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Administrative Report

FISHERIES IMPROVEMENT COMMITTEE

by Grim Berge

1971

Belgium

(P. Hovart)

Pollution

Studies concerning the effects of disposal of domestic sewage and of industrial wastes were carried out.

The sewage pollution was studied by monthly observations on the biological and physico-chemical composition of the sediments, the bacteriology of the sediments, the physico-chemical composition and the biology of the seawater, the bacteriology of the sea-water, the phyto- and zooplankton. Hydrographical observations were carried out. Monthly evaluations of fish and shrimps were continued. These studies consist of a qualitative and quantitive determination of the stocks.

Mercury determinations were started on cod, whiting, plaice, sprat and shrimps.

Regarding ships dumping of industrial waste waters, studies were started on the pollutants and their effects on fish and fisheries.

The interministerial Commission for Research Programming has elaborated a national pollution research programme. The test area for the mathematical model covers approximately the coast line from Calais to Texel. On about 30 fixed stations, vessels of the Belgian Navy have carried out continuous observations on the surface and bottom waters, on plankton, on sediments, on currents and on fish populations.

Canada

(J.M. Anderson)

Pollution

Marine organisms were monitored for halogenated hydrocarbons such as polychlorinated biphenyls (PCB'S), polychlorinated terphenyls, chlorinated hydrocarbon pesticides, chlorinated dibenzodioxins, and dibenzofurans. Following the official ban on the swordfish fishery, an intensive sampling programme was launched to try to determine the factors responsible for the variations in mercury levels in swordfish (Xiphias gladius) over the range of the species off the North American coast. Another special programme was one measuring organo-chlorine residues in marine oils from fish from the Gulf of St. Lawrence, North Atlantic, and Antarctic areas. Mercury levels of up to 150 ppm were found in Pacific fur seals (Callorhinus ursinus) and 387 ppm in North Atlantic grey seals (Halichoerus grypus), although no evidence of toxic effects on the seals has yet been noticed.

In studies on the biodegradation of oil, a variety of hydrocarbon-oxidizing micro-organisms, capable of degrading oil at temperatures as low as 3°C, have been found in coastel areas of southern Newfoundland, Nova Scotia, and Prince Edward Island. The numbers of such micro-organisms are greatest where the oil pollution is the heaviest. Mouse tissue culture cells (L-cells, Clone 929), cultivated in suspension, have been shown to be sensitive to common pesticides, herbicides, phosphorus, and mercury. The tissue culture method appears to be a useful bioassay system to replace live fish in monitoring water pollution.

Numerous monitoring programmes were also carried out on water quality. A quarterly sampling programme was begun to study petroleum hydrocarbons and other oceanic pollutants along a section from Halifax to Bermuda. This study will allow comparisons to be made of coastal and oceanic waters. Through discussions and negotiations with the Pollution Abatement Section of the Resource Development Branch of the Federal Department of the Environment, effluent water quality of several industrial operations was improved, in some cases markedly sc; the industries included pulp and paper, food processing, chlor-alkali production, oil refineries, smelters, base metal mining, and a range of secondary manufacturers.

Sublethal studies, including behavioural effects, were continued with emphasis on PCB's, crude oil, and chlorinated pesticides including metabolites of DDT.

Fish Transplantation and Cultivation

There continues to be a significant natural run of pink salmon (Oncorhynchus gorbuscha) in Newfoundland from the egg transplantation programme begun during the period 1959-1966. In 1971, there were 622 total returns (spawning plus known commercial and other recoveries) of salmon from the natural spawn of 1 116 spawning adults in 1969.

A large-scale oyster spatfall monitoring programme has been implemented to determine commercially reliable spat collection areas. A total of 112 stations are being monitored in Prince Edward Island and New Brunswick. Initial results are encouraging, with approximately 25% of the stations in Prince Edward Island taking a commercial set.

An estuarine resource inventory project has been modified and expanded to determine the potential of Maritime estuaries for aquacultural development and to provide a sound information base for management of the resource.

Work in aquacultural techniques for off-bottom rearing of the American oyster (Crassostrea virginica) has progressed to the stage where commercial implementation for rearing to seed size (4-6 cm) is practical. Future emphasis will be placed on manipulation of the seed oyster to improve shell and meat characteristics to increase marketability of the product.

Denmark

(Vagn Olsen)

Some preliminary rearing experiments have been carried out during the year. A closed circulation system has been built up containing 800 litres of sea water. In February, the system was stocked with stripped plaice eggs. Two and a half months later, the survival was 8.6%. It is the intention to continue the rearing experiments in October with herring from the Sound.

An experiment on the toxicity of dispergents and some mixtures of different crude oils and dispergents to marine fish has been carried out during March 1971.

Finland

(A. Voipio)

The continued pollution studies (Baltic Sea and the coasts of Finland are mainly directed to the monitoring of the primary production and related topics. In addition, the studies of the dating and properties of the recent sediments in the Northern Baltic are in progress. The contents of some elements determined (e.g. C,N and Mn) show remarkable variations in time during the last few centuries. Attempts have also been made to study the accumulation of lead and mercury in these sediments.

France

(L. Martell)

Mollusques

De grandes quantités de naissains C. gigas ont été introduites en 1971 afin de repeupler les parcs d'élevage français décimés par la mortalité de C. angulata. La plus grande partie provenait du Japon, le reste de Colombie britannique ou d'écloseries installées en Angleterre ou aux U.S.A. (Californie). Une attention particulière a été portée à la destruction des parasites et prédateurs, notamment de Pseudostylochus ostreophagus. Les lots importés étaient traités, en France, une nouvelle fois, en eau douce, avant d'être immergés. La croissance de ce naissain, quelle qu'en soit l'origine, a été excellente en 1971.

