

MACKEREL

Mackerel are packed at Gloucester, Mass., and Portland, Me., on the Atlantic Coast. The mackerel canning industry of the Pacific Coast is confined to the southern California area, with San Pedro as the most important center. Mackerel are also packed to some extent at San Diego and in small amounts at Monterey.

EASTERN OR "BOSTON" MACKEREL

A pack of eastern or "Boston" mackerel has never been prepared in more than comparatively small quantities due to competition with California canned mackerel. The canning season is approximately from July 15 to November 1. The mackerel used in canning are caught by purse seines. They are iced down in the hold of the fishing vessel as soon as caught and usually have been out of the water from 24 to 36 hours when landed at the cannery.

The mackerel are hoisted out of the hold in large tubs holding about 500 pounds each, and are piled near the cannery door. A workman lays the fish in slots on a conveyor which carries them past automatic knives set to cut the mackerel into can-length pieces ($4\frac{1}{4}$ inches). The cut fish pass to dressing tables where the belly is split open and all offal is removed by hand including the kidney, which is the dark streak along the backbone.

The fish are washed thoroughly in 2 or 3 successive waters, each time for about 15 minutes, and are then put into wicker baskets to drain from $\frac{1}{2}$ to 2 hours. The baskets are carried to filling tables where the mackerel are filled into cans which are usually inside lined with "C" enamel, seafood formula. Heads and tails are alternated in filling and no small pieces are used to fill up the can. Some packers use no spices or condiments but others may add a bay leaf to each can. No. 1 tall cans are filled to a declared net weight of 14 ounces, while the stated net weight of No. 2 short cans is 16 ounces. The cans are exhausted for 10 minutes at 200 to 212° F., sealed by an automatic can seamer and processed for 75 minutes at 240° F. The pack is water-cooled immediately after processing.

Some Atlantic Coast mackerel are canned as "fillets of salt mackerel." In preparing this pack the fish are headed and cleaned by hand, taking care to remove viscera, congealed blood and other offal as completely as possible. The cleaned fish are placed in wooden tanks, half filled with brine testing 90 to 100° salinometer, where they are left for about 12 hours, the exact length of time depending on the size and fatness of the fish and on the judgment

NOTE.—[FL-83. Commercial canning of miscellaneous fishery products. Reprinted from Research Report 7, Fish and Wildlife Service, U. S. Department of the Interior. The complete report (366 pp.) is a reference book on the canning of fishery products and is obtainable from the Superintendent of Documents, Washington 25, D. C. Price \$1 a copy.]

of the packer. When brined sufficiently, the fish are filleted and the fillets are filled into oval cans of the type used for California sardines, which are lined with "C" enamel, seafood formula.

Two fillets are placed on the bottom of the can, then a piece of vegetable parchment paper is laid in, and two more fillets are placed on top. The cans pass along a conveyor under a perforated pipe which fills each can with hot brine. This brine is made in the proportions of 20 pounds of salt to 100 gallons of water, to which is added 1 quart of white distilled vinegar of 6-percent acidity. The cans are sealed in a double seamer without heat exhaust, or the use of mechanical apparatus to secure a vacuum and are processed for 75 minutes at 240° F. The pack is water-cooled immediately after processing.

The cans are not labeled, but are packed in individual lithographed pasteboard cartons. Fiberboard cartons holding 1 or 2 dozen cans are used as shipping containers. The cans are filled to a declared net weight of 12 ounces but usually contain somewhat more than this weight. The total loss in weight is estimated at 50 percent.

PACIFIC MACKEREL

The Pacific mackerel (*Pneumatophorus japonicus diego*) belongs to a different genus than the common or "Boston" mackerel of the Atlantic Coast (*Scomber scombrus*) although both belong to the same family (Scombridae). To the layman, the Pacific mackerel differs but slightly from the common mackerel in external appearance, the principal distinguishing characteristics being that the stripes or reticulations are finer and closer together, while dark green rather than blue predominates as the color of the back. Both species are about the same in size, but the fat content of the Pacific mackerel is much lower.

FISHING AREA AND METHODS

Walford (1931) gave the range of the Pacific mackerel as Puget Sound southward to along the coast of Lower California and possibly farther south, the southernmost limit not being definitely recorded. It is not common north of Santa Cruz County, Calif., and the largest catches are made in the Los Angeles area. The Pacific mackerel are taken off the coast of California throughout the year, but the principal season is from July to November.

Pacific mackerel are taken commercially by purse seines, ring nets, set and hand lines, with ring nets as the most important type of gear. Mackerel canning became important about the time that ring nets were being displaced by purse seines in fishing for sardines. Many of the lampara and ring-net boats which had been fishing sardines turned to mackerel fishing. The ring net was

found to be better suited to this fishery than either the lampara net or purse seine. Sardine ring nets were used at first but these required too much time to haul, so special nets were made with larger mesh and smaller bags, which could be hauled in less time. The Pacific mackerel do not run in large schools, so many hauls must be made to obtain a load.

The ring net varies in details of construction, and the design has been influenced by the purse seine. Fry (1931) stated:

* * * the ring net, like the purse seine, has purse rings along its lower edge. Some of the chief structural differences between the ring net and the purse seine are that the purse seine is made of comparatively heavy tarred webbing, is practically uniform throughout its entire length, and is practically square on the ends; while the ring net, like the lampara, is made of light tanned webbing, is gathered on the ends, and is made in three parts; a central "bag" of fine webbing and two end portions or "wings" of coarse mesh. The relative lengths of bag and wings vary greatly. The bag may be from one-fourth to almost the entire length of the net.

In day time, schools of mackerel are located by signs such as flocks of sea birds hovering at the surface, dark patches of water, or numerous flecks of foam made by the mackerel when they break at the surface. If signs of mackerel are not present the captain may trust to luck or knowledge of the fishing grounds. The fishing boat stops at the selected spot where "chum" (ground fish, usually mackerel) is thrown into the water. If sufficient mackerel are attracted to make a set worth while, a skiff is lowered with a man who continues to chum, to hold the school together and keep it quiet. The fishing boat backs away from the spot. When it has reached a distance of about 100 to 150 feet from the skiff the small kegs attached to the end of the net are thrown overboard, the boat is turned and commences to circle the spot including the skiff, requiring about 2 minutes for this operation. The net is payed out as the boat makes the circle.

When the boat has completed the circle, the keg floats are picked up and the set is complete. The bottom of the net is pursed together, the bunched rings are pulled up against the pursing davit and they, with the head line, are hoisted aboard, after which "chumming" is discontinued by the man in the skiff, but not before. The wings are hauled in, with half the crew working on each wing, then the finer meshed bag, until the mackerel are concentrated in the bunt of the net, which is brought around opposite to the hatch. The fish are then loaded into the hold by a brailing net.

Mackerel ring nets are also fished by night, the method differing, since the schools are located by luminescence in the water and chumming is not employed as mackerel seem to run in denser, larger schools. A detailed description of the construction and operation of rings nets, purse seines and other gear used in taking

mackerel may be found in "The California Mackerel Fishery" (Crocker, 1932).

