

PLANKTON COMMITTEE

(D.H. Cushing)

1974

Belgium

(R. de Clerck)

The study on the distribution in space and the evolution in time of sole eggs and larvae was continued during 1974.

The sampling took place from March till June on 43 stations along the Belgian coast.

This study shows that the strength of the year class 1974 of soles was poor.

In addition the following species occurred during sampling :

Sprattus sprattus, Engraulis encrasicolus, Limanda limanda, Platichthys flesus, Rhombus maximus, Trachinus vipera, Trigla gurnardus and Callionymus lyra.

Canada

(T. Platt)

In August a cruise was made to the zone of presumed upwelling off the Yarmouth area of south west Nova Scotia. Temperature, salinity, phytoplankton nutrients, chlorophyll and particulate carbon concentration, phytoplankton cell numbers <sup>14</sup>C uptake and zooplankton biomass were measured at 47 stations. In addition three selected stations were occupied for 26 h continuously. The results from this cruise have been analysed and published in Technical Report #524 of the Fisheries and Marine Service. Preliminary interpretation supports the view that the water in the vicinity of Yarmouth is richer in nutrients and higher in productivity than the surrounding water on the Shelf.

At the Marine Ecology Laboratory work has continued on the investigation of the relationship between spatial structure of phytoplankton populations and the physical structure of the mixed layer. Power spectra of chlorophyll fluctuations are similar to those of temperature for horizontal scales between about 100 m and 5 km. They are consistent with the spectra one expects to find in a stratified medium when turbulence and internal waves are present. For scales greater than about 5 km temperature and chlorophyll spectra diverge, it is thought that in this range biological processes begin to dominate over physical ones in controlling the distribution of chlorophyll. In July, two cruises were made on the Scotian Shelf using a porpoising towed body fitted with a STD and a continuous fluorometer. This allowed a collection of data on the 3-dimensional distribution of chlorophyll and physical variables. It is thought possible that with these data the effects of internal waves can be

separated from other mechanisms controlling the local abundance of phytoplankton. Analysis of the data is continuing.

Experiments have been conducted on the possibility of stimulating primary production in the coastal inlets of Nova Scotia by artificial upwelling. Controlled additions of bottom water to surface water in vitro have been made to measure the quantitative response of the surface phytoplankton community. The optimal enrichment of bottom water to surface water to stimulate primary production is 0.75%.

Maximum productivity : biomass ratio was reached about 5 days after enrichment.

Development is continuing on the high frequency sonar technique for rapid assessment of euphausiid stocks in the Gulf of St Lawrence. Concentration on euphausiids up to 4 g wet weight per cubic meter have been found. In addition data have been collected on the behaviour, feeding habits, age structure and species distribution of these animals. Simultaneous measurements were made using continuous fluorometry and continuous high frequency sonar. A high positive correlation was found between chlorophyll concentration and euphausiid abundance.

A re-examination has been made of the available theoretical techniques for the modelling and prediction of marine primary production. Published theoretical descriptions of the photosynthesis light curve have all been expressed in terms of the same parameters for ease of comparison. All of the models have been integrated over depth and time. The fundamental limitations which exist on predictability in the marine environment, particularly prediction of primary production have been investigated. This work is available as Technical Report #523.

At the University of British Columbia work is continuing on studies of controlled aquatic ecosystems (CEPEX). Last year successful experiments were carried out on total pelagic ecosystems held in six, 70 ton plastic containers. These experiments were designed to test the effect of very low concentrations of copper and hydrocarbon in marine ecosystems. In addition work is continuing on metal availability in coastal waters with emphasis on the toxicity of copper and zinc and different water types.

On the specific question of algal blooms Canada has had little concern (in the marine environment) with detrimental effects, except for the occurrence of paralytic shellfish poisoning associated with blooms of the planctonic marine dinoflagellate Gonyaulax tamarensis. Since 1880 over 200 reported illnesses and 23 deaths have been associated with this phenomenon in Canada. A recent review is available (Paralytic Shellfish Poisoning in Eastern Canada. 1971. A. Prakash, J.C. Medcof, and A.D. Tennant. Bulletin #177, Fisheries Research Board of Canada). Considerable work has been done in eastern Canada at the Marine Ecology Laboratory on the general properties of nondetrimental algal blooms. The most recent of these is available as Technical Report # 423 (Primary Productivity and Nutrient Measurements on the Spring Phytoplankton Bloom in Bedford Basin, 1971. 1973. Trevor Platt, B. Irvin and D.V. Subba Rao. Fisheries Research Board of Canada); references can be found in it to previous studies. A generalisation which might be made is that during these blooms 80% of the variance in primary production can be accounted for by chlorophyll and light. Knowledge of the available inorganic nutrients add relatively little to our ability to predict the turnover time.

Denmark

(E. Smidt)

Home Waters

Besides participation in the annual ICES herring larvae programme, no plankton research work has been carried out.

West Greenland Waters

As in previous years, routine stramin net samples (2 m ring diameter,  $\frac{1}{2}$  hour oblique hauls from about 50 m depth) were taken on 4 east-west hydrographic standard sections in the Davis Strait in July, primarily for estimating numbers of cod larvae - fish eggs and larvae and invertebrates were sorted and counted - and the investigations will be continued in 1975.

Federal Republic of Germany

(J. Lenz)

1. Institut für Meeresforschung an der Universität Kiel

The long-term observations on the standing stock of phytoplankton, zooplankton and detritus in relation to environmental factors at the fixed station Boknis Eck - which is representative for the western Kiel Bight (Western Baltic) - were continued for the 18th year. This data collection proves very valuable in demonstrating the seasonal and annual fluctuations of physical, chemical and biological parameters in this transition area between North Sea and Baltic. In 1974 the measurements comprised temperature, salinity, oxygen, total phosphorus, seston, protein, chlorophyll a, organic carbon, organic nitrogen, and caloric value of particulate matter in water samples taken from 6 standard depths and from the main thermocline where present. In addition the total amount of plankton in the water column is sampled with three mesh sizes (56, 100, 300  $\mu\text{m}$ ) and analysed for dry weight, organic matter and caloric content.

The observations at Boknis Eck have been intensified since 1972 within the framework of a multidiscipline programme entitled "Exchanges between water and sea bottom" sponsored by the German Research Association. At a nearby station physical, chemical ( $\text{PO}_4$ ,  $\text{NO}_2$ ,  $\text{NO}_3$ ,  $\text{NH}_4$ , dissolved C) and biological parameters (composition of seston, phytoplankton and zooplankton abundance and species composition) were measured at fortnightly intervals. In addition to the analysis of the standing stock, primary productivity was measured by the  $^{14}\text{C}$  in situ technique. The data obtained revealed interesting results regarding the sequence of phytoplankton blooms and the rate of primary productivity in the course of the year. The publication is in preparation.

Within the same programme, the sedimentation of plankton and detritus was studied with the help of specially developed in situ samplers positioned close to the bottom. Experimental in situ work on the enclosure of a large water column from the surface to the bottom by means of plastic bags was continued.

Plankton work in the Marine Pollution Programme (TG 63, Federal Ministry of Science and Technology) dealt with three main topics :

- 1) The influence of sewage on the distribution of plankton and primary production. Primary production and related physical, chemical and biological parameters were measured at three stations (inner Kiel Fjord, Kiel sewage outlet at Bülk, outer Kiel Fjord) twice a month.
- 2) In situ experiments on the influence of different concentrations of mainly domestic sewage on natural plankton populations. Sewage concentrations of 0.5% and 2% were added to enclosed water bodies (800 l). Phytoplankton development, changes in the composition of particulate matter (C/N ratio) and especially of phosphorus in its different fractions were observed daily in both the plastic bags and in a control bag without sewage.
- 3) The determination of heavy metals in seston. A new method was developed where the dry combustion takes place in the measuring vessel itself on the atomic absorption spectrometer. In contrast to the old method which was based on a wet combustion, the quantity of seston required is much lower. Both methods are approximately equally precise. The concentration of heavy metals in seston was measured by the new method on a cruise to the Baltic proper.

Apart from the above programme the seasonal influence of pollution was studied along a section from the inner Kiel Fjord to the open Kiel Bight together with the department of microbiology. The monthly sampling programme covered 4 stations and included besides the above mentioned components of particulate matter the analysis of lipids, carbohydrates and ATP.

Studies on the distribution, abundance, and ecology of pelagic fish eggs and larvae have been continued in several areas :

Analysis has advanced in the material sampled in previous years by RV "Meteor" in the upwelling area off the northwest African coast and by RV "Walther Herwig" in the North Atlantic along the Faroe-Shetland Ridge ("Overflow" programme). In the north-west Atlantic in the George's Bank-Gulf of Maine area, surveys especially of larval herring were carried out in spring and autumn within the scope of ICNAF; the results of this survey programme in previous years have been summarised in ICNAF research documents.

Within the scope of ICES, herring larvae were surveyed in the southern and northern North Sea in winter and autumn respectively. In conjunction with this sampling programme studies on the effect of mechanical stress on fish eggs and of oil pollution on fish larvae have been made; in addition, the food supply for fish larvae has been monitored. The occurrence and distribution of fish larvae in the summer plankton of the North Sea was studied during two short cruises.

The analysis of a detailed monthly survey programme in 1970/71 on the heterogeneity and variability of zooplankton in the Kiel Bight, western Baltic, has almost been completed with regard to the fish eggs and larvae. A new sampling programme has been started in the Bornholm Basin, central Baltic. A special study on the feeding ecology of herring larvae is being continued in the Schlei fjord, western Baltic. On almost all cruises a modified neuston sampler according to David was used. Analysis of this material has been chiefly carried out for the area of the western Baltic. Seasonal and spatial differences in the zooplankton of the uppermost centimeters of the water columns in relation to the hydrography have been studied.

## 2. Biologische Anstalt Helgoland

### a) Helgoland

Covering the year's period, 132 samples were taken at Helgoland Roads and counted following the Utermöhl method. Phytoplankton development started in April with a considerable diatom population (Coscinodiscus concinnus), a second outburst appeared in June (Cerataulina bergonii and Noctiluca miliaris) and a final peak, with Ceratium furca and Rhizosolenia delicatula as dominating components, occurred in July and August. No population densities comparable to red tides were observed, although the standing stock of microplankton (summarised in carbon units) was found to be more than twice that of 1973.

To control ecological factors, data on salinity, temperature, nitrite, nitrate, ammonia, phosphate, and silicate were collected on 151 days. In this connection, methodical research was carried out on automated  $PO_4$  and  $NO_3$  determinations.

Between April and September 1974, primary productivity estimations were done with  $O_2$  and the  $^{14}C$  method. A good correlation between these two methods, and also to phytoplankton concentrations was observed, while in general  $^{14}C$  results were found to be slightly below net productivity data calculated from  $O_2$  measurements.

Experimental investigations of carnivorous zooplankton interactions as well as studies on zooplankton population dynamics at Helgoland Roads and on macrozooplankton in the southern North Sea and around the British Isles were conducted during 1974.

### b) List/Sylt

Hydrographic conditions, micronutrients and particle concentrations were measured at three stations in the Wadden Sea of Sylt twice a week. Phosphate, silicate, ammonia, nitrite and nitrate concentrations were measured throughout the year. Besides phytoplankton counts the quantity of seston and its content of organic carbon and nitrogen was analysed.

