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Administrative Report

FISHERIES IMPROVEMENT COMMITTEE

by Grim Berge

1973

Belgium

(R. de Clerck)

Research was continued on the disposal of industrial waste water derived from the titanedioxyde process and the production of proteolytic enzymes.

The density of the fish and shrimp stocks was measured on a monthly basis by means of research vessel catches.

The occurring fauna was also quantitatively and qualitatively determined.

With regards to the effects of dumped waste derived from the titanedioxyde process no negative effects on the macro marine life was ascertained.

The organic waste derived from the production of proteolytic enzymes neither shows negative effects. On the contrary, this waste seems to have positive effects on a few species : Crangon crangon (L), Merlangius merlangus (L), Asteria rubens (L), Ophiura texturata, Lamarck and Pagurus bernhardus (L). Indeed the densities of these species were generally higher in the dumping area than in the reference area.

Research was continued on the determination of heavy metals, PCB's and pesticides in fish and shrimps. A monitoring programme was carried out on shrimps, plaice, sole, cod and whiting off the Belgian coast.

Market research samples of sole were taken from four fishing grounds, viz. the North Sea, the English Channel, the Bristol Channel and the Irish Sea.

Canada

(R. O. Brinkhurst)

Pollution

Heavy Metals

Chemical analyses of frequent water samples indicate that copper-zinc pollution carried in by the Tomogonops should no longer be a deleterious factor in the lower reaches of the Miramichi River, New Brunswick, unless from occasional accident. While some resident fish (trout, chub) seem to be re-establishing in the Tomogonops, electrofishing indicates that late-run salmon, which used the river before pollution began in 1960, are not repopulating this stream, although they spawned in small rivers on either side of the Tomogonops in 1972. Eggs from Northwest Miramichi River late-run parents are being incubated at St Andrews to repopulate the stream with underyearlings in 1974 and smolts in 1975.

Pollution effects in the estuary, as judged by straying of angled, tagged Northwest Miramichi native fish, may have been greater than in 1972 (19% straying as against 13%). If so, they were probably associated to some extent with low summer river flows in 1973 compared to noticeably higher discharge in 1972. Effluent of the kraft mill on the Northwest arm has received secondary treatment since 1972, so any diverting pollution now appears to be attributable to other, urban and industrial sources.

Sublethal dosages of copper (7.5-15 ppb 24 hours) lowered the temperature preference of juvenile Atlantic salmon by 2°C.

The toxicity of copper was tested on adult lobsters in running water tests at 12°C. The 48- and 96-hr LC50's for adults was 0.25 ppm and 0.08 ppm respectively, and the insipient lethal level wast estimated to be 0.06 ppm.

An investigation is under way into analysis of the various forms of zinc present in fish tissues. This effort is background to a new study of the sublethal effects of zinc on Atlantic salmon fry and parr.

Newer methods of sample preparation have revealed previously unsuspected high levels of arsenic in a number of marine commercial species, particularly flatfish and invertebrates. The arsenic, however, appears to be in the form of a very stable organic compound of unknown structure and almost unknown biological properties. There is no apparent biological magnification of arsenic in marine food chains; although individual organisms may accumulate the element (in organic form) to many thousands of times the ambient levels, the highest concentrations tend to be found at the lowest trophic levels. Near an abandoned mine which drains a considerable amount of arsenic into the sea, of several organisms examined, only sea urchins accumulated higher than normal levels of arsenic.

The phytoplankton flora of lakes close to the Sudbury, Ontarion, smelters is poor both in species and in numbers. The lakes have abnormally high levels of several toxic heavy metals, including nickel and copper. Algal isolates were obtained from two lakes which contained up to 3 ppm of nickel and 0.7 ppm of copper in solution. These isolates were found to be tolerant to higher levels of nickel, copper and silver than were laboratory strains. Their growth response to metals in the medium is distinctive and different from that of the lab strains. Lab strains of Scenedesmus and Chlorella stop growing at 0.1 ppm Cu and 0.5 ppm Ni. "Adapted" lake strains of Scenedesmus, however, continue to grow up to 1.0 ppm Cu and 3.0 ppm Ni. Both of the"adapted" lake isolates showed a gradually decreasing growth rate with increasing concentrations of metals, whereas the lab strains showed total inhibition at a low metal concentration. Lab and lake strains both take up copper. The uptake is linear with concentration in the media. The lake isolates continued growth until a Cu concentration of 2 400+ ppm was reached (on dry T. basis). This suggests a mechanism of metal tolerance rather than one of exclusion as means of survival. The ecological implications of this adaptations to high levels of toxic metals are discussed, especially the finding that the tolerant algae are adapted to high silver levels, even though silver is not a pollutant in the lakes.

Oil

Field and laboratory experiments have been conducted to determine the toxicity of crude oil to freshwater alage. In the field, experiments were continued for a 2-year period and changes in the abundance and species composition of phytoplankton tabulated. Species were found to differ markedly in their response to an oil spill - varying from considerable suppression of growth to stimulation.

A research programme, begun in 1973 and continuing into 1974-75, is designed to gain some insight into the potential impact of various Arctic crude oils upon species of marine invertebrates inhabiting coastal and estuarine areas of the Beaufort Sea. Several of the species appear to be fairly resistant to high concentrations of seawater soluble components of the crude oil. Indications are that for certain of these resistant species short-term contact with oil masses leads to high mortality, possibly through physical interference with critical physiological functions. Two species of amphipods were, in a series of laboratory studies, shown to be repelled by Arctic crude oils. The degree of repulsion varies with both species and type of crude oil examined. A marine isopod was found to be completely indifferent to the presence of certain types of crude oil. Sublethal effects on a number of physiological parameters are also being investigated in an attempt to establish a sensitive indicator of adverse pollution effects. Respiration of a marine amphipod is significantly increased by acute exposure to a number of Arctic crude oils, but only at very high concentrations. Preliminary studies indicate that bacterial enrichment cultures are able to degrade the aliphatic fraction of indigenous northern crude oils at low temperatures.

In the laboratory, the effects of aqueous extracts of seven crude oils on a selected test species, Chlorella vulgaris, were determined. Marked differences in toxicity, as indicated by reduced growth, were found to exist between oils. Work with oil extracts of different ages suggests that the short-term toxicity of oils is due to the rapid loss of volatile compounds. Differences in the toxicity of selected aromatic components of crude oils - benzene, toluene, o-xylene and naphthalene - were observed and are believed to relate to an increase in methylation. Aqueous crude oil and naphtalene depressed the ^{14}C-$NaHCO_3$ uptake (i.e. photosynthesis) of Chlamydomonas angulosa. ^{14}C-naphthalene was rapidly taken up by Chlamydomonas cells. However, release of this compound was much slower and, in unwashed cells, seemingly dependent upon cell division.

Crude oil at high concentrations prevents the development of capelin eggs. Lower concentrations depress the hatching success, and many deformed larvae are produced. Very low levels appear to accelerate development. Under natural conditions, however, sprayed oil (2 l/m^2) had no effect on the hatching of eggs, as judged by the concentrations of empty egg cases.

Improved fluorescence methods have been developed for the detection of trace amounts of petroleum residues in sea water and sediments. Methods have been compared with ultraviolet spectroscopy, gas liquid chromatography, and elemental analysis for evaluating specificity and accuracy. These methods have been used to examine the present level of oil pollution in sediments and sea water from numerous eastern Canadian coastal environments, continental shelf and open ocean. A gaschromatographic method of detecting paraffinic hydrocarbons in sea water has also been developed and evaluated with samples collected along the Halifax-Bermuda section.

Work on the effects of different petroleum products on the growth of marine phytoplankton have continued using laboratory cultures. These experiments last about 30 days compared to one day in the previous work

using natural populations so that long-term effects can be evaluated.

Large-scale outdoor tank experiments have been started to study the weathering of spilled petroleum products and their appearance in the water column and sediments. Ninety-day experiments are being conducted during various seasons of the year.

In continuing Chedabucto Bay studies, the spring 1973 sampling showed continued high contamination of shorelines, marine sediments and sublittoral biota indicating no reduction in the oil present.