TRANSPORTING AND UNLOADING

The fishing boats bring their catches into the canneries, since the fishing grounds are only from 30 minutes to 5 hours distant. If a capacity catch has been secured, a deckload is carried. The fish are not iced, as a rule, although this should be done if the catch is made at some distance from the cannery. An awning should be



FIGURE 42.—Elevator and conveyor for unloading mackerel and sardine boats at Terminal Island, California.

rigged above the deck to protect the fish against the sun, if the vessel is carrying a deck load. Carelessness in handling the catch while on board, as for example walking on the fish, results in bruises which show up in the canned product as dark discolored areas.

The mackerel are unloaded onto hoist-or belt-conveyors at San Pedro (Fig. 42) but they are pumped into the cannery at Monterey as described in canning sardines. The fish are weighed in auto-

matic recording scales in lots of 750 pounds. From the scales, the mackerel are flumed into a tank where they are held until used, or they may be emptied directly into bins from which they are delivered to the butchering tables. In California, the inspector stationed at each cannery by the Department of Health, inspects every load of fish to determine their freshness and condition. The fish may not be unloaded until the inspector certifies that they are fit for use. The captain of the fishing boat must report to the inspector the time and date of departure, the time and date of arrival, the location and time of making each set involved in the load and the approximate amount of fish taken at each set. The inspector supervises the unloading, examines the mackerel from time to time as to firmness, and determines the presence of bruised, broken, soft, sunburned, decomposed, or otherwise injured fish.¹³ All information is noted in the inspector's mackerel boat report and if data on the report indicate the necessity, the supervising inspector may limit the catch of the boat and require better handling.

The mackerel should be handled as rapidly as possible. Regulations of the Board of Health, State of California, require that fish canned from any individual load shall be prepared and canned within 12 hours of arrival of the boat making the delivery. If the mackerel cannot be canned almost immediately on arrival, they should be covered with finely crushed ice, using at least 50 pounds of ice per 100 pounds of fish, or they should be stored in refrigerated brine at a temperature about 32° F. Mackerel boats fish at night as much as possible, delivering to the cannery in the morning, so the fish need not be held long before canning.

CLEANING OR BUTCHERING

Apparatus for butchering the mackerel and cutting them into container length pieces is being developed to efficient performance and is apparently displacing hand butchering. If the fish are dressed by hand, the head is cut off just back of the gills; the worker then turns the fish quickly, almost simultaneously slashing the ventral surface of the body to the vent, scraping out the viscera. The heads and other offal are tossed into a flume by which they are carried to the reduction plant, while the butchered fish fall into a box with a capacity of about 20 pounds. The workers are paid according to the quantity of fish cleaned.

The mackerel are carried by flume to cleaning tables where other workers scrape out the primordial kidney, the long black "blood streak" along the backbone, trim out any remaining bits

¹³ Duffy, Milton P., 1935. Instructions to fish inspectors, State of California, Department Public Health, Bureau Cannery Inspection, no pagination.

of intestines or membranes and complete the washing action of the flume by brushing the fish. Workers then cut the mackerel into container-length pieces, using a mitre box to gauge the proper length of cut. The cut fish are dropped on a belt conveyor by which they are carried to the packing table or they may be emptied into a brine tank.

Machines used are of the same general type as equipment for mechanical dressing of sardines. The fish are placed in deep slots in individual blocks which are the upper part of a chain conveyor and pass under revolving circular knives, so spaced that the head and tail are severed and the body is cut into two container length pieces. Another knife slits the body lengthwise and the fish are cleaned under a rotating brush. A final cleaning is given by hand under running water to remove the last traces of blood. Hand butchering is preferred as doing a better job of cleaning, and resulting in less waste of raw material. With large fish it is possible to obtain three pieces of fish by hand butchering. It is claimed that a crew of 14 can handle from 1 to 1½ tons per hour by hand.¹⁴

BRINING

The general practice has been to hold the mackerel after dressing and washing for 60 minutes in a brine testing 80 to 90° salinometer. The objective of brining the mackerel is to improve the color of the canned product by soaking diffused blood out of the flesh, making the texture firmer and to give the necessary salt flavor to the finished article. Brining is now eliminated by some packers, who fill the mackerel into the cans immediately after cutting, mechanically adding from 3/16 to ¼ ounce of salt to each can as it comes down the conveyor from the can loft. This is done to save time and reduce the cost of packing, but is undesirable since the texture is usually softer and the flesh darker. Canning technologists recommend that some system of brining be employed.

FILLING

The brined fish are carried by conveyor to a packing table where the containers are filled by hand, women and girls doing the work. Beside or in front of each worker is a case of empty cans. The cans are removed from the case and filled with fish as rapidly as possible. As each case of cans is used, it is replaced by a checker, who punches a piece-work card hanging by each worker.

Mackerel are packed in four sizes of containers. The containers are filled with raw fish to a level slightly above the rim of the can as considerable shrinkage occurs in cooking. Head and tail ends

¹⁴ Continental Can Co. The canning of mackerel, Bull., Research Department, Continental Can Co., Inc., 8 pp. New York.

of the pieces of fish are alternated in filling the cans. A 1-pound tall can will usually hold two body sections of mackerel, one whole, the other split, so that a solid cylinder is obtained; or one large piece and two or three small pieces. The fill-in weights of raw fish are as follows:

Can (trade name)	Can maker's designation	Fill-in weight
		<i>ounces</i>
No. 1 tall -----	301 x 411	17 $\frac{5}{8}$ to 17 $\frac{3}{4}$
No. 1 meat -----	301 x 407	17 to 17 $\frac{1}{2}$
No. 1 standard -----	211 x 400	11 $\frac{1}{2}$
8-ounce -----	211 x 304	9 $\frac{1}{8}$

The filled cans are placed on a belt conveyor running along the packing table. An inspector stands at the end of the table, culling out protruding bones, adding sufficient fish to slack-filled cans to bring them to weight and removing the excess from overfilled cans. If the filling shows any amount of careless workmanship, the forewoman checks the individual packers to determine responsibility.

PRECOOKING OR EXHAUSTING AND SEALING

The mackerel are cooked in the open cans until the excess moisture is extracted. As the cans are still warm when sealed, a vacuum is obtained, which is incidental to precooking since the time is much longer than necessary to exhaust the containers. There is no standard length of precook as it varies according to the size of container and the preference of the individual packer. In most canneries the precooking is done in exhaust boxes of the same type as formerly used in salmon canneries, but of larger size.

Other canneries, especially those where mackerel is not a major pack, precook in processing retorts or tuna cookers, the cans being stacked in retort baskets which are trucked to the retort. This practice requires more handling of the product and a greater amount of labor. If exhaust boxes are used, the cans are given a precook of from 20 to 45 minutes at 210° to 212° F. Cans in retorts or cookers are usually heated for a period of approximately 20 minutes at 216° F.

When the cans leave the exhaust box a perforated pipe above the conveyor fills each container with 3-percent salt brine. Some packers do not use brine, especially if the cans have been salted. The addition of brine should not be necessary if the fish have been brined before precooking and the containers are properly filled.

