Progress on Projects, September 1953

REFRIGERATION: Freezing Fish at Sea, Defrosting, Filleting, and Refreezing the Fillets: VESSEL: Two attempts were made by the research trawler Delaware to carry out full-scale fishing and freezing fish at sea operations. After about 16,500 pounds of haddock had been caught and brine-frozen, the first of these test cruises (Cruise No. 22, completed August 24) was interrupted due to difficulties with the ammonia pumps of the refrigerating equipment. The catch from the 5-day cruise consisted of 14,000 pounds of scrod haddock and 2,500 pounds of large haddock. These fish were caught and frozen during about one day of round-the-clock fishing and freezing operations. Two types of chutes, both still in the experimental stage, for moving the frozen fish from the freezer tank to the frozen storage holds were tested. Results obtained with the chutes were quite favorable.

After 44,000 pounds of groundfish had been caught and brine-frozen, the second of these cruises was terminated September 4 due to the jamming of the elevator chains of the brine-freezer mechanism. Fishing took place on Western Bank in the area of Sable Island. The catch on this 9-day cruise consisted of 25,000 pounds of scrod haddock, 14,000 pounds of large haddock, 4,000 pounds of cod, and 1,000 pounds of pollock. The haddock and scrod haddock were sold over the New England Fish Exchange to fillet processors, while the cod and pollock were stored in commercial cold storage by the laboratory for obtaining data on the cold-storage characteristics of these fish.

During the month the ammonia pumps were repaired and the elevator chains revised to eliminate the difficulties experienced during full-scale continuous operation. Also, additional fuel tanks on the vessel were placed in good condition so as to permit longer test cruises and extended periods of fishing.

(Boston)

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BYPRODUCTS: Vitamin Content and Nutritive Value of Fishery Byproducts: Analyses were made of 23 samples of menhaden meal for riboflavin content. The results were:

Meal	Number of Samples	Riboflavin (micrograms per gram, as received)		
		Maximum	Minimum	Average
Menhaden	23	5.8	2.0	3.2

One sample of crab meal showed 11.9 micrograms of riboflavin per gram of meal, as received.

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NUTRITION: Discoloration in Canned Tuna: The technologist assigned to the project visited the plant and laboratory in Chicago of the can company sponsoring the project to obtain basic information on the manufacture of cans and can enamels, and for current data on the problem of discoloration in canned tuna. A trip was also made on a commercial tuna fishing vessel operating out of a California port. Samples of albacore tuna were o

tained for the preparation of experimental canned packs. The samples of raw fish will be handled and treated in various ways in an attempt to determine the conditions that lead to sulfide discoloration after canning.

(Seattle)

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ANALYSIS AND COMPOSITION: Composition of Fish: The proximate composition of individual samples of sheepshead (Aplodinotus grunniens) from various areas and of squawfish (Ptychocheilus grandis) from the Columbia River was determined. A detailed study is being made of the variation in composition of sheepshead from different areas and for different seasons of the year. The results are as follows:

Composition and Fillet Yield of Sheepshead Caught in Clearwater Lake, Minnesota, May 1953

Sample Number	Length	Weight	Fillet Yield	Proximate Composition of the Edible Portion			
				Moisture	Fat	Protein	Ash
	Cm.	Grams	Percent	(Percent)			
1	25.0	140	28.9	83.4	0.74	15.6	0.96
2	24.5	135	29.6	83.3	0.90	15.7	1.02
3	24.5	145	24.1	82.5	1.20	15.9	1.15
4	26.0	145	24.1	83.3	1.17	15.9	1.00
5	25.5	150	30.0	82.5	1.21	16.7	1.05
6	24.5	145	32.1	83.5	1.47	15.6	1.08
7	26.0	165	39.4	82.4	0.80	16.1	1.06
8	28.0	205	31.7	83.2	0.92	16.4	1.07
9	28.0	200	32.5	81.8	1.00	16.4	1.13
10	27.5	210	23.8	82.5	1.24	16.7	1.05
11	26.5	175	40.0	82.5	1.14	16.4	1.03
12	28.5	235	29.7	82.4	0.83	16.6	1.15
13	28.5	215	32.5	82.2	0.72	16.1	1.10
14	29.0	225	29.0	83.1	0.72	15.7	1.02
15	33.0	325	29.0	81.8	1.67	17.0	1.05
16	28.5	265	24.5	83.0	0.90	16.1	1.15

Composition of Sheepshead (Edible Portion) Caught in Lake Winnebago, Wisconsin, July 1953.

