  
P. J. Schmidt  
H. L. A. Tarr

In view of the fact that whale and many fish livers with a low oil content are obtainable on this coast it has been decided to investigate the manufacture of meals from these livers and analyze them for a nutritional source of protein, fat, mineral matter, vitamin A, riboflavin, thiamine, nicotinic acid, and vitamin B<sub>12</sub>. If the results indicate high levels of these constituents as would be expected by analogy with liver meals produced from cattle, it might be possible to use them as blending meals. Sample liver meals from four humpback and ten sperm whales have now been prepared in the lyophilizer and are being analyzed. It is intended to prepare samples of finback whales, salmon and halibut liver meal in the same way.

Although the most economical way to produce liver meals may be by some method other than lyophilization, this technique does give a product in which the vitamins and other factors have not been heated and it serves as the acme of perfection for a meal. Other samples will be prepared by the spray drier when it is installed. The results of the two series will be compared statistically.

SUMMARY NO. 36

ARMY ARCTIC RATION

N. M. Carter  
J. S. M. Harrison  
N. E. Cooke  
P. J. Schmidt

A request from Army for suggestions on a fish product to be included in a special Arctic luncheon ration was referred by the Department to the Station. The conditions and limitations imposed to meet Army expectations made some further information desirable in order to be able to meet the time element involved. It was decided to submit immediately some samples of the types of dehydrated cooked fish flesh product developed at the Station during the war (Prog. Rep. Pac. No. 56, pp. 7-9, 1943), and to experiment further with other types of material while awaiting additional information. One of the conditions imposed was a desired weight of 3 oz. with a calorific value of 400-450. Three ounces of pure protein can supply only 348 calories; hence a 3-oz. unit would have to consist of not less than 11.5% fat, and not more than 88.5% protein, exclusive of any moisture content whatever, to reach the minimum calorific value of 400. Allowing for a low moisture content, the calorific value is best retained by addition of a greater proportion of fat. Rancidity effects are thus invited.

Mr. Harrison prepared a type of deep-fried fish cake from canned sock-eye salmon that had been drained of excess moisture, then incorporated with sufficient whole-wheat flour to form a cake which was deep fried in lard to remove much of the moisture and to firm it. Sample cakes were individually wrapped in parchment paper and packed in cans which were given a thermal

processing. Such cans would serve as containers during storage, to be opened on the day of issuing the ration.

Mr. Cooke prepared a type of fish biscuit from salmon flesh that had been dehydrated by freeze drying while raw (see Summary No. 55). The raw "flour" was mixed with butter, salt, and an accepted antioxidant (Griffith's G-4) to retard rancidity since the bars need not be hermetically sealed for other keeping qualities, and baked in the form of bars. Typical analyses, performed by Mr. Schmidt, showed a content of 29.4% protein, 55.9% fat, 2.5% mineral ash, 12.2% moisture. The calorific value of such a 3-oz. bar would be 546.

Samples of the cakes and biscuits were submitted, and further samples are to be prepared in the light of additional information recently received from Army through the Department.

FISH AND WHALE OILS (INCLUDING VITAMIN A)

## FISH AND WHALE OILS (INCLUDING VITAMIN A)

### SUMMARY NO. 37

#### REVISION OF BULLETIN ON MARINE OILS

B.E. Bailey

The manuscript of the revision was sent to Dr. H.N. Brocklesby for criticism. He suggested a number of changes and additions. These were made, and the manuscript largely re-typed. Dr. Carter has since been going over the re-revised manuscript. At the time of writing the present report, Chapters 1 to 5 inclusive of the revision have been sent to Dr. Reed for arranging commencement of typesetting. The rest will be submitted as rapidly as the final internal editing progresses.

There are a total of 510 references in the revision, exclusive of those on specifications. Of that 510, approximately 215 are to papers published since the latest references given in Bulletin 59. A substantial number of 1949 references are included.

Of the two additional chapters which, as mentioned in last year's Annual Report (Summary No. 33, 1948), were still to be completed - one on specifications for marine oils in different countries, and one on analysis of marine oils - the latter has been completed (it was condensed and called "The Significance of Analytical Values.") In connection with the other chapter information has been obtained respecting specifications for marine oils in Norway, Sweden, Denmark, Germany, Belgium and France, in addition to the countries mentioned in last year's Annual Report (Summary No. 33, 1948). Much of this additional information has been translated and typed out.

### SUMMARY NO. 38

#### EXPERIMENTAL WORK IN CONNECTION WITH THE REVISED EDITION OF BULLETIN ON MARINE OILS

B.E. Bailey

(a) Variations in Iodine Value of Herring Oils. - Some processes in which pilchard oil was used require an oil of high unsaturation. The scarcity of pilchard oil made it advisable to find out if herring oil could be used instead. Herring oils do not generally have a high enough iodine value to make them suitable for many such applications. However, data in Bulletin 59 (Table LXIX, page 388) indicated that the iodine value of some samples of herring oil is unusually high. To provide more comprehensive information than is contained in that table, samples of bulk shipments of herring oil from the various parts of the B.C. coast and covering one entire season's production were obtained from Shafer-Haggart Ltd. (fishery-products brokers of Vancouver) for determination of iodine value. It was thought that perhaps the oil from one particular part of the coast at one particular part of the season might have an especially high unsaturation. Such oils could then be segregated and used for applications requiring an oil of high iodine value. However, the highest iodine value (of the 31 representative herring oils examined) was only 135; and no particular seasonal or geographical trend was found. The over-all range in iodine values was from 112.74 to 135.0. Apparently any wide individual variations in the iodine value of herring oil, such as had been reported by Brocklesby in Bulletin 59, are nullified by the mixing of bulk shipments in large tanks. The data obtained have been incorporated in the revision.

(b) Characteristics (Analyses) of Fish Oils.- To provide further data for the revised edition of the Bulletin on Marine Oils the following analytical determinations were made on various fish oils during the present year. Saponification value: 25 oils; free fatty acids: 19 oils; unsaponifiable matter: 23 oils; and iodine value (in addition to those in 2(a) above): 13 oils.

The data obtained have been incorporated in the revision.

SUMMARY NO. 39

THE CHEMICAL CHARACTERISTICS AND VITAMIN A POTENCY OF  
FRESHWATER FISH OILS

P.J. Schmidt

This work was a continuation of last year's investigation of the chemical characteristics and vitamin A potency of freshwater fish oils. (See mimeographed Annual Report for 1948, Summary No. 36). The data obtained during the year will be found in Industrial Memorandum No. 12 and in a subsequent memorandum.

The oil samples for these analyses were extracted from the liver, remaining viscera and body of 6 to 10 fish of ten different species. To determine the characteristic properties of these oils, the following tests were made: oil content, vitamin A potency, saponification value, percent free fatty acids, percent unsaponifiable matter and iodine number. A total of 144 determinations were made.

The following data includes the vitamin A potency of some of the oils examined:

Type of Oil	Scientific Name of Species	Liver or viscera as % of whole fish	Oil Content	Vitamin A U.S.P. units per gm. of oil
Alta. Common Sucker liver	Catostomus commersonnii	0.70	5.83	10,300
Ont. Bowfin liver	Amia calva	1.9	8.49	10,500
Ont. Ling liver	Lota lota maculosa	3.9	25.7	3,980
Man. Ling liver	Lota lota maculosa	6.0	35.8	2,050
Sask. Jackfish liver	Esox lucius	2.2	3.56	38,000
Sask. Tullibee liver	Leucichthys tullibee	1.1	9.74	54,600
Alta. Inconnu liver	Stenodus leucichthys	.91	4.28	52,000
Sask. Pickerel liver	Stizostedion vitreum	1.9	6.07	59,200
Sask. Whitefish liver	Coregonus clupeaformis	1.4	8.96	12,200
Sask. Tullibee viscera less liver	Leucichthys tullibee	4.6	8.37	22,000
Alta. Inconnu viscera less liver	Stenodus leucichthys mackenzii	7.4	51.2	1,440
Sask. Mullet viscera including liver	Moxostoma rubreque	14.4	6.90	1,772

The vitamin A assays were made on the unsaponifiable matter of the oils, using a Beckman Spectrophotometer. The conversion factor 2000 was used to convert E 1% at 325 mu to U.S.P. units per gram of oil. Only a few of the 1 cm.

visceral (less liver) oils were found to contain considerable amounts of vitamin A. Of the visceral oils assayed only those from the tullibee and from the inconnu possessed a potency of over 1000 U.S.P. units. None of the body oils were found to contain appreciable amounts of vitamin A, the potency ranging from 107 to 480 U.S.P. units per gram. The vitamin A assays indicated that the following liver oils possessed some vitamin A<sub>2</sub>: Saskatchewan and Manitoba pickerel, Ontario bowfin, Saskatchewan jackfish, and Alberta inconnu. None of the ling liver oils possessed the absorption spectra characteristic of vitamin A<sub>2</sub>. However the sample of Ontario ling liver oil examined last year did show indications of vitamin A<sub>2</sub>. Presumably, the presence of vitamin A<sub>2</sub> is not restricted to certain species. There were no indications that any of the body or visceral oils possessed vitamin A<sub>2</sub>.

The results of these analyses indicated that there was no consistent relationship between the chemical characteristics and the vitamin A potency. They showed, however, that oils with small amounts of unsaponifiable matter have a low vitamin potency. A high percentage of unsaponifiable matter does not necessarily indicate a potent source of vitamins.

Reported below are the average value and range of the analytical results obtained for freshwater fish oils from ten different species of fish.

Type of Oil	Fat Content %		Sapon. Value		Free Fatty Acids %		Unsapon. %		Iodine No.	
	Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
Liver	3.4 -40.8	12.8	168-191	183	2.01-59.9	33.3	0.71-10.8	7.14	112-171	140
Viscera less liver	0.81-51.8	14.7	171-200	186	4.88-29.7	16.2	1.45-9.90	4.84	108-178	138
Body	1.19-10.3	4.31	183-205	185	2.20-20.2	8.73	2.50-5.35	3.43	115-147	132

The high free fatty acid values indicate that the storage conditions of the fish were unsatisfactory prior to their arrival here from the interior provinces.

The results of the analyses indicate that the chemical characteristics of oils from different fish of the same species are not uniform.