The cans next pass to the closing machines. These are usually set up with an attachment of plungers the diameter of the con-

tainer. The plungers are adjusted to push the fish down into the cans packing the fish into a solid cylinder and forcing out excess moisture. A runway carries the sealed cans to a washing machine.

The cans roll down a runway from the washing machine into large metal retort baskets, moving on low trucks. An apron of wire mesh is hung below the end of the runway to break the fall of the cans, thus preventing heavy dents but it is not entirely effective.

PROCESSING AND COOLING

The time required to fill one of the large horizontal retorts is about 75 minutes, but there is some variation depending on the size of the retort and the rate of speed at which the closing machines are operating. The temperature in the center of the first cans placed in the retort should be approximately 130° F. when processing begins. Processes worked out for canned mackerel are based on this initial temperature. Excessive delay in filling the retort or in starting processing may, therefore, affect the sufficiency of the process. Control of processing by the Bureau of Cannery Inspection, California State Board of Health, guards against such delays. No. 1 Tall or No. 1 Meat cans must be processed 90 minutes at 240° F. (10-lb pressure) or 75 minutes at 250° F. (15-lb pressure). No. 1 Standard or 8 oz. Eastern oyster cans are processed 75 minutes at 240° F. or 60 minutes at 250° F.

The cans are usually water cooled to a temperature of 100° F. in the retort, by a spray cooling system. The cans are machine labelled and cased after the inspector has marked the batch as released on the production records. The standard case of mackerel contains 48 No. 1-tall cans.

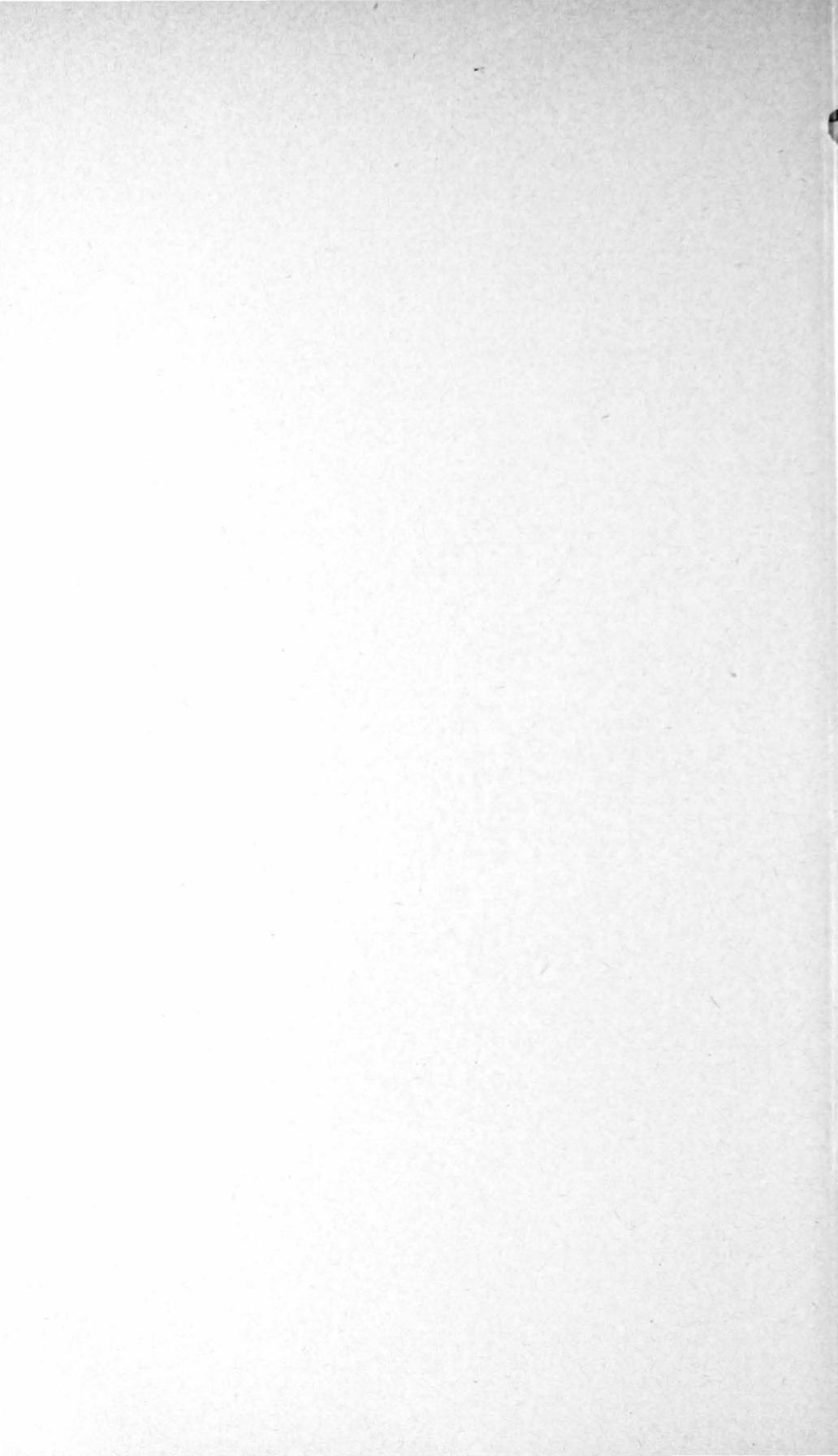
MACKEREL, TUNA STYLE

A small amount of California mackerel is canned tuna style in ½ lb. tuna cans. Only the largest mackerel are suitable for this pack. The fish are headed and gutted, washed, then precooked in tuna cookers using the minimum precook for tuna. Other details in the packing method followed are the same as for tuna. The process given is the same as for tuna in ½ lb. cans. The pack makes a very acceptable substitute for whitemeat tuna, but the cost of packing is higher. The amount of suitable raw material is limited, more labor is required to separate out the white meat and to fill the containers because of the smaller size of the pieces.

MACKEREL FILLETS

Some mackerel are filleted by hand and packed in ½ and 1 lb. oval cans. The fillets may be brined in an 80° to 90° salinometer

brine but this is not always done. The fillets are packed in the cans by layers, flesh side up and the filled cans are precooked for 20 to 25 minutes at 210° F. in a long steam exhaust box. Liquid is drained from the cans as they emerge from the exhaust box, using the equipment for draining oval sardine cans. After sealing and washing, 1-pound cans are processed for 65 minutes at 240° F. (10-lb. pressure) or 50 minutes at 250° F. (15-lb. pressure). One-half pound oval cans receive a cook of 55 minutes at 240° F. or 40 minutes at 250° F. The cans are spray cooled in the retort. While most of this pack is canned "natural" style, tomato sauce or spiced vinegar sauce is added to some packs, mostly on special order.



MISCELLANEOUS FISH

A number of other species of fish are canned commercially, but not on a scale requiring an extensive description of methods. A short discussion is sufficient to furnish all essential information. To devote a separate section to each product of this type would involve a certain amount of duplication. Therefore, they are described under a single heading and in alphabetical order.