Sample Number	Length	Weight	Proximate Composition of Edible Portion			
			Moisture	Fat	Protein	Ash
	Cm.	Grams	(Percent)			
1	37.0	425	82.6	1.23	15.5	1.00
2	36.0	460	84.3	0.71	15.6	0.95
3	39.5	575	82.1	1.79	16.7	1.04
4	39.0	525	83.3	0.89	14.8	1.00
5	38.0	570	82.6	1.20	16.3	1.00
6	36.5	520	81.4	2.00	17.1	0.90
7	33.5	525	70.3	15.3	14.9	1.14
8	36.0	475	81.3	1.91	17.0	0.98
9	35.0	390	82.5	1.33	16.1	1.03
10	33.0	455	75.7	9.8	15.3	0.91
11	34.0	470	82.5	2.33	16.2	0.94
12	35.0	425	82.7	1.00	17.0	1.07
13	48.5	1330	82.7	1.71	15.7	1.00
14	42.5	665	84.6	0.56	14.5	0.97
15	38.0	640	82.7	1.15	16.1	0.95
16	37.0	555	83.3	0.64	15.6	1.05

Composition of Sheepshead (Edible Portion) Caught in the Mississippi River, May 1953

Sample Number	Length	Weight	Proximate Composition of Edible Portion			
			Moisture	Fat	Protein	Ash
	Cm.	Grams	Percent	Percent	Percent	Percent
1	31.5	395	76.0	4.75	18.1	1.15
2	29.5	325	75.4	5.36	18.1	1.15
4	27.5	255	79.4	1.45	17.9	1.12
5	33.0	420	72.5	9.08	16.9	1/
6	31.5	435	73.6	7.30	17.6	1/
7	33.0	425	74.8	8.58	17.1	1/

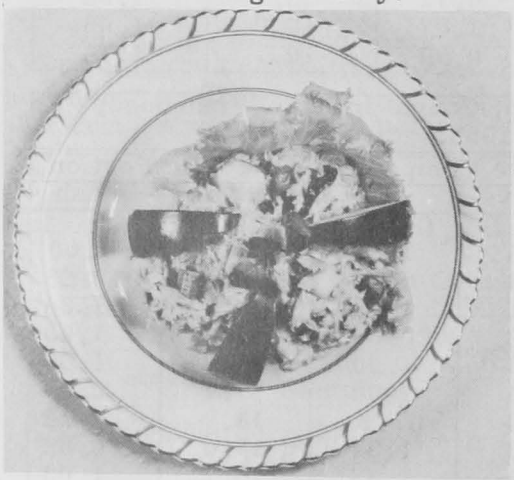
1/ANALYSIS NOT YET FINISHED.

Composition of Squawfish (Edible Portion) Caught in the Columbia River, June 1953

Size Class of Fish	No. of Fish in Sample Group	Length			Avg. Weight	Proximate Composition of Edible Portion			
		Avg.	Min.	Max.		Moisture	Fat	Protein	Ash
		Cm.	Cm.	Cm.	Grams	Percent	Percent	Percent	Percent
Small	16	24.5	22	28	186	80.1	1.76	15.6	1.06
Medium	9	32.5	31	35	353	79.0	3.06	17.3	0.97
Large	8	36.9	34	40	548	78.8	2.41	18.0	1.07
Mixed	33	29.8	22	40	319	79.3	2.83	17.1	1.13

CANNED TUNA GOLDEN ANNIVERSARY

National Tuna Week will be celebrated November 5 to 14, the 50th Anniversary of the tuna canning industry.



Fifty years ago the tuna industry consisted of one cannery in San Pedro, California, supplied by a few boats fishing in nearby waters. Thus originated the industry that has made available the canned tuna now so abundant in our food markets.

For versatility, canned tuna wins the homemaker's vote every time whether it's a full-fledged meal for the whole family or a quick snack for hungry youngsters. Protein-rich tuna is the perfect ingredient for many types of dishes. Nutritious salads and cold-weather casseroles are easily made and in short order when several cans of this fine food are handy on your kitchen shelf.

For a quick snack that the children will love, the home economists of the Fish and Wildlife Service suggest a Tuna Waldorf Salad.

TUNA WALDORF SALAD

2 7-OUNCE CANS TUNA
1 CUP DICED APPLES
1/2 CUP MAYONNAISE OR SALAD DRESSING
1/2 CUP CHOPPED CELERY
1/4 CUP CHOPPED NUTS

Drain tuna and flake. Combine all ingredients, being careful not to break fish into pieces too small; chill. Serve in lettuce cups with a bright-colored garnish. Serves 6.

PROGRESS ON FISHERY TECHNOLOGICAL RESEARCH PROJECTS, FISCAL YEAR 1953

A discussion of the Fishery Technological Research Program for fiscal year 1952 (July 1, 1951, to June 30, 1952) appeared in the November 1951 Supplement of Commercial Fisheries Review, vol. 13, No. 11a, pp. 2-7 (also reprinted as Separate 294). A review of the progress made in each project during fiscal year 1952 appeared in the December 1952 Supplement of Commercial Fisheries Review, vol. 14, No. 12a, pp. 1-7 (Separate 327). The program for fiscal year 1952 was continued for fiscal year 1953 (July 1,1952, to June 30, 1953). New projects were added during the year as the old ones were completed or as the need for specific information arose. Progress on each project from July 1, 1952, to June 30, 1953, was as follows:

REFRIGERATION

FREEZING FISH AT SEA, DEFROSTING, FILLETING, AND REFREEZING THE FILLETS: Fishing Operations and Overhaul of the "Delaware:" Cruises during the summer and fall of 1952 permitted thorough testing of the freezing and cold-storage facilities on the Delaware. Fish were supplied for pilot-plant, laboratory and storage studies, and other phases of the project. Round fish brine frozen at sea were landed at the Boston Fish Pier and sold to producers for commercial processing into fillets.