Studies on soft-shell clams (Mya arenaria) in oil-polluted sediments have shown behavioural abnormalities, mortalities and caloric content changes correlated with oil quantity.

Synthetic surfactants form the active ingredient of many oil dispersing formulations and may be introduced intentionally into the aquatic ecosystem. With commonly used nonionic surfactants, such as polyoxyethylene esters and ethers and cationics, such as polyoxyethylene amines, lethal response of teleosts is semi-logarithmically related to the number of moles of ethylene oxide in the molecule.

Teleost liver can hydrolyse polyoxyethylene esters and there is evidence that some detoxication is involved in the lethal response by teleosts to this compound at least to 18-20 moles of ethylene oxide. Teleosts exposed to polyoxyethylene esters can be recognised post-mortem by reduction in esterase activity.

The amplitude of locomotor activity in the winter flounder is reduced by treatment with polyoxyethylene esters down to 1.0 mg/l. Tidal periodicity of swimming is not affected by sublethal, but is destroyed by 96-hr lethal concentration at exposure times of 24 hours.

Chlorinated hydrocarbons

PCB residues in the Gulf of St Lawrence herring OECD samples increased significantly over a period of one year (0.25, 0.36 µg/g wet weight of muscle). The levels of p,p'-DDE (0.059, 0.066), p,p'-DDD (0.042, 0.038) and p,p'-DDT (0.021., 0.025) have not changed significantly. The same year class was analysed and the data indicate the accumulation of PCB with age of the fish. The levels of PCB are well below the current FDA tolerance, but their sublethal effects on herring are not known.

A 3-year study of the levels of chlorinated hydrocarbons in double-crested cormorant (Phalacrocorax auritus)and herring gull (Larus argentatus) eggs has been completed. The main chlorinated hydrocarbons present are PCB and p,p'-DDE approximately 9, 6, and 4, 2 µg/g wet weight in cormorant and gull eggs, respectively. The concentrations are highly variable, but may indicate either a steady-state or a slight decrease. Chlorinated dibenzofurans are photochemically quite unstable yielding dechlorinated products on irradiation. The accumulation of chlorinated dibenzofurans in the environment as a result of photochemical transformation of PCB is therefore unlikely. 2,8-dichlorodibenzofuran has a low acute toxicity in immature brook trout. This may be due to its poor absorption in the gut and to the excretion of a conjugated hydroxy derivative. A dichlorohydroxydibenzofuran was identified in the dosed fish by mass spectrometry . The residues of 2,8-dichlorodibenzofuran ranged from 0.01 to 0.4% of the administered dose. Tri- and tetrachlorodibenzofurans accumulated much more than 2,8-dichlorodibenzofuran. These residues were not quantitated due to the lack of standards.

Metabolism of chlorinated hydrocarbons in marine organisms appear slow. No degradation of DDT administered to copepods was observed within six weeks. In trout, DDT was metabolised to DDE, but only to a limited degree: 10% conversion was observed after 5 weeks. Not metabolism of structurally related compounds known to be metabolites of DDT in mammals was observed. Excretion of DDT and related compounds from fish was also very slow : no change in residue content was observed over a 3-5 week period in skate and trout dosed with ^{14}C-labelled DDT.

In contrast, metabolism of biphenyl (the non-chlorinated basic molecule of PCB's) proceeded at appreciable rates in various marine organisms. 2- and 4-hydroxybiphenyl were the major metabolites detected.

Studies on the uptake, metabolism and excretion of organochlorine compounds (DDT-group pesticides and PCBs) by marine organisms have continued. In small plankton, uptake and elimination appear to be primarily adsorptive and descriptive processes; in larger animals, the processes tend more towards ingestion and excretion.

The adsorption of organic pollutants (organochlorines and petroleum hydrocarbons) on particle surfaces is being studied in laboratory experiments using labelled compounds. Variables being studied include exposed time, pollutant concentration and particle size. Results support the observation that in nature most "dissolved" pollutants are actually adsorbed to particle surfaces.

Surveys of organochlorine residues in Canadian Arctic seals have continued. Significant residues were found in whales taken in the Mackenzie Delta area; such residues may have arisen from spraying programmes upstream. Residue accumulation in ringed seals from the Arctic has been shown to be both age- and sex-dependent.

Pesticides

Larval and adult lobsters have similar sensitivity to fenitrothion, for both the 96 hr LC50 is about 1.0 ppb. The lethal threshold for larvae is about 0.015 ppb and that for adults is 0.3 ppb or lower.

Exposure to sublethal doses of fenitrothion (0.5-1 ppm) lowered the temperature selected by juvenile Atlantic salmon by 1.5°C. Sevin had no effect.

The effect of fenitrothion and phosphamidon on a well known behaviour pattern, the olfactory responses of lobsters to food odour, was tested. Each compound was mixed with food odour to yield concentrations of 10 - 400 ppb in the section of troughs where animals received initial stimulation. No effect on response to odour was detected at concentrations up to 400 ppb. Although exposures on fenitrothion were brief, the animals exposed to 400 ppb became excessively active indicating initiation of lethal effects.

The toxicity of phosphamidon to adult lobsters was tested in static tests at 12°C. The 48- and 96-hr LC50's were 0.08 ppm and 0.04 ppm respectively. The incipient lethal level was estimated to be 0.017 ppm.

Sublethal dosages of sodium pentachlorophenol (100 ppb) lowered the temperature preference of juvenile Atlantic salmon by 4°C.

Considerable increase in diversity of intertidal biota has been observed in the Red Head-Hazen Dyke area of Saint John harbour, New Brunswick, following pollution abatement measures.

Aquaculture

In June at St Andrews, smolt-sized 1-year-old Atlantic salmon, rainbow and brook trout placed in cages in sea water began to reach marketable size (1/2-3/4 lb) in August. Growth continued through November and most individuals reached the required size during a single season of post-smolt growth. Because of low seawater temperatures, it is impracticable to hold salmonids over winter in the St Andrews area. This would apply to other places where temperatures fall below 0°C. The lower lethal temperature for the above species in sea water (salinity 30‰) was ca. -0.8°C.

From a planting of eggs from British columbia in North Harbour River, St Mary's Bay, Newfoundland, a small stock of natural spawning fish was established. Returns from these fish are steadily declining. The total number reported in 1973 was 174. These were the progeny of 468 adults which spawned in 1971 and a subsequent fry run of 267 000 during the spring of 1972. There were reports of pink salmon which had strayed as far north as Nain and Saglek in northern Labrador.

Cage rearing of Atlantic salmon and rainbow trout was successfully carried our at two locations on the Nova Scotia coast. The best strategy for rainbow trout has been the seasonal culture of smolts (10-13 cm) to pan-sized fish (280-335 g) during the four months July through October. Salmon are being reared for 12-16 months in salt water, with the objective of producing "steak-size" (2.2-4.5 kg) fish. A joint Federal-Provincial government study was initiated to assess the aquaculture potential of heated effluent produced by thermal power plants, particularly as it relates to the fossil fuelled plant being constructed at Lorneville, New Brunswick.

Atlantic salmon kelts (i.e. spawned fish)were reconditioned at an experimental site in Nova Scotia. These experiments were conducted to determine the feasibility for recycling valuable Atlantic salmon broodstock which are difficult to obtain as well as in short supply. Kelts were held in water at different salinities (15‰ and 30‰) from May to August, and then acclimated to fresh water. Hormones were used in some groups to induce sexual maturation. Fertilised eggs obtained will be checked for viability.

Lobsters

Re-examination of the artificial lobster reef off Richibucto shows that this reef is now clearly mature, has a full range of lobster sizes and the population is now stabilising at around 400+ individuals. Annual productivity is in the order of 12 kg which is equivalent to 40+ kg/ha. A report was prepared for submission to ICES.

In 1972 we reported a new host record (Homarus - the lobster) for the facultative blood parasite Anophrys sp., a lethal ciliate known to infest crabs but not previously noted in lobsters. This parasite reappeared in winter of 1973, infesting healthy, unplugged and unwounded lobsters as well as those for which a mode of entry was obvious. We also found this parasite inside dead lobster larvae, but were unable to determine whether death was caused by or was incidental to the ciliate.