Une transplantation de sujets adultes de C. gigas a été tentée en 1971 dans les régions de Marennes et d'Arcachon. 105 tonnes d'huîtres provenant du secteur de Pendrell Sound, au nord de Vancouver, ont été immergées à l'emplacement d'anciens bancs naturels de C. angulata. En dépit de la date tardive de l'introduction (mai-juin), ces mollusques se sont généralement bien comportés et se sont reproduits in situ, le même été. Des fixations nombreusesde C. gigas ont été observées au voisinage des lieux de semis; le comportement de ce naissain était très satisfaisant à la fin de l'année 1971.

Crustacés

Homards - Les essais d'élevage de Homarus vulgaris se sont poursuivis en 1971. Des améliorations très nettes ont été obtenues et le taux de survie au 4ème stade a été compris entre 80 et 100%. Des expériences ont été faites en vue de préciser l'influence de la température sur la croissance des immatures. 30 000 jeunes homards au 4ème stade, provenant d'une écloserie, ont été immergés dans un but de repeuplement.

Les tentatives menées en laboratoire en vue de déterminer si l'acclimatation du homard américain Homarus americanus est possible, ont donné des résultats positifs. L'accouplement, la ponte et l'éclosion ont été observés (femelles en captivité depuis 1969). Plusieurs centaines de larves au 1er stade ont été obtenues. La croissance des jeunes élevés en captivité, paraît normale.

Langoustes

Les observations sur le comportement de Jasus lalandei en captivité, ont été poursuivies en 1971. Les tentatives d'élevage des phyllosomes de Jasus lalandei, de Palinurus vulgaris ont échoué.

Algues

Des essais ont été tentés avec prudence pour déterminer si Macrycystus pirifera peut vivre sur les côtes françaises de la Manche. Des folioles reçues du Chili ont été mises en culture, au laboratoire. Les plantules obtenues ont été immergées en aquariums alimentés en eau de mer prélevee sur le littoral. On espère ainsi suivre le comportement de l'espèce dans des conditions hydrologiques très proches de celles des côtes où l'espèce pourrait être implantée si l'opération se révélait souhaitable et sans danger.

Germany (F.R.)

(H. Mann)

Pollution

Many institutes, in close collaboration with each other, are working on problems of marine pollution. This type of work is supported and coordinated by the Deutsche Forschungsgemeinschaft which some years ago suggested drawing up a basic programme on littoral research and pollution of coastal waters. The essential problems concern the effect of pesticides and metallic salts on the organisms of the sea. For several years various commercially important fish, mussels and shrimps have been examined regarding their content of DDT and metabolites, dieldrin and endrin. During the last year research was also started on the content of PCB. In this connection investigations on the transformation of pesticides in marine environment were carried out. Further studies are dealing with the question concerning the way in which a transformation of these substances takes place in the organisms themselves. It is of equally great importance whether the composition of pesticides is changed during the various processing stages. This work is supplemented by investigations on the influence of DDT on the embryonic development of fish.

Regular studies deal with the content of heavy metals (strontium, calcium, zinc, manganese, iron, cobalt, chromium, and mercury) in coastal fish, plankton and water samples.

The influence of red mud on fish, plankton and organisms living on the water bottom was examined in detail in laboratory experiments and also by field studies. Investigations on the population dynamics of the microfauna in the dumping area of a titanium dioxide factory have been continued. The effect of iron hydroxide on the filtration and food utilization of the blue mussel was the subject of physiological research.

Studies were completed on the effect of detergents and some additives to washing compounds, e.g. proteolytic enzymes, on fish and fish food at different degrees of salinity. Further, investigations on the effect of reduced oxygen partial pressure on cells

and tissues should be mentioned. It should also be reported that research has been carried out on the chronical influence of sublethal concentrations of pollutants on marine organisms, especially with respect to the ulcer genesis of eel.

The effects of 2,4-dinitrophenol (DNP), an inhibitor of the oxidative phosphorylation, on the embryonic development of the herring Clupea harengus were investigated. Mortality rates, morphological anomalies and energy metabolism (respiration, concentrations of low molecular sugars, polysaccharides, free amino acids and adenosintriphosphate) were determined at different stages of embryonic development, as well as under normal conditions and under the influence of 2,4-DNP.

Investigations on the effects of acute x-irridiation during the course of early embryonic development of marine teleosts were started last year.

Iceland

(J. Hallgrimsson)

Samples of fish and plankton were collected in cooperation with the Woods Hole Oceanographic Institution in the Denmark Strait for the determination of DDT and PCB pollutants.

Ireland

(F.A. Gibson and
D.G. Griffith)

Investigations into the toxicity of new oil-dispersing preparations were carried out in the fisheries laboratory of the Department of Agriculture and Fisheries by Mr David Griffith, using the larvae of the Brine Shrimp (Artemia salina).

Dr Geoffrey Crapp completed the first year of a study of the littoral and sub-littoral ecology of the inner part of Bantry Bay, where Gulf Oil Terminals (Ireland) Ltd. have a crude oil storage terminal. Dr Crapp was conducting this programme under a Fellowship set up by Gulf Oil and the Department of Agriculture and Fisheries, but as from November 1971 he has been continuing the work under a Department of Education post-docturate grant at University College, Cork.

During the summer months the Department of Agriculture and Fisheries employed an undergraduate, Mr Dealga O'Ceallachain of University College, Cork, to investigate BOD, O_2 and salinity levels at selected sites in Cork Harbour, particularly the highly polluted estuary of the Owenacurra River at Midleton.

