Chairman: PROFESSOR R. A. MORTON, Ph.D., D.Sc., F.R.I.C., F.R.S., *Department of Biochemistry, University of Liverpool*

Commentary on the preservation and distribution of the catch

By GEORGE A. REAY, *Department of Scientific and Industrial Research, Torry Research Station, Aberdeen*

Since fish is highly perishable, widely ranging fisheries and the steady distribution of fluctuating catches all the year round in acceptable condition pose severe problems in preservation, still awaiting fuller practical solution. After noting how the world catch is at present preserved and distributed, recent trends and developments in using cold for preservation are specially considered in this paper.

Disposal of the catch

Table 1 (Food and Agriculture Organization of the United Nations, 1957*a*, p. E-1) shows disposal in 1938, 1948, 1953 and 1956. 'Live weight' is the whole, fresh weight at catching.

Table 1. *Summary of the disposal of the world catch**

	1938		1948		1953		1956		Increase in 1956 as against 1948
Mode of disposal	A	B	A	B	A	B	A	B	(%)
Total catch	20·5	100	19·2	100	24·8	100	29·3	100	53
Marketing fresh	[10·3? 11·3	50?] 55	9·8	51	11·0	44	12·3	42	26
Freezing	[1·0?	5?]	1·0	5	1·5	6	2·2	8	120
Curing	5·0	24	4·5	24	6·3	26	7·1	24	58
Canning	1·6	8	1·4	7	2·0	8	2·6	9	86
Reduction to meal, oil and other products	1·6	8	1·5	8	3·0	12	4·1	14	173
Miscellaneous	1·0	5	1·0	5	1·0	4	1·0	3	0

A, expressed in million metric tons 'live weight'; B, expressed as percentage of total catch.

*Food and Agriculture Organization of the United Nations (1957*a*, p. E-1).

'Fresh' fish is marketed alive or as fresh, chilled or iced, round or dressed fish or, e.g. as fillets, cutlets. Frozen products are round or dressed fish, cutlets, fillets and the like.

Cured products are mainly fish dried; dried and salted; wet-salted and brine-packed; smoked, always with some and often with much drying or salting or both. Spiced, seasoned, marinated, vinegar- and sugar-cured products are also included as well as fermented preparations such as sauces, juices and pastes.

Canned products are those packed in hermetically sealed containers. Reduction products are here, oils, meals and fertilizers made from whole fish. Those made

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from 'offals' or waste from dressing and filleting are already included 'invisibly' under the other headings. Miscellaneous products include fish used as bait, pearls, essence and glues.

In 1956 the catch was respectively 43% and 53% larger than in 1938 and 1948. Methods of disposal rank as follows: (1) marketing fresh (42–51%), (2) curing (24–26%), (3) reduction (8–14%), (4) canning (7–9%), (5) freezing (5–8%) and (6) miscellaneous (3–5%). Relative increases since 1948 rank as follows: (1) reduction (173%), (2) freezing (120%), (3) canning (86%), (4) curing (58%), (5) marketing fresh (26%) and (6) miscellaneous (0%).

Though so pre-eminent, marketing fresh has fallen relatively since 1948 (from 51 to 42%), absorbing only the same share—one-quarter—of the 10·1 million tons increase by 1956 as curing and reduction. The steady usage of about one-quarter of the catches for curing, and of about one-twelfth for canning should be noted, together with the striking advances made by reduction and freezing, claiming by 1956 about one-seventh and one-twelfth respectively.

International trade in fishery products

Table 2 (Food and Agriculture Organization of the United Nations, 1955, p. 3) gives estimates, as annual averages for 1950–3, of the international trade of 110 reporting countries, accounting for 90–95% of the world trade. The primary figures are the 'net product weights' of commodities, from which 'live weight' equivalents have been calculated. The percentage share in total trade for each class of product is calculated on 'live weight' equivalents, and the percentage of the total production of each traded internationally is calculated on 'net product weights'.