ALEWIVES

Alewives or river herring (*Pomolobus pseudoharengus*) were first canned commercially as a part of the food conservation program during the first World War, though river herring roe was canned many years previous to 1917. Most of the canning takes place in the Chesapeake Bay area.

Alewives used in canning are caught by trap nets and are usually landed within 3 or 4 hours from the time they are caught. They are hoisted out of the boat, in metal buckets holding approximately 500 fish, into a scaling and washing machine which consists of an inclined, revolving, wire-mesh drum with a perforated pipe running along the axis. As the fish are carried through the drum the scales are removed by the tumbling action. Sprays of water from the perforated pipe wash the fish at the same time.

From the scaler and washer they are carried by belt or chain conveyors to long tables or low platforms fitted with slots, through which waste can be dropped onto belt conveyors, or into buckets or barrels. The fish trimmings are manufactured into meal and oil. Alewives are cleaned by hand, the cleaner first cutting through the black spot just below the gills, then down the side from the throat through the vent, so as to remove the thin belly flesh without cutting into the roe.

After rinsing the fish in fresh water they are placed in a 100° salinometer brine, where they remain from 8 to 12 hours. The exact length of time depends on the size and condition of the fish and is determined by the appearance and texture. The fish must be removed before the skin starts to wrinkle and change color, or before the texture of the flesh becomes too firm.

As soon as the alewives have absorbed enough brine to give the desired texture and flavor, they are cut into container length pieces and piled into small baskets which are taken to the filling table. Holding in baskets also allows surplus brine and moisture to drain away. The pieces are filled into the cans, head and tail ends alternating and empty spaces are filled with the short pieces

of flesh removed in cutting the fish to fit containers. The cans are packed with fill in weights of 14, 16, 17 and 19 ounces. A No. 1 tall can with a fill of 16 ounces is the most popular container.

A flow sheet for canning alewives is shown in figure 43.

In some canneries the fish are trimmed to container-length size before brining. Only the extreme tail end is trimmed off and no short pieces are used as fillers. The container used is taller and of greater diameter than the No. 1 tall can, and is known as a 307 cylinder, (307 x 604) or No. 2 tall can. Net contents of this can average 1 pound 9 ounces. Alewives packed in containers of this size are wrapped separately in vegetable parchment paper before filling into the can.

The cans travel from the filling table to the exhaust box, passing under a perforated pipe, from which they are filled with hot brine, usually testing 20° salinometer; or sometimes hot water alone is used. The cans are exhausted by steam at a temperature of about 210° F., and for a period averaging about 3 minutes. This exhaust is insufficient. Cans examined rarely show more than 2 inches of vacuum and often none at all. Exhaust should be increased to 8 minutes or the cans sealed with vacuum closing machines. The exhausted cans are sealed by a standard type closing machine and loaded into metal retort baskets, which when filled are hoisted into vertical retorts.

Processes differ according to the preference of the individual packer. Representative processes are: For No. 1 tall cans, 50 minutes at 244° F. (12-lb. pressure); and for No. 2 tall cans 60 minutes at 250° F. (15-lb. pressure). While labeled "fresh river herring," this product most closely resembles and is used in place of, "corned" or lightly salted alewives.

EELS

The market for fresh and canned eels in this country is largely among the foreign population in the cities of New York, Boston and Philadelphia. Some eel products are also sold to the local delicatessen trade among the Scandinavian and German population of the Middle West. These specialties were formerly all imported but the local product has now acquired a portion of the market.

The common eel (*Anguilla rostrata*) is widely distributed. It is found along the Atlantic coast from Canada to Key West and may be distinguished by the slender snake-like form of body; the low vertical fins, devoid of spines, and the absence of ventral fins. The common or "fresh-water" eel varies in length from 2 to 3½ feet and reaches a maximum weight of 16½ pounds.

Eels are caught in eel pots, which are small cylindrical traps, usually made of heavy galvanized wire screen with a ¼- or ½-

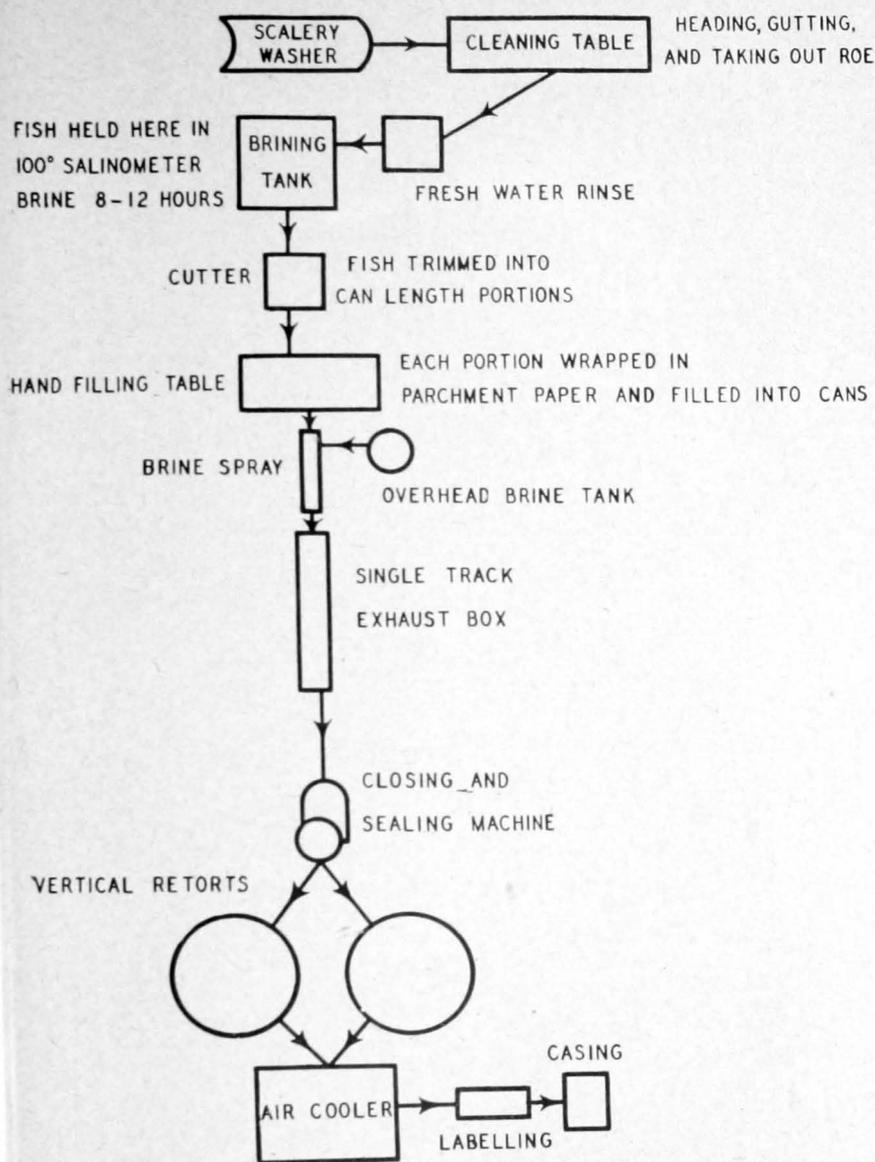


FIGURE 43.—Flow sheet for canning alewives or river herring.

inch mesh and funnels of cotton webbing in the ends. The eels can enter the traps, which are baited with stale fish waste, but cannot escape through the funnels. The traps are anchored on the bottom of a stream moored to a line, or with a float to mark the location. Eels are also caught by spearing. This is usually done at night. The fisherman carries a torch or lantern, the fish is attracted and dazed by the light, when it is a comparatively easy matter to spear it. Eels are also taken on hand lines, trawl lines, in fyke nets, pound nets, haul seines or "drag nets," otter trawls, and floating traps.