The Department of Agriculture and Fisheries commenced, on a nationwide basis, the collection of organic and inorganic samples from the littoral and sub-littoral zones of the shore for heavy

metal analysis. This survey is being conducted with the assistance of the Veterinary Research Laboratory and the State Laboratory.

Netherlands

(P. Korringa)

Immediately after the opening of the Dutch mussel season on 1 July a real epidemic of serious gastro-intestinal complaints resulted from the consumption of both uncooked and cooked mussels. With the aid of laboratory rats it was demonstrated that these effects were, indeed, caused by a toxine present in the mussels from the south-western part of the Netherlands. Although the symptoms were quite different, the toxic compound present seemed to be in all probability a saxitoxin related to the paralytic shellfish poison (PSB). This idea was supported by the fact that the toxine could be isolated and identified by the same method as has been described in literature for PSB. For example, it gave the same colour reaction with picric acid as PSB and could, indeed,be quantified in this way.

As a result of the shellfish poisoning, the Dutch mussel industry was forced to postpone all sales for about one month. Although the toxicity of the mussels was beyond any doubt, the very origin of the poison remained uncertain. The only connection which could be made to the mussel poisoning of 1961, was the sunny and warm type of weather with very little wind, resulting in an enormous bloom of all kinds of plankton, including dinoflagellates, in the entire Dutch coastal area. This was, however, in contrast to the cases of mussel poisoning reported from the U.K. in June of this year, where it coincided with cold, rainy and stormy weather.

Apart from the period of mussel poisoning, the sanitary control of shellfish gave no further reason for concern in the rest of the year.

At the beginning of 1971, a general uneasiness reigned in the Netherlands about environmental pollution with mercury. The rapid increase in alarming news on this subject reached its peak with the withdrawal of swordfish from the USA market by the FDA. Later on, when it became clear that no higher mercury levels occur in fish from the open seas now than have always occurred before, the public opinion was somewhat eased down.

Mercury determinations in fishery products from the Dutch coastal waters revealed no elevated levels at present. Flounder from the Wadden Sea was found to contain relatively high amounts of mercury, but presumably this amount represents only its natural level. Besides, it was found that mercury in fish from the North Sea was present as methylmercury in the order of 40-60% methylmercury being the only mercury compound in fish important from a toxicological viewpoint. A comparison of the mercury content of perch and of pike-perch from the Ijssel Lake, an area which is contaminated to some extent by the polluted water from the Rhine, suggests that there exists a relationship between the mercury content of a fish and the conversion of its food into body-tissues, resulting in a higher mercury content at lower conversion values, i.e. a higher mercury content in older fish. With this in mind, it becomes possible to explain the large differences in mercury content between the different species of fish, such as swordfish, tuna, flounder and herring.

Regarding the other pollution problems in the Netherlands it may be stated that there exists a great deal of concern about the high levels of PCB contamination of fish, especially from the inshore waters. Chlorinated hydrocarbon concentrations in the fatty tissues of fish from the Ijssel Lake were found to be of the same order of magnitude as the corresponding concentrations in aqueous organisms from the Baltic. In the Dutch coastal waters, especially in the vicinity of the Rhine delta, the situation is far from reassuring.

The incidence of Anisakis marina in mackerel was successfully used to support the identification of three distinct mackerel populations. The mackerel from the north-eastern North Sea has been shown to be twice as much infected with Anisakis as the mackerel from the southern part of the North Sea. Both these heavily infected populations could be sharply distinguished from the mackerel of the north-west (Shetland) group which was virtually not infected with Anisakis.

Publications 1971

van Banning, P.	1971	"Wratziekte bij platvis" (Engl. sum.) Visserij 24 (6), 336-343.
van Banning, P.	1971	"Some notes on a successful rearing of the herring worm Anisakis marina L. (Nematodes: Heterocheilidae). J.Cons.Expl. Mer 34 (1),84-88.
Hagel, P. and Copius-Peereboom,J.W.	1971	"Hoe groot is de milieuverontreiniging met kwik in Nederland?". Chem.Weekbl. 67 (32), 9-11.
Roskam, R. Th.	1971	"Kwik in vis - vis uit de Nederlandse binnenwateren". TNO-Nieuws 26 (7), 390-394.
Roskam, R.Th.	1971	"De verontreiniging van de zee met olieachtige stoffen". Visserij 24 (7), 391-401.

Norway

(G. Berge)

Pollution

The investigations of the conditions of polluted fjords have continued. Observations have been carried out in the Hardanger fjord, where several laboratories cooperate on the study of distribution of heavy metals in biota and sediments. The pollution in this area originates in the industries in the inner part of the Sørfjord branch of the Hardanger fjord. (The results are made available to the Institute of Marine Research.)

A survey of the condition ot the Ranafjord was also undertaken, where pollutants from a coke plant and an iron factory are released to the inner fjord. Measurements were made in sea water of nutrients, salinity and temperature, and arsenic was analysed in samples from attached algae along the fjord. Gradient studies of total hydrocarbons, particle concentration and primary production were made throughout the entire fjord. (Institute of Marine Research).

Pollution surveys have been carried out in fjords by the Norwegian Institute of Water Research. The surveys include :

Quantity and quality of the receiving waters, waste waters, waste water discharges and mixing processes, the information of which give the necessary background for concessions to municipal and industrial corporations.