#### SUMMARY NO. 40

#### CHARACTERISTICS OF BELUGA WHALE OIL

P.J. Schmidt

A sample of head oil and one of body oil were received from the Game and Fisheries Branch, Winnipeg, Man. Some characteristics of these oils are recorded below:

Sample	Sapon. Value	Free Fatty Acids %	Unsapon. %	Iodine No.	Vit. A U.S.P. units per g. oil
Head oil	297.0	2.54	3.12	32.6	500
Body oil	218.4	1.23	1.57	93.8	226

SUMMARY NO. 41

LIVER OIL PRODUCTION

L.A. Swain  
N.E. Cooke

On returning to Vancouver, after visiting the Atlantic Fisheries Experimental Station and discussing with Dr. Vandenneuvel his new method for liver oil extraction, a modified Waring Blendor cup with heating jacket was made. It was hoped that this method could be adapted to livers with a low oil content. Several solvents including butyl and amyl alcohols were used to extract salmon livers. In general the method worked but due to the inherent structure of the cup quantitative assay was impossible.

The method described by Dr. Vandenneuvel (Appendix No. 32, 1948 mimeographed Annual Report Atlantic Fish. Exp. Stn.) was applied to some dogfish liver which had been homogenized in a Waring Blendor, let stand a week, and re-homogenized before subdividing into small samples in test-tubes. Varying volumes of a solution of sodium hydroxide were added to 4 tubes. They were kept a few minutes at 50°C. with stirring, and then let stand. Similar sets were heated at 60° and 70°. The settled oils were decanted through anhydrous sodium sulphate. All showed the same vitamin A potency as oil extracted from some of the liver by steaming, probably due to the length of storage of the ground material. Further application of the method has been delayed, pending repair of a Blendor cup modified to his design.

SUMMARY NO. 42

VITAMIN OIL IMPROVEMENT

L.A. Swain

At the request of A.W. Nickerson and Co. of Prince Rupert an attempt was made at clarifying a sample of oil produced by that Company from preserved shark livers. It was viscous and turbid, resembling in appearance a cold herring oil. It was only partially soluble in fat solvents, and a definite residue remained on addition of acetone, resembling lecithin. However, while giving a positive test for phosphorus it gave a negative test for nitrogen. The oil contained 1.4% water, the removal of which by heating under vacuum left a clear dark oil which solidified on cooling. Addition of the oil to a large volume of dogfish liver oil formed a cloudy mixture which slowly separated to a clear brownish oil with a small settled sludge. This was essentially a method of increasing the vitamin A potency of the dogfish liver oil.

A very viscous black visceral oil was submitted by Solvex, Ltd. for possible improvement. It contained 5.5% unsap. Much of the colour was removed by a partial saponification which, however, increased the vitamin A potency only slightly due to loss of vitamin in the soap phase.

SUMMARY NO. 43

LIVER OIL FROM THE OCEAN SUN-FISH (MOLA MOLA)

L.A. Swain

A 48-lb. specimen of the Ocean sun-fish, Mola mola, was landed in Vancouver. Its liver, 730 g., was 3.4% of the weight of the fish. It contained 50.1% oil. The E 1%/1 cm. value at 328 mu on the oil was 0.147, and at 325 mu on the unsap was 0.105. The ultraviolet absorption curve of the oil showed no inflection for vitamin A, only rising values with shorter wavelengths. The oil was therefore of no value as a source of vitamin A.

## VITAMIN A STABILITY. (A) TEST

L.A. Swain

The dogfish liver oils prepared by several methods (described in mimeographed 1948 Annual Report, Summary No. 35-B) were again blown with air but for a longer period of time than before, yielding comparable results. The ether-extracted oil was the most stable, followed closely by the methylene chloride-extracted oil. The steamed oil was least stable, the alkali-steamed oil was slightly more stable than it. Peroxide values increased rapidly at the time of 50% loss of vitamin A. These conclusions follow from examination of 20 samples of oils for whole oil vitamin A, unsap vitamin A, and peroxide values.

Commercial extraction of liver oils in early days of the industry required preliminary removal of gall bladders from livers. This requirement is no longer followed carefully, especially with dogfish livers where the large number of livers handled together with the relatively inaccessible location of the gall bladder (compared for example with halibut liver) make the procedure difficult. The effect of bile on vitamin A stability in dogfish livers seemed worthy of examination. The bile was removed from two livers which were then ground and mixed thoroughly and divided in two parts. All the bile was then mixed with one of the two portions. The oil was separated from each portion by steaming and centrifuging, and spread on filter papers. The oil from the bile-free liver lost 50% of its vitamin A in 176 hours, whereas the oil from liver plus bile lost 50% in 189 hours. In other words it was slightly more stable, suggesting the bile to be possibly an asset.

Shaking a sample of dogfish liver oil with dilute alkali solution either cold or hot, or with a saturated solution of alum did not affect the stability of the oil appreciably, time for 50% loss of vitamin A being between 69 and 66 hours, for the original oil being 70 hours. However, shaking the oil with finely powdered alumina increased this time to 86 hours. None of these treatments affected either the vitamin A potency of the oil or its peroxide value.

## (B) IN LYOPHILIZED WHALE LIVER

A sample of whale liver meal, prepared by Mr. Cooke by lyophilization of liver, was subdivided and the samples (seven) were stored at 0°C., at room temperature, and at 29°C. in closed brown bottles and in open Petri dishes, and in a clear glass closed bottle at 29°C. under continuous illumination. A sample of each was periodically removed, destroyed by saponification, and the unsap extracted with ethyl ether for vitamin A determination. This was done by measurement of ultraviolet absorption at 325 m $\mu$ , by applying Osér's correction to this value (Anal. Chem. 21, 529) involving measurements at 312 and 336 m $\mu$  (41 samples), and for some by antimony trichloride reaction (21 samples).

The bottled samples at room temperature and at 0°C. retained 90% of the original vitamin A (325 m $\mu$  measurements) at 25 days, then dropped quite rapidly; that at 28°C. was lower in vitamin A potency than the others at all times. The samples in open Petri dishes dropped in potency immediately. Osér's correction reduced all potencies very materially, and soon caused "negative" potencies on samples which still gave a good blue colour with antimony trichloride, implying the inapplicability of the correction to these samples. The antimony trichloride values followed the 325 m $\mu$  determinations.

SUMMARY NO. 45

CHROMATOGRAPHY

L.A. Swain

(A) Fish oils.— The losses of vitamin A experienced in columns has been found to be due, in some cases, to incomplete elution of the vitamin by small volumes of methylene chloride, since ethyl ether produced almost quantitative recovery. This conclusion followed from experiments with activated alumina from five different sources.

Some of the unsaps prepared during Dr. Bailey's examination of liver oils for the Oil Bulletin revision were separated in columns of alumina by the procedure developed in this Laboratory (Summary No. 42, mimeographed 1948 Annual Report), with the following results. A sample of humpback whale liver oil unsap (8.6% of the oil) was similarly treated.

Liver oil from	% of unsap eluted by			
	Light petroleum	Methylene chloride	Ethyl ether	Methanol
Sunfish (Halifax)	17.4	10.5	77.3	14.3
Crab viscera	7.6	18.0	76.1	10.0
Spotted cow shark	10.5	9.8	80.2	3.7
Sleeper shark	4.4	13.7	85.5	4.2
Skate	3.6	60	25	12.9
Jew-fish	3.8	68.8	47.0	11.1
Sole	8.4	44.6	71.0	5.1
Basking shark	95.3	2.6	6.8	3.4
Humpback whale	8.1	61.6	25.3	5.0

(B) Separation of vitamin A and kitol in whale liver oils.— Passage of methylene chloride solutions of unsaps from humpback and from sperm whale livers through columns of alumina allowed elution of a vitamin A fraction possessing a characteristic vitamin A absorption curve. Elution of the column with methanol produced a fraction with an E maximum at 280-285 mu, which is characteristic of kitol. It was noted that continued passage of methylene chloride caused elution of kitol. Solvents as used by Gridgeman *et al.* (Analyst 73, 662, 1948) for the same purpose were also found satisfactory.

SUMMARY NO. 46

VITAMIN A DETERMINATION IN WHALE LIVER OIL

L.A. Swain

At the request of the Western Whaling Corporation a series of analyses for vitamin A was carried out by different methods on a sample of humpback whale liver oil, in each case using Canadian Reference Standard Vitamin A for calculation of results. Some of the results were published in Progress Reports No. 79, p. 40, and for convenience are repeated here. Determined on the unsap these values were as shown in the second column. The ultraviolet absorption values, corrected after Oser's method, are shown also.

Method	Vitamin A, U.S.P. per g.	
	whole oil	unsap
2000 x E at 328 or 325 mu. corrected after Oser	309,400	308,700
Antimony trichloride	183,600	197,500
Activated GDH	196,000	170,400
	155,200	

A fourth determination, by rat feeding test, led to the value of 150,000 units per g. The ultraviolet absorption method was expected to be high, because of the frequently reported extraneous absorption due to the recently named substance, kitol. In this case, Oser's correction resulted in values approaching the biological value.

Two whale liver oils, submitted by Western Whaling Corporation, gave the following results by different methods of vitamin A analysis. Here the extraneous absorption at 328 mu was much less, although chromatographic examination showed the presence of kitol.

Method	Vitamin A, U.S.P. per g.	
	Oil 1	Oil 2
Antimony trichloride	39,800	138,000
Activated GDH	33,000	116,000
2000 x E at 328 mu	42,000	142,000

At the request of Western Whaling Corporation several solvents were tried to determine the most effective for laboratory use in the determination of vitamin A and oil in humpback and sperm whale livers. Samples of finely macerated liver tissue were mechanically shaken with two portions of solvent, anhydrous sodium sulphate and sand. Duplicate determinations were made with each solvent used. Ethyl ether gave the highest figure for the humpback liver potency (E 1%/1 cm. at 328 mu being 4.45), then methylene chloride (4.32) and isopropyl ether (4.25); light petroleum was poorest (4.0). Two samples of the liver were destroyed by saponification and the unsap extracted (E=4.580), a value slightly greater than the ether-extraction value. The oil content of the liver was essentially the same with all solvents, about 5.5%. With sperm liver the check determinations were not too good, probably due to the non-uniformity of the macerated liver tissue. All solvents averaged to essentially the same result, E=4.38, the determination through unsap was 4.44.