Mussels

Experiments on culturing blue mussels (Mytilus edulis) in warmed Bay of Fundy water have shown that temperatures of about 15-20° and salinities of about 20‰ result in best growth and lowest mortalities. Continuous phytoplankton cultures in nutrient-enriched water do not appear to provide adequate food.

Oysters

A large-scale oyster (Crassostrea virginica) spatfall monitoring project is in its third year of implementation. This project has provided the environmental information necessary for assessing reliable spat collection and has pinpointed several commercially exploitable natural spatfall areas. Greater success in obtaining natural seed oysters for cultivation will result in tangible gains for the oyster industry.

Currently, through technical assistance and training programmes, emphasis is being placed on education of oyster farmers in the growing, maintenance and harvesting techniques necessary for the establishment of economically sound oyster farms.

The experimental transplant of the European oyster (Ostrea edulis) to two sites in Newfoundland continued. Specimens placed on bottom at Holyrood (Conception Bay), November 20, 1972, were again suspended at the surface on 27 June, 1973. These were found to have had an over-winter mortality of 41.1%. Mortality continued over the summer and decreased in the fall, total mortality from 28 June to 29 November(when the oysters were again placed on bottom) was 42.2%. Mean length and width increased only slightly, from 44.9 and 40.8 mm to 46.2 and 43.9 mm, respectively. However, the trays were on bottom in 30 m depths for part of the growing period.

Specimens placed on bottom at Pinch Gut (St Mary's Bay), 14 November 1972, were again suspended at the surface on 20 June 1973. When examined on 3 July, the total mortality observed since the previous fall was 30.0%. Mortality was light over the remainder of the year, 5.3% to 28 November when the oysters were again placed on bottom. Mean lengths and widths increased from 53.0 and 51.9 mm to 58.8 and 61.2 mm respectively.

Clams

Renewed interest has been shown in the managed exploitation of other shellfish, such as the soft-shelled clam (Mya arenaria). Population characteristics on natural beds in contaminated areas are being surveyed to assess the feasibility of commercial depuration.

Denmark

(Vagn Olsen)

The rearing and cultivation experiments with flatfish have been stopped. The results have been published in an internal report.

Experiments with shrimps (Leander adspersus) have been started. The purpose is to investigate the biology of this species, especially the spawning activity.

Federal Republic of Germany

(H. Mann)

As in former years, the work which was supported and coordinated by the Deutsche Forschungsgemeinschaft, was continued to the same extent.

The investigations on the influence of red mud on marine organisms were continued. Within this scope especially a report on the influence of red mud on the culture of some marine plankton algae should be mentioned.

Furthermore, the disposal of wastes from titanium dioxide production was given in a summary report.

The investigations on the content of PCB, DDT and Hg in fish, mussels and crustaceans were continued, whereby special emphasis was laid on a comparison between the values from the Baltic and the North Sea and the values from inland waters. In order to obtain comparable values certain fish species were selected for the investigations. This work was especially concentrated on the content of the above mentioned substances in the muscle flesh. Lately, the investigations were extended to sea-birds, e.g. Guillemot (Uria alge).

A special programme has been drawn up for the Baltic. Investigations will be carried out on the content of heavy metals and pesticides in water, in biological samples and sediments. Similar investigations have already been started in the large rivers and estuaries, or are being planned. Special investigations concern the effect of heavy metals on the growth of algae, copepods and the embryonic development of marine fish.

The investigations on the microbial decomposition of oil and oil products are being continued. Some institutes are concerned with the whereabouts and the effect of radioactive wastes in the sea.

A particular problem which has come up recently, was the question whether the wastes from working with asbestos straw material can be discharged into the sea. In this respect investigations with mussels were carried out.

As it is intended to set up nuclear power stations near estuaries, investigations were carried out on temperature distribution in a tidal current after cooling water had been introduced into it.

Further investigations concern the chemical and physical conditions of the chelate development of metal salts. Further, the significance of suspended substances regarding the adsorption of metal salts will be investigated.

The investigations on the effect of non-ionogenic tensides on fishes and food animals of brackish water will be continued. Further work concerns the decomposition of non-ionogenic tensides in seawater at various temperatures.

Several Working Groups dealt with the effect of organic, especially domestic sewages, on the organisms of the coastal regions. Within this work investigations were carried out by planktologists, chemists and microbiologists.

In order to make a statement on the noxiousness of wastes a test has to be worked out which produces comparable values. Such tests can only be carried out with living organisms of the marine ecological system. A Working Group is, therefore, dealing with the question of the selection of organisms which would be suitable for testing.

The work already begun on the accumulation of noxious substances in food chains was continued.

At the Institut für Küsten- und Binnenfischerei experiments on cage farming of rainbow trout in the Eckernförde Bight and the Flensburg Bight were continued. Special emphasis was given to the development of optimal pellet feeds.

At the Biologische Anstalt Helgoland some experiments were carried out on rearing of flatfish and on the effects of parasites on flatfish.

The Institut für Meereskunde carried out three sets of experiments :

1) Effect of ammonium and of different salinities (0, 6, 11, 18, 22‰) on the growth of brook trout and rainbow trout at optimal feeding.
2) Tank farming of salmonids in warm sea water of a conventional power plant in Kiel fjord .
3) Cage farming of salmonids and cod, partly in combination with mussel culture.

Finland

(A. Voipio)

The pollution studies and monitoring programmes have been continued as outlined in the Administrative Report for the year 1972.

Fish culture (P. Tuunainen)

In the southwest archipelago of Finland a development programme for cultivation of rainbow trout, Salmo gairdneri Richardson, in net cages in sea water has been carried out for some years. In 1973 there were six commercial fish farms in that area with a yield of 90 tons.

Marine pollution

In connection with work on the analytical methods of DDT and PCB in fish, some results concerning the contents of pike, Esox lucius L., perch Perca fluviatilis L., and bream Abramis brama (L.) from the Gulf of Finland were also published in 1973. The pike contained 0.13 ppm PCB in wet tissue and the content of total DDT in wet tissue was 0.012 ppm (N=12). The contents in the perch were 0.3 ppm and 0.03 ppm (N=41) and in the bream 0.3 ppm and 0.016 ppm (N=40) respectively. These fish were found to contain 4-10 times as much PCB as the same species in fresh-water and DDT two times as much (Marja Liisa Hattula 1973: Analysis of DDT- and PCB-type compounds at low level in fish with reference to pike, perch and bream in Lake Päijänne. University of Helsinki, Institute of Food Chemistry and Technology, EKT series 301:1-147).

The effects of effluents from Helsinki on the coastal fish fauna have been investigated for many years. In 1973 two studies, one dealing with the fish biomass values, production and catches, and the other dealing with the effects of pollution on the spawning and feeding areas of fish were completed. (Reports of the Water Conservation Laboratory of the City of Helsinki No. 3/1973 and No. 11/1973 with English summaries).

In 1973 eleven projects on the eutrophication and pollution problems in marine and coastal waters were carried out in Finland. These investigations included different trophic levels below the fish. (For further information see Nordforsk, Secretariat of Environmental Sciences, Publication 1974:1).

A study on the effects of effluents from titanium dioxide industry on the fishery and fish fauna was started in 1973. This work includes among other things the studies on the levels of some heavy metals in coastal and marine fish.

France

(L. Marteil)

Elevage de Poissons

Les essais ont été poursuivis en 1973 sur le bar (D. labrax), le turbot, la truite; le saumon du Pacifique (O. kisutch) a fait l'objet d'expériences préliminaires en enceintes fermées par les soins du CNEXO et en mer libre par une société. L'élevage des poissons rencontre des difficultés variables selon les espèces qui concernent soit la reproduction (turbot) soit le grossissement (bar).

Elevage de Crustacés

Les essais d'élevage de crevettes bouquets (P. serratus) et pénéides ont été poursuivis sur le plan de la reproduction, de la croissance, de la nutrition etc. Par ailleurs, la production de jeunes homards en écloserie a été développée et le nombre d'individus immergés en mer a été accru.