A study of the biological aspects of a planned nuclear power plant in south-eastern Norway has commenced. The study is jointly undertaken by biologists from several research laboratories, organised by the Norwegian Institute for Water Research. The studies are aimed at enlightning the problems connected with cooling-water discharges, thermal, radioactive and other pollution aspects.

A monitoring programme on occurrence of hydrocarbons from oil in seawater was initiated. Gas-chromatographic analysis of montly samples form a permanent sec ion between Norway and Scotland have been conducted since autumn 1971. (Institute of Marine Research).

Mercury in commercial fish are analysed regularly, in a programme organised by the Director of Fisheries. The results are made available to the Institute of Marine Research.

Samples of shellfish, crustaceans and fish for the North Sea baseline studies have been collected along the Skagerak and the North Sea coast of Norway. The organic pollutants (PCB's, DDT and metabolites) are measured at the Institute of Marine Research, whereas heavy metals are analysed at the Institute of Marine Biology, the University of Oslo.

Captured waste containers from the North Sea bed are irregularly being brought in to the Institute of Marine Research. Their contents are analysed, using gas-chromatography-massprectrometry. Records are stored for the purpose of evaluating quantitites of different types and the future risks involved with deterioration of containers on the fishing grounds. (Institute of Marine Research).

The cooperative Norwegian-Swedish investigations on chlorinated aliphatic hydrocarbons are continuing. The Norwegian contribution to this project is a study of pathological effects on exposed marine organisms (Institute of Marine Biology, University of Oslo), and the distribution of Cl-C in the sea. A repetition of the last year's sampling in a grid system of the North, Norwegian and Barents Seas with subsequent gas-chromatographic analysis are in work.(Institute of of Marine Research).

An investigation of sublethal effects of chlorinated hydrocarbons on fertilisation, egg development and larvae survival is continuing. Routine toxicity tests (LC_{50}) are carried out on fish with relevant pollutants of current interest. Effects of 1,2-dichloropropane and other hydrocarbons from North Sea Oils on the rate of photosynthesis in natural marine phytoplankton communities are also studied. (Institute of Marine Research).

Possible pathological changes in the liver of cod along the southern coast of Norway have been observed. A sampling programme at selected stations was initiated last year, and further material is planned to be collected for histopathological investigations. (Institute of Marine Research and Institute of Marine Biology, University of Oslo.)

The studies on the influence of polluted water on fundamental biological processes, the variation in different nitrogene compounds in polluted water systems, and the effect of purified and untreated sewage water on shellfish have been continued. (Institute of Marine Biology, University of Oslo).

The fauna of a sewage contaminated pool has been investigated and described. Investigations are going on in unpolluted pools for comparison. (Biological Station, Espegrend, University of Bergen).

In connection with plans for a new aluminium factory to be established near Bergen, a study of the bottom fauna has been made to evaluate probable changes expected from "red mud" discharges. (Biological Station, Espegrend, University of Bergen).

Experimental studies of oil and oil detergents on attached algae have been concluded. The effect of Kuwait oil and the detergent Corexit on urchin eggs have been studied. (Biological Station, Espegrend, University of Bergen).

Cultivation

Cultivation experiments with salmon, rainbow trout, flounder, lobster and mussels in enclosures in the fjords have been initiated. The objective is to investigate the productivity of different stocks and develop optimum conditions for practical cultivation. (Institute of Marine Research).

Problems of technical, biological and genetical nature in the rearing of marine fish larvae are investigated. A new hatching and rearing system has been developed. The intraspecific variation in fertilisation success and viability of pelagic flatfish larvae are investigated. Genetic studies to determine the heredity and effects of hybridisation are continued. The investigation on intraspecific variation in egg size and growth of yolk sac larvae of Arcto-Norwegian cod will be concluded this year. A similar investigation on mackerel eggs and larvae is continued. (Institute of Marine Research).

The experiments with cultivation of mussels, Mytilus edulis with net bags were continued in 1971. Experiments were started with sorting of spat with the intention to increase mean length and decrease the time needed for growth to marketable size. In the autumn 1971, the first commercially cultivated mussels were processed. Due to very good quality, high prices were obtained.

Unusual cases of food poisoning occurred in Norway in the winter 1970/71. The symptoms were vomitting and diarrhoea. During 1971 samples of seawater and mussels were taken. Though the phytoplankton samples have not been examined in detail, it seems that food poisoning is not due to blooms of toxic phytoplankton or sewage contamination.

Tests with white rats have given no evidence upon the applicability of tests on the mussels in Norway. At present (1 March 1972), no explanation of the food poisoning can be given, but the group of haemolytical bacteria are under investigation. These bacteria have formerly been recorded in connection with food poisoning after consumption of mussels. (Institute of Marine Research).

Experiments have been continued on hatching and rearing of lobster at increased levels of temperature compared to the natural environment. Preliminary experiments on hatching and rearing hybrids of plaice and flounder have been carried out with regard to growth and mortality (Statens Biologiske Stasjon, Flødevigen, Arendal).

Poland

(W. Mańkowski)

The Environment Protection Laboratory of the Sea Fisheries Institute at Gdynia undertook in 1971 very extensive research activities in the area of the southern and central Baltic. During two cruises material was collected that made it possible to try the elaborations concerned with the state of pollution. The following objects have been studied :

1. Dubrawski, R. & Andrulewicz , E.	:	Chemical composition of the river waters discharging from Poland's area into the Baltic Sea.
2. Dubrawski, R.	:	DDT and the Man's Environment.
3. Maciejowska, M. & Rakowska, E.	:	Preliminary investigations on decomposition of the fuel oils by marine micro-organisms.
4. Mańkowski, W.	:	Zooplankton - an indicator of marine pollution.