The concentration of Appendicularia in the Wadden Sea zooplankton was investigated and the potential food resources for filter-feeding zooplankton determined by measuring chlorophyll a, organic carbon and nitrogen content of four size fractions of the seston. Two calanoid copepods were cultured to measure food uptake, growth rate and mortality under experimental conditions.

## 3. Institut für Hydrobiologie und Fischereiwissenschaft der Universität Hamburg

The investigations on zooplankton from the Norwegian Sea and the upwelling region off NW Africa have been continued.

Scientific results on zooplankton from the cruise of FFS "Walther Herwig" in 1970/71 through the Central and South Atlantic Ocean will be published in 1975 in Ber. dt. wiss. Komm. Meeresforsch. The distribution of pontellid copepods along three transects from the Canary Islands to the Patagonian shelf, across to Cape Town, and from there northwards to Madeira is described. Pontellid species are increasingly employed as biological indicators.

4. Institut für Küsten- und Binnenfischerei der Bundesforschungsanstalt für Fischerei Hamburg

Routine investigations on the species composition of phyto- and zooplankton and the amount of detritus in the Elbe estuary were continued within a fortnightly sampling programme.

Finland  
(Å. Niemi)

Institute of Marine Research, Helsinki

Phytoplankton and primary production:

- a) Investigations on phytoplankton, primary production ( $^{14}\text{C}$ , in situ, and in incubator in constant light and temperature), total phosphorus and nitrogen, and environmental parameters were made in unpolluted sea areas at 4 coastal stations: Orrengrund (mid part of the Gulf of Finland), Tvärminne (entrance to the Gulf of Finland), Kaskinen (north-eastern part of the Bothnian Sea) and Ulkokalla (Bothnian Bay). Samplings were made every second or third week; during the ice-period more sporadic samples were taken.
- b) During the cruises (May-November) with RV "Aranda" measurements of chlorophyll a and the primary production ability ( $^{14}\text{C}$  incubator, constant light and temperature) were made at international stations in the Baltic proper, Gulf of Finland and Gulf of Bothnia.

Zooplankton

Zooplankton sampling (Hensen net, mesh size  $150\ \mu\text{m}$ , vertical haul: 25-0 m) has been continued at the following coastal stations: Orrengrund (1967- ), Tvärminne (1966- ), Seili in the Archipelago Sea (1966- ), Kaskinen in the Bothnian Sea (1973- , irregularly) Ulkokalla (1973- , irregularly) and Krunnit in the Bothnian Bay (1966- ). Sampling has been performed three times a month (once a month during the ice-period).

During the cruises with RV "Aranda" zooplankton has been sampled (Nansen net, mesh size  $150\ \mu\text{m}$  , vertical hauls, 25-0, 50-25 m) at international stations in the Baltic proper, Gulf of Finland and Gulf of Bothnia.

Institute of Radiation Physics, Helsinki

Studies on primary production ( $^{14}\text{C}$ , in situ, and in incubator in constant light and temperature) and phytoplankton have been made in the Loviisa area (mid part of the Gulf of Finland), and at Olkiluoto (off Eurojoki, Bothnian Sea) in order to get background data from these two areas, where atomic power plants are being built. One or two samplings a month have been made during the ice-free period.

National Board of Waters, Water Research Office

Phytoplankton and physicochemical parameters were measured twice a year, at the beginning of March and in early August, at about 30 stations in the Gulf of Finland and the Gulf of Bothnia.

### Tvärminne Zoological Station

Phytoplankton, chlorophyll a primary production ( $^{14}\text{C}$  in situ), total phosphorus and nitrogen, and environmental parameters have been studied in the Tvärminne-Pojoviken area. Samples were taken 1-2 times a month and once during the winter season.

Bacterioplankton was sampled at approximately two-weekly intervals during the whole year. Quantitative estimates were made by direct counts and plate counts.

### Helsinki City Water Conservation Laboratory

Phytoplankton and zooplankton (vertical series, mesh size 50  $\mu\text{m}$ ) were sampled and primary production ( $^{14}\text{C}$  in situ) and environmental parameters were measured in the archipelago waters off Helsinki and Espoo twice a month during the ice-free period. Samples were taken at several stations extending from the severely polluted inner bays to the unpolluted area outside the archipelago.

### France

(L. Marteil)

### Travaux de l'Institut des Pêches

#### Zooplancton

Etude des euphausiacés, mysidacés et larves de décapodes récoltés dans le golfe de Gascogne en automne 1973 en vue d'établir des relations entre le plancton trophique et les merlus. Inventaires de ces crustacés dans les collections de 1971 et 1972 (Mme Beaudoin).

#### Ichthyoplancton

Etude comparative de deux filets à plancton, le Gulf III "encased" et le Bongo, afin de préciser l'efficacité de ces deux filets pour la capture d'oeufs et de larves de poissons, Clupéidés et Engraulidés notamment. Pour la France et l'Espagne, le filet Bongo a été retenu en vue d'effectuer une étude quantitative des oeufs et larves de sardines.

Etablissement d'un fichier des oeufs et larves de Clupéidés et Engraulidés pour les années 1971, 1972, 1973 dans le Golfe de Gascogne. 15 000 données environ (sonde, température, salinité, état de la mer, nombre d'oeufs et de larves...) ont été stockées sur bande magnétique pour chaque station (Mmes Arbaults et Lacroix).

### Travaux du Laboratoire de Biologie Animale Marseille

#### Aire du CIEM

Copépodes de la côte atlantique du Maroc (inventaire - répartition - données écologiques). (M.L. Furnestin et M. Donati).

Zooplancton (NO "Thalassa", 1973) récolté dans le sud de l'aire CINECA, entre les Iles du Cap Vert et les côtes sénégalaises (biomasse - espèces caractéristiques). (J.P. Casanova, Doc.C.M.1974/L:3).

Décapodes pélagiques de la province atlanto-méditerranéenne (inventaire, taxonomie infraspécifique, biogéographie). (J.P. Casanova, comm. CIEM, Monaco 1974, Comité du Plancton).

Etude de l'ichthyoplancton (larves) par microradiographie (J.M. Barrois).

Histologie et ultrastructure des organes oculaires de Chaetognathes (Sagitta - Eukrohnia). Etude expérimentale de certaines relations écologiques (F. Ducret).

#### Autres secteurs

##### Méditerranée

Regroupement de douze années d'observation sur les Euphausiacés : systématique et développement larvaire, biogéographie et biologie (B. Casanova, Thèse doctorat).

Etude de Cavolinia inflexa (Thécosome) dans les sédiments et le plancton (taxonomie infraspécifique). (J. Rampal, Sym. "Marine Plankton a. sediments", Kiel 1974).

Copépodes du golfe du Lion au cours d'un cycle annuel. Relations avec le milieu hydrologique et les concentrations de Clupéidés (S. Falke).

Etude expérimentale du comportement nutritif des Copépodes vis-à-vis de diverses espèces phytoplanctoniques (filtration, ingestion, étude histochimique de la structure du tube digestif d'espèces de régimes différents (J. Mazza - J. Arnaud).

##### Océan Indien

Chaetognathes des Isles Seychelles (récoltes du Musée royal de Tervuren) (M.L. Furnestin).

Les Euphausiacés du "Magga-Dan", des côtes orientales d'Afrique à l'Antarctique (B. Casanova).

##### Iceland

(I. Hallgrímsson)

##### Zooplankton

Zooplankton sampling was carried out at 248 stations in 1974 in the following surveys :

In the latter part of March and the first week of April 69 stations were worked in the Irminger Sea and East Greenland waters. The material was collected with Icelandic High Speed Samplers at the depth of 2, 15 and 25 meters. In the latter part of May and the first week of June 109 stations were worked off the W and N coasts with Hensen net (50-0 m) and Icelandic High Speed Sampler at 5 and 25 m depths.

In August 70 stations were worked off the south coast, oblique hauls with Gulf III sampler.

A continuous plankton survey Reykjavik-Newfoundland and Reykjavik-Suleskerry was carried out as previously in cooperation with the Oceanographic Laboratory, Edinburgh.



Ireland

No research to report for 1974.

Netherlands

(P. Korringa)

Increasing eutrophication of the Dutch inshore waters may favour the development of dinoflagellate blooms, including the species which are held responsible for outbreaks of shellfish toxicity. In August Ceratium fusus reached a maximum of 200 000 cells/litre, and micro-organisms suspected for causing shellfish toxicity, viz Prorocentrum micans and Prorocentrum redfieldi showed a September maximum of 3 600 and 16 000 cells/litre respectively.

The phytoplankton monitoring in the Dutch coastal waters has in the year 1974 been extended to 70 km offshore. This from the Belgian border to the Isle of Texel. The phytoplankton composition as characterised by a species diversity index (Margalef) revealed an increase in diversity going from the coastline to some 30 km offshore, next followed by a decline going from 30 km to 70 km offshore. No correlation could be found thus far between salinity (used as a measure of influx of river water loaded with nutrients and pollutants) and the distribution pattern of phytoplankton over the sampling area.

As usual a great number of plankton samples was collected and analysed for quantitative studies on herring larvae in the North Sea, Wadden Sea and English Channel, on cod eggs in the southern North Sea, on shrimp larvae along the Dutch coast, on eggs and larvae of sole in the Wadden Sea, but those investigations will be discussed in the reports of the relevant Committees.

Scientists of the Netherlands Institute for Sea Research made a detailed study of the phytoplankton and zooplankton spring bloom in the eastern part of the Southern Bight of the North Sea, with the aim of a better understanding of production processes and their interactions with physical, chemical and biological conditions in these waters. Measurements were made of <sup>14</sup>C primary productivity, phytoplankton (biomass and species composition of populations), chlorophyll, zooplankton (biomass, species composition) light extinction, transparency, temperature and salinity, nutrients.

Publications:

Kat M. 1974. Phytoplankton aan de Hollandse kust. Visserij 27(3):146-158.

Norway

(G. Berge & F. Beyer)

1. Institute of Marine Research, Bergen

Phytoplankton

1. The primary production rates and the standing stock of phytoplankton were measured at the coastal banks west of Norway, (Møre) with the emphasis on the nursery grounds of cod and herring. The programme is a long-term monitoring of environmental conditions during and after hatching of the fish larvae and includes also light and turbidity measurements and particle size frequency analysis. The primary production rates per unit of chlorophyll at standardised conditions (PI) was used to compare local and annual

changes in the activity of the producing plankton 30/4 - 16/5 1974.

2. The surveys of fjords in Western Norway in connection with pollution studies continued. Fensfjord, Borgundfjord and Glomfjord were observed. Nutrients, primary production, chlorophyll and particle volumes were measured. Sediment cores were sampled for analyses of persistent organic pollutants with emphasis on PAH. May 1974.
3. The investigation of water exchange and biology of the fjord system enclosing Bergen was carried out with monthly observations until March 1974. The material covers primary production, chlorophyll, water transparency and particle size frequency analysis and will be used for a student thesis at the University of Bergen as well as being reported to the municipal authorities of Bergen. (Institute of Marine Research and Geophysical Institute, University of Bergen).
4. On a survey of Kattegat, Skagerak, the North Sea and the coastal banks of Western Norway during June/July 1974, the primary production, chlorophyll, nutrients and particle size frequencies were analysed. The particle distributions were continuously recorded. The programme is part of a pollution study.
5. In connection with a planned thermic power plant in South Eastern Norway, a programme covering baseline studies of phytoplankton, zooplankton and fish productivity in the Oslofjord and adjacent waters was carried out. During January to June 5 surveys in the area were conducted. Primary production, chlorophyll and size frequencies analysis were measured. The results have been published in a report to the Norwegian authority of waterways and electric power. (Institute of Marine Research, Biological Station, Flødevigen).