The Delaware was drydocked and placed in good operating condition. A ventilator was installed on the main deck aft and forward of the trawl winch to supply fresh air to the refrigeration machinery room.

Freezing and Storage of Fish Aboard the "Delaware:" Results of modifications in the experimental refrigeration plant and fish-freezing equipment, and expansion of the cold-storage hold were observed during the seven test cruises conducted from June to October 1952. Recent alterations to the brine cooler are expected to increase the fish-freezing capacity from 550 pounds to about 1,200 pounds an hour.

A new type freezer mechanism is now under construction and has been designed to (a) permit the loading and unloading of the freezer at deck level, (b) increase freezer capacity 50 percent, and (c) increase cold-storage capacity in the hold.

Unloading, Storing, and Processing Ashore: Some progress was made in developing methods for unloading the vessel and handling brine-frozen fish. Procedures normally employed at Boston for unloading iced fish were modified slightly to provide a partially satisfactory method for unloading frozen fish. From the dock into the cold-storage plant the frozen fish were moved in boxes (of a variety of sizes), on four-wheel hand trucks. Experiments with mechanical conveyors and self-unloading boxes for making these operations more expeditious are contemplated.

Large lots (5 to 10 tons) of brine-frozen haddock were held in commercial cold storage and removed at intervals to determine the effect of such storage on the subsequent handling of the fish and the quality of fillets produced therefrom. Improvements in the preparation or storage procedures, such as glazing or other means of preventing desiccation, appear to be desirable before storage periods longer than two months can be recommended for frozen haddock held in the round.

Defrosting methods whereby the fish were held in circulating water at 60° F. or lower were found to be very satisfactory. Detailed technical information on thawing methods and equipment were made available to the industry.

Laboratory Tests: The various lots of frozen fillets prepared from round brine-frozen and iced gutted haddock landed by the Delaware have been evaluated for quality by taste panel, chemical, and physical testing. Results of tests made on haddock fillets held for 12 months in frozen storage showed no appreciable differences between the quality of the fillets prepared from round brine-frozen fish and those from iced gutted fish. A consumer taste panel composed of about 125 families in the Boston area has been par-

ticipating in a number of tests with various lots of fillets from brine-frozen and iced gutted fish. The fillets, identified only by a code unknown to the panel members, are cooked and served in the home by the housewife. On the basis of several such tests, the results indicate that fillets from round brine-frozen haddock are at least equally as acceptable as those from iced gutted haddock, and in some instances there might be a slight preference for the fillets from the brine-frozen fish.

Tests of various solutions for attaining immersion-freezing temperatures of about -15° F. showed some promise. The suitability of such solutions is limited (1) by the necessity of meeting certain acceptability requirements for food and (2) the need for obtaining certain physical properties with existing freezing equipment aboard the vessel.

Comprehensive tests to determine the degree of salt penetration into the meat of haddock during freezing in brine at various temperatures and brine concentrations are well under way. Tests are also in progress to determine the effect on weight, salt uptake, and drip of fillets dipped in brine solutions of various concentrations. This information is particularly desirable in connection with fillets that have been prepared from brine-frozen fish and which might contain slightly more salt than those from iced fish.

FREEZING AND STORING ALASKA SHRIMP AND DUNGENESS CRAB MEAT: Alaska Shrimp: Storage tests of frozen precooked shrimp were completed. The effects of brine-cooking procedures, packaging methods, and storage temperatures at 0° F. and 10° F. on the keeping quality were determined. Emphasis was given to those factors responsible for toughening of the shrimp during the preparation and storage. Significant conclusions were: (1) the texture of precooked pink shrimp varied widely in any given lot processed under uniform conditions; (2) use of minimum cooking time and low salt concentration in the brine precook process resulted in superior texture and minimum shrinkage of the meats; recommended precook is 1 minute in 5-percent brine by weight; (3) keeping quality was improved markedly by flooding the shrimp with dilute brine (2 percent by weight) or by vacuum packing (18 to 20 inches of vacuum) in hermetically-sealed containers (storage life under these conditions was longer than 8 months at 0° F.); (4) use of 0.3 percent dry monosodium glutamate in dry-packed shrimp meat did not improve keeping quality.

Dungeness Crab Meat: Storage tests are in progress on the effect of storage temperature and packaging methods on keeping quality of the frozen meat. Samples have been examined at intervals during 6 months of storage. The highest quality packs with a storage life greater than 6 months were: (1) crab meat flooded with dilute brine (2 percent salt by weight) packed in sealed cans and stored at 0° F.; (2) vacuum-packed (18 to 20 inches of vacuum) crab meat in cans stored at -20° F.; (3) vacuum-packed crab meat in cans stored at 0° F. Crab meat packed in cans under atmospheric pressure or in plastic containers and stored at 0° F. was of inferior quality and had a storage life of less than 6 months.

Frozen Shrimp Cocktail: Tests are in progress on the keeping quality of frozen shrimp cocktail packed in hermetically-sealed cans stored at 0° F.