Portugal

No report received.

Spain

No report received.

Sweden

(B. I. Dybern)

Baltic Sea

The research work has been carried out along the same lines as during the foregoing year. The most important investigations are:

1. Physical-chemical (temperature, salinity, currents, oxygen, hydrogen-sulphide, pH, phosphorus, nitrogen, etc).
2. Biological (plankton, macrobenthos, fish distribution, primary production, algal drift, etc.).

3. Toxicological (content of certain metals, especially mercury, DDT, PCB, dieldrine, a.o., in sea water, in fish and other organisms).

The investigations are :

1. General (spread as networks over the western part of the Baltic and the Swedish coastal areas).
2. Regional or local (concerning special problems, e.g. a rivermouth study, sites for present and future warm water discharges, influence from different kinds of industries, among others paper and pulp mills and from sewage water discharges. The regional investigations are mostly carried out in the coastal zone.)

Many of the investigations are coordinated and constitute pieces in a national programme for the exploration of the Baltic. Efforts are made to construct a model, based on results hitherto, with the aim to facilitate future research work in the Baltic area, especially that related to the oxygen conditions in the deep water and the pollution conditions of the open sea.

Øresund

The regional research work carried out by the Danish-Swedish Øresund Water Committee has been carried out during more than 10 years and the second 5-year Report has recently been publshhd (Report on the the investigations of the Swedo-Danish Committee on Pollution of the Sound 1965-1970, 324 pp, Lund 1971). (In Danish and Swedish with English summaries).

Besides, a series of investigations on local pollution situations on the Swedish side are carried out by the regional organisation SKU (the South Coast Investigations).

West Coast

Local and regional investigations are carried out at a number of sites as in previous years. The most important are those of the Göteborg, Värö and Stenungsund regions. The cooperation between Norway and Sweden as to the Idefjord problem has continued and the discussions now concern to what extent the waste waters should be treated in order to get the best and cheapest water conditions in the fjord for recreational use and fishery.

A regional organisation, VKU (the West Coast Investigations) has been working for about one year on a summary of the pollution status of the west coast. It is intended to use this summary as the basis for future investigations and planning along the coastal area in question.

United Kingdom

1. England and Wales

(H. A. Cole)

Pollution

Measurements of Pollutants. The monitoring of commercial species of fish and shellfish for persistent substances has continued in co-operation with DAFS. The distribution of organochlorine pesticide residues, PCB's and certain metals has been measured in fish and shellfish from distant and middle waters; coastal and estuarine areas. Samples for pesticide and PCB analysis have been taken twice yearly, from 9 ports in England and Wales and during 1971 no noticeable changes or trends were evident. The survey of metals in fish and shellfish has been extended to include cadmium, lead, copper and chromium. Above average levels of lead were found off the south east and north west coasts of England and of lead and cadmium in the Bristol Channel. Limpets (Patella vulgaris)and periwinkles (Littorina littorea) appear to concentrate these elements. A start was made on the North Sea baseline study for the determination of persistant substances. During the year, all invertebrate samples were collected and examined, and studies on the distribution of metals in water were started.

A special investigation was made to determine the distribution of mercury in commercially important fish and shellfish landed in England and Wales. Several thousand analyses of fish and shellfish were made. Most of the mercury in the fish was found to be in the methyl form, whereas that in shellfish ranged from 20-85%. Highest concentrations of mercury were found in flat fish, mainly plaice and flounder, in industrial estuaries such as the Thames, the Mersey (Irish Sea) and in Morecambe Bay. A detailed report describing the results and the significance has been published.

Ecology

Surveys have been made of the benthos and its substrate in areas subject to pollution by domestic and industrial wastes. The effects of dumping domestic sludge have been determined in the Black and Barrow Deeps of the Thames estuary, and in Liverpool Bay, of china clay wastes off the Cornish coasts, of potash wastes and other mineral wastes off the north east coast. In addition, the effects of a paper mill effluent has been determined in a narrow estuary close to an important oyster fishery. In the Falls area of the Southern Bight, a benthic and sediment survey showed an area of instability with relatively poor benthic fauna; as a result an area designated for controlled dumping of wastes was re-defined.

The effects of gravel extraction on benthos and fisheries have been examined in the North Sea and in the English Channel, using benthos surveys divers and the sector scanner. Holes made by dredging do not fill in quickly, and may severely interfere with trawling. Natural setting in these depressions is mainly fine material, and this together with the effects of increased suspended matter as a result of washing the gravel are likely to have a severe local effect on fisheries. Studies are continuing.

Detailed investigations will be made in 1972 to determine the fate of sewage sludge released into the Barrow Deep, using further benthic and sediment studies, radioactive tracer and hydrographic studies.

Toxicology

Advice is given on the effects of disposing liquid and solid wastes to sea, and where necessary these substances are tested in the laboratory to determine their effect on marine organisms. During 1971, toxicity tests were undertaken to determine the lethal threshold concentration (TLm) rather than the 48 hour median lethal concentration (LC50) in the previous years. A new continuous flow apparatus was devised for some of these investigations. Tests were usually carried out with the brown shrimp (Crangon crangon)and the armed bullhead (Agonus cataphractus). During the year, 52 industrial wastes or effluents were tested, and most had a TLm in excess of 1000 mg/l; values less than 100 mg/l were rarely encountered. 43 oil dispersants were tested and several had TLm values for Crangon crangon greater than 1 000 mg/l

In addition to routine testing, special investigations were made related to toxicology and behaviour. Long term tests in the continuous flow apparatus with Crangon showed that threshold concentrations of cadmium and mercury were not reached after exposures lasting several weeks. The tests with mercury showed dead animals contained 15-100 mg/Kg of mercury in their tissues; survivors contained up to 20 mg/Kg. Smaller animals were more susceptible, and moulting increased sensitivity.