#### Zooplankton

1. Sampling was continued at the permanent oceanographical stations along the coast of Norway, West Spitsbergen and station Mike in the Norwegian Sea. The material is worked up and processed by methods described earlier. No salps were observed in 1974.
  2. Investigations in connection with commercial fishery for zooplankton (Calanus) and krill were carried out during early spring and summer. In the open sea, echo recording of Calanus was partly successful. Trawling was carried out on swarms with densities of 3-7 g of Calanus per m<sup>3</sup> both near the surface and at 15-25 m. In sheltered waters dense swarms, a few m in diameter, containing up to 15 kg per m<sup>3</sup> were observed, colouring the sea intensely red. Experiments with anchored traps were continued and a manual worked out for fishing and handling of Calanus.
  3. Echo surveys of krill in fjords south of Bergen were carried out during early spring, there are problems in distinguishing traces of krill from those of small fish and medusae.
  4. Various methods with conservation and processing of Calanus and krill for feed and human consumption were tried, they were also used in experiments with artificial fish bait.
2. Norwegian Institute for Water Research (NIVA), Oslo
- For the purpose of estimating the danger of internal fouling of the cooling water system of a planned nuclear power plant in the Oslofjord area the vertical distribution of Mytilus larvae was studied from June through September by means of a plankton pump.

3. University of Bergen, Biological Station, Espegrend

Work in 1974 was concentrated on studies on populations from two fjord areas.

1. Continued sampling in fjords in Ryfylke, NE of Stavanger, scheduled to be affected by a hydro-electric scheme, is providing a three-year picture of the plankton stocks and their natural fluctuations before the artificial diversions of fresh water begin to take effect.
2. Field investigations of the macroplanktonic populations in Korsfjorden over three years were completed and the emphasis in the project, which is aimed at elucidating trophic dynamics in a plankton community of an oceanic nature, shifted to biochemical calorimetric, and experimental studies of the main populations.

4. University of Oslo, Institute of Marine Biology and Limnology

1. Phytoplankton surveys

- a) The investigation of the spring phytoplankton in the spawning areas of cod and herring (Lofoten to Møre) was continued, in collaboration with the Marine Research Institute of the Fisheries Directorate, Bergen. This investigation is part of the Norwegian IBP/PM programme. (I. Nygaard, T. Braarud).
- b) Phytoplankton was examined as part of oceanographic surveys carried out in connection with hydroelectric power plant projects. Samples from two of these surveys have been worked up and reports have been prepared: (i) from Skjomen, near Narvik (published by B. Schei); (ii) from the Hardangerfjord (by A. Dick, unpublished). A third survey, in the Ryfylke fjords is in progress (I. Nygaard, T. Braarud).
- c) An all-year survey of the near-surface phytoplankton in the Korsfjord near Bergen and a survey of the autumn and winter phytoplankton in the Hardangerfjord have been concluded (K.E. Berg).
- d) A report is in preparation on the summer phytoplankton of Nordåsvatn, a bay near Bergen (K. Tangen).

2. Special phytoplankton studies

- a) Taxonomic studies on coccolithophorids, by means of transmission and scanning electron microscopy, were continued (K.R. Gaarder).
- b) Morphology, taxonomy, and distribution of marine plankton diatoms were studied by means of light and electron microscopes (G.R. Hasle, D.L. Evensen).
- c) Primary production measurements were carried out on various size fractions of phytoplankton in the Oslofjord (J. Throndsen) and in the Tromsø area (J. Throndsen, B.R. Heimdal).
- d) An investigation was made of variations in diatom shell morphology brought about by changes in growth conditions, especially salinity (G.R. Hasle, E. Paasche, others).
- e) A series of experiments were carried out on the salinity tolerance of marine and brackish water plankton diatoms (E. Paasche).
- f) Growth of the plankton diatom Thalassiosira nordenskioeldii at low silicate concentrations was studied experimentally (E. Paasche).
- g) Enrichment experiments and other studies of the possible role of silicon as a limiting nutrient in the Oslo Fjord were continued (B.J. Langemyr).

### Zooplankton

1. As a minor part of an extensive natural conservation study zooplankton of the Glåma Estuary was studied by means of vertical net hauls of about 3 weeks interval. (R.H. Hovde, Zoological Museum and Institute of Marine Biology and Limnology).
2. A new gear for collecting neuston - hyponeuston was developed. Based on routine samples with this gear as well as Nansen net and pump samples, detailed studies of species distribution in relation to hydrography were initiated in a shallow bay of the Oslo Fjord (T. Schram).

## 5. University of Tromsø, Marine Biological Station

### Phytoplankton

Quantitative samples of phytoplankton were taken in the Ullsfjord from March to July.

### Zooplankton

Looking particularly for pelagic fish eggs and larvae, weekly samples were taken from March to July in the Ullsfjord by means of Bongo net, IKMT and vertical Juday net. The material is worked up.

## 6. University of Trondheim, Biological Station, and the Institute of Marine Biochemistry

### Phytoplankton

1. Work on the production of protein and carbohydrates (cellular and extracellular) and accumulation of N and P in marine diatoms was continued.
2. The occurrence of phosphatase in marine diatoms was studied.
3. Work was done on the development of dialysis culture equipment for bioassays of pollutants.

### Zooplankton

Studies on the distribution and seasonal variation in the stocks of Chaetognatha in the Trondheimsfjord were continued.

## Poland

(W. Mańkowski)

The material for phytoplankton studies from 1974 were taken at routine Baltic stations in February, April, June, August and November. The samples were collected by a sampler of the Hydro-Bios type from 0.5, 5, 10, 15, 20 and 30 m depths. Quantitative occurrence of species were counted by means of cylindrical plankton cells of 100 ml capacity under the reverse microscope of Utermöhl's type. The cell coefficient K was 8 400, 20 fields of vision were counted for each sample.

### Results

The first phytoplankton bloom in 1974 occurred in early spring days (April) and extended all over the southern Baltic area. At the time the bloom of the planktonic Chlorophyceae Kirchneriella obesa was observed. The maximum cell number of this species was found at station G<sub>2</sub> of the Gdańsk Deep where it reached  $2\ 578 \times 10^6$  cells per cubic metre of water at 10 m depth. At station B<sub>1</sub> of the Bornholm Deep  $2\ 410 \times 10^6$

cells/m<sup>3</sup> were found at 15 m deep and in the Arkona Sea (Station A<sub>1</sub>) the maximum amounted to 2 154 x 10<sup>6</sup> cells/m<sup>3</sup> at 5 m depth.

The next very intense phytoplankton bloom took place in June. At G<sub>2</sub> the species Kirchneriella obesa reached the number of 2 704 x 10<sup>6</sup> cells/m<sup>3</sup>. At the same time the bloom of the diatom Skeletonema costatum at G<sub>2</sub> was noted with 1 045 x 10<sup>6</sup> cells/m<sup>3</sup> at 10 m depth, whereas the Dinoflagellatae Dinobryon balticum appeared to bloom at B<sub>1</sub> where its cell number at 5 m depth, i.e. the depth of its most intense blooming was 840 x 10<sup>6</sup>/m<sup>3</sup>.

The last bloom of the year was observed in August. At G<sub>2</sub> the Diatom, Cyclonella stelligera reached then its maximum of 562 x 10<sup>6</sup> cells/m<sup>3</sup> at 10 m depth.

The macro- and ichthyoplankton investigations in 1974 in the southern Baltic were conducted at routine stations along the section from the Arkona Sea to the Gdańsk Deep through the deepest spots of the part of the Baltic. The plankton samples were taken by means of the Hensen net.

The obtained material allowed us to calculate the zooplankton biomass and on this basis the year may be considered as fertile.

During the first part of the year the biological processes in the deeps were active as evidenced by the abundant occurrence of Sagitta elegans baltica in the Bornholm Deep, whereas in the other half of the year there was an almost complete lack of oxygen in the bottom water, restricting the life processes. The oxygen conditions of the Gdańsk Deep were better and organisms dwelling in deeper waters occurred permanently.

In 1974 investigations of the horizontal distribution of ichthyoplankton were made all over the southern Baltic area in the coastal zone from 14°00' to 20°00'E, and from the Polish coast to 56°00'N in the North. During the year seven cruises were made and samples were taken with the Bongo-333 net type at 548 stations.

In each sample the total numbers of fish eggs and larvae were counted for sprat, cod, flounder, Onos cimbrius and the larvae were measured. The total of eggs and larvae was calculated and expressed in numbers per square metre and of the sea surface. Great numbers of sprat eggs and larvae were found all over the investigated area, whereas eggs and larvae of the other commercial fish species occurred only in small quantities.

The Oceanographic Institute of the Gdańsk University carried out investigations at sea concerning the biology and ecology of plankton in three regions of the Baltic :

1. In coastal and estuarine waters (the Vistula Firth and the Bay of Puck).
  - (a) Investigations in the Bay of Puck were made with respect to the species composition and distribution of the phyto- and zooplankton based on samples taken once a month at 5 stations with the Copenhagen net and a 5 liter bottle at three depths. The three-year cycle of observations was brought to an end. The material will be worked up and the results obtained in 1975.
  - (b) Investigations in the Vistula Firth were concerned with primary production, species composition and annual production of phyto- and zooplankton. Besides, the biomass and energy content (in cal.) of the plankton were determined. Samples for this purpose were taken at 10 stations with plankton net and 5 liter bottle from 2 m depth. Material will also be collected in 1975 and a summary of the results will be made.

(Primary production was estimated by the Wimberg method: maximum values not exceeding 6 m O<sub>2</sub>/l were found to occur twice a year, in May and in August. Because of low transparency of water the primary production falls rapidly with increasing depth. Within a water layer from 0 to 0.5 or 1 m depth the rate of production decreases by about 80% compared with the rate at the surface. The compensation point lies at about 0.75 m depth.)

## 2. The North Atlantic area

- (a) The species composition and distribution of the zoo- and phytoplankton in the region of the Bear Island were worked up from the material collected in 1971-1973.
- (b) Material that had been gathered in 1971-1973 by means of the speed plankton sampler (type MFG and Instr. Corp. USA) along the ships' route from the Øresund to the northern coast of the Spitsbergen Island was worked up with respect to species composition and distribution of the phytoplankton.

## 3. The region of the North-West African Shelf

The studies concerning the ecology of some selected zooplankton species were continued on the materials from 1967 - 1973, which had been sampled during the cruise of the RV "Wieczno" and "Turlejski".

### Portugal

Study of phytoplankton samples collected during 1972-1973 at Ria de Faro-Olhão (M.A. Sampaio).

Study of zooplankton samples collected during 1972-1973 at Ria de Faro-Olhão (M.H. Vilela).

Monocultures of phytoflagellates and diatoms to study and to start bigger volumes of these cultures to feed herbivores (M.A. Sampaio).

Cultures of copepods and rotifers in small containers and experiments on mass cultures to future programmes of feeding crustacea and fish larvae (M.H. Vilela).

### Outside the ICES region:

Identification and ecological study of Siphonophora and Chaetognatha collected at Cabo Verde islands in 1970 with neuston net (T. Neto).