#### SUMMARY NO. 47

#### ATTEMPTED CONVERSION OF KITOL TO VITAMIN A

L.A. Swain

In continuation of an experiment described in mimeographed Annual Report (1948) Summary No. 39, some finely ground humpback whale liver, with sodium carbonate added to pH 8.5 was heated on a steam bath for 0.5 hr. Samples of this and of the original liver were sealed in evacuated test-tubes and heated to 190°C. in a corn oil bath, requiring 25 minutes. All but one tube exploded. Samples as described below were destroyed by alkali, the unsap extracted and passed through columns of alumina to separate vitamin A from kitol. The E-values of the fractions were as follows:

Sample	Vitamin A fraction	Kitol fraction
	E 1%/1 cm. at 325 mu	E 1%/1 cm. at 285 mu
Original liver	3.39	0.85
Liver, heated with sodium carbonate at 100°C.	3.01	0.90
Original liver, heated to 190°C.	1.02	0.75

These indicate severe destruction of vitamin A at the high temperature, and slight loss of kitol possibly through conversion to vitamin A.

To check this conclusion in a larger scale experiment the "Oil Utility" apparatus, used in the past at this Station for hydrogenation studies, was nickel plated to overcome the contamination with iron of oil treated in it, and rewound with resistance wire since the previous winding had disintegrated. It was tested to 600 lb. pressure and found safe. Some sperm whale liver which had been previously mixed with water and had its pH adjusted to 8.5 was warmed to accomplish partial solution of the liver tissue (sample 1), was then heated at 15 lb. pressure for an hour (sample 2) (all by Western Whaling Corporation). Some of sample 1 was heated rapidly (20 minutes) to 200°C. (225 lb./sq. in.) with stirring in the Station's apparatus and held there 4 minutes (sample 3). Air was removed by blowing off steam. After maintaining this temperature for 10 minutes longer, sample 4 was withdrawn.

A 2-g. portion of each sample was destroyed by saponification and the unsap extracted. This was passed through alumina and fractions escaping with light petroleum, ethyl ether-light petroleum (1:3), and methanol were obtained. The ultraviolet absorption curves of the unsap and of these eluates were determined. These indicated -

1. Vitamin A was destroyed by the high temperatures, E-325 values of the ether-petroleum eluates being 0.65, 0.56, 0.28 and 0.22 in sample order 1 to 4.

2. Kitol may or may not have been appreciably destroyed, but other substances causing absorption at 285 mu appeared, for the E-285 values of the methanol eluates were 0.54, 0.68, 0.60, and 0.44 in sample order 1 to 4.

Attempted molecular distillation of a sample of humpback liver oil in a Hickman pot still was unsuccessful; there was serious loss of vitamin A although what recovery there was appeared in the distillate. Kitol apparently also disappeared. Unsap esters were concentrated into the initial distillate. The apparatus used was not adequate to the experiment.

#### SUMMARY NO. 48

#### VITAMIN A, MISCELLANEOUS

L.A. Swain

At the request of Mr. G. Cull, in charge of the laboratory of the United Fishermen's Co-operative Association, the procedures used by them for analysis of lots of dogfish livers were observed and found to be satisfactory; several minor suggestions for improvement were offered.

At the request of Western Chemical Industries three samples of margarine (two fortified with vitamin A and one containing none) were tested for vitamin A by the antimony trichloride reaction against Canadian Reference Standard Vitamin A. The results confirmed the labelling and pointed to errors in the local analyses. The blue colour developed was not truly characteristic of vitamin A, and an ultraviolet absorption curve was determined with the unsap of one of the fortified samples. It showed merely a continuously increasing optical density from visible to far ultraviolet, with a very slight inflection around 325 mu, which at 2000 x E-325 mu corresponded to 40,000 U.S.P. per g., over twice the stated potency. Activated glycerol dischlorhydrin (GDH) gave no trace of colour with the stock margarine in which no vitamin A was present.

A sample of oil, reputedly from Pacific herring, was analyzed for vitamin A at the request of Dr. Bailey because of its high claimed potency of 588 units per g. It showed a potency of 101 and 104 U.S.P. units of vitamin A per g. (2000 x E-325 mu via unsap) in duplicate determinations. The high value may possibly have resulted from failure to allow for the absorption at 325 mu resulting from the saponification process.

Since last year's report (Summary No. 45), 3 samples of dogfish liver oil have been prepared and distributed to 10 laboratories, together with ampoules of Canadian Reference Standard for vitamin A. Reports of the potencies found by them have been assembled and distributed to them without identification of the source of the results. This procedure has resulted in the rendering of assistance to several of the laboratories in the adjustment of their spectrophotometers.

#### SUMMARY NO. 49

#### HYDROGENATION

L.A. Swain

In the following experiments the "Oil Utility" apparatus was used, repaired as described above. In all cases the catalyst used was "Selectol A", a suspension of reduced nickel in hydrogenated fat, sold by E.F. Drew and Co., New York.

A. Pilchard oil.— Dr. Hoar, of the University of British Columbia, desired a series of oils of graded iodine value to be used in a goldfish feeding test, designed to determine their effect on the tolerance of the fish to sudden change in water temperature. A simple method of satisfying this requirement seemed to be by the hydrogenation of pilchard oil. Three samples of increasing saturation were prepared, using 25 lb. hydrogen pressure at 180°C., in the presence of 0.26% nickel. To increase the range of saturation, the experiment was repeated with more oil for a longer time, obtaining more saturated oils.

B. Herring oil.— The following experiments were done to determine the properties of hydrogenated herring oil in relation to the possibility of its use in margarine.

A sample of herring oil, obtained from the B.C. Packers, was hydrogenated at 25 lb. pressure of hydrogen and at 180°C. for four hours, using a small amount of nickel. A partial solidification was evident in late samples. Twice the proportion of catalyst gave a solid product in 2 hours; six samples were removed at hourly intervals. The 2-hour and 3-hour samples were separately melted, coloured with food colour, mixed with fresh milk in a homogenizer, and run slowly into ice-water with vigorous stirring. These were palatable, lacking fishy flavour. They were slightly granular in the mouth and had the typical "hydrogenation" odour. A similar run was made with a sample of salmon oil to show the conversion from red oil to white solid. These were used as demonstration samples for a talk on "Margarine" to the Vancouver Section of The Chemical Institute of Canada.

For use in margarine, a selective hydrogenation of the oil is employed to favour the production of "iso-acids". These iso-acids result from conversion of an unsaturated fatty acid from the naturally-occurring "cis-" form to

the "trans-" form, the latter having a higher melting point but the same iodine value. The hardening of a fat is then accomplished with less saturation of the fat, and desirable physical properties are conferred upon it. A sample of cold-cleared herring oil was obtained from the B.C. Packers and was alkali-refined. Portions were hydrogenated with two different concentrations of catalyst and at several temperatures and hydrogen pressures to determine the effect of these factors upon the rate of hydrogenation and development of iso-acids. In each of the eight runs made, samples were withdrawn periodically to introduce variation in the time factor also. On these samples the iodine value was determined for 42 and the % of iso-oleic acid in 17.

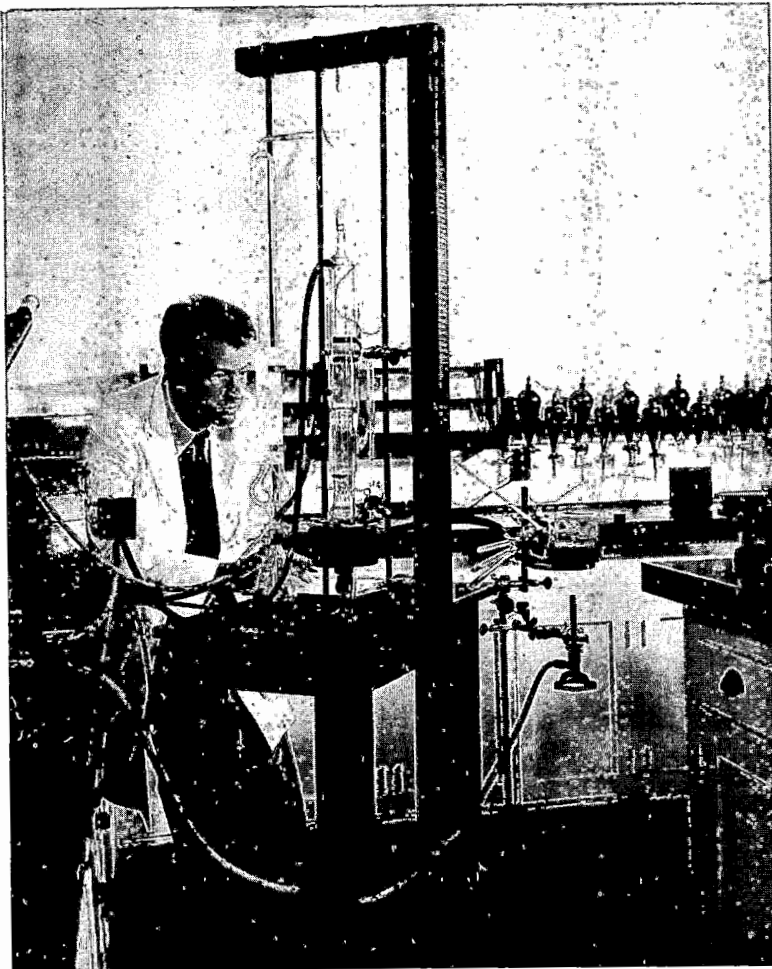
This investigation is actively in progress.

SUMMARY NO. 50

ELAIDINIZATION OF HERRING OIL

L.A. Swain

Elaidinization, the conversion of cis- to trans- fatty acids, raises the melting point of an oil. According to a recent publication it improves the stability of the oil to oxidation. Some preliminary experiments have been carried out to cause elaidinization of herring oil prior to its hydrogenation. So far, the products obtained with three different catalysts do not appear favourable, all becoming unpleasant dark oils during the process. There was a considerable development of iso-acids in them.



Dr. Swain, Associate Chemist,  
distilling whale liver oil  
under high vacuum, as described  
in Summary No. 47

- Photo courtesy of  
Film Board of Canada.