Pollution

Pesticides

Une étude a été entreprise pour déterminer les risques de contamination du milieu marin par les épandages agricoles de pesticides dans les marais littoraux. Les premiers résultats on mis en évidence la toxicité élevée de certains herbicides pour le phytoplancton.

Le DDT et ses dérivés ainsi que les PCB ont été recherchés dans les populations de sardines pêchées en Atlantique et Méditerranée. La présence de faibles quantités de PCB a été notée dans la quasi totalité des échantillons. Les teneurs semblent plus élevées chez les sardines de la Méditerranée.

Métaux lourds

Les teneurs en mercure ont été déterminées dans des poissons appartenant à de nombreuses espèces prélevées lors des campagnes océanographiques. Les teneurs varient suivant les espèces et sont plus élevées chez les prédateurs. En ce qui concerne les lieux de pêche on a constaté que les teneurs sont nettement plus élevées en Méditerranée qu'en Atlantique.

Des quantités importantes de mercure ont été trouvées chez certains cétacés échoués sur les plages de l'Atlantique et de la Méditerranée.

Cette dernière étude a mis en évidence que chez les cétacés le mécanisme d'accumulation du mercure s'accompagne d'une modification du groupement méthylmercure.

Rejets industriels

Des études de toxicité à court terme menées sur des effluents de fabrique d'oxyde de titane ont montré que les effets néfastes disparaissaient lorsque l'acidité était neutralisée.

Iceland

(I. Hallgrímsson)

Routine hydrobiological work was carried out on a seasonal basis, especially off the S and SW coasts, i.a. to trace environmental changes, possibly due to pollutants.

Some basic investigations were carried out on mercury in seawater, and a project on measuring mercury and chlorinated hydrocarbons in selected marine animals has been started.

Publication

Ólafsson, J. Determination of nanogram quantities of mercury in seawater. (to be published in Analytica Chimica Acta, 68, 1974).

Ireland

(F.A. Gibson)

Pollution

Pollution studies were continued in 1973, involving oil, heavy metals and dolomite clay disposal. The effects on the ecosystems of the inner part of Bantry Bay arising from the operation of the major oil terminal on Whiddy Island, continued to be examined by a small team of biologists. Other tests were made on the contamination of salmon flesh by hydrocarbon derivatives which can enter confined estuarine or river areas somewhat irregularly.

The incidence of heavy metal assimilation by mussels in a number of sensitive areas was recorded.

The effects of a dolomite clay reduction plant were studied in Dungarvan Bay. This pollutant, non-toxic in itself, progressively blankets the sea-bed and creates desert conditions. The unused derivatives adhere to rocks so completely that no epi-fauna or flora re-colonises affected surfaces. Although the area polluted at present is quite small, it is extending and it is noticeable that along its perifery where deposits are as yet light, benthic organisms react sluggishly to external stimuli.

The rapidly increasing industrialisation of a number of coastal and estuarine areas of the Irish south and southwest involved considerable research and advice to promoters and the establishment of acceptable levels mandatory to planning permission.

Fish transplantation and cultivation

Mussels from shallow sea areas which every year settle in large quantities but rarely survive their first winter were transplanted into estuaries where their survival and growth was monitored. Research on the cultivation of shellfish was continued and has been reported separately to the Shellfish and Benthos Committee.

Work proposed for 1974: Pollution studies will be continued and intensified by the establishment of a toxicological unit at the Fisheries Field Station at Dunmore East. An enlarged monitoring unit including equipment for the study of lethal and sub-lethal effects of pollutants, is in the planning stage.

An intensive study of the conditions in Cork Harbour (which has been designated as a major industrial growth area) is being organised and a further study is planned for the estuary of the R. Shannon. To date most industrial concerns have shown a willingness to cooperate by way of meeting demands for low levels of discharge and by providing funds to research to be undertaken and administered.

Netherlands

(P.Korringa)

The water of the Oosterschelde and of the mussel growing areas in the Waddenzee was found to be of exceptionally good quality throughout the year 1973. Hence, the sanitary control of shellfish in these areas and in the oyster basins at Yerseke gave no reason for concern. No case of shellfish toxicity caused by phytoplankton blooms has been detected.

After two unusually dry years in which the river Rhine discharged respectively 46 and 47 km^3 of water only, the 1973 run-off showed again the normal pattern with about 70 km^3. This resulted in a somewhat increased down-river transportation of pollutants in comparison with previous years, especially noted for mineral oils and for phosphorus compounds. The difference was, however, not so great that one could speak of a significant change in the state of pollution of the Dutch coastal waters.

Although the heavy metal content is in the coastal waters always noticeably higher than in unpolluted off-shore sea areas, the heavy metal concentration in the fish caught there did not show higher figures. This creates the impression that fish is certainly not a good indicator organism for this type of compounds.

As was reported for 1972, chlorinated hydrocarbons, especially PCB's, are a major problem for the Dutch fishery, both in the North Sea and in the inland waters. Levels of 20-40 mg/kg (on fat basis) in the Dutch coastal waters and up to 200 mg/kg in fresh water fish are often found. There were no indications that the PCB contamination of fish and shellfish declined in 1973 as a result of some voluntary restrictions in the use of these compounds in "open" systems, both in Germany and in the Netherlands.

Parasitological and pathological studies were carried out on several species of marine and fresh water fishes and also on molluscan shellfish. Attention was paid to the helminths, the parasitic copepods, as well as to microbial parasites. The following subjects were studied : the occurrence of Glugea stephani, Myxobolus aeglefini and Lymphocystis in plaice of several areas; the occurrence of parasites in herring larvae; the infestation of mackerel with Anisakis larvae for a possible use as biological tag; the occurrence of Hexamitiasis, Ciliates and Critispira in (imported) oysters; the softening of mackerel tissue due to the muscle-invading myxosporidium Kudoa histolytica.

Publications 1973 :

van Banning, P. 1973.Een specifieke bloedzuiger van tong. (Visserij 26, 75-78).

van Banning, P. 1973."Zwarte haring". (Visserij 26, 145-148).

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Norway

(G. Berge)

Pollution

1. Investigations on the pollution of the selected Norwegian fjords were carried out in May. The fjords were selected so to represent different types of industrial loads, with discharges from timber, fertilisers, aluminium, ferro-silicium and coke plant industries. Measurements were made of salinity, temperature, primary production indicies, nutrients and oxygen distribution, turbidity, particulate matter and heavy metals in water, polycyclic aromatic hydrocarbons in sediments, PCB and DDT in fish (Institute of Marine Research).

2. The inter-institutional study of biological and other aspects of planned nuclear power plants in South Eastern Norway continued. A programme covering baseline studies of fish and shellfish productivity in the Oslofjord and adjacent coastal waters, experimental investigations on termal effects and possible utilisation of heated effluents for fish cultivation was worked by the Institute of Marine Research, Biological Station Flødevigen.

   Specific biological programmes related to plant production and composition (attacked and free-floating algae) was worked by the Norwegian Institute of Water Research, and the physical programmes by the Waterways and Harbours Laboratory.

3. Monitoring Programmes. Hydrocarbons from oil in sea water. Gas-chromatographic analysis of monthly samples in depths of 0, 10, 50 metres from a permanent section between Norway and Shetland, and twice yearly sampling in the central North Sea circling the oil fields (Institute of Marine Research).

   Heavy metals in fish and shellfish. Stocks of commercial fish are continuously being analysed on mercury, cadmium, zink, copper and lead at the Official Norwegian Quality Control Institute for Canned Fish Products. Involved in this monitoring are also the Directorate of the Fisheries, Institute for Technical and Chemical Research, and the Institute of Hygiene of the Norwegian Veterinary High School. Results are made available to the Institute of Marine Research.

   Heavy metals in sea water. Analysis of samples from selected fjords are being made on Fe, Zn, Cu, Cd, Pb and Hg at the University of Oslo Institute for Marine Biology and Limnology.

   Organic pollutants in coastal sea water. This programme is in the process of being developed.

4. The organic load of the Baltic Current is being investigated from the Øresund, through the Kattegat, Skagerrak and along the western Norwegian coast. Continuous measurements are made on particulate matter, organic components, nutrients and temperature, whereas primary production indices are measured at regular intervals (Institute of Marine Research).