Table 2. *Estimated total international trade in fishery products of* 110 *countries (Annual average,* 1950–3)*

Commodity group	Net product weight (thousands of metric tons)	Estimated 'live weight' equivalent (thousands of metric tons)	Proportion of all commodity groups (on 'live weight' basis) (%)	International trade as a proportion of total production of the commodity group (%)
All	2754	5600	100	(25) (on 'live-weight' basis)
Fish, fresh, chilled or frozen	617	950	17	10
Fish, dried, salted, or smoked	620	1900	34	45
Shellfish, fresh, frozen, dried, or salted	141	300	5	20
Fish in airtight containers	287	900	16	60
Shellfish in airtight containers	17	100	2	60
Aquatic animal oils and fats, crude or refined	544	—	—	60
Fish meals and fertilizers	360	1400	25	30
Miscellaneous	168	50	1	—

*Food and Agriculture Organization of the United Nations (1955, p. 3).

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Only about a quarter of the world catch entered into international trade, the catch being mainly used directly as human food in the producing countries, with exceptions, e.g. Norway and Iceland, where export is predominant.

Cured fish was the chief export item (34% of total trade and 45% of its total production). Much of it, being 'heavily' cured, is very suitable for long transport and satisfactory storage for some months, even in the tropics. Some of this trade occurred in limited areas amongst tropical, less developed countries, but most exports came from the fishing countries of the northern hemisphere, which provided some three-quarters of the world's marine catch in 1953.

Many of the consumers, with a special taste for these sorts of cure, live in the northern hemisphere, even in the more highly developed countries there, whereas cured fish such as 'klippfish', 'stockfish' and red herrings, are traditionally exported from northern countries to European and American Latin ones as well as to some Mediterranean and west African areas. However, there is historically a gradually growing preference for fresh fish or products more closely resembling it.

Fish meal came next in importance (25% of total trade and 30% of its total production). Main exports were nearly equal from Norway, Canada and Iceland and from certain regions in Africa along with Peru, and went to main meat-animal producing countries, e.g. the U.S.A., the U.K., West Germany, the Netherlands, Belgium and Denmark.

'Fresh and frozen' fish, regrettably lumped together, accounted for 17% of total trade, 10% of production being traded. Though storage life does not much exceed 2 weeks, chilled fish is traded internationally within restricted areas, e.g. between countries bordering the North Sea or from Canada to neighbouring American States. Development of freezing was gathering way by 1950–3, and today it is playing an increasing part in trade amongst northern countries. In 1957 exports to U.S.A. from Canada, Iceland, Germany and Denmark were 'strong' (Food and Agriculture Organization of the United Nations, 1957*b*); in 1955 exports in and from Western Europe were at least 140,000 tons, or 66% of production (European Productivity Agency of the Organisation for European Economic Co-operation, 1957, p. 37). Outside Western Europe, the U.S.A. and the U.S.S.R. are the main receivers of this export. Frozen fish is suitable for wide international trading provided the necessary 'cold chain' is established.

Canned fish and shellfish together claiming 18% of total trade are eminently suitable for export to anywhere, as the high proportion exported (60%) bears out. Though main producing and exporting countries were comparatively few (French Morocco, Japan, Portugal, Canada, Norway, the U.S.A., South Africa, the Netherlands, Peru), the receiving countries were very well spread out over the continents. Much of the exported fish, however, was of the more expensive luxury variety.

Some current trends and developments in preservation by cold

Chilling in ice. A major part of the world catch is subjected to chilling at some stage or other between catching and consumption. In the northern hemisphere stowage of fish in crushed ice has been a main factor in greatly increasing fishing

range and total catch, especially of demersal fish. The method could also be used much more and is being increasingly used for expanding fisheries off less developed tropical countries. The capacity of ice to keep fish in edible condition is now, however, being habitually exceeded in the distant-water fisheries of Europe. Research has defined the limitations of ice with some precision (Cutting, Eddie, Reay & Shewan, 1953); cod and related species, for example, well iced under best conditions of care and cleanliness in handling and stowage become inedible at about 16 days from catching.

Much white fish offered to consumers in north-west Europe is more than 15 days' caught (European Productivity Agency of the Organisation for European Economic Co-operation, 1957, p. 65). British distant-water trawlers, taking more than half our white-fish catch on average round trips of 20 days, land fish ranging from 5 to 15 days' caught on the average, at least 40% being over 11 days' caught, i.e. no longer reasonably fresh. Distribution has still to take place. Some 0·5% of the catch is condemned at the ports and made into fish meal along with a varying part, up to 10%, that does not fetch the minimum price for 'freshing' and smoke-curing. The large trawlers used, fast and expensive to run, return home on the average only half filled, fishing and steaming time per trip being about equal.