Identification and ecology of the species of the family Pontellidae (Copepoda) collected at Cabo Verde islands in 1970 with a neuston net (I. Paiva).

### Spain

#### Instituto de Investigaciones Pesqueras

During 1974, fortnightly determinations of phytoplankton in Cadiz Bay in relation to temperature and salinity patterns were made.

Studies have also been continued on material collected in the region of upwelling in NW Africa during "Sahara II" and "Atlor II" cruises,

and the raw data have been elaborated for publication.

Spatial heterogeneity of phytoplankton in the Cabo Blanco area has been studied.

The study of distribution in the Mar de España and Alboran Sea in relation with Mediterranean and Atlantic water masses of the most important groups of zooplankton taken near the Gibraltar Strait has been completed.

The study of zooplankton in the Cabo Blanca areas has been continued. Biomass in the second half of winter is very low compared with biomass in the end of summer and beginning of autumn and is inversely correlated with primary production. The large amount of phytoplankton in the water made the measurement of zooplankton biomass difficult. Copepods, euphausiids, molluscs, salps, doliolids, appendicularias have been taxonomically studied in relation with spatial distribution in water masses.

Ecophysiological studies: nutrition, excretion, respiration in zooplankton especially in some copepods have been continued.

Statistical analysis on population dynamics in Acartia in the Ria de Vigo has been made. A new species : Acartia margalefi has been described.

A paper about ostracods in some areas of S.W. Portugal has been completed.

#### Instituto Español de Oceanografía

During 1974 a "Cooperative Investigation of Spanish Coastal Waters" was started. This is a programme in collaboration with the Woods Hole Oceanographic Institution devoted to physical and biological oceanography of the Ria de Arosa.

The biological oceanography programme is especially devoted to marine food chains and is divided into two parts:

- 1) Role of Galician upwelling in nutrient cycling with special study of coastal and estuarine circulation, nutrient concentration and distribution in relation to tide, winds, temperature and salinity patterns.
- 2) Seasonal survey of the biota in the Ria with a study of the phytoplankton and zooplankton. Phytoplankton research includes the study of species composition, particulate carbon, measurements of biomass as standing stock of chlorophyll a, primary production with <sup>14</sup>C incubations. Zooplankton research includes the study on species composition, variation of communities through the year, intrusion of oceanic indicators into the Ria, biomass as dry wet and ash-free dry weight and as caloric content, zooplankton-mussel interaction, C/N relation, ammonia excretion, respiration and nutrition.

During May, June, July, September and October some cruises were made and the collected material is now being studied.

Plankton research in the Ria de Arosa will be continued during 1975. In the Oceanographic Laboratory of the Canary Islands studies continued on primary and secondary production of plankton, biomass of phytoplankton and zooplankton and their relation with concentrations and regeneration of nutrients.

In the Oceanographic Laboratory in Palma de Mallorca, studies on the effects of pollution on phytoplankton and zooplankton in the Mahon Harbour have been made. Also the annual cycle of Appendicularias in the Palma Bay has been studied and a cruise with the purpose of intercalibration of eggs-larvae nets and flowmeters was realised in June.

## Sweden

### Baltic

Special studies on nutrients, chlorophyll, in situ fluorimetry, particulate and dissolved organic matter, primary production and phytoplankton have been carried out in the following areas :

Archipelago of Stockholm (since 1967). In this area also N-fixation and agents hampering the growth of algae have been studied. (University of Uppsala, Institute of Plant Biology, and City of Stockholm.)

Askö Laboratory and archipelago of Trosa (both south of Stockholm). The investigations are part of the study of the energy flow in coastal and open waters. This work has been carried out since a number of years and numerous tests have been made to quantify the energy flow with computers. The work is supported by different bodies. (University of Stockholm, Zoological Institute mainly).

The Institute of Marine Research has regularly carried out zooplankton investigations in the Baltic proper since 1968. The aim of these investigations has mainly been to study the zooplankton fauna and the ecology of the most common species. In 1972 primary production measurements were added to the programme and from 1973 on this work has been intensified and is now a separate branch of the research programme.

In 1973 50 and in 1974 42 primary production measurements were carried out at three off-shore stations in the Baltic proper and one off-shore station in the Bothnian Sea. The measurements were carried out according to the  $^{14}\text{C}$  technique (in situ) at ten depths using an incubation time of four hours.

The zooplankton investigations during 1974 were concentrated on two main subjects :

- 1) A joint biomass investigation in the Baltic proper in cooperation with other Baltic nations.
- 2) A comparative study on the efficiency of different types of plankton nets and on the importance of the mesh size in the gear.

The biomass investigation was carried out during the months of May, August, and October in the mid-western Gotland Sea. Oblique hauls were made with a Bongo-net equipped with 300 and 500  $\mu$  nets. The biomass was calculated by the displacement volume technique.

A comparative study between different types of plankton nets was carried out in the same area and during the same months as the biomass investigation and the gears used were Nansen net 90  $\mu$ , UNESCO WP II-net 90  $\mu$  and UNESCO WP II-net 200  $\mu$ . Parallel hauls were made with the different nets from 90 meters to the surface and from 25 meters to the surface.

The bloom of blue-green algae has been studied by observations supplied from the ERTS-satellite.



Extensive studies of the occurrence of fish eggs and larvae have been carried out, mainly in the southern and central Baltic.

#### West Coast

Studies on nutrients, chlorophyll, particulate and dissolved organic matter and primary production have been made, mainly in the Sound and in the Southern Kattegat. (University of Lund, Marine Biological Laboratory).

Ecological investigations on the zooplankton have been carried out in the Byfjord (University of Gothenburg, Zoological Institute). The ecology of fish eggs and larvae has been studied in several parts of the West Coast. The following should be mentioned, especially : immigration of glass eels in the Skagerak, the Kattegat and the fjords of Bohuslän, occurrence of herring larvae in the same areas. All kinds of fish eggs and larvae have been studied, especially in the Brofjord. Special attention has been given to the bigger larvae, normally not caught with nets. The gear successfully used in many investigations has been the IKMWT, modified. (Institute of Marine Research, Lysekil).

#### United Kingdom

##### 1. England

(J.H.Nichols)

#### A) Offshore Surveys

- (i) Three international herring larvae surveys have been made during the year. The detailed results of these are reported to the Herring Committee. In brief, the areas surveyed and larval abundance were as follows :
  - a) The Southern Bight of the North Sea and eastern English Channel were surveyed in January. Smaller numbers of herring larvae were found than in the previous year; being present on only 12 stations, compared with 43 stations in the previous year.
  - b) The Shetland and Outer Hebrides survey was made in September and numbers of herring larvae were well down compared with previous years.
  - c) The survey of the western central North Sea in October showed a further large increase in herring larval production; numbers of herring larvae found being two to three times greater than the high numbers found in 1973.
- (ii) A survey of an area off the north-east coast of England was carried out in February to determine the distribution and abundance of cod eggs and larvae.
- (iii) Two surveys were carried out, one in the Southern Bight of the North Sea in April and a further one off the northeast English coast in May, to determine the distribution of plaice eggs and larvae. The areas of high abundance of eggs and larvae were then surveyed by midwater trawl to make a qualitative assessment of predation by pelagic fishes.

An experiment to determine the escape of fish larvae and other plankton from the Lowestoft 50 cm unencased sampler was carried out in an area of high plaice egg and larval abundance during the April survey.

## B. Inshore surveys

Three complete surveys were made along the English south coast in February, April and June, and some samples were taken at selected stations in September.

The aim was to identify inshore spawning grounds of fish from the distribution of eggs and larvae. Some headland to headland transects were made to assess the distribution of the larvae of Cancer pagurus. A Lowestoft 50 cm unencased plankton sampler fitted with a 20.3 cm nose-cone and a 0.275 mm aperture mesh was used.

A separate series of samples was taken over a tidal cycle, in a plankton patch. Position on the patch was maintained by the use of a parachute drogue in midwater. This experiment was to test sampling variability of both field and laboratory sampling techniques.

## C. Nanoplankton

Nanoplankton samples were collected on one cruise to the Fladen ground in the northern North Sea in May and on a subsequent cruise to the Barents Sea in August/September. Chlorophyll in the surface water was monitored continuously on both cruises using a Turner Fluorometer. Cultures were also prepared and samples obtained for both spectrophotometry and electron-microscopy on both cruises.

In addition, a series of samples was taken at varying depths on the May cruise in the northern North Sea to determine the vertical distribution of some nanoplankters.

### 2. Scotland

(J. A. Adams)

#### 1. Marine Laboratory, Aberdeen (DAFS)

Standing stock investigations. Chlorophyll a particulate organic carbon and nitrogen, and zooplankton dry weight data have continued to be collected on suitable cruises to the northern North Sea and the west coast of Scotland. Some of these data will be published in Annales Biologiques.

Average geographical and seasonal distribution of chlorophyll a and zooplankton dry weight in the northern North Sea have been calculated from data collected during the period 1961-1970 and these, together with information on other associated environmental factors (temperature, salinity, nutrients, etc.) are being prepared for publication (J.A. Adams, J.H.A. Martin, I.E. Baird, J. Dunn).

Phytoplankton of Scottish inshore waters. Some information on the phytoplankton of the Eden Estuary in Fife has been issued in Marine Laboratory Internal Report New Series No. 4. About 100 samples were collected during 1974 for a study on dinoflagellates. These have yet to be analysed.

No algal blooms were reported from Scottish waters in 1974 but mention should be made of a previously unrecorded bloom in Thurnaig Bay, Loch Ewe, in April 1973 of the euglenoid flagellate Eutreptiella (identified by G.F. Leedale). (D.D. Seaton, J.A. Adams).

Other inshore studies. The main effort during 1974 was directed to the evaluation of previous data rather than the collection of new data. This is still in progress but reports should be drafted shortly on the zooplankton of Loch Ewe and the Firth of Clyde. The limited sampling at Loch Linnhe

and Loch Eil has continued as part of the study of the effects of the pulp and paper mill at Annat Point. Some data on the zooplankton of the Eden Estuary is given in the Internal Report noted in the previous section. (J.A. Adams, N.T. Nicoll, D.V.P. Conway).

Scyphomedusae of the northern North Sea. The fourth survey of the distribution of scyphomedusae in the northern North Sea in the summer was done during the period 6 June to 2 July 1974. Interesting correlations are being found between the distribution of the scyphomedusae and the distribution of young gadoids - in particular whiting.

In 1974 Cyanea lamarckii and C. capillata were absent over a large part of their normal area of abundance south of 59°N and, in marked contrast to 1971, 1972 and 1973, were present over large areas north of 59°N. The rather more coastal Aurelia aurita also tended to show a northward extension of its area of abundance (S.J. Hay, J.A. Adams).

### Fish eggs and larvae

- (a) Distribution and abundance. As in previous years larval herring were sampled (i) on the Ballantrae Bank in the spring and (ii) along the outer part of the continental shelf west of Scotland and in the north-western North Sea in the autumn. Larval production at the Buchan grounds appeared to be higher than in 1973. (A. Saville, D.W. McKay).

Surveys for plaice eggs and larvae were carried out off the east coast of Scotland and in the Firth of Clyde. Analysis of the Firth of Clyde samples is not yet complete, but the east coast survey confirmed previous findings of spawning in the Clythness area at the end of January and beginning of February and of further spawning in St Andrews Bay three to four weeks later (D.W. Armstrong, A. Newton, M.G. Poxton).