5. Bioassays. Experimental studies of effects of Ekofisk oil on natural communities of phytoplankton from localities in north Norwegian waters and in the Barents Sea were conducted. Also the effect of low concentrations of EDC-tar on micro-organisms were studied together with the degradability of this matter in natural sea water. Accumulation experiments were carried out with this matter on fish, lobster and mussels (Institute of Marine Research).

6. A programme studying the influence of various concentrations of pollutants on the biology of Pleuronectus flesus was initiated in the Oslofjord in 1973 (University of Oslo, Institute of Marine Biology and Limnology). The programme is part of a joint Scandinavian effort aiming at a development of an early warning system.

7. The eutrophication of the Oslofjord caused by domestic sewage is continuously being watched by the University of Oslo, Institute of Marine Biology and Limnology.

8. The Norwegian Institute of Water Research, NIVA, has been assigned by several industries and municipal authorities in discharge problems of different water systems including fjords.

9. The programme on recording captures of dumped containers and their contents is continued. Resulting from these observations, regulations of handling such findings have been worked out by Norwegian Health Authorities in cooperation with the Director of Fisheries.

10. A programme on surface water drifts around the North Sea oil fields continued. Plastic envelopes were regularly released from the Ekofisk platforms and surface drifts, based on recaptures, are related to meteorological conditions (Institute of Marine Research).

11. A joint investigation on water exchange and biology of the fjord system enclosing Bergen was carried out with monthly observations throughout one year on hydrography, chemistry, turbidity, primary production, chlorophyll, particulate matter and zooplankton. The aim is to evaluate the health condition of the fjord water and the recipient capacity for domestic sewage. (Geophysical Institute, University of Bergen and Institute of Marine Research).

12. Polycyclic aromatic hydrocarbons, originating from heavy industries using the Søderberg electrode, were analysed in sediments from several fjords in Western Norway. The distribution pattern showed that these pollutants were mainly trapped in the fjord sediments and presence in bottom organisms were also recorded (Institute of Marine Research).

Aquaculture

The expansion of commercial salmonid culture was steadily increasing in 1973. This necessitated laws regulating the fish farming industry which came in operation in June. In September 240 commercial fish farms were registered.

The research activities concerning aquaculture are concentrated at three institutions : The Directorate of Fisheries in Bergen, The Fisheries Research Branch of the Universities of Bergen and Tromsø, and the Agricultural College at Ås.

Under the Directorate of Fisheries a research team is working on the culture of mussels, lobsters, flatfish and salmonids, doing research on disease, ecology, economy, genetics, hydrography, nutrition, physiology and rearing techniques.

The Directorate of Fisheries runs a field station primarily concerned with genetic research at Matre, 90 km north of Bergen and most of the work on mussels and lobsters is done at the station at Flødevigen at the Norwegian south-east coast.

The Fisheries Research Branch of the University of Bergen works in close cooperation with the Directorate of Fisheries and the Fisheries Branch of the University of Tromsø runs a small experimental station on salmonid culture studying the special conditions for rearing in the northern part of the country.

The Agricultural College's involvement in aquaculture is primarily to maintain the natural fish populations in rivers and inland waters. An aquacultural field station at Sunndalsøra near Trondheim is mainly working on population genetics.

Poland

(W. Mańkowski)

The work on pollution problems can be divided into Research Work and Control Work.

Research Work

This covers the following problems :

1. Determination of the influence of Polish rivers on the Baltic pollution and the Baltic eutrophication.
2. Estimation of nutrients in sea water (phosphates, total phosphorous, nitrites, nitrates, ammonia).
3. Bio-accumulation of PCB's, DDT and its metabolites at each trophic level of the marine environment.
4. Estimation of the degree of pollution of the plankton by radioactive strontium and cesium.
5. Estimation of acute toxicity of DDT and PCB's for some marine organisms.
6. Estimation of the respiration activity of marine sediments.
7. Microbiological degradation of mineral oils by marine bacteria.
8. Qualitative and quantitative changes in benthic organisms as an index of changes occurring in the marine environment.

Samples are collected from the Baltic stations twice a year in May-June and August-September during monthly cruises. The stations in the Gdańsk Bay, Gdańsk Deep and along the Polish sea shore are, in addtion, visited twice a year during the research cruises.

Some of the parameters are estimated on board the ship during the cruises and the rest in the Institute's laboratories. Commercial fish are obtained for analysis from fishing vessels. Continuous estimations of some pollutants and nutrients are made at the mouths of the Polish rivers emptying into the Baltic, with samples of river water collected at the middle of every month.

The parameters studied are as follows :

1. Sea water (DDT, DDE, DDD, PCB's, hydrocarbons, nutrients, total radio-activity).

2. River water (nutrients, sporadically zinc and cadmium).

3. Marine sediments (respiration)

4. Plankton; (phyto- and zooplankton together) (total radioactivity).

5. Benthos - Mytilus edulis, Macoma baltica, Cardium edule, Mya arenaria, Cyprina islandica, Mesidotrea entomon, Crangon crangon, (DDT, DDE, DDD, PCB's and for Mytilus edulis - respiration).

6. Fishes - cod, herring, sprat, plaice, cod liver. (DDT, DDE, PCB's, methyl mercury, total radioactivity).

For estimation of the acute toxicity, the following marine organisms are used :

1. DDT - Pontoporeia femorata, Asellus aquaticus, Idothea chelipes, Mesidothea entomon, Neomysis integer, Crangon crangon.

2. PCB's - Neomysis integer, Asterias rubens Brissopsis lyrifer, Scalibregma inflatum, Platichtys flesus, Zoarces viviparus, Cordylophora caspia, Gasterosteus aculeatus.

3. Mineral oils - Crangon crangon.

The results of the yearly investigations are published, among others, in the Bulletin of Oceanographic Department of the Fisheries Institute, in the volume "Marine Zoology".

Control Work

This includes estimation of DDT and its metabolites, PCB's, methyl mercury and total radioactivity in the main species of commercial fish caught in the Baltic by the Polish fishing fleet. The species controlled are cod, herring, sprat, and plaice. Cod liver is given special consideration. Place and time of catching and the age of the fishes are recorded.

Each year a special report on the results obtained is prepared for the Polish fishing industry.

The area of research cruises - from Skagen through the Danish Sounds and the Baltic proper to the Åland Islands, including the Gulf of Finland.

Portugal

(J.Atafde)

The programme initiated in 1972 on monitoring the water quality in the south of Portugal (Ria de Faro-Olhão) to assess its suitability for aquaculture, was continued. Determinations were carried out on both bacteriological (standard plant count at 20° and 35°C, coliforms, streptococus fecal enterococus) and chemical aspects (pH, temperature, salinity, acidity, alkalinity, phosphates, nitrites, silica, iron, dissolved oxygen and pigments).

Observations were made on the contamination by copper and iron in some samples of the Portuguese oyster, Crassostrea angulata before and after tranplantation from production to improvement areas within the River Sado Estuary. The copper level decreased considerably after a period of one year in the improvement areas.

Studies have been pursued on the development of herbivores (the copepods Tisbe spp and the rotifer Brachionus plicatilis) destined to feed the larval stages of crustaceans and fish.

Spain

(A. Alvarez de Meneses)

Cultures

The culture of the red algae Gelidium sesquipedale on the northern coast of Spain has been begun on an experimental scale.

The Instituto Español de Oceanografía in cooperation with other institutions has prepared plans for the research of sea food cultures in the Arosa Bay in northwest Spain.

Under the direction of the laboratory in La Coruña it was possible to rear artificially the clams Venerupis pullastra and V. decussatus in mass production. The artificial rearing of the flat oyster Ostrea edulis has also been studied and the culture of the common prawn Palaena decussatus and the crab Portunus puber at laboratory level has just begun.

We are trying the culture of Palaemon serratus in mass production and the semi-culture of trout in sea water. Papers about these matters are in press.

Publications

Ortega, A. and Ros J. 1973. Primeras experiencas sobre cultivo de peces en el Mar Menor. Bol. Inst. Esp. Ocean. no. 163.