UTILIZATION OF WASTES  
(A) ENGINEERING  
(B) MATERIALS

UTILIZATION OF WASTES

(A) ENGINEERING

SUMMARY NO. 51

THE DESIGN AND CONSTRUCTION OF A PILOT PLANT  
FOR THE UTILIZATION OF FISH WASTE

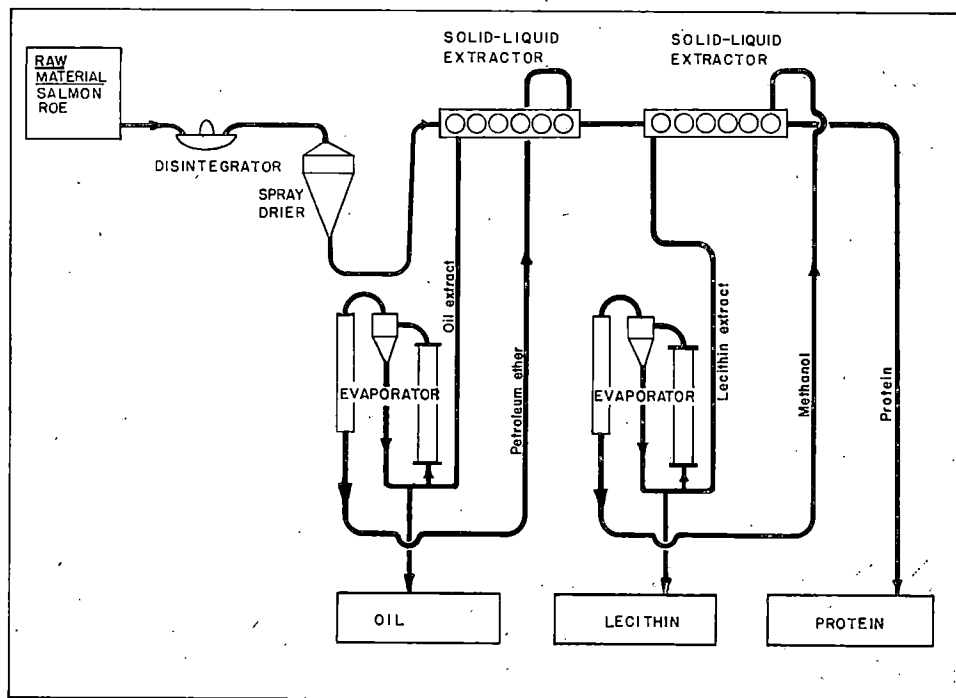
N. E. Cooke

This project is the outgrowth of various investigations carried out in past years at this Station by the writer and various other members of the staff.

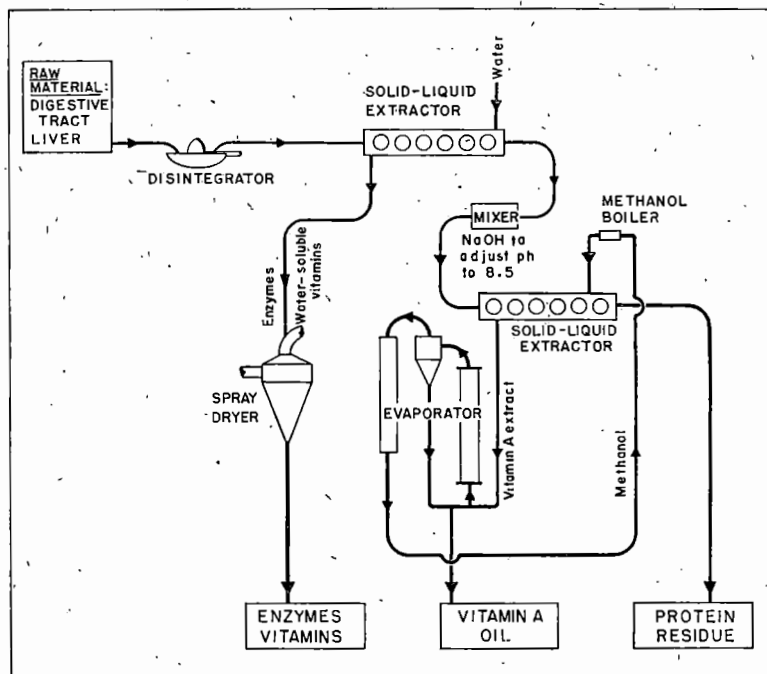
It has been felt for some time now that the investigation of chemical by-products from fish waste should be carried out on a somewhat larger scale than in the laboratory. This larger scale production is desirable so that data may be obtained both on the difficulties of production of the materials and on the costs involved. It is also desirable so that sufficiently large quantities of the by-products may be produced for examination by anyone interested in them.

At present it is planned to build and install the following machines; namely, a heat pump evaporator, a spray dryer, and a solid-liquid extractor. Arrangements have been made with Chemistry Department of the University of British Columbia to have this equipment erected in the Chemical Engineering wing of the Chemistry building.

Possible flow plans for treating certain portions of the waste are shown below. Following summaries Nos. 53, 54 and 55 describe these machines in more detail.



Possible flow plan for utilization of salmon roe



Possible flow plan for utilization of digestive tract or liver

SUMMARY NO. 52

THE DESIGN AND OPERATION OF A LARGE LABORATORY  
LYOPHILIZER.

N. E. Cooke

The principle of lyophilization is well understood since it merely consists of lowering the absolute pressure, above the material to be dried, below the triple point of water. Since at pressures below this point liquid water does not exist, any ice present sublimates. If a solution or mixture of water and other material is frozen the ice crystals form discretely and are separated one from another by particles of the other substance present. This is the well known eutectic formation. When this eutectic mixture is subjected to a high vacuum the ice crystals sublime, leaving a void. Through the voids created by the first layer of crystals the crystals of the second and subsequent layers sublime.

Drying is made up of two rate processes: the first, the rate of evaporation of water from the surface of the material; and second, the rate of diffusion of the water from the interior of the material to the surface. Although in lyophilization the rate of evaporation is slow because of the low temperature at which the process works, the rate of diffusion to the surface is almost infinitely fast because of the formation of the voids mentioned above. From the foregoing explanation, it is seen why it is possible to dry completely certain materials, which are extremely difficult to dry by conventional methods; for example, raw fish flesh.

This machine was built after visiting the Technological Laboratories of the U. S. Fish and Wildlife in Seattle and seeing a small model which they

had there. It was thought at that time that the applications of a machine of this type to work here would be manifold and this view has been well justified as is outlined below.

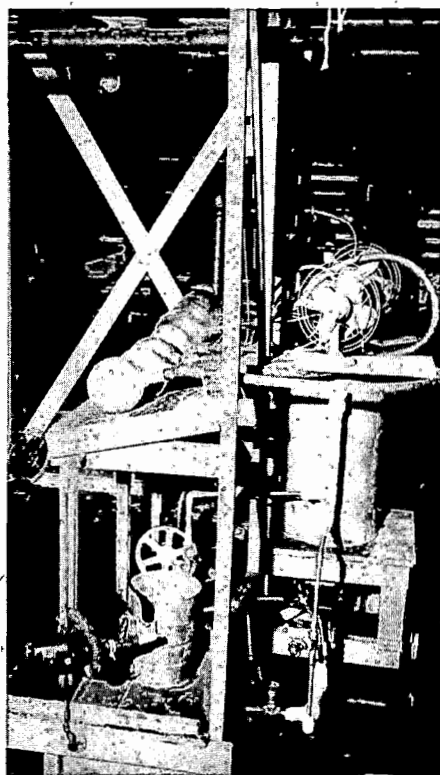
The first machine built here was patterned after the one in Seattle but, subsequently, it has been modified and improved to make it more versatile, and easier and cheaper to operate.

The machine now essentially consists of a large insulated condenser cooled with cold (-23° F) brine. To this condenser eight flasks can be connected. These flasks can be of any size up to three liters provided they are equipped with a 29/42 standard taper neck. The flasks can be charged with one quarter their volume of the material to be dried. The maximum charge, therefore, is six kilograms of material. This can be dried in approximately 24 hours.

This machine, as was anticipated, found wide use in the investigations being carried out at this station. It has been used extensively in the preparation of materials for the investigation of the growth factor for young trout (Summary No. 6); in the preparation of certain enzyme materials (Summary No. 59); in the preparation of liver meals (Summary No. 35); and in the preparation of salmon flour for the Army Arctic Ration, (Summary No. 36). It has also been used by Mr. Khan in the preparation of lipoxidase (Summary No. 4).

Several persons at the University conducting work with sensitive material have been assisted by the use of this machine. Miss Agnes Mehling of the Dept. of Bacteriology used it to concentrate Staphylococcus entrotoxin; Mr. R. Potter of the Dept. of Zoology used it to dry salmon milts in an investigation concerning testosterone; another senior student of the same department used it to dry some plankton which he was investigating as food for trout; and Miss Flora Norris of the Dept. of Dairying used it in an investigation concerning the formation of keto glutaric acid by bacteria.

In view of the great number of applications of this machine the writer feels that the time devoted to its design and construction was well spent. The accompanying photograph shows the machine in use.



The Station's Lyophilizer

SUMMARY NO. 53

DESIGN OF PILOT PLANT SPRAY DRYER

N. E. Cooke  
J. S. M. Harrison

In all design certain specifications and assumptions are used as a starting point. In this case it was desired to build a spray dryer capable of evaporating about 5 pounds of water per hour with the wet bulb temperature not greater than 100° F. For design purposes the incoming air was assumed to have a temperature of 60° F and a relative humidity of a 100%. In order to minimize any difficulty in atomization of the spray the diameter of the spray chamber was set at five feet.

From the literature it was found that for spray dryers operating in a similar temperature range the rate of evaporation is about 0.1 lb/ft<sup>3</sup>/hr. A dryer five feet in diameter, two feet high and with a hanging cone four and a third feet long gives a total volume of 67.7 ft<sup>3</sup>. The volume of the top neglecting the cone is 39.3 ft<sup>3</sup>. If only the top is effective in drying the rate will be 0.127 lb/ft<sup>3</sup>/hr; if whole volume is effective the rate will be 0.074 lb/ft<sup>3</sup>/hr. If the whole volume is effective and the rate is 0.1 lb/ft<sup>3</sup>/hr the feed will have to be 6.77 lbs of water per hour.

The efficiency quoted in the literature for this type of dryer is 20% - from air in, to water out. At 100° F the latent heat of water is 1037 BTUs/lb; therefore, it is estimated that 25900 BTUs are needed to evaporate 5 lbs of water.