Research showed (Cutting *et al.* 1953) that improved preservation could be secured primarily by more effective use of ice as well as by greater care and cleanliness. Trawler owners have responded by building ships with better insulation, easily cleanable metal-lined fishrooms with metal shelves, and washing tanks on deck, but there is still too much poor-quality fish landed. Probably the best performers amongst ships and crews cannot on the whole do much better, but the worst could on the average extend by a few days the time for their fish to reach inedibility. However, there has been a marked improvement since just after the war.

Trawler design and lay-out is not static. Germany and Iceland are experimenting with 'shelter-deck' vessels (Barthel, 1956; Anonymous, 1957*a*, *b*; Thode & Hecht, 1954; Pearson, 1958; Hardy, 1952) and the possibilities of mechanized gutting, washing, transporting and icing of fish on such ships should receive fullest examination and test in relation to quality as well as to saving of labour.

In ice containing 5 p.p.m. of chlortetracycline or oxytetracycline fish become inedible 7–10 days later than in ordinary ice, although there is no obvious effect during the first 10 days (Ingram, Barnes & Shewan, 1956; Tarr, 1956; Partmann, 1957; Shewan, 1958). This use of antibiotics is permitted in a number of countries including Canada, but not in Britain. The Torry Research Station has demonstrated to the trade cargoes of fish carried in ice containing antibiotics (Shewan, 1956) and is now determining the residual amounts of antibiotic in fish after cooking in various ways. With such ice, average quality could be raised on distant-water trips of existing average duration or a little longer. Further extension would ultimately lower average quality although increasing yield per day at sea. The method cannot preserve surplus fish for use months later. Ice with antibiotics could be of special service in tropical fishing and distribution; its use is being investigated (Ducroz, 1957).

Canada has been experimenting with the stowage of halibut and salmon in chilled sea-water on the fishing vessel (Harrison & Roach, 1954, 1955, 1957; Steiner & Tarr, 1955; Schmidt & Idler, 1955), several extra days' preservation being possible, and still a few days more in the presence of 2 p.p.m. antibiotic. The Torry Research Station in shore experiments with cod without antibiotic sees so far no great quality advantage for our distant-water fishery and envisages possible difficulties in securing the stability of the large vessels we employ.

Much that has been said above about chilling preservation applies to short sea voyages followed by distribution over a large land area as in North America. In general there is great need everywhere for better temperature control, care and cleanliness in the transport and retailing of fresh fish, and the Humber Laboratory in Hull has begun a systematic study in this country.

Freezing and cold storage. If quick-frozen and stored at temperatures as low as from −10 to −20°F., really fresh fish may be held in virtually unchanged condition for many months, sufficient for regulating the flow of supplies and exporting over wide areas (Reay, Banks & Cutting, 1950). Production of frozen fish is rising in the large fishing countries, but mostly on shore—not at sea—and the best results can only be got with really fresh fish. The trade so far has been largely in consumer packs, now including frozen, cooked products.

However, for Britain and some other countries a primary problem is how to land in really good condition, in forms suitable for processors, caterers and fishmongers, all fish that cannot be satisfactorily preserved in ice. In recent years, therefore, freezing at sea has been investigated.

The British *Fairtry* (Lochridge, 1955–6), the first successful freezing factory trawler, 245 ft. long, filleting the catch by machine and quick-freezing the fillets and reducing the offals to meal, has now operated for 4 years, landing products, mainly large catering packs, of excellent quality. Two similar vessels were put on order in 1956 (White Fish Authority, 1957*a*), and the U.S.S.R. and Poland are known to be actively developing this line. Ships of this size can make voyages of 2 months or more, covering very wide areas.

In 1956 the Torry Research Station technically planned and supervised a specially interesting experiment financed by the Distant Water Trawler Owners' Development Committee, the White Fish Authority and the Ministry of Agriculture, Fisheries and Food. In eight Arctic voyages the *Northern Wave*, a converted 185 ft. trawler, froze and stored at −20°F. the first quarter of each catch, icing the rest. Specially suitable freezing plant, the prototype of which was designed at Torry, was used (Eddie, Hales & Higham, 1957–8). Technical feasibility was amply proved and the frozen fish, mainly cod and haddock, were excellent even after up to 8 months' storage at −20°F. on shore and suitable for use by the trade in all the usual ways (White Fish Authority, 1957*b*). It seems possible that freezing the first part of the catch could not only raise the average quality, but also be used in a suitably planned trawler of conventional size with somewhat smaller engines, and so less expensive speediness, to secure improved productivity, i.e. longer

fishing per somewhat longer voyage and more fish per day at sea and per ton of fuel.