Sprat eggs and larvae were sampled in the area off the north coast of Scotland and in the northern North Sea. (R.S. Bailey).

- (b) Detailed study of the ecology of larval gadoids. During April 1974 gadoid larvae together with micro- and macro-zooplankton were sampled along a line at 00°30'E from 59°00'N to 61°00'N and within a survey area 40 miles by 40 miles centres on the statistical square 20E. Associated with these were observations of temperature, salinity, nutrients, chlorophyll a and current measurements.

The stomach contents of the main gadoids present (Norway pout, saithe, haddock, and whiting) have been analysed and the results will form the basis of a study of food in relation to microzooplankton availability and of possible interspecific feeding overlap. Larval distribution are being studied in relation to the rather complex hydrographic conditions in the area of the survey and it is hoped to obtain estimates of growth and mortality.

It did not prove possible to get gadoid larvae for the associated experiments in the large polythene enclosures at Loch Ewe (R.C. Minton, D.V.P. Conway, R. Payne and others).

Continuous records of temperature, salinity, nitrate and chlorophyll a obtained during the April cruise are being used for an associated analysis of patch structure. (J.H. Steele).

- (c) The food of larval blue whiting. A study of the food of larval blue whiting in the Rockall area (based on samples collected in 1967 and 1968) has been completed. Eggs, nauplii and copepodid stages of copepods

formed over 90%, by numbers, of the food found in the gut, with cladocerans and larval euphausiids being the most important of the other food organisms. The size of the food organisms generally increased with the size of the larvae.

The larvae caught over Rockall Bank appeared to have a lower feeding success, as judged by the number of organisms in the gut, than did the larvae caught in the more oceanic water off the shelf, even although the latter water had a much lower standing stock of suitable food organisms than did the mixed water over the Bank. As there were considerably fewer fish larvae of all species in the oceanic water the difference may be due to the amount of intra interspecific competition for food.

Diurnal changes in both feeding intensity and composition of the food was also noted. (D.V.P. Conway).

- (d) Environmental, including pollution, factors affecting herring egg and larvae development and survival. Experiments on the effects of different types of water on herring eggs and larvae were continued in 1974, the waters tested being taken from Ballantrae Bank, Irvine Bay and Loch Ewe. Unlike the 1973 results, which showed significant differences in the times taken for the eggs to hatch and in larval mortality after hatching, no differences were found. Chemical analysis of the different waters used suggested that the level of contamination in the Ballantrae Bank and Irvine Bay water was much lower in 1974 than in 1973. (I.G. Baxter).

Experimental phytoplankton studies related to marine pollution. A number of species of nanoplankton and diatoms are now maintained routinely in bacteria-free cultures for experimental purposes. Other species are isolated as required from natural populations and maintained generally as short-term unialgal cultures for specific purposes.

Physiologically uniform algal material, both control and copper-treated, can also be produced from a Bioflow chemostat.

The effect of a number of heavy metals (copper, cadmium, lead, zinc) on algal growth has been examined, using optical density and cell numbers as parameters of growth. These techniques have given useful information for species of nanoplankton but not for the diatoms. For these vital staining and fluorescence microscopy has given reasonable measures of morbidity and mortality. (J.A. Mowat, S. Reid).

Experimental zooplankton studies. During 1974 the main effort was directed to studies of the zooplankton in four polythene columns, each enclosing 100 m<sup>3</sup> of water. These were monitored from April until July to study the effects on the entrapped organisms of enriched inorganic nutrient levels and of the addition of inorganic copper.

Although it was possible to relate differences in primary production levels and the standing stocks of suspended particulate matter to nutrient levels, no differences were apparent in the zooplankton populations. Similarly, there was no change subsequent on the addition of copper, in the zooplankton population structure although the feeding experiments, using phytoplankton at normal levels of abundance, did suggest a slight suppression of activity. This difference could be explained partly by the changes in phytoplankton population size spectra of the copper containing enclosures.

It became evident that the zooplankton population structure was primarily determined by the abundant presence of the lobate ctenophore Bolinopsis infundibulum. This organism flourished in the entrapped water

columns as well as in the outside Loch, and its presence was correlated with a distinct fall in the numbers of herbivorous zooplankters, particularly copepods. Corroborative work on Bolinopsis showed it to be a voracious carnivore easily capable to demolishing the measured population of herbivores.

Feeding experiments were also carried out using inshore copepods from the Clyde and from Loch Ewe. The data from these experiments have yet to be evaluated but they are forming part of a general background information on the biology of inshore copepods in relation to natural and man-made changes in environmental quality.

Assistance was also given to the CEPEX enclosure experiment in Canada where the effect of copper addition to enclosures was again investigated. Unlike Scotland, it was here found that copper both markedly suppressed feeding activity and reduced the standing zooplankton population. (J.C. Gamble, D.D. Seaton).

The Programme for 1975 The main outline of the 1975 programme will be similar to that followed in 1974. The main inshore areas in which plankton surveys will be carried out will be Loch Linnhe-Loch Eil, Cromarty Firth and Firth of Forth. In offshore areas the main plankton sampling will be aimed at (i) a study of the contribution made by micro-zooplankton to the total zooplankton standing stock; (ii) the zooplankton (including neuston) of the area of larval gadoid abundance east of Shetland and (iii) the scyphomedusae of the northern North Sea in mid summer. Larval fish surveys will be basically as described for 1974.

Experimental work will again be largely concerned with (i) studies of the phytoplankton and zooplankton in large polythene enclosures at Loch Ewe; (ii) the effect of environmental factors on the development and survival of herring eggs and larvae with some experiments being done in the large polythene enclosures and (iii) the culture of phytoplankton for studies of the effects of pollutants. Increasing use will be made of the copper treated algal cultures produced in the latter study for zooplankton feeding experiments.

## 2. Oceanographic Laboratory, Edinburgh (I.M.E.R.)

The Continuous Plankton Recorder Survey The Survey by the Continuous Plankton Recorder was continued in 1974 on the same basis as in previous years. Recorders are towed at a depth of ten metres at monthly intervals along the standard routes shown in Figure 1 on page 22.

During the past year, Recorders were towed for 111 000 miles by 26 ships of eight nations. The present survey has been in operation since 1948 and since then the plankton has been collected and the results have been processed in exactly the same way. The data processing system has been fully computerised since 1963 and full details, together with examples of computer output, are given by Colebrook (Bull.mar.Ecol., in press). Further details may be obtained on application to the Oceanographic Laboratory.

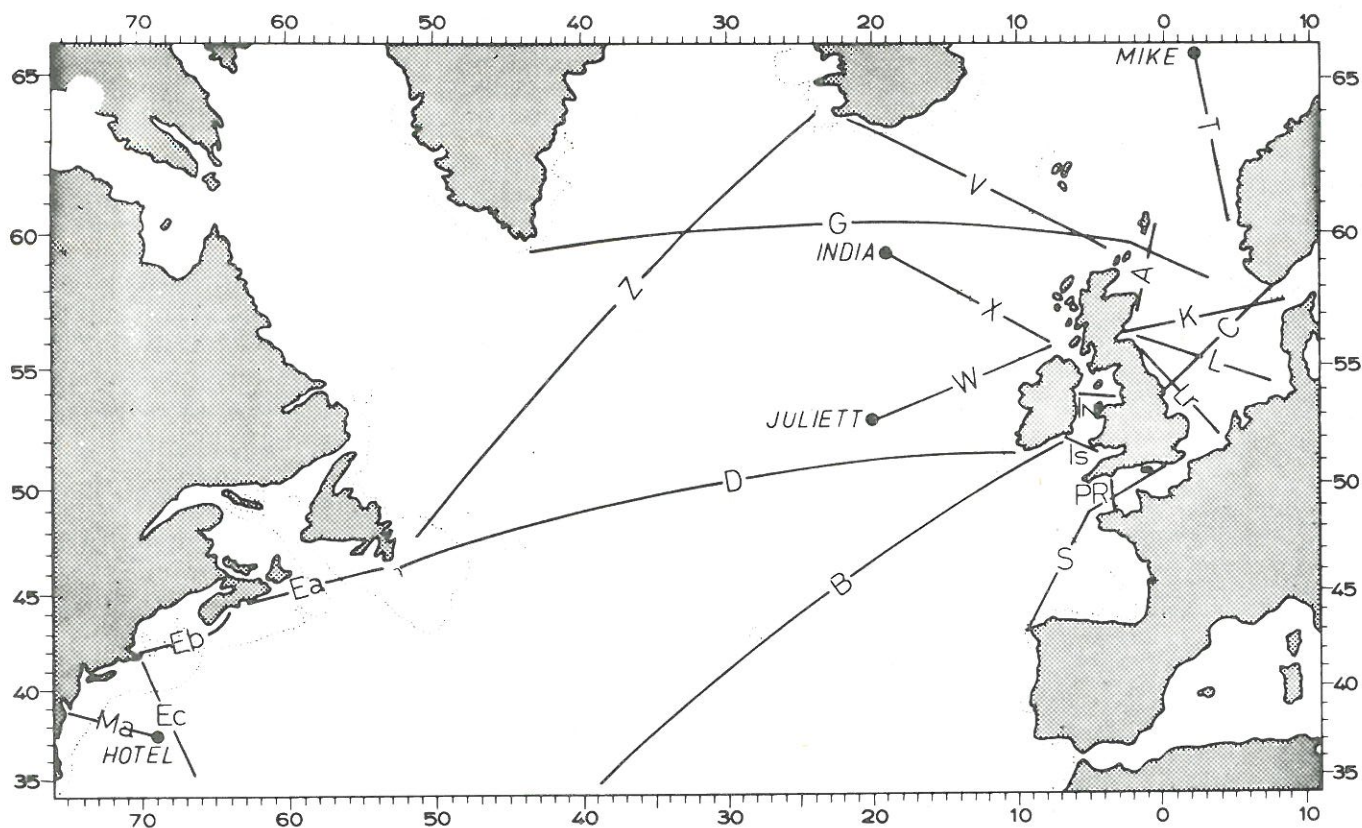


Fig. 1

The Continuous Plankton Recorder during 1974. The routes are identified by code letters and the Ocean Weather Stations by their international names.

The Plankton Indicator Survey Studies of the planktonic environment of the herring fisheries off the northeast coast of Scotland were continued in 1974. Samples have been taken regularly from fishing vessels and research vessels of the Department of Agriculture and Fisheries for Scotland, the Ministry of Agriculture, Fisheries and Food and the Fishery Protection Service.

Ocean Weather Ship Programme An oceanic modelling experiment has been maintained at Ocean Weather Station INDIA (59°00'N 19°00'W) since March 1971. Scientists worked on board Ocean Weather Ships on duty at INDIA from March to October 1974.

Measurements were made of :

- a) the vertical distribution of the zooplankton in the upper 500 metres using Longhurst Hardy Plankton Recorders.
- b) primary productivity ( $^{14}\text{C}$  method), chlorophyll concentration and phytoplankton (species counts) in the upper 200 metres.

- c) salinity, temperature and nutrients in the upper 200 metres.
- d) organochlorines and heavy metals in the plankton.
- e) solar radiation and light attenuation in surface water.

All programmes are supported by the U.K. Natural Environment Research Council.

### 3. Dunstaffnage Marine Research Laboratory (S.M.B.A.)

Phytoplankton Two stations in Loch Creran: phytoplankton species composition and abundance examined, along with measurements of chlorophyll and nutrients including vitamin B<sub>12</sub>. A spring bloom of Skeletomena costatum occurred at the end of March, two weeks later than in previous years. Another bloom of Skeletonema occurred from early September through until early October.