Field toxicity tests are being devised to bridge the gap between laboratory tests and field conditions. Using caged Crangon it was found that in vivo tests could be used to assess the toxicity of a highly acid waste being discharged into an estuary from titanium production.

The relationship between threshold concentrations and avoidance using a Sprague type trough and the shore crab (Cracinus maenas) showed that these animals avoided water of a lethal pH. However, the addition of food reduced the level of avoidance.

Oil

Tests have continued in the laboratory to determine the effect of oil sunken by mineral substances such as amine-treated sand. Preliminary results indicate that the effects on benthos are likely to be small, but a few burrowing animals appear to be very sensitive.

Experiments are in progress to determine the presence of oil and certain polynuclear aromatic hydrocarbon (PAH) substances in a fish (Pleuronectes platessa) the mussel (Mytilus edulis) and hard clam (Mercenaria mercenaria). Tests have been made with samples from coastal areas, and of those subjected to oil pollution in the laboratory. Naturally occurring concentrations of mineral oil and its fractions are low, and substantial reduction appears to take place when the animals are held in clean water. The work is continuing

Microbiology of shellfish

Studies continue to determine the relationship between sewage bacteria and molluscan shellfish. Several new shellfish purification plants have been designed, and two new systems are being examined. In one, a high intensity system with ultra-violet light in which the shellfish are held in shallow trays is being developed for the purification of the hard clam, which requires a water temperature of at least 15°C. A system for mussels in which the water will be re-used is also being examined.

Tests have been made to assess the significance of estuarine bacteria, the so-called normal flora of shellfish, in cases of gastro-enteritis following the consumption of raw molluscan shellfish. To support this investigation a survey has been made on the bacteria present in market-grade shellfish.

Surveys continue to be made to determine the distribution of sewage bacteria in areas of molluscan shellfish production and use has been made of the pigmented bacterial indicator Serratia indica to determine the movement of polluted waters from a particular source.

Annual monitoring of the north-east coast of England for algal toxins in mussels is carried out between March and August. During 1971, toxicity developed sporadically over 50 miles of coast, but did not build up to levels of toxicity comparable to that of previous years. This appeared to be related to a change in the weather pattern.

Fish Cultivation, Port Erin

Larval rearing. The larvae of the Lemon Sole Microstomus kitt which have in the past proved difficult to rear because of the small mouth size at first feeding making Artemia nauplii unacceptable, have this year been reared with 25% survival at 100 days after hatching. This success has been achieved by feeding in succession Mytilus larvae, the rotifer Brachionus plicatilis and Artemia nauplii. Work is currently under way to try to improve overall survival.

Subject to the availability of viable eggs several experiments are planned for the coming year to try to improve on the rearing techniques recently developed for the Turbot S. maximus at Lowestoft. The information and experience gained with the rearing of Lemon Sole larvae will, it is hoped, be of some value in this exercise.

The statistical analysis of the results of growth studies on developing sole and plaice larvae have suggested that length may be a better indication of larval age than either weight or development state for the analysis of larval samples caught at sea.

Water conditions. The effects of dissolved ammonia which, as one of the main nitrogenous excretory products of fish could be an important factor in high density culture, have been studied at sub-lethal levels on small juvenile plaice and sole. The results showed that growth was depressed as the concentration of unionised ammonia increased, but sole which were found to be less affected than plaice also showed some ability to acclimatise to the conditions when exposure was continued.

Studies on the effect of increased concentrations of dissolved carbon dioxide on this depression of growth by ammonia is planned for later in the present year. An examination of small juvenile sole S. solea which had been exposed for 20 days to sub-lethal levels of free chlorine showed no consistent histological differences from control fish at concentrations below 0.06 ppm.

In the study of temperature effects on young flatfish results of the upper lethal limits have been obtained for small juvenile plaice and sole acclimatised to different temperature conditions. Future work will include studies on the effect of temperature on survival, growth and food conversion efficiency in the larval stages, and an investigation into the effects of difference temperatures and feeding rations on growth and food conversion efficiency, standard and active O_2 consumption and activity.

Feeding studies with juvenile fish. Juvenile sole S. solea receiving a moist pellet developed by the NERC Fisheries Biochemical Unit at Aberdeen have shown poor growth and food conversion efficiencies on this food. These poor results may be due in part to the difficulty of adapting fish which have been reared for some time on a live diet of Lumbricillus rivalis to pelleted food. Work in the coming year will be aimed at determining the optimum point for weaning juvenile fish onto an inert food with particular reference to their subsequent growth and food conversion efficiencies.

Although L. rivalis has proved an excellent food for small juvenile flatfish, it has so far failed to respond to conventional culture techniques. It has however been found that a mixture of 75% of the easily cultured Enchytraeus albidus with 25% L. rivalis will support growth in young sole equal to that obtained on L. rivalis alone. A large scale culture technique for E. albidus is being developed, and other Enchytraeid species are being examined with reference to their suitability as food for small fish and their adaptability to culture conditions.