These two British pioneer experiments have indicated two possible ways of improving the exploitation of wide-ranging fisheries. 'Those who rely on supplies brought in by distant-water trawlers may before very long be freezing sizeable quantities at sea' (European Productivity Agency of the Organisation for European Economic Co-operation, 1957, p. 38).

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REFERENCES

Anonymous (1957*a*). *Ship & Boat Build.* **10**, 352.
Anonymous (1957*b*). *Ship & Boat Build.* **10**, 472.
Barthel, F. (1956). *Ship & Boat Build.* **9**, 195.
Cutting, C. L., Eddie, G. C., Reay, G. A. & Shewan, J. M. (1953). *Leafl. Food Invest. Bd*, no. 3, 3rd ed.
Ducroz, J. (1957). *Rev. Élev.* **10**, 147.
Eddie, G. C., Hales, R. T. & Higham, D. W. (1957–8). *Proc. Inst. Refrig.* (In the Press.)
European Productivity Agency of the Organisation for European Economic Co-operation (1957). *Fish Marketing in Western Europe Since* 1950. Paris: European Productivity Agency of the Organisation for European Economic Co-operation.
Food and Agriculture Organization of the United Nations (1955). *Yearb. Fish. Statist. F.A.O.* **4**, Part 2.
Food and Agriculture Organization of the United Nations (1957*a*). *Yearb. Fish. Statist. F.A.O.* **6**.
Food and Agriculture Organization of the United Nations (1957*b*). *The State of Food and Agriculture*, p. 59. Rome: Food and Agriculture Organization of the United Nations.
Hardy, A. C. (1952). *Fish. News, Aberd.*, no. 2024, p. 10.
Harrison, J. S. M. & Roach, S. W. (1954). *Progr. Rep. Pacif. biol. Sta.* no. 100, p. 13.
Harrison, J. S. M. & Roach, S. W. (1955). *Progr. Rep. Pacif. biol. Sta.* no. 104, p. 3.
Harrison, J. S. M. & Roach, S. W. (1957). *Progr. Rep. Pacif. biol. Sta.* no. 108, p. 10.
Ingram, M., Barnes, E. M. & Shewan, J. M. (1956). *Food Sci. Abstr.* **28**, 121.
Lochridge, W. (1955–6). *Trans. Instn Engrs Shipb. Scot.* **99**, 511.
Partmann, W. (1957). *Z. LebensmittUntersuch.* **106**, 210.
Pearson, S. F. (1958). Private communication.
Reay, G. A., Banks, A. & Cutting, C. L. (1950). *Leafl. Food Invest. Bd*, no. 11.
Schmidt, P. J. & Idler, D. R. (1955). *Progr. Rep. Pacif. biol. Sta.* no. 104, p. 9.
Shewan, J. M. (1956). *Fish. News, Aberd.*, no. 2260, p. 10.
Shewan, J. M. (1958). *Rep. Progr. appl. Chem.* (In the Press.)
Steiner, G. & Tarr, H. L. A. (1955). *Progr. Rep. Pacif. biol. Sta.* no. 104, p. 7.
Tarr, H. L. A. (1956). In *Proceedings First International Conference on the Use of Antibiotics in Agriculture*, p. 199. Washington: National Academy of Sciences—National Research Council.
Thode, H. & Hecht, W. (1954). *Hansa*, **91**, 1767.
White Fish Authority (1957*a*). *Sixth Annual Report.* London: H.M. Stationery Office.
White Fish Authority (1957*b*). *Report on an Experiment into the Freezing of Fish at Sea.* London: White Fish Authority.

Fish meal in livestock feeding

By A. A. WOODHAM, *Rowett Research Institute, Bucksburn, Aberdeenshire*

Of the fish meal manufactured in the United Kingdom from both white fish and herring the greater portion is utilized for animal feeding, a very small proportion only of low-grade meal being used as a fertilizer. Non-ruminant farm animals and