PREPARATION OF MANUAL ON THE REFRIGERATION OF FISH: The protracted illness of the original project leader caused considerable delay in the laying of the ground work for the manual. His death necessitated the reassignment of the project. Advantage was taken, however, of this reassignment to reappraise the scope and coverage of the manual in the light of the information collected by the original project leader. Subsequently an entirely revised and more detailed outline of the subject matter to be included was prepared and circulated to a number of industry's fish refrigeration specialists for their comments and suggestions. The many helpful comments received were incorporated. The preparation of material for the manual on the refrigeration of fish is going forward along the lines indicated as most needed and acceptable to the fish-refrigeration industry.

EFFECT OF STORAGE CONDITIONS ON QUALITY OF FROZEN FISH: No work was carried out on this project. The project was completed during the last fiscal year except for the final phase involving commercial-scale tests. This experiment would require large quantities of fish and it was planned to use any tuna landed by the Service's exploratory vessel John N. Cobb. Due to poor fishing conditions, sufficient fish were not landed to carry out the experiments.

QUALITY STANDARDS FOR HADDOCK FILLETS: This project was initiated during the latter part of the fiscal year to set up criteria for comparing the quality of haddock fillets prepared from fish frozen at sea with commercially-processed fillets prepared from fish iced at sea. No work was carried out during the fiscal year on this project.

STUDY OF CAUSE OF TEXTURE CHANGE OF CANNED SALMON PREPARED FROM FROZEN FISH: Studies have shown that the physical destruction of the cell walls of the meat of salmon during freezing and storage is at least partially responsible for the toughening of the product on subsequent canning. Excessive curd formation on canning does not appear to be caused by the physical changes during freezing, but does appear to be related to a chemical change in the meat protein which releases the soluble protein fraction causing the formation of a proteinaceous curd during heat processing. Studies have been started on this latter problem.

Tests with the pretreatment of the cut sections from thawed salmon have shown that curd formation during subsequent heat processing may be minimized by dipping the sections one minute either in saturated NaCl brine or a 5-percent solution of tartaric acid. The acid treatment was more effective in these tests. Analysis of canned salmon treated with tartaric acid showed that the product contained 0.03 percent by weight of tartaric acid.

METHODS OF PRESERVING AND FREEZING SHRIMP ASHORE AND AT SEA IN THE GULF OF MEXICO: Limited tests were conducted at sea and ashore in the Gulf of Mexico to study methods of handling and freezing shrimp. Whole shrimp and shrimp tails were frozen at sea in refrigerated brine (5° F. to 10° F.) and placed in cold storage at 0° F. Frozen whole shrimp were thawed ashore, headed, packaged, and refrozen. All frozen packaged shrimp were glazed. Comparisons of brine-frozen, refrozen, and air-frozen shrimp tails were made during 9 months of storage at 0° F. The results indicate: (1) brine-frozen shrimp which were later thawed, headed, packaged, and refrozen had excellent appearance, flavor, and texture during 9 months of storage; (2) shrimp (brine- or air-frozen at sea immediately after catching) were free of any black-spot discoloration; (3) no excessive salt absorption was found in fresh whole shrimp frozen in brine at 10° F. for periods less than 4 hours; (4) absorption of salt increased when shrimp were held in refrigerated brine for periods longer than 4 hours; (5) salt absorption was significantly higher in iced shrimp frozen in brine as compared to shrimp frozen in brine immediately after catching; (6) the most important factor causing loss in quality of frozen packaged shrimp during storage was dehydration of surface shrimp after the ice glaze evaporated at the corners and edges of the package.

COLD-STORAGE LIFE OF HALIBUT: The cold-storage life of halibut stored as dressed (heads off) and as steaks is being determined as a guide to possible future modification of Federal Specifications. After 9 months of storage at 0° F., halibut stored as dressed fish were superior in quality to those stored as steaks. Steaks sliced from dressed halibut that were stored for 6 months at 0° F. were layer-packed in cartons and then stored at various temperatures for an additional 3 months. The samples stored at 20° F. were rated unacceptable; the steaks stored at 0° F., -15° F., and -20° F. were rated acceptable, with the steaks stored at -20° F. showing the least change in flavor.

COLD-STORAGE LIFE OF KING AND SILVER SALMON: Studies in connection with Federal Specification requirements showed that dressed chinook and silver salmon which were frozen, ice-glazed, stored at 0° F., and reglazed at 3-month intervals were still of good quality after six months of storage. Steaks cut from similar fish immediately after freezing when ice-glazed and stored in institutional size wax paper-lined cartons, passed out of the top quality range at the end of 6 months.

FREEZING, GLAZING, AND THAWING SALMON TO BE CANNED: Studies were made on the feasibility of glazing brine-frozen salmon and on the effect of different thawing technics on the quality of the pack of canned salmon resulting therefrom.

The salt absorbed by brine-frozen fish interferes with successful ice glazing at the storage temperatures commonly used commercially (0° F. to 10° F.). The glaze taken by brine-frozen Alaska red salmon at 0° F. was not considered satisfactory; however, the glaze taken at -20° F. was good. Since glazing of the brine-frozen salmon does not appear feasible at the storage temperatures now used by the freezerships (about 5° F.), these fish will be more susceptible to dehydration and oxidative deterioration upon pro-

longed storage. Therefore, it is highly important to process these fish as soon after freezing as possible in order to have a good quality canned product.