Pérez, A. and Román G. 1973. Desarrollo larvario de Venerupis pullastra Bol. Inst. Esp. Ocean. No. 165.

Pollution by heavy metals

Studies have been carried out on the mercury content of the anchovy from the northern Spain fishery.

Accumulation and elimination of heavy metals by marine organisms are being studied in Mediterranean areas, as well as pollution by Cd, Pb and Zn in marine organisms, sediments and sea water.

Trace elements are being investigated in molluscs from northwestern Spain.

The effects of industrial processing on the mercury contents of fish samples are being studied.

Bacterial pollution

Observations on bacteriology of mussels and oysters from northern and northwestern Spain have been continued.

Oil pollution

The oil content of the meat of Venerupis decussatus and other molluscs in the Bay of Santander was investigated.

Other pollutions

Toxicity of some detergents, pesticides and other products has been studied in southwestern Spain. Techniques for the analysis of lignin from paper mills have also been developed.

Publications

Fernández del Riego, A. 1973. La distribución de lignina en aguas de la ensenada de Lourizán (ría de Pontevedra) como medida de la polución a causa vertido lejías lignosulfónicas procedentes de la fabricación de la pasta de celulosa. Bol. Inst. Esp. Ocean. No. 172.

Besada, J.R. and González-García, N., 1973. Contaminación por mercurio en aguas de La Coruña. Pub. Téc. Dir. Gral. Pesc. Marit. 10.

Sweden

(B. Dybern)

Baltic Sea

Programmes started before are continued (see Administrative Report 1973). In addition, Sweden takes part in a cooperative investigation (Sweden/ Finland) in the Bothnian Gulf regarding, among other things, the nutrient content in the sea water.

Øresund: As for Administrative Report 1973.

West Coast

Local and regional investigations at a number of sites. The most important at the moment are those in the Värö and the Brofjorden areas. The Brofjorden investigation is a broad study of both physical, chemical and biological parameters and is related to the construction of a refinery. The Värö investigation is related to the building of a nuclear power plant.

United Kingdom

1. England (H.A. Cole)

1. Fish Cultivation. (Fisheries Laboratory, Lowestoft)

The objective of this work is to establish techniques for the cultivation of marine fish and to develop these towards standards acceptable in commercial practice.

Further trials with turbot larvae were performed following the successful production of metamorphosed fish in 1972. Two systems were examined, namely chiffon cage and large tank culture. The objective in the former was to confine larvae and their food (rotifers) in small space within a larger, hygienic environment. In the latter, algae, rotifers and turbot larvae were grown sequentially in situ. This system is known to work, but is difficult to control.

Neither system worked well in 1973. Food in the form of rotifers was in short supply for the chiffon cages and it was observed that the young larvae could not feed on mature rotifers - a high proportion of immature rotifers is probably required during the first two or three days of feeding. Initial feeding was good in the large tanks but health problems were encountered about 6 days after first feeding. Symptoms of ailing fish included "water-belly", disappearance of the swim bladder, production of kidney granules and heavy pigmentation. The few larvae that reached metamorphosis all appeared to be free of these symptoms.

The value of dietary lipid was demonstrated in trials with 0-group fish. On sprat diets (high lipid), conversion efficiency over 7 months ranged from 30% to 52%; on cod (low lipid), conversion efficiencies ranged from 21% to 37%. Sprat-fed fish had high lipid contents (9.5%) compared to those on cod (4.0%) but after one month with diets reversed, both sets of fish had lipid contents of about 6%.

Trials on closed-circuit culture of turbot began in August with hatchery-reared (Port Erin) and wild-caught 0-group turbot. Initial biomasses in the two tanks were 1 361.5 g (203 fish) and 915.6 g (199 fish) respectively, and after 6 months growth at approximately 14°C had reached 15 464.0 g (201 fish) and 5 890.1 g (190 fish). Each tank and filter bed system contained 4.5m^3 of water which was changed once a month.

Adult turbot (1970 year class) which had been maintained in captivity from 0-group stages matured in 1973 but egg quality was poor. This was assumed to be due to the high temperatures at which the fish were held and currently the fish are being held at ambient temperature. Beneficial effects in this respect were observed with pleuronectids held in the same tank as the turbot. Mean weights of these brood-stock turbot at 13.12.73 were females, 4.1 kg and males, 2.7 kg.

Parasitological work showed that infestation by the tapeworm Bothriocephalus scorpii did not occur in turbot held in tanks. Ectoparasites, such as Lepeophtheirus spp, reproduced rapidly in tank conditions but could be eradicated with 'Nequvon' (Farbenfabriken Bayer A.G.).

Genetic analysis of 5 enzym systems in plaice showed normal Mendelian inheritance in most crosses but with some exceptions, particularly at a Phosphoglucomutase locus. Cross-over frequencies between centromere and locus were measured for 2 loci using gynogenetic techniques. Values of 3% and 45% respectively, were obtained; the latter value was surprisingly high and, if confirmed, will indicate that inbreeding rates by gunogenesis have been overestimated in the past.

Further trials to induce tripoidly in salmon and trout have again failed. Alternative methods of inducing sterility using hormone diets are being examined. Triploid plaice remained sterile through 1973.

An examination of inbreeding depression in the laboratory fish Poecilia reticulata continued. Seven lines of strict sib-mating were set up from an outbred stock but 5 perished by the 6th generation. Very abnormal sex ratios were observed, with a marked preponderance of males in most broods.

2. Fish Cultivation (Fisheries Laboratory, Port Erin)

Turbot

Using an empirical technique based on indications obtained from the 1972 rearing work 1 100 turbot were reared to metamorphosis at a survival of 6.5%. The use of a large tank, 5 800 litres, and the presence of algae during the rotifer feeding stage were felt to be of importance in obtaining this result. In separate experiments it was established that an improvement in larval growth was obtained when the larvae fed on rotifers which were feeding actively on algae.

A series of experiments have been completed using the hatchery-reared turbot produced in 1973. It was found that an improvement in the protein efficiency ratio could be obtained by increasing the lipid content of the diet to 4% of the wet weight. Fish fed on diets of different water content increased in mean weight from approximately 25 g to approximately 120 g with no difference in growth rate even on a diet with 0% water. Food utilisation was more efficient on the dry diet. This result suggests that turbot could be

fed on a commercially produced dry diet similar to that used for trout. In an experiment carried out in conjunction with the NERC Fisheries Biochemistry Unit the quantitative requirement for thiamine has been determined. Preliminary work on the tolerance of turbot to ammonia showed them to be at least as tolerant as Dover sole.

Dover sole

Fish held at a range of densities from 5 to 475 per m^2 showed no difference in growth rates when grown from 1.5g to 10g. In this experiment very high flow rates were used to maintain equivalent water quality conditions in all treatments. In a separate experiment the growth of Dover sole was only found to be depressed when carbon dioxide levels reached a value which reduced the pH below 7.0.

Disease studies

Work has continued on the isolation and biochemical characterisation of bacteria obtained from diseased fish and the preparation of reference material on the histology of diseased fish tissues.

3. Marine pollution (Fisheries Laboratory, Burnham-on-Crouch)

Extensive investigations have been made covering many aspects of marine pollution, including discharges from dumped wastes, discharges from pipelines, oil pollution and gravel extraction.

Monitoring investigations

For the fifth year, the routine twice-yearly monitoring of fish landed at 9 ports from the coastal regions of England and Wales has continued. Five species of fish (cod, plaice, whiting, herring and mackerel) have been analysed for persistent organochlorine compounds and for a range of metals including mercury, cadmium and lead. Special investigations have also been made of the concentrations of mercury, cadmium and lead and other metals, in fish and shellfish from estuaries, coastal, middle and distant waters. Additional analyses were made of cod, plaice, herring, brown shrimp and mussels as part of the ICES international survey of pollution of the North Sea. As part of this study, and in cooperation with Belgian and Dutch workers, surveys have been made of the concentrations of heavy metals in water, taking care to separate the suspended and liquid phases. The relationship between age and the accumulation of metal and organochlorine compounds by cod and plaice has been investigated. To support these studies, improvements have been made in methods of determining organochlorine compounds, lead and cadmium in fish tissues.