Air at 60° F. and 100% RH contains 0.011 lbs of water per lb of dry air. The specific heat is 0.244 BTUs/lb dry air/°F. For air with a dewpoint of 60° F and a wet bulb temperature of a 100° F the dry bulb temperature is 237° F. The temperature of the air is to be raised 177° F and it is to take up 25900 BTUs/hr. Therefore 600 lbs of air per hour are needed.

When at a temperature of 237° F, air of this dewpoint has a specific volume of 17.8 ft<sup>3</sup>/lb. Therefore 178 ft<sup>3</sup> of air/min will be entering the dryer. It is good practice to keep the air flow entering the dryer at about 100 ft/min. The crosssectional area of the duct must be 1.78 ft<sup>2</sup>. Since the duct is to be two ft high it therefore must be 0.89 ft wide.

If 600 lbs of air picks up 5 lbs of water per hour it increases the water content 0.00833 lbs/lb of dry air. The total moisture in the air will therefore be 0.01933 lbs/lb of dry air. Assuming adiabatic cooling the air will now have a temperature of 200° F and a specific volume of 17.2 ft<sup>3</sup>/lb.

For proper cyclone action the air should enter at a speed of 3000 ft/min. To attain this speed the duct connecting the dryer to the cyclone must have an area of 0.0574 ft<sup>2</sup>; a diameter of 3.22 inches. Similarly the exit velocity from the cyclone must be 600 ft/min which sets the diameter at 7.25 inches.

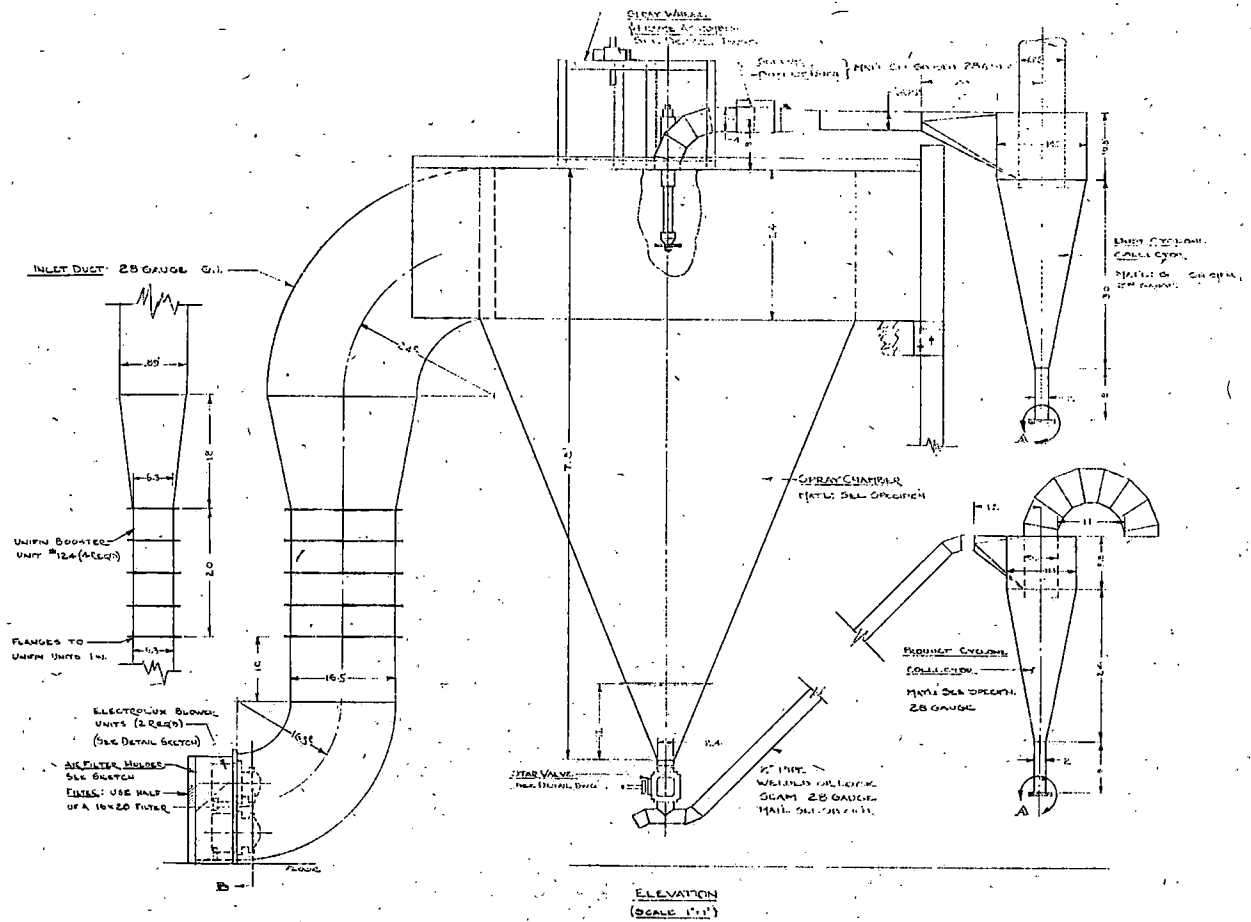
The heat to the air is to be supplied by Unifin Booster Units. Steam is available at 30 lbs/in.<sup>2</sup> The volume of incoming air at 60° F. is 133.5 ft<sup>3</sup>/min. Correcting this to 70° F it is 136.0 ft<sup>3</sup>/min. The velocity for good operation of Booster Units is 300 ft/min. Booster unit #124 has a face area of 0.50 ft<sup>2</sup> which is the closest obtainable to the desired area of 0.455 ft<sup>2</sup>.

Calculating according to the empirical formulas given by the manufacturers of Unifin units, it is found that at least six rows of tubes are needed. Since each unit has two rows of tubes, three units could be used. Since, however, it may be desired to elevate the temperature above 237° F at some time it was decided to use four units. The temperature of the air will be precisely controlled by regulating the amount of steam allowed into the heaters. This is to be done by an air-operated valve actuated by a wet bulb thermostat in the air stream. The amount of steam required will be 30.6 lbs/hr.

The pressure drop through eight rows of unifin tubes is 0.133 inches of water at a face velocity of 300 ft/min. The pressure drop over the rest of the apparatus is estimated at less than two inches of water. It was possible to obtain two "Electrolux" vacuum cleaner motors each of which is capable of delivering 160 ft<sup>3</sup> of air/min with a static head of approximately 10 inches of water. These will be controlled by regulating the voltage with a variable transformer.

The spray wheel is designed to turn at various speeds up to 10,000 revs/min. It will be made from a three inch spur gear cut away in the center. This allows the remaining portions of the teeth to act as a battering edge.

The dry material is removed through a star valve at the bottom of the cone and blown with a blast of cool air to the product cyclone. The air is supplied by a vacuum cleaner motor and the interconnecting pipe is two inches in diameter; this permits a velocity of about 4000 ft/min which is sufficient to carry the dust. The machine is now in the process of being constructed by the Coast Copper Smiths, a firm here in Vancouver. The accompanying diagram is one of the working drawings used for construction.



### Pilot plant spray dryer

#### SUMMARY NO. 54

#### THE DESIGN OF A SOLID-LIQUID EXTRACTOR

N. E. Cooke

In the design of an extractor it was desired to obtain a machine which would be relatively simple to construct and operate and yet would be versatile enough to allow the flow of both liquid and solid. Probably the best machine of this type yet invented is the Kennedy extractor which is used extensively in the processing of soyabeans. After some study of plans it was felt that this machine would be difficult and costly to construct and, therefore, a simpler one is being designed.

Essentially it consists of a cylindrical column made up of sections. Each section consists of a pot-like chamber with a radial segment of the bottom cut away to form a hole. These spaces are set at an angle one to another so that the solid can drop through one hole and light on the floor of the chamber below. Inside the chamber an axially-rotated pusher moves the solid material

through almost a complete revolution before it drops it through the next hole. The pusher is constructed in the form of a helix in order to baffle the liquid, which is flowing up the column, through the solid. The extracted solid is removed from the bottom by a mechanical compression device.

Although a small model of this machine has been constructed, it is only in the initial stages of design and no working drawings have been made of it yet. The design will be completed shortly and construction of this machine will start as soon as possible after that.

SUMMARY NO. 55

DESIGN OF A HEAT PUMP CONCENTRATOR

N. E. Cooke  
D. H. Taylor  
J. S. M. Harrison

One of the basic machines in the proposed pilot plant is to be an evaporator. The capacity of this machine was set at 5#/hr. to be in accord with the rest of the plant. It was decided to build a rising film model since this type is easy to construct and efficient to operate.

Recently there have been commercial installations in the U. S. A. of heat pumps in conjunction with evaporators. With the development of stick-water concentrating plants on this coast it was decided to equip this evaporator with a heat pump so that efficiencies could be studied and possible economies offered to the industry. It so happens that the Station possesses a small freon compressor with a heat output of about 5000 BTUs/hr which is approximately the heat required to condense and evaporate 5 lbs of water/hr.

Some of the materials which it is desired to put through this machine are relatively heat sensitive and the highest temperature which it is desired to have in the evaporating liquid is 100° F. For this reason the high temperature on the freon was set at 115° F. It was decided to condense the steam with the cold freon at 40° F. Using this information suitable heat exchangers were designed. The machine has been built by the Coast Copper Smiths and it is at present being installed at the University.

SUMMARY NO. 56

UTILIZATION OF WASTE FROM MARINE AND FRESHWATER PRODUCTS -  
REDUCTION

A. W. Lantz

The interest evidenced by this station in utilization of wastes from marine and freshwater products has resulted in an increased demand for information regarding reduction processes. Sketches, blueprints, data on materials, equipment and plant layouts have been assembled and mailed to individuals, industry or government in British Columbia's Windermere lake area, Alberta, Saskatchewan, Manitoba and the North West Territories. A plan for a reduction unit installed on a portable barge was included in material prepared for Dr. Bartram of Cambridge University, England, who is acting as advisor for the Eastern Mediterranean countries.

## UTILIZATION OF WASTES

### (B) MATERIALS

#### SUMMARY NO. 57

#### PROTAMINE FROM SALMON MILT

B. E. Bailey

(A) Studies on Methods of Preparation.- Small amounts of salmon milt are sold every year by the B.C. fishing industry as a source of protamine for combining with insulin. Salmon milt protamine has various other uses and potential uses, especially pharmaceutical but its commercial development has been retarded by the low and very variable yields which are obtained from the milt.