In order to compensate for the salt absorbed during brine freezing it was necessary to reduce the amount of salt added to each can up to as much as 50 percent of the amount normally added to cans packed from fresh salmon. Different thawing methods--in running water, in still water, or in air--did not affect the quality of the canned fish.

NUTRITION

INVESTIGATION OF THE TOUGHENING OF FROZEN BLUE CRAB MEAT: Practically no work was done on the problem of identifying the enzymes which may be involved in the change of texture of frozen crab meat because a research fellowship student could not be obtained.

FEEDING STUDIES WITH GUMS EXTRACTED FROM IRISH MOSS: Gums are being extracted commercially from Irish moss, and derivatives of these are being used in foods and pharmaceutical preparations. Rats and mice have been allotted to 5 comparable groups and are fed a balanced ration to which has been added 0, 1, 5, 15, and 25 percent gum. The animals have now been on experiment for about two years. It is expected that the experiment will be concluded during the summer or early fall of the coming year. The data to date indicate that the product is wholesome.

CHEMICAL AND PHYSICAL PROPERTIES OF FISH AND SHELLFISH PROTEINS: A fundamental study of the water retentivity of the meat of fish, with particular reference to the mechanism of drip formation in frozen fish, is being continued. It was found that the concentration of nitrogen in the drip from rockfish stored at 0° F. varied inversely with storage time. The drip produced by gravity was a more sensitive measure of the changes occurring in the fish during frozen storage than was the fluid produced by centrifugation. The studies indicate that ground fish can be used in place of whole fish pieces in drip studies, with a gain not only in the homogeniety of the material but also in the sensitivity of the measurements. Considerable information was obtained on the characteristics of drip formation under various temperature and physical conditions.

THIAMINASE CONTENT OF CERTAIN SPECIES OF FISH USED IN FEEDING FUR ANIMALS: Samples of fillet waste from cod, sole, and rockfish, and cannery waste from the various salmon were found to contain negligible amounts of the enzyme thiaminase. The project was terminated during the early part of the fiscal year.

A STUDY TO DETERMINE THE COMPARATIVE HEMOPOIETIC VALUE OF FISH: An 8-week metabolism study was conducted during the fall in cooperation with the College of Home Economics of the University of Maryland. A group of 10 girls consumed a basal diet low in protein and adequate in vitamins, minerals, and calories. Five girls received a daily allowance of animal protein in the form of haddock fillets and the other five received theirs in the form of sirloin of beef. Blood samples were taken every 2 weeks. During the year, analyses of protein, fat, ash, and iron have been conducted on the samples of foods, urine, and feces collected in this metabolism trial or the one that was conducted year before last. Two master-of-science-degree theses on this work were published during the year. The work will continue during the coming year.

DEVELOPMENT OF SPECIALTY FOOD PRODUCTS FROM ALASKA FISH AND EDIBLE PORTIONS OF FISH WASTE: Development work has been concluded on the preparation of a pasteurized smoked salmon egg spread; canned, smoked, and pickled herring specialty products; canned smoked butter clams, and canned smoked shrimp. Storage tests of inoculated packs of salmon egg spread are in progress at the National Canners Association Laboratory, Berkeley, California, in order to determine whether the product may be stored safely at room temperature. Preliminary tests were made on the utilization of Alaska whitefish. Studies are in progress on the preparation of a canned smoked spread from frozen chum salmon and pink salmon trimmings (edible portions from salmon cannery waste).

ANALYSIS AND COMPOSITION

CHEMICAL COMPOSITION OF FISH: (1) Menhaden: No work was carried out on this project during the fiscal year.

COOPERATIVE WORK WITH THE AOAC ON THE DETERMINATION OF OIL IN FISH MEAL: Some preliminary work has indicated that the rapid acid hydrolysis--Mojonnier tube method--which works well for the meat of fish may (by suitable modification in the hydrolysis procedure) be adaptable to fish meal. Previous tests had indicated that only a part of the oil could be recovered from fish meal by this method. Work is continuing on the modification of the hydrolysis step to see whether this simple procedure can be applied to fish meal.

COMPOSITION AND COLD-STORAGE LIFE OF FRESH-WATER FISH: Proximate chemical composition of the edible portion and waste have been determined for blue pike, yellow pike, yellow perch, whitefish, and sheepshead from Lake Erie; chub and smelt from Lake Michigan; lake trout from Lake Superior; carp, buffalofish, and sheepshead from the Mississippi River; and carp and bullhead from a small lake.

Samples of the frozen fresh-water fish were placed in cold storage to determine their keeping qualities at 0° F. Blue pike, yellow pike, yellow perch, whitefish, and sheepshead showed some deterioration in quality by the end of the 12-months' storage period; however, all species were judged edible. Lake Michigan smelt and Columbia River smelt had cold-storage life of 6 to 7 months and 3 to 6 months, respectively; both developed off-flavors in the belly flaps after 3 months of storage. The keeping quality of lake trout fillets varied considerably; one fillet was inedible after 3-months' storage whereas other fillets were still acceptable after 8-months' storage.