Toxicology

The effects of wastes disposed to sea have been assessed by laboratory tests for toxicity and by field investigations to determine the effects on sediments, benthos and fisheries in several areas.

Over 100 industrial wastes intended for discharge through a pipeline or by dumping at sea have been subjected to a 5 day tests for acute toxicity using the brown shrimp (Crangon crangon) and the armed bullhead (Agonus cataphractus). Long term effects of mercury and cadmium entering the sea have been determined by uptake studies using the continual flow/dosing apparatus with brown and pink shrimps (Pandalus montagui). No threshold could be determined for mercury even after three months exposure, and death appeared to be associated with the level of accumulation of the metals in the tissues, rather than the concentration of material in the water. An attempt has been made with other wastes to correlate laboratory and field toxicity tests.

As a result of discussions at the 1972 meeting, valuable cooperative work was carried out with Germany to determine the toxicity and ecological significance of red mud dumped at sea. The previous differences observed by the two groups of workers were related to differences in the nature of the wastes, and the hydrographic conditions in the areas of disposal.

The toxicity of oil dispersants was established using the standard 48L test. With the introduction of lox toxicity materials, the toxicity of dispersed oil was found to assume increasing significance. Investigations to determine the effects on fisheries of oil sunk to the sea bed by sand were continued. These experiments confirmed that several bottom-living organisms may eat sunken oil, although soon after sinking, probably because of the presence of volatile fractions, little was taken up. Other experiments showed that the toxicity of sunken oil to benthic organisms in the open sea is likely to be of little significance.

Experiments show that fish exposed to oil can eliminate straight chain hydrocarbons from their tissues when held in clean seawater, and that little of the material enters the edible portion. Small amounts of oil cause undesirable flavours, and it therefore seems highly unlikely that significant amounts of harmful substances are consumed by man.

In cooperation with Scottish workers, surveys have been made to determine the quantitites of mineral oil in samples of water plankton, sediment, benthos and fish from 22 stations around the United Kingdom, selected for their range of expected oil pollution. Water samples show a surprising uniformity of hydrocarbon concentrations, despite their origin. During the year, in cooperation with Scottish and Norwegian workers, a monitoring operation for oil was started adjacent to offshore drilling and production sites. Samples were taken of sediments, benthos and fish.

Ecology

Field investigations have continued to determine the effects of dumped wastes and to a lesser extent of those discharged through a pipeline. During the year, the main effect has been devoted to understanding the movement, distribution, and effects of digested sewage sludge, disposed from a vessel into the lower part of the Thames estuary. Hydrographic studies have included the use of moored current meters and radioactive tracers to determine the movement of sludge. Preliminary results indicate that deposition occurs on the sides of adjacent sand banks, but that some of the material is later buried by sand or dispersed, mainly towards the land. Samples of sediment and of benthos which are important as fish food have been taken by grab, and have been analysed for heavy metals, or identified so as to determine changes in the benthos in the area of dumping. Results so far fail to show that dumping has any significant effect. Investigations have been completed on the effects of a china clay waste discharged into a coastal area of the west channel. A study has been completed on the ecological effects of a paper mill waste disposed into an estuary on the east coast once the centre of an oyster industry. Investigations have been made to determine changes in water quality, using mainly the dissolved oxygen concentration, and of changes in the distribution of benthic organisms in the area caused by the deposition of large quantitites of suspended organic material. The distribution of oysters appeared to be related to poor water quality resulting in reduced shell growth and to the unsatisfactory nature of the sea bed. Laboratory tests confirmed that the effluent caused a marked reduction in growth rates of oyster larvae and juvenile oysters.

Investigations into the distribution of several fish diseases including lymphocystis in flatfish were made in a number of sea areas including those adjacent to industrial areas. There was great variability in the incidence of lymphocystis between species and between areas, but there was no obvious reason.

Microbiology

Studies to determine the effects of sewage disposal on molluscan shellfish and methods of treating shellfish have continued. Field surveys have been made to determine the distribution of sewage and its relationship to the uptake of sewage organisms by oysters and mussels. As a result of these studies proposed methods of sewage disposal have been modified to reduce the effects on shellfish.

In order to understand the significance of sewage pollution, an extensive survey has been carried out of the numbers and significance of a wide range of marine and terrestrial bacteria found in oysters and mussels obtained from commercial sources. Wide variations have been found in the numbers and types of bacteria found in shellfish tissues which are influenced by climate, hydrographic and physiological factors. From these studies it is not feasible at the present time to define the maximum numbers of non-faecal bacteria (total bacteria) which may be permitted in shellfish for human consumption.

Studies have continued to develop and improve methods for the removal of faecal bacteria from bi-valve molluscs by purification techniques. A high density pilot plant using a u/v light source and stacked shallow trays, suitable for the purification of hard clams (Mercenaria mercenaria), oysters (Ostrea edulis and Crassostrea gigas) proved successful, and several are now under commercial construction. Monitoring of the operation of traditional oyster and mussel plants continued. To support this work, improved methods have been developed for the recovery of faecal bacteria from seawater and shellfish samples. Tests have included improved methods of preparing media, macerating tissue samples, improved tests for specificity using solid and liquid media, and an improved membrane filter technique.

During the year, samples of mussels from the coast of northeast England were monitored by the mouse bio-assay test to determine PSP toxins which are known to occur in the area. Although trace quantities of toxin were found between March and August, measurable quantities were found only on three occasions and then in concentrations of little toxilogical significance (192-218 mouse units/100 g). The dinoflagellate content of the gut of mussels was determined, but only the higher levels of toxicity appeared to be associated with Gonyaulax spp.

Gravel extraction

As a result of the expanding demand for sea-dredged aggregates, investigations were continued to determine the effects of dredging and the rates of recovery of the seabed. Using the sector scanner, divers and grabs, areas of dredging activity were defined and it was apparent that anchor dredging leaves depressions which could be hazardous for trawling gear. In one area the rate of infill appeared to be slow initially, but in subsequent years filling has accelerated as a result mainly of the collapse of the sides. The fate of dredged holes or trackes therefore seems to depend upon occasional periods of extreme wave action. In old workings there was evidence that new animal communities had colonised the bottoms of the holes. Where sand overlaps gravel, it seems that damage will be minimal as the holes or tracks will be refilled with sand and its fauna. In another area which was surveyed to determine the value of an area as a fish feeding ground subjective assessments made from examination of the benthos were confirmed by the use of long lines, highest catches being made in the areas of most abundant benthos.

2. Scotland (A.D. McIntyre)

1. Food Chain Investigations

In 1973 food chain studies were concentrated in the Firth of Clyde where a detailed examination was made of a number of plaice nursery grounds. Investigations of the mud food chain leading to Nephrops have been continued in Loch Ewe and in particular in this area the technique of using large plastic bags to quantify the flow of energy and pollutants from the water column to the bottom is being developed.

2. Shellfish Cultivation

An experiment in bi-valve culture was initiated. Spat of four species, Pecten maximus and Chlamys opercularis from natural settlements, and Ostrea edulis and Crassostrea gigas from a hatchery, were set out in trays in various conditions in lochs on the west coast of Scotland. All four species have grown well especially scallops, which attained a length of 50 mm in one year, and especially in Linne Mhuirich (Loch Sween).

Observations on the flatworm Notoplana atomata found living on cultivated Crassostrea gigas yielded no evidence of harm to the oysters.

Cockles transplanted from the upper to the lower shore on Traigh Mhor, Barra, in May 1965 were examined in August 1973. Survival had been good and a mean size of more than 50 mm attained.

3. Fish Farming

Disease and parasite studies

Parasitological investigations of farmed marine flatfish have continued in cooperation with the White Fish Authority at Hunterston and Ardtoe. Ichthyophonus, a highly pathogenic fungus, was recorded in plaice and experimental studies have been carried out on the transmission and pathogenicity of, and host resistance to this parasite, and the protozoan Glugea. A study has commenced on the possible role of parasites in the conditions known as "renal calcinosis" and "biliary hyperplasia" in turbot.