SMOKED EELS

Either fresh or frozen eels may be used. If frozen, they must first be "defrosted" by soaking in a tank of cold water from 4 to 8 hours, depending on size. The eels are dressed, after "sliming" or removing the surface slime by scraping or rubbing with fine salt. They then are split down the belly, from the head past the vent and are eviscerated. The large vein along the backbone should be pulled, or cut out if possible, though this is not always done. After washing thoroughly, the eels are brined from 1 to 2 hours in a 100° salinometer brine. The brining period is shorter than usual in smoking eels but as brining is only for flavoring purposes in canning, a longer time is not necessary.

After brining the eels are dipped in fresh water and scrubbed with a stiff bristle brush to remove any remaining slime or excess salt. If they are not scrubbed they do not color well in smoking. The next step is to string the eels for smoking on pointed iron rods, about 1/4-inch diameter, spearing the fish through the head, or passing the rods through the throat cartilage and out through the mouth. The eels are dried in a current of air, until the surface moisture is removed and the surface shows a thin shiny skin or "pellicle."

The eels are smoked for one hour over a low, clear fire without much smoke. Then the fire is damped with moist sawdust and the process continued in a cool dense cloud of smoke until the fish are a yellowish brown in color. The color must not be as deep, nor are the eels hot smoked or partially cooked as in the regular smoking process. Eels are smoked for canning from 3 to 5 hours, depending on smoke density, atmospheric humidity and size of the fish.

After cooling for several hours, the smoked eels are cut in container-length pieces and hand-packed into the containers. There is no standard or usual size of container. The cans used may be 1/2- or 1-pound flats, ovals, or "square" cans of the type used in packing oil sardines. Some smoked eel is packed in 8-ounce glass

tumblers. The cans are filled with olive or cottonseed oil, flavored with bayleaf and allspice, or other preferred spice combinations. The spices are added in the form of essential oils and only a few drops per gallon are necessary. The cans may be exhausted 5 to 10 minutes, or they may be sealed without exhaust or mechanical vacuum. Representative processes used are: For 1-pound cans, 35 minutes at 245° F. (12-lb. pressure) and 80 minutes at 228° F. (5-lb. pressure); for ½-pound cans or glass tumblers 30 minutes at 245° F., or 70 minutes at 228° F.

PICKLED EELS

Freshly cleaned and washed eels are cut into pieces about 1 inch thick. These pieces are parboiled for 10 minutes in a solution of 2 percent vinegar with 3 percent salt and 2 ounces of mixed pickling spices to the gallon. The cooked eels are laid aside to drain and cool since they would crumble if handled while warm. The eels are filled into containers, usually glass tumblers holding up to 8 oz. It is understood ½- and 1-pound flat cans are sometimes used. A few fresh dry spices such as mustard seed, celery seed, white peppers and a bit of bay leaf are placed in the container which is then filled with a vinegar-salt solution having an acidity of 2.5 percent and containing 2 percent salt. Eight-ounce tumblers are processed 30 minutes at 240° F. (10-lb. pressure) while 5-ounce tumblers are processed 25 minutes at the same temperature and pressure.

Some pickled eel is packed in a jelly made by dissolving 10 percent by weight of gelatine in water and adding sufficient vinegar to give it an acidity of 1 percent. Dry spices are not added to the containers but a few drops of essential oils of spices are used for flavor. A vacuum-sealing apparatus is used for closing the tumblers or jars. Two of the processes used for both sizes of containers are 20 minutes at 228° F. (5-lb. pressure) and 25 minutes at 221° F. (3-lb. pressure). The pack is water-cooled. To make sure that the eel is "jellied" it is necessary to place the container in a refrigerator for 2 or 3 hours before opening.

FINNAN HADDIE

The haddock should be fresh, free from blood around the backbone and perforations caused by careless use of fish forks. The fish are caught and landed by otter-trawlers. When the haddock are landed they are washed and scrubbed to remove ice, slime or other debris. The fish may then be split along the backbone, to lie flat in a single piece, although they are sometimes left unsplit or "in the round" depending on the size of the fish. Large had-

dock are usually split, while small ones are not. The heads of unsplit fish are not removed as the smoke stick is passed through the eyes.

Haddock in the round are brined in a salt solution testing 90° salinometer for from 20 to 40 hours, depending on the size of the fish, amount in the tank and amount of smoked fish waiting to be canned. Split haddock are brined 1½ hours in a 100° salinometer brine. As soon as the fish are removed from the tank they are skinned. The skinned haddock are hung on smoke sticks, and "dripped" or allowed to drain and dry for a few hours until a thin skin or "pellicle" forms on the surface.

They are then smoked for about 14 hours over a low smouldering fire, preferably of oak sawdust. The exact length of smoke cure depends on the preferences of the individual packer, the size of the fish, and also to some extent on the weather. Fillets are sometimes used and are given a much shorter smoke cure. The smoked haddock should have a clear light color, with no appearance of reddening in the flesh and should be free from excessive bone or skin.

When the haddock are taken out of the smokehouse, the heads are broken off and the fish are laid in the shallow aluminum pans used for steaming fish in the preparation of fish flakes. These pans are placed in square retorts and the fish are steamed for 15 minutes at 240° F. (10-lb. pressure).

The steamed finnan haddie is broken into pieces, removing the bones and any bits of skin. The cooked fish is transferred to smaller pans which are carried to workers at a filling table. The packers scoop up the hot flakes and fill them into cans holding either 4, 12, or 16 ounces. The filled cans pass to a double seamer and are sealed immediately after filling, without heat exhaust or the use of a vacuum sealing apparatus, as the contents should be sufficiently hot at closing to make other methods of securing a vacuum in the container unnecessary.

The process used for 4-ounce cans is 40 to 55 minutes at 240° F. (10-lb. pressure) and for 12- and 16- ounce cans, 75 minutes at the same temperature and pressure. The pack is water-cooled immediately after processing. The cans when labeled are packed in fiberboard cartons, holding either 12 or 24 cans.

FISH FLAKES

Fish flakes may be prepared from haddock or cod, or a mixture of the flesh of both species, but haddock is probably most often used. This pack is usually prepared in the period after Lent, when large catches are being landed and the market for fresh fish is not so active as at other seasons, making a supply of raw

material available for canning. The fish are caught and brought in by trawlers and are of the same quality as those used in the preparation of fresh fillets.