Zooplankton in 1974 Samples of oceanic plankton were taken from 0-4 500 metres depth near 16°W between 40° and 55°N in March, May and November. The biology of dominant species in these hauls is being examined. Studies of the populations of Pareuchaeta norvegica in Loch Etive and near 55°N 12°W are continuing.

Programme for 1975 An examination will be made at one station in Loch Creran of phytoplankton species composition and abundance, chlorophyll and primary production. Particular attention will be paid to phosphorus among the nutrients examined. An attempt will be made to replicate the Skeletonema bloom in the laboratory in the laboratory in the spring. The zooplankton studies described above will continue.

### 4. Department of Biological Sciences, Dundee University

Scapa Flow, Orkney A study of the plankton of Scapa Flow was started in July 1974 but the samples have not yet been analysed for species composition (A.M. Jones).

U.S.A.

(K. Sherman)

#### 1. Ichthyoplankton Surveys

- 1.1 MARMAP Programme
- 1.2 Joint International Surveys and Operations
- 1.3 Atlantic Coastal Surveys
- 1.4 Eastern Pacific Surveys
- 1.5 Estuarine Studies.

#### 2. Larval Studies

#### 3. Marine Contaminants

- 3.1 Transfer of Pollutants through Food Chain
- 3.2 Study of Effects of Pollutants in the New York Bight
- 3.3 Physiological Effects of Oil Contamination in San Francisco Bay
- 3.4 Alaskan Coastal Waters.

#### 4. Taxonomy and Zoogeography of Larval Marine Fish

- 4.1 Handbook of Fish Eggs and Larvae of the Californian Current
- 4.2 Nomeid Taxonomy
- 4.3 Scorpaenid Taxonomy
- 4.4 CalCOFI Neuston Collections

5. Training in Ichthyoplankton Taxonomy, Sampling and Processing

- 5.1 Visiting Scientists, NMFS, La Jolla
- 5.2 International Training Course in Fish Eggs and Larval Studies
- 5.3 CICAR Workshop on Fish Eggs and Larvae.

6. Technical Developments

- 6.1 Automatic Plankton Sorting Developments
- 6.2 Undulating Oceanographic Recorder (UOR)

1. Ichthyoplankton Surveys

1.1 MARMAP Programme

Since 1971 the National Marine Fisheries Service has been developing a nationally coordinated programme for Marine Resources Monitoring, Assessment and Prediction (MARMAP). Surveys are conducted for ichthyoplankton, groundfish and pelagic fish to measure changes in the distribution, abundance and condition of principal fish stocks of the continental shelves off the U.S. and in selected oceanic regions. The surveys support comprehensive analyses of the effects of fishing on the stocks and other oceanographic and biological studies underway in the National Marine Fisheries Service (NMFS), several universities, State agencies, and international organisations. In 1973, as part of the MARMAP programme, ichthyoplankton surveys were conducted in the Atlantic from the Gulf of Maine to Florida Straits and from Cape Mendocino to the Gulf of California.

1.2 Joint International Surveys and Operations

International Commission for the Northwest Atlantic Fisheries (ICNAF)  
A joint larval herring (Clupea harengus) survey in the northwest Atlantic from the Gulf of Maine to the Nantucket Shoals was completed in autumn 1973. As in the preceding 3 years, participating nations included Canada, Federal Republic of Germany, France, Poland, and the USSR. On the surveys standard sampling procedures were followed using paired 60 cm Bongo plankton nets fitted with 0.333 mm and 0.505 mm mesh apertures; all tows were oblique from a maximum depth of 200 metres to the surface. Neuston collections were made at each station with a 2 x 1 metre rectangular frame fitted with 0.947 mm mesh apertures. Environmental observations included hydrographic casts for temperature, salinity and ancillary meteorological measurements. As in former years, small larvae were concentrated principally within the 200 metre isobath on the Georges Bank. Significantly, greater numbers of larvae were found in 1973 than in 1972. For the entire survey area, the average increase in abundance was about 5 times greater than in 1972. The 1973 year class will be carefully monitored to determine the impact of larval survival on subsequent recruitment to the juvenile and adult herring fisheries. The results of the 1973 survey were available for discussion during the June 1974 ICNAF meeting, where plans were made for another joint survey in autumn 1974.

Eastern Pacific Hake Cooperative surveys for larval hake were conducted with the USSR on the research vessel EKVATOR (EQUATOR) based in Vladivostock. Sampling was conducted from San Francisco Bay south of Punta Eugenia, Mexico, during February-March 1974. Collections of eggs and larvae of hake were subdivided with half of each sample to be analysed in Vladivostock and the other half by scientists of the Southwest Fisheries Center, NMFS, La Jolla, California. The results of the survey will contribute to the development of a management policy that will allow for modifications of harvest levels based on monitoring changes in recruitment and estimates of the size of the commercial stock.



United Kingdom As part of a continuing joint programme with the Institute for Marine Environmental Research (IMER), Plymouth, U.K., monthly sampling has been initiated by the MARMAP Field Group, NMFS, Narragansett, R.I., with the Continuous Plankton Recorder (CPR) on a route from Boston to Bermuda, and with the U.S. Coast Guard from Chesapeake Bay to ocean station Hotel. The CPR data are used to monitor changes in plankton populations in the North Atlantic in relation to the availability, abundance, and condition of fish stocks. Annual reports on changes in plankton populations are submitted by IMER to ICNAF for consideration in fish stocks assessment investigations. The CPR transects made off the U.S. coast will be analysed in Narragansett and the results reported to the June 1975 ICNAF meeting.

Poland In July 1974, NMFS and the Sea Fisheries Institute, Gdynia established a Plankton Sorting Center. The Center, located in Szczecin, Poland, was established jointly with a contribution of U.S. counterpart funds allocated to NOAA and a large contribution of funds from the Polish Government. A building has been constructed on the campus of the College of Agriculture and Fisheries in Szczecin that includes a lecture room, three scientific laboratories, and a large sorting room capable of handling up to 3 000 plankton samples per year. During the first 6 months of operation an ichthyoplankton sorting and taxonomy training programme will be initiated that will involve the exchange of scientists between the U.S. and Poland. Drs Stefan Grimm, Leonard Izemont, and Idzi Dryzycimski assigned to the Sorting Center will be visiting the Northeast Fisheries Center, Woods Hole, and Narragansett, for training in plankton sorting and taxonomy for 3 weeks, in September 1974. Mr David Kramer, NMFS, La Jolla, will visit the facility in Szczecin for several weeks in October 1974 to provide training in larval taxonomy. The Center will provide sorting services for plankton samples collected as part of the accelerated ICNAF fish stock assessment studies now underway in the Northwest Atlantic. The facility will be engaged in special studies to advance plankton sorting techniques. The time consuming and expensive hand sorting methods now in use impose severe limits on attempts to gain a better insight on the food-related factors controlling larval fish survival in the ocean. In addition to routine sorting operations, rapid means for sorting plankton, including automated density gradient generator systems and counting and sizing systems will be employed and tested by the Center staff.

### 1.3 Atlantic Coastal Surveys

In 1973, spring and autumn surveys for groundfish and ichthyoplankton using standard MARMAP sampling methods were conducted from Nova Scotia to Florida. The coordinated MARMAP surveys included the vessels "Albatross IV" from the Northeast Fisheries Center, NMFS, Woods Hole; the "Delaware II" and the "Atlantic Twin" from the Middle Atlantic Coastal Fisheries Center, NMFS, Sandy Hook, New Jersey; and the "Dolphin" operated by the State of South Carolina. Samples collected off the New England coast are being sorted at the Northeast Fisheries Center, Narragansett. Results will be available in late 1974.

Mid-Atlantic Coastal Region During spring 1973 survey, the dominant larvae from New Jersey to Cape Fear, were spot Leiostomus xanthurus and weakfish Cynoscion regalis; off the South Carolina, Georgia, and Florida coasts larval spotted hake Urophycis regius, spot, and croakers Micropogon dominated the catches. During the autumn 1973, survey in the mid-Atlantic Bight, 98 plankton samples and 166 neuston samples were collected. Sorting and identification of larvae and juvenile fishes from these samples has been completed. Hakes of the genus Urophycis predominated. The center of their abundance was off the southern New England coast, over depths between 36 and 90 metres.

Analyses of 10 years of larval survey data for summer flounder Paralichthys dentatus, hake Merluccius bilinearis, bluefish Pomatomus saltatrix and mackerel Scomber scombrus has been completed recently by the staff of the Mid-Atlantic Fisheries Center, Sandy Hook. The most productive spawning ground of summer flounder, was located off New York and New Jersey. Spawning of this species begins in southern New England and New York waters in September and progresses southward with the season. Eggs occur north of Chesapeake Bay from September to December and south of the Bay from November to February; larvae are found north of Chesapeake Bay from September to February and south of the Bay from November to May. Although spawning occurs offshore, the young are estuarine dependent. Bluefish spawn offshore, near the inner edge of the Gulf Stream from Florida to North Carolina in the spring, and in Middle Atlantic Bight waters in mid-summer. The relative importance to the population of these two spawnings is as yet unknown. Those spawned in the spring spend their first summer in estuaries along the Middle Atlantic Bight and are caught as "snappers" (20 to 25 cm) in later summer and early fall. Bluefish spawned in summer remain at sea and are transported south of Cape Hatteras in early fall when they are 5 - 7 cm long. Silver hake spawn between New England and North Carolina from May until November, with peak in June; most spawning takes place off southern New England and the eggs and early larval stages are carried to the southwest along the continental shelf.

Southeast Coastal Region The coastal waters from North Carolina to Cape Kennedy were surveyed by the South Carolina Marine Fisheries Department, as part of the MARMAP programme. The dominant larvae in spring were mullets (Mugilidae), bluefish Pomatomus, jacks (carangids), flyingfish (exocoetids), and dolphin (coryphaenids). Mulletts were abundant inshore of the 40 m isobath all along the coast. In contrast, bluefish and dolphin larvae were concentrated in a newly discovered area of upwelling 100 to 125 kilometers east of Charleston, South Carolina. In autumn, the dominant ichthyoplankters were hakes (urophycids), followed in decreasing numbers by sciaenids, clupeids and bothids.

Menhaden At the Atlantic Estuarine Center, NMFS, Beaufort, North Carolina, ichthyoplankton studies focused on characterising the spawning areas and larval dispersal of Atlantic menhaden Brevoortia tyrannus. Progress was made in the application of meteorological and oceanographic data to the delineation of processes responsible for the transport of menhaden larvae from offshore spawning grounds to inshore nursery areas between Long Island, New York, and Cape Canaveral, Florida. Initial analyses showed a significant correlation between onshore Ekman transport, computed from historical world-wide field data by the NMFS' Pacific and Atlantic Environmental Groups and the strength of menhaden year classes on the Atlantic coast. Intensive field studies on Onslow Bay, North Carolina, to define the larval transport processes were completed in April 1974.