With a view to expanding the commercial utilization of salmon milt protamine by increasing the yield obtainable, a study was made of methods of preparing the protamine from the milt. The yields obtained by a recently-published method (Block, Bolling, Gershon and Sober - Proc. Soc. Exptl. Biol. Med. Volume 70, pages 494-496, 1949) were determined in comparison with those obtained by the method used at Connaught Laboratories, where the protamine for use with insulin in Canada is prepared. At the same time a comparison was also made with an older method (Kossel - Protamines and Histones, 1928, Method I, page 18.) A procedure involving various features of all three methods was found to give the best results but no great increase in yield was attained.

(B) Yields of Protamine from Different Species of Salmon.- This project was outlined in the 1948 mimeographed Annual Report of this Station (Summary No. 54). Nine samples of spring salmon milt, six samples of chum salmon milt, and one of coho milt have been examined. The yields from the chum salmon milt were consistently the highest, while the yields from the spring salmon milt were the lowest. The yield from the sample of coho milt was intermediate.

(C) Effects of Season and Locality of Catching on Protamine Yield.- The projected seasonal study was outlined in the 1948 mimeographed Annual Report (Summary No. 54). Some additional samples were obtained in 1949 to include the effect of locality of catching. Three samples of spring salmon milt from fish caught in July, August and September, 1948, showed a marked progressive increase in yield. On the other hand samples of chum salmon milt taken in August and September, 1948, showed only a slight, although progressive, increase in yield.

Comparisons were made between the protamine yields from milts of salmon caught near the upper limits of commercial fishing in a river (Fraser river) and at sea, adjacent to the mouth of the river on the same day. A sample of milt from spring salmon caught in the river in late August 1949 was essentially the same as that from sea-caught spring salmon taken on the same day. Similar results were found in the case of two samples similarly taken early in September 1949; but in another pair of samples also taken early in September 1949 the yield from the milts of the river-caught fish was somewhat higher than that from sea-caught fish.

(D) Effect of Cold Storage of Milts on Protamine Yield.- The impression exists among producers of both salmon milt and salmon milt protamine that the yield of protamine obtainable decreases during cold storage of the milts. In order to obtain definite information about this, 18 lb. of fresh chum salmon milt were divided up into individual 1-lb. samples, each in a separate small

glass jar. All were frozen at once and stored at  $-15^{\circ}\text{C}$ . Two samples were thawed and the initial protamine yield determined. It is planned to thaw and test the others at intervals of several months.

SUMMARY NO. 58

PROTEINS OF SALMON MILT

B. E. Bailey

As a fundamental approach to the development of new by-products from salmon milt, a study has been undertaken of the composition of the milt. Work thus far has been confined to separation and identification of the proteins.

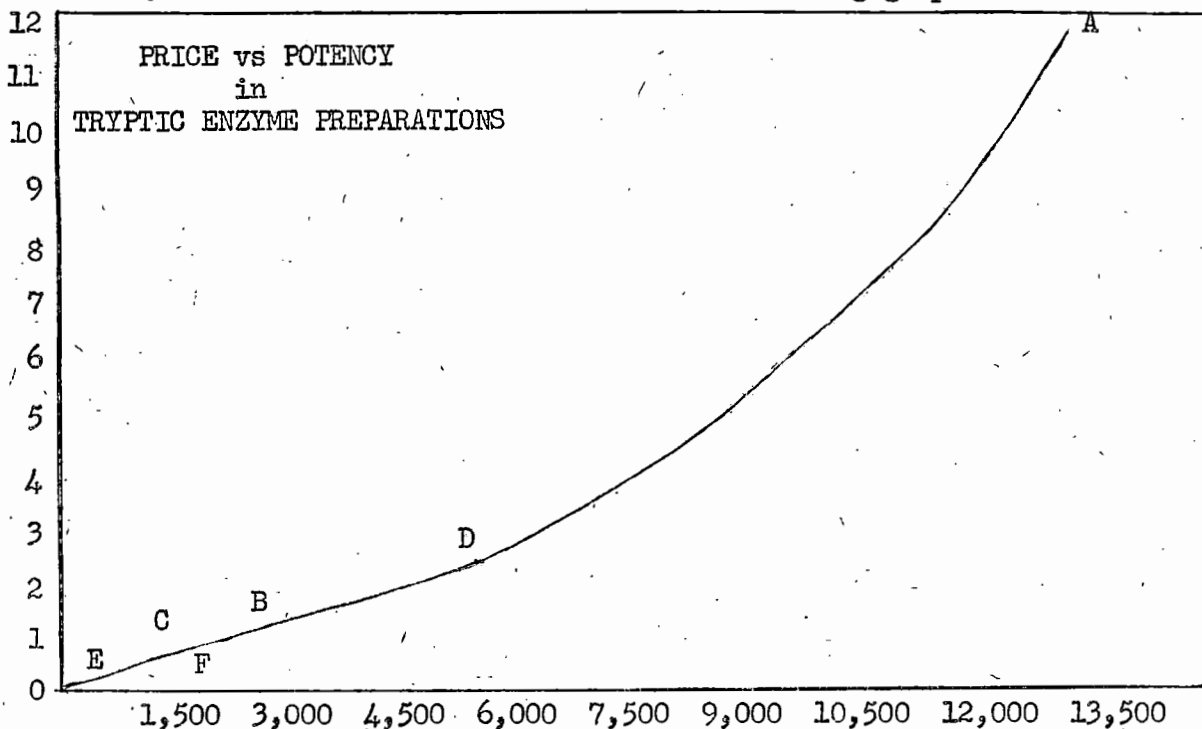
In addition to protamine and the nucleoprotein in which form at least part of it occurs in the milt, the following proteins have been found: two apparently distinct histones, a globulin, and a scleroprotein.

SUMMARY NO. 59

ENZYMES OF THE PYLORIC CAECA OF SALMON

N. E. Cooke

Subsequent to the work reported in last year's mimeographed Annual Report (Summary No. 53), some work has been done in an attempt to evaluate the worth of this material to the fishing industry of this coast. Several commercially marketed preparations were assayed in conjunction with preparations made by us. The results are shown in the following graph.



A Trypsin 1-300

B Pancreatin (sample 1)

C Pancreatin (sample 2)

D Pangestin 1-75

E Lyophilized pink salmon digestive tract

F Lyophilized extract of chum salmon caeca

From the value of these materials as estimated from the graph,  
 $E = \$.056/100 \text{ grams} = \$.256/\text{lb.}$

- 1 lb. wet digestive tract costs \$.01 to collect.
- 1 lb. wet digestive tract contains approximately .3 lb. of dry material.
- 3.3 lb. wet material contains 1 lb. of dry material.

Cost to collect 3.3 lb. = \$.033  
Then, assuming cost of drying = \$2.00/ton of water  
driven off = \$.001/lb.

For each lb. of dry material, 2.31 lb. of water is driven off at a  
cost of \$.002.

Although it is still too soon to make complete estimates, these two items constitute the major costs of production and amount to \$.035/lb. As pointed out, the estimated value of the material is \$.256/lb. The difference is \$.221/lb. More work along this line will be done. It is desired to compare our material with commercial leather bates and beef pancreas as well as with those materials already mentioned.

It is very heartening to note that one of the fishing companies is interested in leather bates and is now investigating these enzymes themselves. Several analyses of enzyme potency have been done for them.

#### SUMMARY NO. 60

#### INSULIN POTENTIALITIES OF HALIBUT AND LINGCOD

N. E. Cooke  
G. Campbell

According to a statement made recently by Dr. H. C. Best of the Banting Institute, the demand for insulin has been doubling every five years since 1930. The inference is that this increasing demand will continue in the future and the time may well arrive when the supply will no longer be adequate. He suggested that sources of insulin other than beef pancreas, from which our present supply is obtained, be investigated.

Around 1922 and 1923 an examination was made, at the Atlantic Fisheries Experimental Station, into the insulin content of certain Atlantic coast fish with some promising results. With this information as a basis it was decided that at the present time the potential importance of insulin would justify an investigation of west coast fish for this material. As mentioned in the mimeographed Annual Report for 1946 (Summary No. A24) a small amount of work was done on the insulin possibilities in some native fishes but the work was discontinued when it was found impossible to conduct assays of the material at this Station. Subsequent to the senior writer's attendance at the Board's Annual meeting in Ottawa last January he visited the Connaught Laboratories in Toronto and made arrangements to work in collaboration with that institution.

The fact that insulin deteriorates so rapidly necessitated preserving the material as soon as it was obtained from the fish. To make this possible one of us (G. Campbell) went to the scene of various operations with suitable apparatus for immediate freezing of the material. As a result it is hoped that very little loss of potency resulted from decomposition.

Three trips were made - one each to Halibut Areas 2 and 3 and a trip on a beam trawler to certain banks off the west coast of Vancouver Island.

From the first two trips to the Halibut grounds, a total of approximately 780 grams of the insulin-containing islet of Langerhans tissue was obtained. Part of this material was frozen in the natural state and the rest was preserved in a 0.3% hydrochloric acid-alcohol mixture. We were interested in discovering if there were any advantages in using the chemical preservative. The capsules which were made up of the insulin-producing cells were remarkably easy to find, and it was a matter of an instant to snip them off with a pair of scissors. Since halibut fishing involves individual hooks, the fish are brought into the boat at a fairly slow speed and no trouble was found in keeping up with the dressing of the fish in removing the islets. Since the capsules are so readily recognized after a few tries, it is felt that collection of them would not necessarily involve the need for extra personnel on the boat.

The trip on the beam trawler proved to be somewhat disappointing. Lingcod was the only species of fish taken which could be considered for our purposes and even this was found almost impossible. The islet capsules in lingcod are not so easily found as in the halibut and are easily confused with the large number of fat bodies found in the regions of the stomach and gall bladder. Moreover, the time element worked against this form of fishing. In trawling, a net is used and therefore comparatively large numbers of fish are brought into the boat at one time. Consequently they must be handled (dressed) very rapidly in order to clear the deck for the next drag. For this reason there was insufficient time to examine each fish properly to make sure of the capsule. At the present time it would seem that this type of fishing would not be suitable for insulin production.