Disease and pathology. A comparison of the histology of hatchery reared fish with that of wild fish has shown consistent differences in the appearance of liver sections, hatchery fish showing gross vacuolation (perhaps due to oil storage) and poorly defined sinusoids. Haematology values (haemglobin, packed cell volume and red cell count) have been obtained from hatchery fish maintained at 20°C and 10-15°C. No significant differences were found in these values after a period of three months at these temperatures. Lower values were however recorded from diseased fish. Wild plaice trawled in November had higher haemglobins and packed cell volumes but lower red cell counts than hatchery fish sampled at the same time. Stress due to trawling may however have been responsible for these differences. This work, to provide background information for the evaluation of disease monitoring techniques is being continued in the present year.

Mortalities in plaice stocks infected with Gyrodactylus were found to be increased when a marine trichodinid ciliate was also present in the skin, this organism was quickly killed by the one hour duration 1 in 400 formalin bath treatment used to remove the Gyrodactylus.

Attempts to replace antibiotics by chemical bacteriostats for the treatment of fish eggs to reduce bacterial contamination during incubation has so far proved unsuccessful. Formalin, Roocal and Lysol have so far been tried, and further treatments may be tested this year.

Further work this year will include an investigation of the organisms responsible for skin lesions and fin rot in captive fish, a continued examination of the causes of mortality during rearing of juvenile flatfish and a histological examination of sole and plaice exposed to sub-lethal concentrations of ammonia.

Fish Cultivation, Lowestoft

Gynogenetic plaice produced in 1970 now measure up to 25 cm in length but are not yet sexually mature. Approximately 30% of the fish are males which suggests that sex-determination in plaice is not of the usual type in which females have 2 X-chromosomes, males an X and a Y. If this was the case, gynogenetic fish should all be female. It remains possible that the female is the heterogametic sex (WZ) or that sex is not determined by chromosome complements.

As predicted, the gonads of triploid plaice and flounder hybrids produced in 1970 failed to mature in 1972, although those of the control diploids did. Sterility of triploids was thus confirmed and the induction of triploidy may therefore be a useful technique to avoid undesirable filling of gonads in cultivated fish which mature early. Attempts were made to produce triploid trout since sexual maturation is not a desirable feature of fish stocked in still-water reservoirs. These preliminary trials failed, although considerable chromosome abnormalities, including polyploidy, were observed in eggs given a cold shock 8 hours after fertilisation.

Rearing trials started in November 1970 with captured 0-group turbot, were continued. These were run at ambient temperature until November 1971 and at 18°C thereafter. On a diet of trash fish, the turbot reached a mean weight of about 1 kg after 18 months and at this time almost all fish were above the legal limit of 30 cm. Trials with 0-group fish reared at a minimum of 18°C suggest that turbot could be reared to market size in 14 months. Survival of captured 0-group turbot was very high. Apart from an accidental loss of fish midway through the trials, the mortality in the the original 400 fish was less than 10% over an 18 months period. Most of the deaths occurred early on and appeared to be confined to fish which failed to start feeding. Food conversion efficiencies ranged from 18% in small fish at ambient temperature at the start of the trials to 40% in the larger fish at temperatures of 18° - 23°C. Overall conversion efficiency up to Month 16 was 35%.

Attempts to rear turbot larvae from eggs through metamorphosis were partially successful in that the early feeding problems were overcome using rotifiers as an initial feed followed by Artemia nauplii. Several fish survived almost to metamorphosis and one actually completed metamorphosis. Much remains to be done before the techniques are satisfactory for routine production.

2. Scotland

(A.D. McIntyre)

Food Chain Investigations. Studies of food chains leading to juvenile flatfish in a sandy bay and to Nephrops norvegicus on a muddy ground have been going on for some years in a Scottish Sea Loch. This work provides the information on the factors controlling survival and recruitment of these commercially important species.

Mussel Cultivation. Experimental cultivation of mussels in sea lochs in the west coast of Scotland has continued. Mussels have been transplanted successfully in tubes of plastic netting.

Shellfish. Coliform examination has been continued of water and mussels (Mytilus edulis) from various parts of Scotland. Enquiries on methods of shellfish purification have been dealt with and advice given.

POLLUTION

Pulp Mill Surveys. The routine surveys in Loch Linnhe and Loch Ewe have continued in relation to pulp mill effluents. The hydrographic and chemical data covering the period 1964 - May 1966 and May 1966 to date have been analysed and relationships have been established between oxygen and effluent parameters, and between biological oxygen demand and effluent parameters. Further television, grab and core surveys have been carried out. A small part of the bottom of Loch Ewe (not more than 10%) shows some change to anaerobic mud with associated changes in pH and eH in the core profiles and in the dominant components of the benthos.

Firth of Clyde. Several detailed studies have been made in this area during 1971 and samples of mud, water and bi-valve Tellina were collected for analysis of copper and where applicable nitrate levels. In one area studied, copper content of the soft bodies of Tellina reflected their position on the beach with respect to the discharge of an effluent containing copper. A grab survey and an underwater TV camera survey were carried out in the vicinity of a sewage sludge dumping ground. Chemical analysis of these grab samples indicated significant accumulation of copper, zinc, lead and cadmium in the sediments. Biological analysis together with the TV survey further demonstrated the effects of dumping. A major survey was carried out in July/August on RV "Explorer" to examine the circulation of the Clyde Sea area and the extent of nitrate and chlorophyll distribution in relation to a major discharge of nitrate.

Experimental work. Studies are being made of the effects of various pollutants on an experimental prey-predation food chain (bi-valve-flatfish) set up in large outdoor tanks. So far, copper, mercury and DDT have been tested and the experiments are continuing.