#### 1.4 Eastern Pacific Surveys

CalCOFI time series analyses A review and analyses of the data from CalCOFI ichthyoplankton survey operations over the last several decades is underway at the Southwest Fisheries Center, NMFS, La Jolla. The task is expected to produce a bibliography of about 2 000 entries, including (1) a summary of existing time-series data, (2) assembly of data in computerised and uniform tabular format, and (3) a book containing a critical evaluation of the CalCOFI programme especially in respect to future work on other oceanic regions under the NMFS-MARMAP programme. Among the data assembled for the project are larval records for inshore sportfish, including white seabass Stereolepis gigas, California halibut Paralichthys californicus, halfmoon Medialuna californiensis, ocean whitefish Caulolatilus cyanops, California

yellowtail Seriola dorsalis, and California barracuda Sphyraena argentea. A time-series describing changes in seasonal and regional differences in distribution of chaetognaths has also been assembled for the same time period. Using a time-series of environmental parameters, an index has been developed of the degree of flushing which occurs in the southern California Bight by virtue of variations in the southern California Eddy. The index will be used to evaluate dispersal rates of fish eggs, larvae, and chaetognaths during periods of favourable and unfavourable environmental conditions.

Using 25 years of the CalCOFI larval data, calculations have been made for sampling means, standard errors and negative binomial k-factors for inshore sportfish larvae collected on CalCOFI surveys. The statistical parameters will be used to determine spatial and temporal survey effort required to assess sportfish populations. A set of sardine and anchovy egg and early larva mortality rates has been developed by season and by geographic area for 1951-1960. Egg and larva census data corrected for escapement and temperature dependent growth rates were used to study the regional, seasonal, and annual mortality rates from field samples. This time-series will be extended to a 20 year set of CalCOFI data and compared to upwelling and secondary productivity estimates to develop criteria for determining the importance of these environmental events to the early stages of these fish. In an associated study concerning the effects of egg dispersal on survival, it was found that sardine eggs are spawned in a mosaic pattern of fish-school proportions, and the eggs at the perimeter subsequently disperse to a condition of randomness in a large corona around a concentrated centrum. Horizontal mean space between nearest neighbour eggs is on the order of 1 or 2 cm at spawning and changes to 15-20 cm mean space between most several day-old larvae.

### 1.5 Estuarine Studies

Newport River, North Carolina During 1974 ichthyoplankton studies in the Ecology Division of the Atlantic Estuarine Fisheries Center, NMFS, Beaufort, N.C., have continued to emphasise assessment of larval fish abundance and distribution within the Newport River estuary,, and the feeding ecology and physiological relationships of the more abundant larval fish species. Larval fish abundance studies have utilised both 20 and 60 cm Bongo tows, tidal bridge nets, 2 mm mesh portable drop-nets and a series of comparative samplings using the above gears. Studies of feeding ecology of larval fishes in estuarine waters have included determining the effects of prey density on food consumption with changes in day-night, tidal velocity and turbidity. This information combined with data on the rates of evacuation of copepods has been used in estimates of the daily rations of selected larval species. Physiological studies have stressed determining the effects of temperatures, biocides, and metals on larval fishes during simulated entrainment in power plant condenser cooling systems. In addition, studies on (1) the effects of temperature, salinity, and food availability on larval fish growth, and (2) the carbon, nitrogen and caloric content of estuarine larval fishes were completed, and a manuscript dealing with the biomass of zooplankton in the Newport River estuary and the influence of post-larval fishes on those zooplankton has been published.

Florida Coastal Waters Identification of fish larvae from plankton samples taken in Tampa Bay, and adjacent coastal waters by the Gulf Coastal Fisheries Center, NMFS, Galveston, was completed. A manuscript is being drafted that will cover 16 key stations from May 1971 through April 1973. Based on the total number of larvae caught and the species diversity, lower Hillsborough Bay was the most productive area within the Tampa Bay estuarine system. A total of 21 families, 29 genera and 28 species were recorded; 86 percent of the total catch consisted of larvae of the families Engraulidae, Blennidae, Clupeidae, Carangidae and Sciaenidae.

Identification of juvenile fishes collected during May and June 1974 from one intake pipe at the Crystal River, Florida Power Plant was completed. A total of 25 families, 36 genera and 47 species was recorded. Five species of fishes (thread herring, bay anchovy, tide-water silversides, dusky pipefish and the spotfin mojarra) accounted for 73 percent of all the fish sampled. All these fish will probably be killed as they pass through the turbines and condenser system of the plant. This mortality is expected to reduce the estuarine fish population in that area.

Columbia River, Washington Data for 1972 and 1973 are currently being summarised at the Northwest Fisheries Center NMFS, Seattle. The results will be of particular significance because river flow varied considerably between years - 1973 was a year of unusually low rainfall and river flow, whereas heavy flooding occurred in 1972. The study for 1974 will entail moving up the food chain, concentrating on larval fishes of the Columbia River estuary, and defining populations of the brackish water copepod Eurytemora, especially E. affinis.

## 2. Larval Survival

Anchovy larvae, Engraulis mordax produced in the laboratory by laboratory reared fish have been used to detect concentrations of larval fish food in situ along the California coast. First-feeding larval anchovies, brought to this condition by controlling developmental temperatures aboard ship, were placed in samples of Los Angeles Bight water from the surface and from the chlorophyll maximum layer. Surface feeding was minimal in all experiments, but extensive feeding occurred when the chlorophyll maximum layer contained phytoplankton with a minimum diameter of 40 microns and at a density of 20 to 400 particles per milliliter. In March and April of 1974, the chlorophyll maximum layer along the California coast from Malibu to San Onofre (a distance of about 100 kilometers) consisted chiefly of a bloom of the dinoflagellate Gymnodinium splendens. The seaward extent of the bloom was at least 14 kilometers. A storm which caused extensive mixing of the top 20 meters of water obliterated the chlorophyll maximum and effectively destroyed the feeding condition for the larval anchovies. This was demonstrated before and after the storm aboard ship using the larval fish bioassay. This work suggests that specific criteria can be established for the survival of first feeding anchovies and perhaps other fish larvae as well. Cruises to determine this are planned as part of the upcoming 1974-1975 CALCOFI surveys.

As part of the stock-recruitment studies at the SWFC, the maturation and spawning of a number of important species has been altered to ensure that adequate supplies of larvae would be available on demand for mortality studies. Marine fishes which have been successfully matured and spawned include the northern anchovy Engraulis mordax, Pacific sardine Sardinops sagax, croaker Bairdiella icistius, Pacific mackerel Scomber japonicus, and the striped bass Morone saxatilis. Rearing of larvae through metamorphosis has been achieved using cultured marine food organisms such as the dinoflagellate Gymnodinium splendens, the rotifer Brachionus plicatilis, and the harpacticoid copepod Tisbe furcata, or with wild plankton sieved from sea water. Combinations of selected photoperiods and temperature are environmental cues used to mature these marine fish. Anchovy can be induced to mature and spawn daily throughout the year if kept under a constant daily 4 hours light - 20 hours dark cycle at 15°C. Other fishes may require long light and short dark daily cycles and different temperatures. Although the anchovy spawns eggs spontaneously under laboratory conditions throughout the year, this is not common in other fishes. Under normal circumstances, mature fish require injection of human chorionic gonadotropins to induce

mass spawning. Despite its anadromous nature striped bass have been induced to mature and spawn out of season in full sea water.

### 3. Marine Contaminants

#### 3.1 Transfer of Pollutants Through Food Chain

Fishery Biologists at the La Jolla Laboratory, NMFS, are testing the properties of chlorinated hydrocarbons (CHC's) in sea water as part of a study of the transfer of pollutants through the marine food chain.  $^{14}\text{C}$  labelled DDT was introduced into sea water in the vapour phase and absorbed on aerosol particles. Experiments were designed to measure the transfer of  $^{14}\text{C}$  DDT from the water onto phytoplankton (Dunaliella). A method developed for recovering small quantities of CHC from sea water onto charcoal-celite was compared to the Harvey method which recovers CHC's onto amberlite columns. Both methods were found to be equally efficient in their ability to recover  $^{14}\text{C}$  DDT. However, the charcoal-celite method was found to be more convenient because the sample to solvent ratio is larger, fewer changes of glassware are necessary, and there are fewer manipulative steps.

#### 3.2 Study of Effects of Pollutants in the New York Bight

As part of the Marine Ecosystem Analysis (MESA) programme in the New York Bight, the Middle Atlantic Coastal Fisheries Center, NMFS, Sandy Hook, New Jersey, initiated investigations of phytoplankton and primary productivity in Raritan and Sandy Hook Bays. Salinity, temperature, dissolved oxygen, pH, total alkalinity, and inorganic carbon, chlorophyll, nutrients,  $^{14}\text{C}$  primary productivity (both particulate and dissolved), and light penetration of the water column are measured at 9 stations each month. Water samples for phytoplankton identification, cell numbers, and species diversity are also collected.

Continuous underway fluorometry of the surface water of Raritan, and Sandy Hook Bays was undertaken to investigate horizontal distribution of chlorophyll in this heavily polluted waterway. These data will be important in understanding man induced changes in the bays and may help explain the extensive local variations in abundance of such important gamefish as the weakfish as well as spot, striped bass, and butterfish.

#### 3.3 Physiological Effects of Oil Contamination in San Francisco Bay

Studies are underway at the SWFC Laboratory, NMFS, Tiburon, on the effects of crude oil fractions on the survival of larval fish. Accumulation and depuration of xylene by juvenile herring exposed to isotope-labelled xylene ranging from 0.9 - 1.0 ppm has shown accumulations highest in brain, liver, and muscle tissue after 6 days of exposure. At the end of a 24 day experimental period concentrations of xylene were lower than any other time during the experiment. The accumulated residues were rapidly lost, but there are indications that the xylene was being metabolised to benzene and toluene. Methods for detection of possible toxic metabolites are presently being investigated and should aid further definition of potential problems surrounding exposure of larval fish to crude oil.

#### 3.4 Alaskan Coastal Waters

The Northwest Fisheries Center is investigating the effects of oil on important fish stocks in Alaskan coastal waters. At the Centers' Auke Bay Alaska Laboratory experiments are underway on the relationship among acutely toxic doses of oil, doses that cause physiological stress, and doses that stimulate behavioural changes. Pink salmon eggs, alevins and fry have been the organisms used in the majority of studies; herring eggs and larvae and Dolly Varden

fingerlings have been used in other experiments. Bioassays on several life stages of pink salmon indicate an increasing sensitivity to oil and benzene from eggs to alevins to fry, if death is used as an end point; studies with herring eggs and larvae indicate that hatching success may be a more proper criterion. Hatching of herring eggs was inhibited at the lowest doses of oil tested (100 pm). A chronic bioassay testing the long term exposure of pink salmon eggs, alevins and fry to benzene is underway and is expected to further define the impact of oil and benzene on these life stages of pink salmon in both the freshwater and intertidal environments.

#### 4. Taxonomy and Zoogeography of Larval Marine Fish

##### 4.1 Handbook of Fish Eggs and Larvae of the California Current

The NMFS, SWFC, La Jolla, reports that several series of illustrations were prepared during 1973, for the proposed handbook of fish eggs and larvae of the California Current. The handbook will treat approximately 100 species. Adequate illustrations and descriptions are available in the literature for only about 20 of the species to be included in the handbook, less complete accounts are available for approximately 40 species and no published information is available for the remaining species.

##### 4.2 Nomeid Taxonomy

Work is continuing on the pelagic trawl collections made on Tropical Pacific of the David Starr Jordan in May and October 1972. Meristics including vertebral counts obtained from x-rays are being obtained for a number of species for inclusion in a manuscript, including the species composition of nomeid fishes which are among the abundant epipelagic oceanic fishes in tropical and subtropical waters. The most common species, Cubiceps panciradiatus, attains a length of only 12 or 13 cm. Nomeids are a primary prey fish for apex oceanic predators.