SUMMARY NO. 61

INSULIN POSSIBILITIES IN WHALES

N. E. Cooke  
G. Campbell

As mentioned in last year's mimeographed Annual Report (Summary 58) some samples of whale pancreas were obtained and shipped to Connaught Laboratories for insulin assay. The results, although few, were promising and this year a more concentrated effort was made to obtain more and fresher samples.

It was planned to obtain five samples from the pancreas of each of ten sperm, finback and humpback whales. Unfortunately the required number of each species was not brought into the whaling station during the stay there. However, it is considered that we have obtained sufficient material for an adequate determination. The approximate weights of material obtained for each of the three classes of whales was:

Sperms	2500 grams
Finbacks	2100 grams
Humpbacks	1000 grams

This amount of material was obtained from ten sperms, ten finbacks (including one foetal whale) and four humpbacks.

All the material collected for this project has been shipped by air cargo to Dr. Fisher at Connaught Laboratories in Toronto for assay. A report of the findings will be published at the conclusion of the work.

SUMMARY NO. 62

LECITHIN, OIL, CHOLESTEROL AND PROTEIN FROM  
SALMON ROE

N. E. Cooke

In connection with the possible commercial exploitation of salmon roe, a large quantity (50 kilos.) has been fractionated over a period of time. The material is first dried by lyophilization and pulverized. It is then extracted with twice its weight of petroleum ether, then 3 more times with an equal weight of petroleum ether. This process removes the oil present. This oil is salmon-coloured and has the extraordinary property of not solidifying at low temperatures (-23°F.) while most other oils do solidify. Some samples, however, do become very viscous at that temperature but the others remain very fluid. This point should be investigated.

After the oil is removed, the material is extracted in the same manner with methyl alcohol and the phospholipids (crude lecithin) are removed. This lecithin behaves chemically in every way as other lecithins.

The protein material remaining is a buff-coloured substance. One attempt to produce a glue from this material was not successful. The work, however, will be repeated along other lines.

Several estimates of the values of these materials have been made but, since there are several important factors unknown, any estimate at this time is not exact enough to be of any true value.

SUMMARY NO. 63

DECOLORIZING CARBON FROM FISH SCALES

B. E. Bailey

This project was outlined in the 1947 mimeographed Annual Report (Summary No. 21D). Simple charring of fish scales (herring scales) failed to produce a very active product, even though several different temperatures and times of heating were tried.

It was found that addition of a small amount of either acid or alkali to the scales, and then leaving them overnight before carbonizing, gave a far more active product than simple carbonization of the untreated scales. Further studies of the effect treatment of the scales with acids and with alkalis have shown that different acids and alkalis have slightly different effects on the activity of the resulting carbon. The most active products resulted from pretreatment on the alkaline side with potassium hydroxide, and on the acid side with phosphoric acid. But still there appears to be a pH optimum, the best results being obtained when the treated scales were only slightly alkaline - at a pH of approximately 8.5 at the time of carbonization.

Activation of the carbon itself with high-pressure steam was tried but only a very slight increase in activity resulted.

Treatment of the scales with several different inorganic compounds which have been used commercially as activators in the manufacture of active carbon was tried out. However, none of these compounds nor a number of other compounds chemically similar to them, yielded products as active as those obtained when sufficient potassium hydroxide was added to bring the pH of the scales to approximately 8.5.

SUMMARY NO. 64

GLUE

L. A. Swain

A sample of glue, together with the oil and protein prepared from sockeye salmon waste by Mr. A. W. LePage were examined with the following results -

- glue (water - 50% by three different methods, ash - 1.8% containing only a trace of chloride)
- meal (oil - 18.4%, protein - 53.7%, ash - 22.6%)
- oil (f.f.a. as oleic acid - 0.37%, vitamin A by unsap - 60 U.S.P./g.)

Three samples of oils separated during development of his process were examined earlier in the year with the following results -

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Source of oil	Vitamin A U.S.P./g.	% f.f.a. as oleic acid
Coho	89	1.4
Salmon	670	3.0
Coho & dog salmon	810	1.6

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Meal submitted at the same time was 19.0% oil, 16.6% ash, and 49.5% protein.

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SUMMARY NO. 65

VISCOSITY OF "FISH SOLUBLES"

L. A. Swain

At the request of the B. C. Packers the viscosity of a sample of fish solubles, coming into production at their Steveston plant, was determined with a Stormer Viscometer. The results showed the thixotropic nature of the preparation, faster rotation of the inner cup decreasing viscosity markedly. Determinations were made at 30° and 40°C., using simultaneous determinations with castor oil for calculation of the viscosity.

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Driving wt., g.	Viscosity in poises at temperature	
	30°C.	40°C.
100		357
200	184	77
500	59	44

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MISCELLANEOUS PROCESSING DEVELOPMENTS

## MISCELLANEOUS PROCESSING DEVELOPMENTS

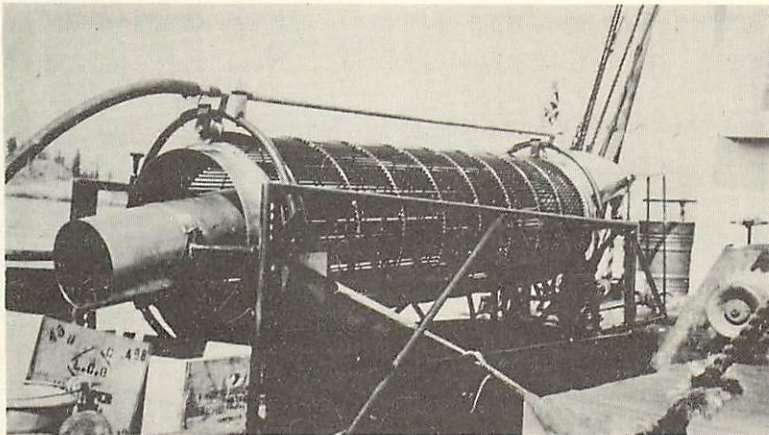
### SUMMARY NO. 66

#### A DEVICE FOR SORTING AND CLEANSING SHRIMP DURING FISHING OPERATIONS

A.W. Lantz

Requests from shrimp fishermen for a simple apparatus to clean shrimp of seaweeds, silt, etc. led to the development of a device which sorts and cleanses shrimp in a single operation. This device was reported briefly in Progress Reports No. 79, p. 41 from this Station.

The apparatus was designed to fit the framework of the flesh and bone separator described in Progress Reports No. 73, p. 58, 1947. The present device consists of three concentric barred cylinders revolved together on their longitudinal axis. Spacing of the parallel bars, covering of the metal with "Lithcote" enamel and direction of water spray are the features of the machine's effectiveness. Operation may be by hand or from the engine shaft of the shrimp-fishing vessel.



The shrimp-sorting device (showing delivery end) as installed for demonstration on a commercial shrimp-fishing vessel.

The shrimp as caught are fed into the central cylinder. The water spray cleanses during sorting of the shrimps into three recognized commercial sizes that are delivered from the ends of the annular spaces into suitable receptacles. Shrimps below commercial size are delivered from the outer cylinder to the deck or scupper of the vessel whence they may be returned to the sea sufficiently rapidly to retain vitality for survival.

The device has been tested on shrimp-fishing vessels in the Vancouver area and at time of writing is in the Prince Rupert area where two fishing companies have requested its use for test runs. A member of the Nanaimo Station staff is making observations regarding conservation of the under-sized shrimp.

### SUMMARY NO. 67

#### A SCREEN FOR WASHING FISH PRIOR TO FILLETING OR DRESSING

A.W. Lantz

Experience with operation of the flesh and bone separator developed at this Station during 1947 (Pacific Progress Reports No. 73, p. 58, 1947) led to trial of other types of screens of somewhat different design to those originally used. A six-sided screen made from unpressed expanded monel screen (1/2 inch mesh) was designed for washing fish prior to filleting. This screen proved very effective as a scaler for herring and anchovies, (Pacific Progress Reports No. 77, pp. 114-115, 1948). Recent tests in the Prince Rupert area using the screen as a scaler for scaling coho which were free from skin

discoloration were successful. Scales on chum and discolored coho were not readily removed by the screen. The screen was demonstrated as a washer at the Fishermen's Co-operative Plant at Prince Rupert. Discolored coho salmon and chum salmon were scaled by hand using a curry comb. Following this the fish were cleansed effectively in the screen washer.

Laboratory experiments to determine the efficiency of the screen as a washer were conducted at this Station in collaboration with Dr. H.L.A. Tarr. Results of these tests are reported elsewhere in Summary No. 3.

SUMMARY NO. 68

AN ANCHOVY GIBBING MACHINE

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

Observations on the commercial canning of anchovies in this locality have shown that a great deal of time and labour are consumed in "gibbing" the fish. This can be readily understood as the number of fish averages twelve to the one-quarter pound can. Cannery on the United States Pacific coast have developed and are using a machine which performs the operation by beheading the fish and then removing the viscera by means of a vacuum pump. This machine, although effective, is very costly and it was felt by us that a simple machine could be developed which would closely duplicate the hand "gibbing" operation.

The hand operation of gibbing anchovies consists of cutting just through the backbone behind the gills with a knife and then moving the knife away from the body of the fish in the direction of the fish's longitudinal axis. The viscera, which is permitted to remain attached to the head of the fish below the backbone, is thus removed along with the head. A device was built which performed the above operation in the following manner. The fish is conveyed first under a rotary knife which makes the required cut through the backbone and then under a curved leaf spring which is stressed to a straight position, the spring now being located in the backbone cut. The spring is then released ejecting the head and viscera attached to it.

The above-mentioned device was found easily adaptable to the herring gibbing machines commonly used by fish canneries in B.C. These machines have the necessary conveyor belt, fish holders and rotary knife and with the addition of the curved spring and its stressing and releasing attachments comprise the complete anchovy gibbing machine. Since there are herring gibbing machines in almost every fish cannery in B.C. and the cost of the attachments for converting them is only in the neighborhood of ten dollars anchovy gibbers are now available to canners at virtually no cost whereas vacuum machines cost approximately three thousand dollars. The machine has been demonstrated to all the interested local representatives of the fishing industry who were favourably impressed. (Patent proceedings are under way.) The patentability of the attachments are being investigated before the developments are fully described in our publications.

SUMMARY NO. 69

ULTRA-VIOLET RAYS FOR DETECTING SHELL IN PICKED  
CRAB MEAT

S. W. Roach

Pacific Progress Reports No. 79 of July 1949 included an article describing experiments conducted at this Station to test the feasibility of using ultra-violet rays to detect shell in picked crab meat. These experiments showed that the shell and skeletal fragments fluoresce when exposed to ultra-violet light which phenomenon greatly simplifies their detection and removal from the crab meat.