Monitoring. Fish and Shellfish from the Clyde have been examined for their trace metal content (copper, zinc, lead, cadmium and mercury) as part of a National survey (Elton Committee - Working Party on Monitoring of Foodstuffs). Additional sampling programmes have been organised in relation to international commitments to ICES and IDOE. For the former samples include 1967 year class cod and plaice and 1968 year class herring as well as Mytilus edulis and Crangon crangon from six areas in the North Sea. Samples for IDOE have been mainly plankton from the North Atlantic, North Sea, and west coast of Scotland including the Clyde.

At the Freshwater Fisheries Laboratory at Pitlochry the analysis of a wide variety of samples from the marine environment for organochlorine residues was continued during 1971. The twice-yearly sampling of five species of fish (herring, mackerel, plaice, cod and whiting) from six coastal areas was extended to include haddock, and a seventh area in local Shetland waters. The results for the 1969 and 1970 surveys are being combined with those obtained for England and Wales by the Ministry of Agriculture, Fisheries and Food, in a report for publication.

Samples of herring and mussels were examined as part of the 1969-71 OECD collaborative study, the data from which will be prepared for publication during 1972. This programme also involved the analysis of samples for mercury residues. Analyses for mercury on a large scale began in January 1971, as part of a Government enquiry into the levels of mercury in food in the United Kingdom. Fish contain higher concentrations than almost all other foodstuffs, and twentyfive species of fish and shellfish, including six freshwater or amadromous species, were examined. Of the marine species, none of the samples indicated the existence of any areas of significant pollution by mercury in Scottish waters. The mean concentration of mercury in Scottish fish was 0.07 mg/kg but lobsters were found to have appreciably greater levels, up to 0.75 mg/kg.

Other investigations into the levels of organochlorine pesticide and PCB residues in the aquatic environment included analyses of river waters, sea-trout, plankton, seals and porpoises. The river waters were examined in a survey of seventy streams and rivers during April, to establish current levels and the quantity of organochlorines discharged to the sea from the major Scottish rivers. The mean concentrations of the four common pesticide residues found were 2.28$\mu g/m^3$ dieldrin, 1.11$\mu g/m^3$ DDE, 1.47$\mu g/m^3$ TDE and 1.26$\mu g/m^3$ DDT. No PCBs were detected. Sea-trout samples were taken from 8 estuaries or river mouths and the concentration ranges of dieldrine, total DDT and PCBs in these samples were 0.008-0.020 mg/kg, 0.052-0.139 mg/kg and 0.21-0.33 mg/kg respectively.

Plankton samples have been obtained from the Clyde and Forth estuaries, the area west of Scotland to a point beyond the continental shelf, and the Bristol Channel. The qualitative composition of these samples was very variable and almost certainly influenced the residue concentrations found. In the Bristol Channel, a high proportion of sediment collected in the sampling net probably accounted for the unusually high PCB concentrations found. The levels in the Firth of Clyde samples were lower, but significantly higher than in those from the Firth of Forth in the eastern Atlantic. These samples were examined as a contribution to the IDOE programme.

Samples of blubber from seals, pilot whales and porpoises around the coasts of the United Kingdom have been examined for organochlorine residues in continuation of past studies. Other organs are also being analysed from some specimens, and livers have been analysed for mercury residues. Over 700mg/kg has been recorded in one large seal, and there is evidence of an increase in level with age. Ringed seal pups from the Arctic contained less than 1 mg/kg in liver.

Analyses for DDT of water, algae, sand, Tellina and plaice were made as part of the Marine Laboratory studies on the effect of DDT on the food chain of plaice. Most of the DDT recovered was in the sand and algae, but only a small proportion of the total DDT added was eventually accounted

for in the entire eco-systen. Concentrations in young plaice were over a thousand times greater than the initial concentration in the water, but it is not yet clear whether this was the result of a direct intake from the water, or from the Tellina siphons on which they feed.

U.S.S.R.

(A.S. Bogdanov)

Marine pollution

The investigations of physical, chemical and biological aspects of marine pollution have been continued.

The velocity, temperature and salinity field surveys, characterising the physical background of pollution have been carried out. These localities have been studied by field measurements as well as by their mathematical models. In the open sea, temperature, salinity and velocity have been measured at IHD stations as well as at other selected stations. Nearshore measurements have been carried out at special national stations placed both in polluted and unpolluted areas.

The hydrodynamical fields of the Baltic Sea have been modelled by numerical solution of the hydrodynamic equations for baroptric and barocline conditions. The study of probability characteristics of pollution fields in the open sea as well as in the nearshore areas and river mouths have been continued. The calculationmethods of sewage outlets into the sea by fixed probability characteristics of the water quality have been worked out.

Besides the common chemical analysis of sea water, oil, phenol and nutrient content measurements in the open sea have been continued. The pesticides and mercury in open sea water have not yet been studied. The special chemical stations in nearshore areas were visited four times a year. In nearshore areas also the pesticides and mercury content in sea water have been measured.

The bacterial pollution of sea water have been studied in nearshore areas. The primary production was measured in gulfs and bays: in the Gulf of Finland, in the Gulf of Riga and in the Bay of Kurshi. The influence of pollution on plankton was studied in the Gulf of Riga.

The modelling of the Baltic Sea eco-systen has begun in.1971.

The laboratory investigations of pesticides (especially DDT), herbicides and heavy metals on fish were continued.

The pollution studies of the Gulf of Finland have been carried out in cooperation with Finnish scientists in the Sovjet-Finnish Working Group on the Gulf of Finland Pollution Studies. The main aim of this Working Group has been the development of acceptable criteria for the effects of pollution on the marine environment and to model spreading of pollutants in the sea water.

The survey of pollutants discharged into the Baltic Sea by rivers and sewage outlets has been continued.