BYPRODUCTS

VITAMIN CONTENT AND NUTRITIVE VALUE OF FISHERY BYPRODUCTS: Experiments on the Unidentified Growth Factor(s) in Fish: Laboratory procedures have been established for the preparation of fish-liver concentrates containing the growth factor. A microbiological assay has been developed which permits rapid measurement of this growth factor. Studies now under way are directed at correlating the growth response as measured microbiologically with that measured by rat assay. Experiments also are being carried out with the object of obtaining the growth factor in pure crystalline form.

Vitamin Analyses: Twenty-three samples (600 bags each) of pilchard meal were analyzed. On a moisture-free and oil-free basis the average for niacin was 84 micrograms per gram and for vitamin B_{12}, 0.27. Twenty-one samples of individual bags of tuna meal averaged 0.33 micrograms of vitamin B_{12} per gram of meal. These tuna meal samples are being analyzed for their riboflavin and niacin content. Meals prepared from menhaden, anchovy, whale loins, mackerel, mackerel offal, herring, and crab were also assayed.

Biological Assays and Evaluation: a. During the previous year a number of assays with chicks were conducted to determine the vitamin B_{12} content of fish meals and fish solubles. The Seattle laboratory completed the microbiological assay on the same samples during this year. A limited number of reassays will be conducted during the coming year to determine causes of differences noted. Some bioassays of the dried solubles products are contemplated during the coming year.

b. Due to the relatively large amounts of fish oils available and the comparatively low market value, feeding tests were conducted with broilers to determine the feasibility of adding these oils to commercial poultry and swine feeds. The first series of experiments indicated that menhaden oil could be fed at levels of 2 to 8 percent without adversely affecting the health, feathering, or color of skin and shanks of the birds. Even the lowest level fed, however, gave a fishy flavor to the meat so it could not be recommended. A second series of experiments is now under way feeding oil from 0 to 2 percent by $\frac{1}{2}$ percent increments. The results should indicate conservative levels which may be fed without affecting the flavor of the meat.

c. A limited number of meals and condensed fish solubles were fed late last year to chicks to determine the nutritive value of the protein. Variable results were obtained which could not be correlated with known differences in raw materials or the processing methods used. More extensive tests are expected to be carried out on this project during the coming year.

UTILIZATION OF VISCERA FROM ROUND (WHOLE) FISH FROZEN AT SEA: No work was done on this product due to the shortage of laboratory personnel.

STUDY OF PHARMACEUTICAL AND OTHER INDUSTRIAL PRODUCTS FROM SALMON EGGS: Amino Acid Content of Salmon Egg Protein: The "essential" amino acid content of roe at different stages of maturity from the five species of Pacific salmon has been determined by microbiological-assay methods. The distribution of amino acids in the roe was generally uniform, being significantly altered only by maturity. Most of the amino acids were present in increasing quantities with increasing maturity. The average amino-acid content of mature roe from the five species of salmon in percentage of protein was: arginine 7.1; histidine 2.8; isoleucine 7.3; leucine 10.0; lysine 8.8; methionine 2.9; phenylalanine 4.9; threonine 5.9; tryptophane 1.0; and valine 7.3. A preliminary report has been submitted for publication.

The Fatty Acids of Salmon-Egg Oils: The long chain of unsaturated fatty acids present in salmon-egg oil have considerable promise for specialized applications, but basic information is lacking on the fatty acid fractions. A study of salmon-egg oil has been initiated with particular emphasis on the unsaturated fraction.

DEVELOPMENT OF A DRIED PRODUCT FROM CONDENSED MENHADEN SOLUBLES OR STICKWATER: This project has three interlocking phases: (a) sample collection, (b) analysis of solubles, and (c) preparation and a chemical-physical study of dry "solubles." The field work, determined by the seasonal nature of the fishery, was made as extensive as possible because of the wide variability in the solubles produced from different plants, by different equipment, and in different areas. Eventually, samples were obtained from all but two of the 20 plants which produced solubles during the 1952 season.

The analytical work on the solubles supplied background information (completely lacking in the literature) on the physical and chemical properties of the product. This information was essential to the evaluation of the third phase--the preparation of a satisfactory dry product from solubles.

A pilot-plant-size drum dryer, with 6 x 6 inch drum, was ordered in July 1952, but delivery was not made until January 1953. Thus less than six weeks were available for the actual study of the drying operation. In this time, 24 dry samples have been prepared. These include a straight run of almost all of the soluble samples on hand. These dry samples are now being studied as to composition, and especially their hygroscopic properties. It is expected that differences in both the behavior in the drying operation and in water absorption can be related to other properties of the solubles, and that some correlations may be found which will aid in the ultimate object of explaining and controlling the principal difficulty in producing a satisfactory product, namely, excessive hygroscopicity of the dry material.

PROGRAM FOR FISHERY TECHNOLOGICAL RESEARCH, FISCAL YEAR 1954

The program for fishery technological research for Fiscal Year 1954 (July 1, 1953, to June 30, 1954) was developed on the basis of recommendations from members of the fishing industry. When the amount of funds allotted to the Section was known, the assignment of projects was made after taking into consideration the location, facilities, and personnel at each of the four technological laboratories. For ready reference all projects assigned for Fiscal Year 1954 are listed by general field of study.