The first step in canning is to wash the whole fish thoroughly, removing all traces of blood, viscera and other offal. When washed and cleaned, the fish are placed in a tank and brined for an average of 10 to 14 hours in a brine 100° salinometer. The length of brining period may vary according to the size of the fish, the total amount to be brined in an individual tank and the strength of the brine. It may be as much as 36 hours.

After brining, the fish are placed in large shallow aluminum pans, which are stacked in horizontal retorts and steamed for about 1 hour at 250° F. (15-lb. pressure). The object is to improve the texture by reducing the moisture content, and to separate the flakes readily from the skin and bones.

Some packers use fillets of haddock, canning that portion of their fillet production which the fresh fish market will not absorb except at prices showing a loss to the packer. Fillets are



FIGURE 44.—Canning fish flakes; removing the skin and bones after precooking (Courtesy, Burnham & Morrill, Portland, Maine.)

brined from 1 to 3 hours in a 70° salinometer brine, and steamed for 30 minutes at 250° F. (15-lb. pressure).

The steamed fish are picked free of skin and bones (Fig. 44) and are placed on a circular revolving filling table (Fig. 45). As the cans pass under circular openings around the circumference, packers direct a sufficient amount of fish from the heap in the center of the table into the cans to obtain the required fill.

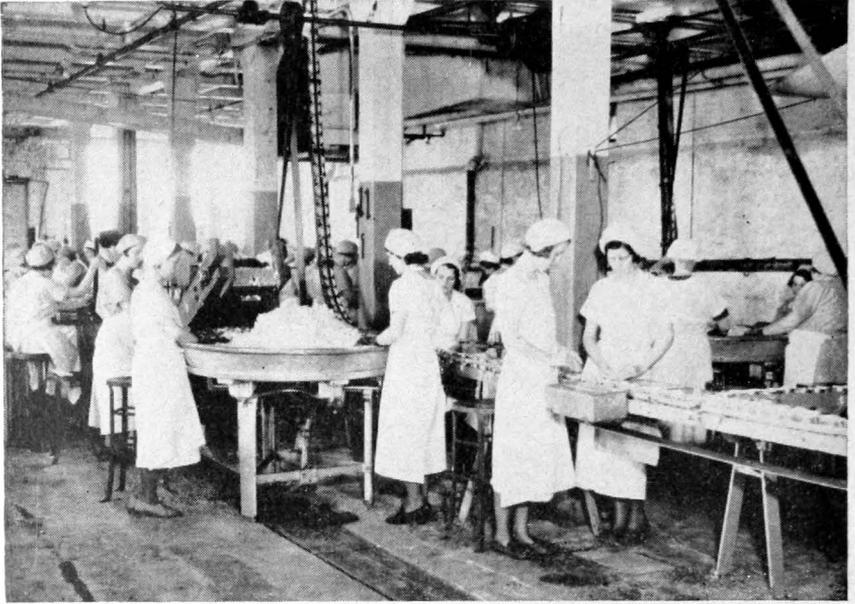


FIGURE 45.—Filling cans with fish flakes. (Courtesy, Burnham & Morrill, Portland, Maine.)

In other instances, especially where fillets are used, the flakes are packed at hand filling tables of the usual type. The hot flakes are turned out of the steaming pan into smaller trays placed by each packer. As the empty cans pass down the conveyor belt on the filling table, they are filled with hot fish scooped up in large spoons from the trays. The filler table conveyor takes the filled cans directly to the double seamer. Since the temperature of the contents averages about 165° F. at sealing, other means of obtaining a vacuum are not necessary. Three sizes of can are used, No. 300, 1/2- and 1-pound flat and both are lined inside with "C" enamel, seafood formula.

The 1/2-pound cans are processed for 60 minutes at 240° F. (10-lb. pressure) to 245° F. (12-lb. pressure), while No. 300 and 1-pound cans are cooked 90 minutes at the same temperatures and pressures. The pack is water-cooled and when dry is labeled and packed in fiberboard shipping containers, usually 2 dozen cans to the case.

HERRING

KIPPERED HERRING

Most of the canned kippered herring sold in the United States is imported either from Great Britain or Norway. The former country puts up kippered herring in 1-pound oval cans, while the latter exports kippered herring fillets in various sized containers with the foreign-trade designation of $\frac{1}{16}$ (96 x 43 x 17 mm.) (1½ oz.) to the 1/1 square (159 x 105 x 39 mm.) (1 lb.). Of these, the "30 m/m club" (105 x 60 x 29.7 mm.) with net contents of 4½ ounces, is believed to be sold most widely in the United States market. A small amount of canned kippered herring is packed occasionally in Maine and New Brunswick. Kippered herring was canned for a few years in Alaska but none has been packed there for several years. Suitable raw material was plentiful, the product was appetizing, but packing methods were not sufficiently well developed so that it could withstand competition from other sources.

Only the freshest herring, fat and of good quality, should be used for kippering. The herring are split down the back and eviscerated. After washing to remove blood and slime, and after draining they are placed in a 90° salinometer brine for 30 minutes. The brined herring are then hung on smoke sticks. Nails driven at a slight upward angle are spaced at intervals along the sticks, so that when a fish is spiked on 2 of these nail points it is held open. The sticks, when loaded, hold from 12 to 20 fish and are placed in a current of air for 1 to 2 hours or until a thin shiny "skin" or pellicle forms on the surface and free moisture is not apparent. The sticks are then hung in the smokehouse, from 6 to 8 feet above the floor and the fish are smoked over a low smouldering fire of hardwood sawdust.

When not intended for canning, kippered herring are smoked 6 to 8 hours, and this cure is sometimes given to herring prepared for canning. Such fish are darker in color than is desirable, the flavor is likely to be strong or caramelized, and is apt to have an after taste. Kippered herring for canning should be smoked only sufficiently to develop the smoke flavor, and the color should be lighter than for distribution fresh. The smoking time should be reduced at least one-third; that is, to 4 hours.

When the kippered herring are cool enough to handle, they are removed from the smoke sticks, heads and ails trimmed away and the kippers filled by hand in 1-pound oval cans, flesh side up, alternating head and tail ends to secure an even fill. The cans are given heat exhausts ranging from 3 to 15 minutes. The shorter exhaust is not effective and should not be used. Packers

giving the short exhaust seal the cans immediately. Some of those giving the long exhaust drain the cans for 30 seconds before sealing. The pack is processed for 65 minutes at 240° F. (10-lb. pressure).

HERRING IN TOMATO SAUCE

The "raw pack" method used in canning California sardines is followed in packing fresh herring in tomato sauce. All details of the method, including draining of the precooked fish, amount of sauce, and processing are the same.

ANIMAL FOOD

Fish for use in animal feeding (frequently called pet food), are canned commercially in the New England States and California, with production about equally divided between the two areas. On both the Atlantic and the Pacific Coasts, animal food is canned as a by-product to utilize material which otherwise would be wasted. In the New England area raw material for pet food canning consists of waste from filleting. In California, whole sardines (pilchards) or mackerel, fresh and of good quality, but unsuitable for canning because of size, are canned for animal feeding.

