

BIOLOGICAL OCEANOGRAPHY COMMITTEE

1978

by T.C. Platt

BELGIUM

(R. De Clerck)

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Fisheries Research Station - Ostend.

The studies on the different trophic levels in marine ecosystems were continued on an interdisciplinary basis.

A. Phytoplankton. Studies on the primary production in the Southern Bight of the North Sea. Possible importance of the excretion of phytoplankton. Natural mortality of phytoplankton.

B. Zooplankton.

1. Elaboration of modelling of the biomass of the most important copepod populations in the Southern Bight.
2. Continuation of grazing experiments at nearly in situ conditions (natural concentrations of zoo- and phytoplankton), determination of energy-transfer of living phytoplankton to zooplankton.
3. Grazing experiments on total particles (living and non-living material) and selection due to particle size.
4. Drifting and development of fish eggs.

C. Bacterioplankton. Total planktonic respiration measurements (oxygen consumption, dark CO<sub>2</sub> fixation) heterotrophic activity measurements; incorporation and respiration of radioactive substrates.

Determination of organic matter concentrations (BOD, TOC); glucose and carbohydrates concentrations and activities.

Discussion of those results in relation to two main problems:

- contradiction between total primary production and total consumption.
- relative role of zooplankton and bacteria in recycling the organic matter.

D. Seabirds. Distribution of seabirds in the North Sea, in connection with food distribution and the ecological structure of the water bodies.

CANADA

(T. Platt)

Four zooplankton-hydrography surveys in the Newfoundland region have recently been completed, establishing for perhaps the first time the details of species composition and spatial patterns of the organisms available to MARMAP BONGO gear (333 and 505 micrometer nets, 3.5 knot tows). These included: Flemish Cap, October 1978; Southern Grand Bank, May, June, July 1978; Flemish Cap, July 1978 and March, April-May 1979. Analysis includes maps of species, larval fish production, a checklist of species and a species code, chlorophyll and other hydrographic maps. These surveys are background to more detailed ichthyoplankton work.

Of particular value may be the concurrent STD-plankton surveys of Flemish Cap while 4 current meter arrays and 8 satellite-tracked drogues are present. This work, in conjunction with groundfish surveys, is expected to reveal mechanisms of the stock-environment-recruitment process. The Flemish Cap Project, reported through the ICNAF Environmental Subcommittee, coordinates the ecosystem integration of individual surveys and projects.

An interdisciplinary committee of physical oceanographers and fisheries experts has been formed with these objectives:

1. To review the contemporary utilization of ocean climate data in fisheries management, comparing Canada to the rest of the world.
2. To review the role of ocean climate in the life-history of fish and to explain why contemporary fish management utility of climate data is low.

3. To advise on a decade long monitoring program.
4. To advise on the objectives of, and to propose specific research projects of the next five years to interpret ocean climate indices and help resolve the role that oceanography and ocean climatology could eventually play in fisheries management and biology. The reduced objectives of fisheries management may be more tractable than the vast general problem of the interaction of physical and biological oceanography.

The investigation by members of the Institute of Oceanography at Dalhousie University of production off the coast of Nova Scotia is continuing. The following summarises the work so far.

Overall primary production on the continental shelf SE of Nova Scotia is  $102 \text{ g C m}^{-2} \text{ yr}^{-1}$  and of the slope waters is about 25% higher,  $128 \text{ g m}^{-2} \text{ yr}^{-1}$ . Demersal fish production is highest on the shelf ( $4.1 \text{ kcal m}^{-2} \text{ yr}^{-1}$ ) and decreases in the offshore direction, while pelagic fish production (nearly  $16 \text{ kcal m}^{-2} \text{ yr}^{-1}$ ) peaks over the continental slope and decreases to very low levels in the inshore direction. It is believed that fish production is a manifestation of two intergrading ecosystems. One is centered on the shelf, where demersal fish like cod, haddock, pollock and flat-fish are abundant. The other is at upper or mid-slope depths in the region of the shelf-slope front; its main species are pelagic, for example hakes, redfish, argentines and grenadiers. One of the most surprising features of both food webs is the low abundance (and production) of the herbivorous zooplankton, which is not high enough to support the zooplankton predators on which the pelagic fish production is based. This problem may be resolved when the production of the microzooplankton is properly assessed. The role of gelatinous zooplankton (salps, ctenophores, medusae) and chaetognaths also needs concerted study because two methods of estimating their production lead to different results. The differences in pelagic fish production between shelf and slope could be due to a simple difference in the pelagic

predators; if energy were lost in ecologically-inefficient ctenophores on the shelf but directed to pelagic fish via, for example, chaetognaths over the slope, the major difference in levels of production could be explained.