##### 4.3 Scorpaenid Taxonomy

Progress has been made by the SWFC on the preparation of a guide to the identification of scorpionfish larvae (family Scorpaenidae) in the eastern Pacific. Introductory sections of the manuscript are completed and the generic and species descriptions are finished for some species of rockfish (Sebastes). Descriptions of the remaining species of Sebastes should be completed in April and those include S. paucipinis, S. macdonaldi, S. levis, S. jordani, two species from the Gulf of California, S. capensis, S. oblongus (a Japanese rockfish) and S. marinus (the Atlantic rosefish). Descriptions will be prepared for the remaining genera and species to be included in the guide, which should be completed by the end of summer. A manuscript describing the early life history of the channel rockfishes (Sebastolobus) was completed. Sebastolobus larvae occur in CalCOFI samples and the juveniles are common constituents of mid-water trawl hauls taken off the coast of California. Adults of Sebastes altibelis are deep-living (550 - 1300 m) and this species has a prolonged pelagic juvenile stage that remains in mid-water for more than a year. Adults of S. alascanus are shallow-living (180-550 m) and have a pelagic juvenile stage of short duration. The manuscript describes development of these stages and gives information on growth of these two species.

#### 4.4 CalCOFI Neuston Collections

A report was recently completed on the results of neuston net hauls taken on CalCOFI cruise 205 made during May 1972 from the research vessels "David Starr Jordan" (NMFS) and "Alexander Agassiz" (SIO). This cruise surveyed almost as extensive a part of the eastern Pacific as the CalCOFI contribution to Norpac (August 1955) - from 20° to 46°N and offshore to 145°W. This is the first report on neuston collections made on CalCOFI surveys. Larvae occurring in largest numbers in the neuston collections were those of the northern anchovy, Engraulis mordax and of the Pacific saury, Cololabis saira. An interesting point about the collections of Engraulis mordax is that they contained a much larger proportion of large larvae than are taken in regular oblique plankton hauls. In the latter type of haul larvae 15 mm long consistently made up about 1 percent of the total anchovy larvae (Ahlstrom 1965), whereas in the neuston hauls the large larvae contributed over 15 percent of the total. Larvae and early juveniles of the sablefish, Anoplopoma fimbria were taken in larger numbers than in oblique plankton hauls, especially in a collection made off northern Oregon (45°50'N 125°38'W) which contained 443 specimens ranging in size from 9.0 to 32.5 mm. This single collection contained more specimens of sablefish than were obtained altogether in about 30 000 oblique hauls made over the CalCOFI pattern from 1949 to 1972. Obviously, neuston collections are excellent for locating the areas of occurrence of sablefish young. Other species that occurred in some abundance in neuston hauls include Sebastes sp., Trachurus symmetricus, Mugil sp., Auxis sp. and flyingfishes. Several kinds of myctophid larvae were taken in surprisingly large numbers in neuston hauls as compared to their abundance in oblique hauls, particularly larvae of Taaningichthys minimus, and of Lampadena urophaos.

#### 5. Training in Ichthyoplankton Taxonomy, Sampling and Processing

##### 5.1 Visiting Scientists

The La Jolla Laboratory, NMFS, continues to serve as a Center for the Study of fish eggs and larvae. Dr Leslie Knapp, Supervisor Vertebrates at the Smithsonian Sorting Center, arrived at the La Jolla Laboratory on 14 January to work with Dr E. Ahlstrom, Senior Scientist, on the identification of fish larvae.

Mr Keiichiro Mori of the Far Seas Fisheries Research Laboratory at Shimizu, Japan, visited La Jolla for about 6 months continuing his studies on identification of fish eggs and larvae. Several graduate students from the Scripps Institute of Oceanography also continue to work on ichthyoplankton under Dr Ahlstrom's supervision. Ms. Thalia Castro, Biologist at the Escuela de Ciencias Marinas at Esenada visited the La Jolla Laboratory several times during the year to consult with Dr Ahlstrom on larval fishes.

##### 5.2 International Training Course in Fish Eggs and Larval Studies

During 3 - 28 September an FAO/MARMAP-sponsored International Training Course dealing with fish eggs and larvae brought participants from 12 nations to the Southwest Fisheries Center, NMFS, La Jolla. The course was divided into two subject areas, one dealing with identification of fish eggs and larvae, the other with their collection, processing and quantification. The identification section was taught by Dr E. Ahlstrom and the quantification section by Dr P. Smith. Dr Elda Fagetti, FAO representative, arranged the attendance of most participants and prepared a report on the course which will be processed and distributed by FAO. Practical work sessions included such topics as designing sample surveys, the techniques involved in taking quantitative plankton hauls, standardising sampling data, sorting fish eggs and larvae and reporting results. Also covered were statistical techniques for evaluating sampling methods, intercomparison of historical and new

plankton sampling methods, and the use of assigning confidence limits to additive or multiplicative error distributions. A highlight of the course was the actual rearing of fish eggs in the laboratory at controlled temperatures, and calculations of the relation between temperature and time of development to hatching. Participants represented the following countries : Mexico (3), Panama, Colombia, Peru, Chile (3), Indonesia, Thailand, Taiwan, Japan, Italy, Spain and Finland. Fourteen participants took the full training course, while six additional participants took either the Identification Programme or the Quantification Programme. A 20-hour cruise was made aboard the NOAA research vessel "David Starr Jordan".

### 5.3 CICAR Workshop on Fish Eggs and Larvae

A Workshop on Fish Eggs and Larvae was held at the Mexican Sorting Center from 17-26 July sponsored by UNESCO, CICAR, and IOC. There were 33 participants and 12 observers representing the following countries : Mexico, USA, France, Jamaica, USSR, Panama, Cuba, Venezuela, Brazil, Colombia, Scotland, U.K. Lectures were presented on ichthyoplankton sampling; handling ichthyoplankton and oceanographic data; taxonomy; and application of ichthyoplankton studies to fisheries research. The lecturers included A. Saville, MAF, Aberdeen, A. Aboussoun, Marine Station, Endoume, E. Ahlstrom, NMFS, La Jolla, E. Houde, University of Miami, R. Marak, NMFS, Narragansett, B. March, NOS Consultants Pittsburgh, D. Smith, Marine Biomedical, Galveston, P. Wilkins, NOS Consultants, Houston. The taxonomy sections covered the common families found in the CICAR Area. Most participants brought samples which were looked at by the expert taxonomists and some of the problems of identification were worked out immediately. Each participant had the opportunity to discuss their problems with the invited experts. At the conclusion of the Workshop the Group recommended that the CPOM (Mexico Sorting Center) be used as a repository for the exchange of samples and data collected in the CICAR area. MARMAP standard log sheets are being sent to all the institutions to assist in the effort to standardise sampling and reporting methods.

## 6. Technical Developments

### 6.1 Automatic Plankton Sorting Developments

Testing and evaluation of an automatic plankton sorting system utilising iso-pycnic sedimentation in gradients of colloidal silica is continuing at the Northeast Fisheries Center, NMFS, Narragansett. Present efforts are directed towards the testing and refinement of the recently designed gradient generator which is capable of generating up to 20 simultaneous gradients of 13 litres each in about an hour and a half's time. The gradients generated, however, are not linear but S-shaped, with the actual density varying at times from the theoretical one. This results in the compression of certain bands of the plankton spectrum. Elimination of the S-slope is being achieved through modifications to the gradient generator. Recent difficulties with the system are under investigation. Satisfactory separation of Gulf of Maine larval herring samples in which the copepods Pseudocalanus minutus and Centropages typicus were also present in significant numbers were not possible because of the similar densities of the invertebrates and larvae involved. Future work will be focussed on selectively shifting the mean density of these groups through modifications of the silica gradient by the addition of small amounts of polymers, osmotica or charged small molecules.

### 6.2 Undulating Oceanographic Recorder (UOR)

In cooperation with the Institute of Marine Environmental Research, the UOR System was tested at sea in May 1974, to evaluate its components including the towed vehicle, Oceanographic Data Acquisition System (ODAS), power generator, dive control unit, and the plankton sampler. Nineteen tests were made during 14 launches of the instrument, 10 of these launches were



successful. The UOR moved between a maximum 70 m to 8 m. Undulations from 0.8 to 15.0 kilometers were made. Translation of sensor data from analogue to digital read-outs aboard ship was successful. Malfunctions were corrected aboard-ship without difficulty. No problems were experienced with the sensors for depth, temperature and salinity; the plankton recorder failed to operate satisfactorily on only a single tow.

#### U.S.S.R.

In 1974 observations on the spring-summer development of plankton in the southwestern Barents Sea and in the Norwegian Sea were made. The euphausiid abundance in the Barents Sea in the winter period was determined and feeding of the 0-group Barents Sea cod of the 1973 year class was studied. Seventyfive phytoplankton, 1 273 zooplankton and 472 euphausiid samples were collected. 2 909 fingerlings of cod were analysed.

Laboratory treatment of all the samples comprised the identification of the specific composition and age stages of organisms, the biological condition and sizes of individual specimens and calculation of their quantity per unit volume.

Some idea of the peculiarity of the spring-summer development of Calanus and other species in the Barents and Norwegian Seas were gained from the results of treatment of the plankton samples collected in the previous year (1 350 samples); the terms of sinking of Calanus from the upper 0-50 m layer to the lower ones were defined, and the average plankton biomass was calculated. A marked delay in the terms of the plankton development depending on the long-term mean level was found. Delay in the Norwegian Sea and acceleration in the Barents Sea.

Treatment of the material obtained during the survey on determination the euphausiid abundance gave an idea of the abundance distribution and peculiarities of the specific and age composition of euphausiids in the Barents Sea in 1974. These data are indicative of the summer food base for commercial fishes. Besides, statistical treatment of 1 922 euphausiid samples collected in 1953-1974 was made, so specific bathymetric ranges of the mass species were revealed.

In the coastal Murman waters works on the bacterioplankton production were started.

The coefficient of survival of fishes from fingerlings to three year olds was calculated on the basis of studying the feeding of young cod of the 1973 year class and taking into account the wintering temperature conditions.

In 1975 control investigations of plankton (Calanus and euphausiids mainly) will be continued in the above mentioned areas of the North-Atlantic according to the previous years' programme. Simultaneously with these works, generalisation of many years' material on individual problems of the biology of plankton organisms will be conducted.

#### Baltic Sea

Phytoplankton. During standard oceanographic surveys (12 stations in the Baltic itself, six in the Gulf of Riga, three in the Gulf of Finland) the dynamics of phytopigments-chlorophylls and carotinoids and its correlation with physical and chemical conditions in the sea was investigated. On this basis, conditions and the character of primary production for some sea areas in 1974 were evaluated.

Zooplankton. Samples of zooplankton were collected and treated in accordance with the routine methods.

On this basis the composition, abundance and distribution of food supply for plankton eating fish by seasons, months, depths ranges and areas were estimated.

Diurnal vertical migrations of plankters from different ecological groups. Fecundity and generation changes of Eurytemora hirundoides in the Gulf of Riga were investigated.

Ecological communities of zooplankton and correlation between them and hydrological conditions in the sea, water currents and areas were characterised. The simultaneity of biological rhythms within communities was investigated.

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