ATLANTIC COAST METHOD

Filleting waste, mostly heads and backbones, is brought into the cannery by small hand trucks as required. It is pitchforked into large shallow metal pans, about 4 feet square by 6 inches deep, with perforated bottoms. The loaded pans are stacked 4 or 5 deep on a small wheeled truck. The truck is then shoved into a horizontal "Portland" retort, where the raw material is steamed for an average of 60 minutes at 250° F. (15-lb. pressure) though if the scrap is from large fish the time may be 90 minutes, while waste from filleting small fish or "scrod," is precooked for 45 minutes at the same temperature and pressure.

When the material is cooked sufficiently, the retort is opened and the pans are emptied into large sheet-metal baskets of the type used in precooking ingredients for fish cakes. These baskets have a capacity of about 200 pounds each. Loaded baskets are lifted by an automatic hoist and carried by overhead conveyor to a grinder with a $\frac{3}{8}$ -inch plate. The cooked fish are unloaded into the hopper of the grinder by opening a trap door in the bottom of the basket.

The ground material is discharged onto large shallow metal pans, which are conveyed to a hand filling table, where the fish

are immediately filled into No. 1 tall cans to a net weight of 16 ounces, though the declared weight on the label is usually 15 ounces, to guard against occasional variations in weight. The cans are carried by a belt conveyor to a double seamer where the lids are sealed on. Neither exhaust or mechanical vacuum seal is considered necessary as the temperature of can contents at time of sealing averages 160° F.

The process for pet food in No. 1 tall cans is 90 minutes at 236° F. (8-lb. pressure). Some animal food is packed in No. 10 cans for use on fur farms. The process for this size of container is 150 minutes at the same temperature and pressure.

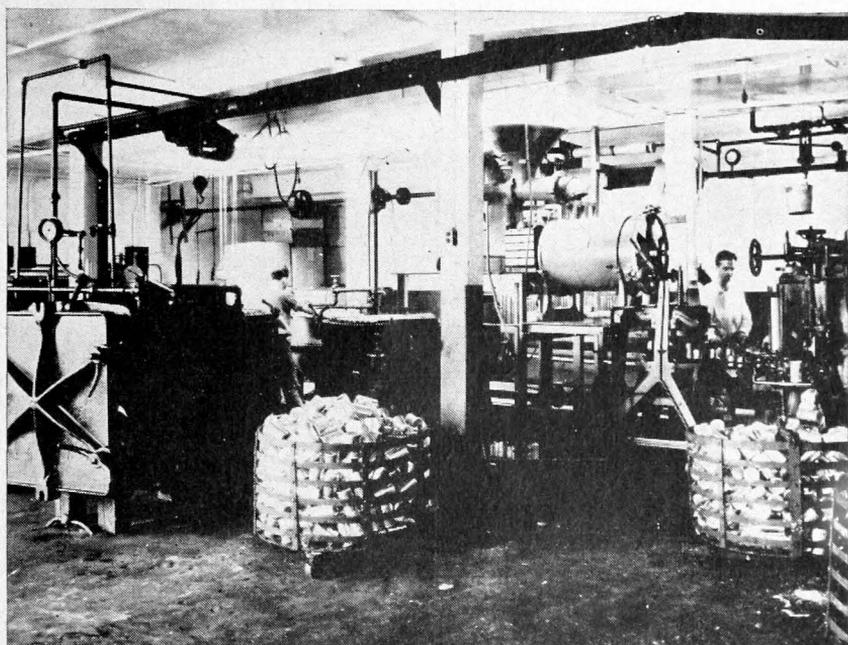


FIGURE 46.—Canning pet food from fish waste. Left, Portland type horizontal retort. Right center, grinder. Right, can closing machine. (Courtesy, Forty-Fathom Fisheries, Boston, Mass.)

PACIFIC COAST METHOD

In addition to Pacific mackerel and sardines, whale and seal meat are utilized in the canning of "pet food" in California. Animal food which includes whale or seal meat is usually of the "balanced ration" type. While these or other fishery products are usually the principal ingredients, they are sometimes supplementary to slaughter-house products. Each cannery uses a secret

formula, usually based on the receipt of a veterinarian or successful kennel operator. The following formula is representative:

Ingredients	Percentage by weight
Steamed ground fish or whale meat	35
Steamed cracked cereal	35
Cooked vegetable	10
Water	10
Agar-agar or kelp meal	2 $\frac{1}{2}$
Dried milk	2 $\frac{1}{2}$
Dried brewer's yeast	2 $\frac{1}{2}$
Cod-liver oil	2 $\frac{1}{2}$
Salt per No. 1 tall can	About $\frac{1}{4}$ oz.

The cereal used may be cracked wheat, broken rice or barley. The vegetable is usually carrots, although spinach, string beans and tomatoes also are used.

Steamed whale meat or fish is ground, then the other ingredients are added and blended in a beating or mixing machine. The mixture is pre-cooked for about 20 minutes in a steam jacketed kettle until thoroughly heated. No. 1 tall cans are filled with heated material either mechanically or by hand. The fill is 16 ounces while the declared net weight is 15 or 15 $\frac{1}{2}$ ounces. For No. 10 cans the fill is 7 pounds. The cans are sealed immediately after filling and the No. 1 tall can is processed for 90 minutes at 240° F. (10-lb. pressure), while No. 10 cans are cooked 4 hours at the same pressure and temperature.

The larger size container is bought by kennel operators, fish hatcheries and "fur farms."

In most plants, Pacific mackerel are canned for animal feeding by the batch process. Details differ in various plants, but the following is descriptive of the general method: Whole mackerel are ground, then emptied into an 80 gallon steam-jacketed kettle. About 20 percent of steamed cracked grain or flour is added to the fish. The mixture is stirred mechanically until it is cooked and blended, or from 20 to 30 minutes, then emptied into the hopper of a filling machine. The cans are sealed immediately and given the same process as the pet food previously mentioned. One cannery, the first in California to can animal food commercially, has developed a continuous method of packing.

When sardines (pilchards) are used in preparing a canned animal food, the fish are fed into a steam cooker of the type used in the manufacture of fish meal. The cooked fish pass into a screw type press, where they are pressed until the oil content has been reduced to about 2 percent, but not to such an extent that the moisture content is reduced below 65 percent. The pressed mass is filled into No. 1 tall or No. 10 containers, to which is added the press liquor minus oil which has previously been condensed to approximately one half the original volume in a triple effect

vacuum pan. The cans are sealed immediately without heat exhaust as the temperature of the contents averages from 150° to 160° F. when filled. In some instances cereal is not added, the product consisting solely of ground cooked fish.

Animal food made from fish is such a recent development of the canning industry that it is still in the experimental stage. Reliable packing data are lacking, and a research study must be made before a more detailed description of methods and processes can be published.

SHAD

The canning of shad is confined to the San Joaquin and Sacramento River districts in California and to the Columbia River area. Few shad are canned on the Atlantic Coast as the entire supply is usually taken by the fresh fish market, and even when there is a large supply at lower prices than usual, canners cannot afford to compete with fresh fish dealers. Shad are canned as a by-product to the canning of shad roe and at times when market conditions make it unprofitable to ship Pacific Coast shad to the fresh fish markets of the Atlantic Coast.