Further studies of the protective mechanisms of plaice showed that most antibody-bearing cells, largely small lymphocytes, are resident in the head kidney, spleen and thymus. A close association was found in the kidney and spleen between macrophage cells and melanomacrophage centres, both terminal areas for the concentration of the simulated antigens, carbon black thorotrast and bovine serum albumin, and antibody-bearing cells of the lymphocyte series.

A study of the parasites of juvenile salmon in the Department of Agriculture and Fisheries for Scotland smolt-rearing station at Almondbank showed a number of parasite species, several of which are potentially pathogenic. Some species showed marked seasonal variations. A comparison was made between the parasite faunas of the farmed fish and wild salmonids in the river supplying the station.

Infectious pancreatic necrosis (IPN) virus has not previously been recorded in wild fish stocks in the United Kingdom. However, now that several outbreaks of IPN virus disease have been found in Scottish fish farms in recent years, a survey of wild fish stocks in waters adjacent to an infected farm has been made. IPN virus was recovered from 5 different species of fish, namely salmon parr, juvenile and adult brown trout, juvenile perch, minnows and lampreys. None of these wild fish from which IPN virus was isolated showed any gross pathology

and no morbidity was observed in any wild fish in the general area of sampling.

Physiological studies

Investigations of the use of anabolic steroids in salmonid rearing were initiated. Results indicate that during the four month period of the experiment, incorporation of the steroid into the diet of rainbow trout results in a significant increase ($P<0.005$) in growth rate, the mean increment being approximately 25%. This appears to reflect the combined effects of an improvement in food conversion efficiency (mean 8%) and an increase in appetite.

4. Pollution

Shellfish and public health

Advice on purification has been provided and analyses of shellfish and water has been done for indicators of faecal pollution. Surveillance has been maintained round the coast in relation to paralytic shellfish poisoning.

Firths of Clyde and Forth

The study of the Clyde in relation to pollution problems was continued and further current-meter records were obtained in an effort to explain the mechanism controlling overall circulation in the Clyde Sea area. In the Firth of Forth a start was made in producing a balance sheet of pollutant input and output.

Baseline surveys, monitoring and other pollution investigations

In collaboration with Torry Research Station a baseline survey was made of the hydrocarbon content of water, sediment and organisms in the vicinity of the main North Sea oil fields from Ekofisk to north of Shetland.

Monitoring for a number of heavy metals in selected species of fish and shellfish has continued in relation to Scottish fisheries.

A number of possible sites for sewage sludge disposal from Edinburgh have been examined and a number of short-term investigations or single surveys have been made in connection with specific effluents, actual or potential.

Experimental Work at Loch Ewe field station

During 1973 the experimental studies of the effects of pollutants on the Tellina/plaice food chain were continued. Tellina from the 1972 experimental series were kept in uncontaminated sea water to determine retention times of accumulated copper and mercury in Tellina and other components of the tank ecosystem.

Further experiments were undertaken to determine the effects and accumulation of cadmium. The experimental design was as in previous experiments. Cadmium concentrations of 1.0, 10.0 and 100 µg/l were tested in duplicate and in addition the possible antagonistic effects of cadmium and nutrient enrichment on the Tellina/plaice food chain were investigated. These experiments will be continued in 1974.

A joint project was begun in collaboration with the Medical Research Council (Carshalton Laboratory) to study the mechanism of accumulation of cadmium in the tissues of various shellfish. The edible crab, the scallop, the edible mussel, the limpet (Patella aspera) and Tellina tenuis were exposed to a cadmium dose of 100 µg/l. Samples were taken during the course of the experiment to determine total levels of cadmium and also

levels of enzyme-metallothionein/ cadmium complexes in the shellfish tissues and in subcellular fractions of these tissues. Some shellfish species can accumulate very large amounts of heavy metals in their tissues, far in excess of those recorded in other marine organisms. It is possible that the mechanism of uptake and retention of such pollutants is fundamentally different in such species.

In collaboration with the Ministry of Agriculture, Fisheries and Food (Torry Research Station) experiments were undertaken to determine the effects on codling of oil in the food and of soluble components of oil in the water. A number of fish were fed with oil encapsuled in their food for a period of six months. The remaining fish were then fed on an oil-free diet. Fish were sacrificed regularly during the experimental period to determine the circulation/elimination of oil traces in the flesh and organ tissues. Experiments with codling and scallops exposed to soluble components of oil in the water but not in the food were run at the same time and on the same lines.

Experimental food chain studies at Loch Ewe have been concerned so far with a benthic food chain. In 1973 a start was made in studying fish feeding directly on zooplankton. Sandeels (Ammodytes lancea), juvenile gadoids (haddock and lythe) and sprats were maintained in tanks and supplied with a viable natural zooplankton source. Survival, growth and biochemical conditions were monitored to assess whether these types were suitable for tank rearing. It is eventually hoped to study the effects of pollutants on one or more of these food chains.

Experimental work at Aberdeen Laboratory

Studies of the effect of changes in the nutritional status of rainbow trout on the mobilisation of ingested loads of DDT have been continued. Food deprivation, which resulted in a reduction of body lipids from 9% to 1% wet weight, caused a 40-fold increase in the concentrations of pollutant in the blood plasma and in brain tissues. In agreement with the theoretical model of pollutant mobilisation, this was accompanied by a sharp rise in the rate of elimination of DDT, some 50% being excreted during a period of two weeks and a marked increase in the rate of metabolism of DDT to DDE.

Work at the Pitlochry Laboratory

During 1973, further samples of plankton, fish and marine mammals were analysed for organochlorine residues (pesticides and PCB's). In addition, samples of seawater from the North Sea, Firth of Clyde and Firth of Forth were examined, but most contained less than 1 mg/l of any organochlorine residue. Two samples of the surface film in the North Sea, however, contained relatively high concentrations of organochlorines, and large amounts of other unidentified electron-capturing substances.

The six-monthly sampling of commerical fish species for organo-chlorine analysis was reduced to four species (cod, whiting, herring and plaice), from four areas in view of the very low levels of contamination found in most of the samples in the past four years. The Clyde area showed consistently higher levels of dieldrin, DDT and PCB residues, as in the past. Herring from the Clyde and North Sea coast were sampled as part of the 4-year OECD international collaborative study of environmental contamination. Further samples of plankton from the Firth of Clyde and eastern Atlantic were examined for organochlorines, giving additional proof of the relatively high contamination level in the Firth as compared with the open coastal area to the west.

The analyses of seal blubber from United Kingdom waters were augmented by analyses of samples from the Netherlands, Faroes, South Africa and a sea-lion from New Zealand. The specimens from the Netherlands coast were very highly contaminated by organochlorines, in contrast to those from South Africa and New Zealand, where concentrations were lower than those found in Arctic seals. Several samples of seal liver were analysed for mercury and values as high as 770 mg/kg were found in specimens from the Netherlands. In contrast, samples from seal pups off South Africa contained a mean level of 0.24 mg/kg.

Further samples from the Marine Laboratory studies of the effects of DDT amd PCB on a plaice-Tellina ecosystem were analysed, to assess the extent to which these pollutants accumulate in various components of the system from known aqueous concentrations.

The method of analysis for organochlorines in precipitation was improved, to reduce the extent of background contamination from laboratory materials. The concentrations of DDT and PCBs in both rain-water and solid deposition at four sites in Scotland were compared with similar measurements in Sweden. The Scottish samples are believed to be free of local environmental contamination, and to contain only material derived from long-distance atmospheric transport.

5. Sargassum muticum

Following on C.Res.1973/4:5 arrangements were made with a number of marine laboratories and institutes round the coast to report on the distribution of Sargassum if it appears in Scotland

U.S.S.R.

(A. S. Bogdanov)

The results of the work on acclimatisation of pink salmon conducted by the USSR are given in the Administrative Report of the Anadromous and Catadromous Fish Committee, 1973.

Work on the acclimatisation of pink salmon in the Baltic Sea and on farming marine organisms at the edge of the sea was started by Soviet specialists in 1973. Results were not yet obtained. In 1974, the investigations will be continued.