SUMMARY NO. 70

HOT WATER GENERATOR

A. W. Lantz

A modified U.S. Navy fog generator was loaned to this Station to test its capacity to produce boiling water quickly and inexpensively. It is our opinion that this equipment may prove of definite value for canneries and small processing units in remote areas. In the northern regions such as Great Slave lake a major problem is the procuring of adequate supplies of fuel. The above mentioned apparatus uses fuel oil which is the only fuel readily available. The apparatus, as installed for tests in the Station's engineering laboratory, shows near the left-hand side of the photograph of the vacuum-closing canning machine reproduced in the Director's Report.

SUMMARY NO. 71

CONSULTATION

A. W. Lantz

In June of this year Mr. Dempsey, Supervisor of Fisheries at Winnipeg, requested the writer to make a survey of operations at Hay river, North West Territories, and to recommend methods for improving operations. A detailed report was made including a suggested plan for either a dock or shore installation including processing units and reduction plant. Mr. P.J. Schmidt accompanied the writer, for the purpose of becoming acquainted with the Industry personnel and the commercial handling and processing of freshwater fish. Mr. G. Clarke, Director of Western and Inland Fisheries and Mr. Dempsey expressed the appreciation of the Department of Fisheries for the work done by this Station. We have been told that some features of the report are under consideration by the Industry.

A member of the Industry operating a plant at Hay river visited this Station for further details regarding construction of buildings for cannery, processing plant and a reduction unit.

MISCELLANEOUS

MISCELLANEOUS

SUMMARY NO. 72

ULTRA-VIOLET ABSORPTION SPECTRUM OF A BACTERIOLOGICAL  
PREPARATION

L. A. Swain

The ultra-violet absorption spectrum of a solution of a toxin was examined with the Beckman Spectrophotometer for a graduate student in Bacteriology at the University of British Columbia in hopes of finding an absorption band suitable for identification purposes. The search was successful, the absorption increasing smoothly as shorter wavelengths were approached.

SUMMARY NO. 73

RAT COLONY MAINTENANCE

N. E. Cooke

For a great many years now this Station has maintained a rat colony for use in vitamin assays and other work which arises from time to time.

At present, no experimental work is being done using the rats, and therefore, the colony is being kept at a minimum. To keep it virile, however, it is necessary to periodically breed the rats and select the best of the litters to perpetuate the strain. The colony is cared for by Miss Iris Smith who deserves considerable credit for the efficient way the colony is run.

SUMMARY NO. 74

SPECIAL MISSIONS FOR THE FISHERIES DEPARTMENT

O. C. Young

It may be recalled that in 1948 the Fisheries Department commenced developing a scheme to further stabilize and possibly expand the fishing industry. In order that the development be on a sound basis, it was felt that more use should be made by the industry of the scientific knowledge already available. It has long been felt by both the Department and the Fisheries Research Board that there is much too great a lag between research and application, and ways of reducing this lag have been the subject of much discussion.

A scheme proposed within the Fisheries Department involved the setting up of a technical consulting service for all branches of the industry. This service was to supply not only biological and technological information on fishery operations but helpful advice and recommendations as well. Where needed, plans and specifications were to be prepared and some degree of inspection provided, particularly in new ventures in the engineering field.

Actually the Fisheries Research Board through its various biological and technological Stations has been giving services much like those proposed by the Department though with not quite as broad a scope. Therefore the Deputy Minister suggested that a memorandum be prepared covering the present status of the various branches of the fishing industry in relation to technical information available and observations made where further research may be required.

Such a memorandum was prepared by the writer in January of this year. It comprised some 25 typewritten pages and discussed Fisheries Development in

Canada under the four arbitrary divisions, catching, storage, processing and distribution. These divisions were further broken down as follows:

1. Catching: (a) boats; (b) gear; (c) lures.
2. Stowage: general; (a) uniced; (b) iced; (c) other forms of cooling; (d) freezing on board; (e) salting.
3. Processing: (a) fresh; (b) frozen; (c) canning; (d) salting; (e) smoking; (f) pickling; (g) by-products.
4. Distribution: general; (a) transportation; (b) wholesale; (c) retail.

Copies of this memorandum are on file in the Fisheries Department, Ottawa, in the Fisheries Research Board, Ottawa, and at the Vancouver Station.

- - - - -

In the latter part of September at the request of Mr. Stewart Bates, Deputy Minister of Fisheries, through Mr. George R. Clark, Director of Pacific and Inland Fisheries, a survey of the cold storage facilities for the holding of frozen fish in the city of Toronto was made.

It appears that the need for the survey arose out of the varied reactions from public cold storage warehousemen, fishing companies and wholesale fish dealers in Toronto, to the programme of development of the fisheries of Canada proposed by the Minister of Fisheries in the earlier part of the year.

The Minister's intimation that improved cold storage facilities might be necessary to carry forward the Department's plans, was taken by some, as a statement of Government intent to set up those facilities in different localities.

Cold storage warehousemen in Toronto were opposed to the setting up of any further public facilities in that city and made the claim that the Toronto facilities were adequate and of a high standard. Fishing companies and some wholesalers, on the other hand, claimed that improved facilities for the holding of fishery products were needed. These conflicting views were confusing, therefore the survey was undertaken.

The survey covered those public cold storage warehouses in which fish would be a welcomed commodity; all the wholesale fish dealers; several retailers; and some brokers. The results revealed the anomalous situation that although ample facilities for the holding of frozen fish in public cold stores are available in Toronto, that space was not being used by fish wholesalers whose own facilities were entirely unsuitable for the storage of frozen fish. Rather than use the public facilities these wholesalers contemplate building new plants.

A confidential report on the survey gives the results in detail and outlines four courses that could be followed by Government Agencies in dealing with the Toronto area. Copies of this report are on the files of the Department and the Fisheries Research Board as well as at the Vancouver Station.

SUMMARY NO. 75

AMBERGRIS

L. A. Swain

A sample of "ambergris" from the digestive tract of a male sperm whale landed at Coal Harbour (Western Whaling Corporation) was ambergris by the qualitative tests used for identification. A prospective buyer refused the material, and further examination was given it. None of the material distilled with steam. The alcohol-soluble portion did not separate needles of ambrein when cooled. Other results fell within the ranges published for ambergris -

% unsap	85.7
% cholesterol	1
Alcohol-soluble portion	93.5%
- consisting of glycerol	0.6%
- fatty acids	5.8%
- unsap	85.9%

Chromatographic analysis of the unsap by the writer's method implied the unsap to be over 80% monohydroxy alcohols.

A 4-gallon sample of putrefying reddish fleshy-appearing material was submitted for examination with the firm belief that it was ambergris. Acetone extraction showed it to be 17% solids, 56% oil and 27% water. It was not ambergris.

A sample of "ambergris", submitted through the Provincial Department of Fisheries, resembled a piece of Parowax and did not give the qualitative tests for ambergris. It was almost insoluble in ethanol, and passed completely through a column of alumina in light petroleum solution, indicating it to be of hydrocarbon nature. It was not ambergris.

Some six or eight additional samples of other submitted substances were tested by Dr. Carter, only one of which was ambergris. It had been found several years earlier.

SUMMARY NO. 76

TECHNOLOGICAL ASSISTANCE FOR THE EASTERN MEDITERRANEAN COUNTRIES

A. W. Lantz

Dr. G. C. L. Bartram, advisor to the Eastern Mediterranean countries, visited this Station in September. He requested as detailed suggestions as possible for the establishing of processing, cold storage and freezer units, including data regarding equipment and reduction processes. Consequently, blueprints, sketches and photos of installations on barges were prepared. Processing procedures for washing, butchering, dressing, packaging, freezing and storing fish products were included. The completed data were mailed to him at St. John's College, Cambridge, England.

SUMMARY NO. 77

NANAIMO STATION FIRE HYDRANT SYSTEM

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

A trip was made to the Nanaimo Station on request from the Pacific Sub-Executive to examine the existing Nanaimo Station fire hydrant system and the proposed changes. A report was submitted giving our recommendations.

SUMMARY NO. 78

CONSULTATION

H. L. A. Tarr

A variety of samples have been received with requests for determination of vitamin B<sub>12</sub>, and the necessary tests have been made where possible. Requests for information on the following subjects have also been answered: preparation of canned baby food from halibut, preparation of chilled shrimp cocktail in a manner calculated to avoid rapid bacterial spoilage, use of lemon juice concentrate to control rancidity in fish flesh, reason for the non-bacterial softening of black cod flesh (tests indicated this was not due to myxosporidiosis), desirable germicides for use in fish plants, bacterial spoilage in a mild cured type of product made from chum salmon.

SUMMARY NO. 79

VESSEL REFRIGERATION

D. H. Taylor

Enquiries continue to be received for information on principles of fishery vessel refrigeration, such as methods of applying chilling or freezing temperatures in the hold, conservation of ice, construction of holds, and installation of insulation. Frequently such requests involve only discussions with, or calculations for, the interested party, but have at times also involved demonstrations, laboratory or field work. Proposals of some enquirers fail to materialize, and our follow-up of certain other proposals is difficult.

Summary No. 11 of last year's mimeographed Annual Report summarized some preliminary assistance given in connection with unsatisfactory operation of refrigeration on a commercial fish transport scow. About a week was spent this year in trying to determine the cause of the difficulty. Accurate instrument readings of air velocities and temperatures were difficult to secure because of bends in the duct work, and no conclusive results could be obtained. It was thought, however, that a contributory cause of inefficiency was infiltration of hot engine-room air into the return-air header. Further data on the superheat through each branch of the multi-circuit refrigerator coils would be desirable. One or more branches may be flooded and the rest starved, due to either a faulty distribution or faulty positioning of same.

SUMMARY NO. 80

MISCELLANEOUS INVESTIGATIONS

B. E. Bailey

Some work was done on pressing of pressure-cooked fish waste, using the laboratory hydraulic press. This work, which was done principally as a demonstration, was specifically for Gordon Young (B.C. Ltd.), fish- and meat-meal producers.

Assistance was also given to a Fraser valley fur farmer in connection with overcoming the toxic effect (Chastek paralysis) in feeding raw fresh-water fish to his animals.