The analysis has allowed a comparison of the fish production systems of the Scotian Shelf with that of the North Sea, as outlined by Steele (1974) in his book *The structure of marine ecosystems*. Primary production is 33% higher off Nova Scotia than in the North Sea, but zooplankton and macrobenthos production is nearly 50% lower. Although the demersal fish catch per unit area is identical in the North Sea and the Nova Scotian area, the overall fish catch is 35% lower in the Canadian system. This occurs because the pelagic catch off Nova Scotia is centered in a very productive but very small area relative to that in the North Sea. One is led to believe that these marine ecosystems may have important structural differences that greatly affect the levels of production of the components.

Biological oceanographic studies were resumed in the coastal waters of Frobisher Bay (southeast Baffin Island) in 1978. Work was carried out on levels and activities of bacterial populations, bacterial degradation of oils, production and growth of phytoplankton and attached plants, effects of oils and dispersants on cold-water plants, zooplankton distribution and physiology. Microbiological surveys and fish larval distribution and feeding observations were made as part of the Eastern Arctic Marine Environmental Survey (EAMES) program, in response to anticipated oil exploration in Davis Strait. Reports were produced on effects of crude oils and dispersants on growth and production of arctic phytoplankton and seaweeds, nutrients in sea ice, seasonal cycles in caloric levels in arctic amphipods and osmoregulation of arctic marine isopods.



## Phytoplankton

At the Marine Ecology Laboratory, natural phytoplankton populations in Bedford Basin have been used to study dynamic relations between photosynthesis, light and nutrient levels, and to further elucidate light-inhibition mechanisms and the parameters for a phytoplankton growth model. Related observations have been made at a number of HUDSON stations in the eastern Arctic and Labrador Sea, and in the tropics. The Bedford Basin populations have also been used to study the relative roles of size-fractions of phytoplankters in total production at different seasons, and in the physiological adaptation of phytoplankton cellular enzyme systems to changing conditions through the year. Studies of size-dependent growth rates and doubling times of phytoplankton populations in relation to temperature and day length have also been made in Bedford Basin, with related studies in St. Georges Bay and in the tropics.

Bedford Basin zooplankton have been used to study the feeding behavior and nutrition of copepods and the life cycles of representative microzooplankters. On the basis of laboratory-determined rates, it was calculated that from 20% to 50 of the daily plant production, in terms of carbon and nitrogen, could be grazed off by the zooplankton during the spring bloom. Of that ingested, about 13% of the carbon and 29% of the nitrogen might be incorporated into zooplankton growth. Absorption efficiency was about 60% regardless of food concentration or amount of food ingested. It has also been shown that the relative occurrence of digestive enzymes used by copepods to process different nutritional substrates are highly correlated with the relative abundance of different substrates in the ambient food particle population. The multi-net, multi-sensor BIONESS has been brought to operational status and is now equipped with sensors for CTD, roll, pitch, yaw, illumination, and internal and external flow. It is also now associated with optical (camera, strobe) and acoustic (120 kHz) tools for observing plankton before the nets. It has been used to study the orientation, and hence acoustic properties, of euphausiids in scattering layers, as well as mesoplankton ecology at the shelf-break front of the Scotia Shelf.

The surface area/volume/swimming speed relationships of copepods and euphausiids have been studied to investigate the dynamics of the passive uptake across body walls of substances dissolved in sea-water: in the case studied, it was found that hydrocarbons were taken up at equivalent rates by both sizes of zooplankters.

Studies of the locations and hatching time of herring larvae have demonstrated that the spring and autumn spawning stocks in the southern Gulf of St. Lawrence are actually composed of four distinct parental groups, each with characteristic growth rates. MEL participated in the ICNAF-sponsored international herring larva patch studies on Georges Bank in 1978; recently hatched herring larvae were found at the Nantucket Shoals by the second part of the cruise. A larval patch of about 3 x 10 miles in dimension was identified and mapped five successive times. The patch-mapping included fine-scale sampling of the vertical and horizontal distribution of both the larvae and their food organisms, sampling for midwater and bottom predators, and studies of drogues to identify the movement of the larvae in relation to water motion. A chaetognath patch (*Sagitta elegans*) was observed to reside in the Northeastern Georges Bank area for more than two weeks and data from the study appear adequate to explain its stability and retention on the Bank. It was also concluded that depth-variability in residual currents was the strongest component in larval dispersion.