The shad catch of the Pacific Coast is incidental to the salmon catch. Most of the shad are taken in salmon gear by men who are fishing for salmon. In California and the coastal district of Oregon, salmon drift gill nets varying from 150 to 350 fathoms in length and with a mesh size of 5½ to 6½ inches, stretch measure, account for the entire catch. In the Columbia River district the catch is taken about equally by salmon gill nets and the haul seines operated on sand bars near the mouth of the Columbia River. The greatest part of the catch is made in June.

Shad are canned salmon style. The shad are scaled and scraped, after which the head, tail and fins are removed. A cut is made down the middle of the abdomen, and the shad are eviscerated, the body cavity scraped to remove all traces of blood and membranes, and washed thoroughly.

When cleaned and washed the shad are cut into can-length pieces by machine. The operation of these machines is described under the discussion of salmon canning. The cut pieces are automatically filled into cans, usually No. 1 tall salmon, after which the containers are weighed and the lids are sealed on by a vacuum seamer. A heat exhaust of 10 minutes at 212° F. is used if the fish is packed in ½-pound flat cans and the containers are sealed by an ordinary type closing machine. The process for 1-pound tall cans is 90 minutes at 240° F. (10-lb. pressure) and for ½-pound cans 80 minutes at the same temperature and pressure.

The texture of canned shad is slightly soft, but sufficiently firm so that the contents of the can should be removed in a solid cylinder. The color of the flesh is somewhat darker than that of freshly cooked shad.

KIPPERED SHAD

A small amount of shad is lightly smoked or "kippered" and packed in 1/2-pound flat salmon cans. This is distinctly a specialty product and is only canned on occasion and in lots of a few cases, although it makes an excellent hors d'oeuvre or sandwich filler.

The shad is scaled under a pressure jet of water and the head, tail and fins are removed. A split is made down the back, inserting the knife on the upper side of the backbone, with the edge of the blade at a slight downward angle so that an even cut will be made with little flesh adhering to the backbone. If the cut is made properly it should be possible to open the shad in a single flat piece from the napes to the tail. After splitting, the shad are eviscerated and scraped free of all traces of viscera, blood and other offal. The dressed fish are washed thoroughly and allowed to drain.

When sufficiently drained the shad are brined from 1 to 2 hours in a 90° salinometer brine. Since brining is for the purpose of flavoring only, an hour should be sufficient. The brined fish are fixed on smoke sticks, then hung in a strong current of air, until no traces of surface moisture are to be observed and a thin, shiny "skin" or pellicle has formed on the surface.

The shad are then ready to be hung in the smoke house, where they are given a smoke cure at a temperature of from 70° to 90° F. They are smoked over a low fire giving off a light smoke for the first 2 or 3 hours. The fire should then be covered with sawdust, producing a dense smoke until the surface of the flesh is straw yellow in color. The entire smoking process will require 5 to 12 hours, varying according to the size of the fish, weather conditions and the type and size of smokehouse. The smoke cure should not be heavy. Oversmoking makes the flavor of the canned product disagreeable.

The smoked fish should be cooled in a current of air. When cooled the shad are cut into container-length pieces and filled into 1/2-pound cans by hand. Some packers add about 1 oz. of a weak salt solution, made up in the proportion of 1 ounce of salt to a gallon of water, although 1 ounce of salad oil may be used instead. The covers are then clinched on loosely and the cans are given a heat exhaust of about 10 minutes at 212° F. After exhausting, sealing is completed and the pack processed 70 to 80 minutes at 240° F. (10-lb. pressure).

STURGEON

Three species of sturgeon are canned in the United States. The common sturgeon (*Acipenser sturio*) is found along the Atlantic Coast from Maine to South Carolina, but is now taken principally in New Jersey and Virginia. Large-mesh gill nets were formerly used in fishing but most of the catch is now made in pound nets incidental to other fisheries. This species has been greatly depleted in numbers through overfishing and water pollution.

The green sturgeon (*Acipenser medirostris*), has a distribution from northern California to Alaska, but the commercial catch is now almost entirely taken in the Columbia River area. Small sturgeon are taken in salmon gill nets, but the large ones are only caught by the use of set lines, specially made of strong rope with a large iron hook. The green sturgeon may reach a very large size. Cobb (1919) stated that the record weight is 1,000 pounds, with a length of 13 feet.

The third species canned in the United States is known as the Caspian sturgeon (*Huso huso*) imported as frozen fish from the U.S.S.R. Caspian sturgeon may include other species such as *Acipenser mediventris* and *Acipenser ruthenus* as the common name apparently is used rather loosely for several species.

PLAIN OR IN TOMATO SAUCE

The sturgeon is cut into pieces which can be fitted into the container. These are washed, brined in a 90° salinometer brine for about 1 hour, and packed into the containers by hand. The cans are precooked in an exhaust box or hot water bath at 212° F. for a period varying from 30 to 60 minutes. The cans are then inverted for 1 or 2 minutes to drain the excess moisture. In some instances the cans are sealed without using any sauce. In others about 1 ounce of heavily spiced tomato sauce is added to ½-pound, and 1½ ounces to 1-pound containers. The process for ½-pound flat cans is 75 minutes; and for 1-pound flat cans, 90 minutes at 240° F. (10-lb. pressure).

"KIPPERED" OR SMOKED STURGEON

"Kippered" sturgeon (smoked sturgeon) is canned commercially in the Columbia River area. Both fresh and frozen sturgeon are used. Frozen sturgeon must be first thawed in tanks of cold water, overnight or for a period of 8 to 10 hours. The fish are cut into chunks weighing about 1 pound each, which are held in a 90° to 95° salinometer brine for 2½ to 3 hours, the exact time depending on the size and thickness of the pieces. The brined chunks are then rinsed in fresh water, after which they are al-

lowed to drain for a few minutes and are placed on $\frac{1}{4}$ -inch mesh, wire-bottomed wooden trays. The wire should be rubbed with lard oil before use to prevent sticking of the flesh. The pieces of fish are placed in the trays so that no two chunks touch.

The trays are placed in racks in the smoke house, from 8 to 12 feet above the fire. The chunks are allowed to drip and dry for a few hours, after which a low fire is started and the fish are smoked at a temperature not higher than 80° F. from 4 to 8 hours, depending on the density of smoke, the size of the pieces and the atmospheric humidity. The fire is then built up so that the temperature is 175° to 180° F. and the fish are smoked at this temperature for one-half hour.

The trays are taken out of the smokehouse and the fish are allowed to cool. When the smoked sturgeon is cold and firm enough to handle, it is taken to tables and packed by hand into $\frac{1}{2}$ -pound flat salmon cans. Three tablespoons of olive or cottonseed oil is added, after which the cans are exhausted for 10 minutes at 210° to 212° F., sealed and processed for 70 to 75 minutes at 240° F. (10-lb. pressure). The cans are air cooled.