NUTRITION

1. Investigation of the Toughening of Frozen Blue-Crab Meat (cooperative project sponsored by the Refrigeration Research Foundation)--continued project: Practically no work was done last year on the problem of identifying the enzymes which may be involved in the change of texture of frozen crab meat because a research fellowship student could not be obtained. The project will be activated as soon as a fellow is available. A technologist will supervise a graduate student on this project. (College Park)

2. Chemical and Physical Properties of Fish and Shellfish Proteins (continued project): This study is directed toward providing basic information on the toughening of fish and shellfish in cold storage, the nature and control of drip in frozen fish, and the nature of the chemical and physical changes which occur in dried or dehydrated fish and in fish meal. This information might lead to methods of control of undesirable changes and eventually to the improvement in the quality of fishery food products. The phase of the project to be considered during this year will be the mechanism of drip formation in fish and shellfish. A study of the drip formed on cooking will also be included. The work will be carried out on a part-time basis by one technologist. (Seattle)

3. Determination of Chemical Changes in Fish Protein during Freezing and Storage (new project): When fish are frozen certain changes take place that may not be attributable entirely to physical reactions. The study will attempt to reveal any chemical change that takes place in the fish protein and to apply the results toward methods of improving the quality of frozen fishery products. The study will require the full time of one technologist. (Ketchikan)

4. Comparison of Nutritive Value of Fish and Meat (continued project): The University of Maryland, College of Home Economics, in a cooperative project, compared haddock fillets with sirloin of beef as the animal protein in test diets consumed by two groups of girls. This study is expected to be continued with some additional stress on the calorific values as measured by an improved laboratory procedure. One technologist supervises a graduate fellowship student conducting these studies. (College Park)

5. Discoloration in Canned Tuna (cooperative project sponsored by the Continental Can Company)--new project: Cans used for packing tuna require a special enameling process to prevent inner-surface can discoloration. A study will be made of the mechanism of this discoloration reaction. Application of the information obtained may result in less expensive preventive measures. The project will be carried out by one fellowship student on a part-time basis. (Seattle)

REFRIGERATION

1. Freezing Fish at Sea, Defrosting, Filleting, and Refreezing the Fillets (continued project): The freezing-fish-at-sea project has as its objectives: (1) raising the over-all quality level of frozen fillets to meet the competition of other animal protein foods and of other countries marketing fish in this country; and (2) extending the effective range of our vessels to more distant but less depleted fishing areas. Activities on the project have included: (1) The modification of a standard New England trawler for commercial-scale freezing experiments at sea. (2) The development, installation, and testing of round-fish freezing equipment and techniques adopted to existing vessels and crews. (3) The development and testing of acceptable defrosting equipment and procedures.

(4) The study of the cold-storage life of round fish frozen at sea prior to filleting, and of refrozen fillets from these stored round frozen fish. (5) Laboratory and consumer acceptance tests of fillets from fish frozen at sea compared to those from iced fish.

Haddock was the principal species used in this development work. In this fiscal year the economic aspects of freezing fish at sea will be evaluated as compared to the current New England iced-vessel type of operation, again using haddock, Thereafter similar tests are contemplated using the same or suitably modified techniques to obtain information on other important New England species, such as cod, flounder, and ocean perch. Personnel assigned to this project include the fishing vessel complement, one full-time technologist, and the part-time services of two technologists, one chemist, and one refrigeration engineer. (Boston)

2. Quality Standards for Haddock Fillets (continued project): The quality standards for haddock fillets in use in the industry were developed largely for fillets from fish preserved at sea in ice. Early in the study of fillets from round haddock frozen at sea, variances not found in fillets from iced fish were observed. On this project information will be obtained essential to the preparation of quality standards for haddock fillets prepared from iced fish (sold either as fresh or frozen fillets) and from frozen round fish (sold as frozen fillets). The availability of fish of known history for this work from the Delaware makes this a logical study to supplement the freezing-fish-at sea project. One technologist will work part time on this project. (Boston)

3. Preparation of a Manual on the Refrigeration of Fish (continued project): An advisory group of fishery technologists interested especially in iced and frozen fishery products cooperated in the preparation of a subject outline for the refrigeration manual. The object is to compile into one reference the current acceptable methods and equipment for preparation, transport, storage, and distribution of refrigerated fishery products. Much of the source material was collected late last year. During this year the writing and editing of the manual is expected to be completed. One technologist will be working part-time on the project. (Washington)

4. Cold-Storage Life of Fish (continued project): Studies have been completed or are in progress on the storage life of rockfishes, salmon, halibut, and various species of fresh-water fish under simulated commercial packaging and storage conditions. The work will be expanded to include other species of marine and fresh-water fish. Those fish showing limited cold-storage keeping quality will be further tested by improved handling and packing methods. This information on the cold-storage life of various fish provides a guide for packers and distributors in the handling and marketing of their fishery products. It serves, also, as a basis for the requirements in the Federal Specifications which insures government procurement of good quality fishery products. Much of the study will be concentrated on fresh-water species of fish. Because of the location of the Service's technological laboratories along the seaboard, work on the fresh-water fish has been neglected. However, 150,000,000 pounds of such fresh-water fish taken commercially each year make up a significant portion of the fisheries production. An understanding of the cold-storage characteristics of these and of the marine fish, and application of the findings, would undoubtedly tend to improve market quality and permit wider distribution. The study will be carried out on a part-time basis by one technologist. (Seattle

5. Study of Cause of Texture Change of Canned Salmon Prepared from Frozen Fish (continued project): Freezing and storing salmon prior to canning causes undesirable quality changes in the final product. Among these changes are the toughening of the meat and the development of curd. Previous studies have shown: (1) that the physical alteration of the cell walls of the meat of the salmon during freezing and storage is at least partially responsible for the toughening; and (2) that the curd formation is probably relate to chemical changes in the protein. The current phase of the project will be devoted to a study of the mechanism of the effect of brine on the meat of the fish in reducing the release of soluble protein to form the curd. The information will contribute materially to a fuller understanding of the proper use of brine dips for the reduction of drip in frozen fish. The work will be carried out by one technologist working full time. (Ketchikan)

PROCESSING AND PRESERVATION

1. Development of Specialty Food Products from Alaska Fish and Edible Fish-trimmings (continued project): In Alaska the more important fisheries are of a seasonal na

ture. This situation poses serious economic problems for the local residents during the balance of the year. One possible way to augment earnings and extend the period of employment will be the establishment of industries more fully utilizing fishery resources during the "off-season." Studies will be continued to develop specialty food products from fish and from edible parts of the fish trimmings. The work will be carried out part-time by one technologist. (Ketchikan)

ANALYSIS AND COMPOSITION

1. Composition of Fish (continued project): There has been a growing demand by physicians, dietitians, nutritionists, and others for information on the composition of foods, including fishery products. Information is also needed by the fishery industry regarding the chemical composition of various organs and tissues of fish with a view to the preparation of new products. Much of the work on proximate composition for this year will be concentrated on the fresh-water fish for which there is little available information, and on the underutilized species of fish to promote their greater acceptance. The work will be carried out as a part-time project by one technologist. (Seattle)

2. Determination of Oil in Fish Meal (cooperative work with the Association of Official Agricultural Chemists)--continued project: The present official method for the determination of oil in fish meal is quite tedious and time consuming. A rapid but accurate method is needed to provide the efficiency needed in transactions involving the marketing of fish meals. Current studies involve adaptation of the Mojonnier-type extraction tube using various chemicals to hydrolyze the meal. The work is being carried out on a part-time basis by one technologist. (Seattle)

BYPRODUCTS

1. Vitamin Content and Nutritive Value of Fishery Byproducts (continued project): a. BIOLOGICAL STUDIES: Chick assays for vitamin B_{12} content of fish meals and fish solubles were conducted in 1953. Tests on the feasibility of adding fish oils to commercial poultry feeds, also begun last year, will be continued to determine conservative levels which may be fed without affecting the flavor of the meat or eggs. Studies begun late last year to determine the nutritive value of fish meal and fish solubles gave widely variable results not correlated with known differences in raw materials of processing methods used. More extensive feeding tests will be carried out this year on these fishery products in an effort to account for the wide differences in nutritive values observed. One technologist works part-time on this project. (College Park)

b. CHEMICAL AND MICROBIOLOGICAL STUDIES: Lack of information on the nutrient content of fishery byproducts is a serious handicap to the fishery byproducts and feed industries in the marketing and utilizations of these products. Analysis of meals and scrap for the various B vitamins will continue and the study will be broadened to include additional samples from the East Coast, such as solubles and crab meal. Further work on the isolation and identification of unknown growth factors will also be pursued. Two technologists will be assigned to work full time on these studies. (Seattle)

2. Utilization of Viscera from Round (Whole) Fish (new project): The freezing of round fish at sea will make available larger amounts of viscera at shore processing plants. Studies are planned to determine the uses for which the various components are suited, both to increase the revenue from fisheries activities and to utilize more effectively the viscera now discarded at sea. One chemist will work full time on the project as soon as a qualified man can be employed. (Boston)

3. Study of Pharmaceutical and Other Industrial Products from Salmon Eggs (continued project): Millions of pounds of salmon eggs are discarded every year at salmon canneries in Alaska for want of a suitable and profitable outlet. On the basis of preliminary work, salmon eggs may be a good potential source of pharmaceutical and other industrial products. During the current year the oil fraction of the eggs will be considered since it is a source for the long chain fatty acids that may be modified for specialized industrial applications. The study requires the full time of one technologist. (Ketchikan)

4. The Development of a Dried Product from Condensed Menhaden Solubles or Stickwater (continued project): Stickwater samples, collected from practically all the plants in production, were dried, chemical analyses completed, and hygroscopicity studies begun on the dried product during the past year. This year studies will be made to determine (1) what constituent or factor in the raw material causes the undesirable hygroscopicity; (2) what changes in methods of manufacture, as the use of additives, can be devised to yield a less hygroscopic dry product; (3) what packaging materials are most satisfactory for the dry product. One technologist is working full time on this project. (College Park)

5. Chemical Evaluation of Fish Oils and Investigation of New Uses (new project): The current domestic surplus of fats and oils makes imperative the need for the development of new uses for fish oils to broaden the market and increase their value. The initial phase of the project will involve a study of the chemical composition of fish oil, particularly menhaden. This basic information will be used to determine current and new uses for which the various components are best suited. The work will be carried out by one technologist. (Seattle)

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