Studies of the seasonal size-cycle of mackerel eggs in inshore areas showed that the spawning cycle was so adjusted as to match larval size with seasonal cycles in available food particle size. Investigations were also performed on the behaviour and nutrition of first-feeding larvae of the Peruvian anchoveta (*Engraulis ringens*).

Benthic studies concentrated on the trophic relationships between the plankton and benthic ecosystems, at a number of sites off eastern Canada, and some in tropical regions. Studies have involved the use of both upward-downward pairs of plankton traps and sediment traps to study particle flux

within the water column and to the sediments, together with consideration of the role of particle flux in the transfer of organic contaminants to the benthos. Instrumented, untended benthic chambers have been deployed at a number of continental shelf and coastal sites for the measurement of benthic community respiration for extended periods, and for the release of dissolved material from sediments and the benthic community to the overlying water column.

In the Bay of Fundy, the second field season of a study to investigate the ecology of the macro-tidal portion of the Bay has been completed.

Two sites have been investigated on the very extensive inter-tidal mud-flats, and one of these selected for further studies. A carbon-flow model of the interactions between water-column and mud-flat production and utilization of organic carbon will be formulated. Surveys have been performed in the outer parts of the Bay with the research vessel DAWSON to investigate the distribution of benthic and plankton communities, and water column chemistry over tidal cycles within the deep channels in the macrotidal basins.

In Quebec, investigations by the GIROQ group on phytoplankton are mainly oriented toward the study of photosynthetic variability in the St. Lawrence Estuary. The influence of the tidal regime (neap vs spring tides) on chlorophyll spectra, on photosynthetic capacity and on the response of production to stability was demonstrated. The study of photosynthetic response to rapid light fluctuations is underway, both in the laboratory and in the field, and preliminary results suggest that they may induce changes in carboxylation pathways of natural phytoplankton populations. Also, the feasibility of measuring instantaneous *in situ* primary production by DCMU-enhanced fluorescence was demonstrated on cultures and at sea. On the other hand, biological oceanographic studies in Hudson Bay showed a possible deficiency in nitrates, probably related to limited exchanges with the Atlantic. Studies on zooplankton were mainly conducted in the

Saguenay Fjord, in order to quantify the input of food resources and of zooplankters from the deep waters of the St. Lawrence Estuary. An extremely pelagic behavior of Mysidacea was observed and its study is under way in the general framework of the relationships between zooplankton and suprabenthos. A major study is also starting on the interactions between the larvae of three fish species (Herring, Capelin and Smelt) in the St. Lawrence Estuary.

Benthic researches were centered on the distribution and abundance of intertidal and subtidal epibenthos in the Estuary and the Gulf of St. Lawrence. A study of the fauna on buoys showed a marked reduction of the number of species and community densities (numbers and biomass) on passing from the Gulf of the Estuary and also changes in the dominance patterns. The distribution and abundance of subtidal epibenthos is also under study on both sides of the lower Estuary, with special attention to the population dynamics of sea urchins and their influence on the vegetation. Littoral investigations initiated in 1978 include intertidal and subtidal community relationships as influenced by the physical environment, the effect of ice on the littoral community, and seaweed and phytoplankton productivity. Extensive studies of the comparative structure of offshore benthic communities of the Estuary and of Baie des Chaleurs in the Gulf are also being carried out.

DENMARK

(K. Vagn Hansen)

Danish Institute for Fishery and Marine Research (D.F.H.)

During May 22 - June 2 short term variations in 7 hydrochemical parameters, chlorophyll, rate of photosynthesis and micro zooplankton were measured at one anchored station in the Kattegat. The cooperation in the Belt Project 1973-78 with the Marine Pollution Laboratory was terminated on March 31. A model on the rate of exchange of water masses in the Kattegat is being developed as a part of an ecological/energy model for the said area.

The Marine Laboratory, National Agency of Environmental Protection

The Belt Project 1973-78 was terminated on March 31. The reports on the project are published currently. A reduced programme is however being continued by monthly monitoring of eutrophication and various related chemical parameters at 8 stations selected from the original grid of stations of the Belt Project.

GREENLAND

Greenland Fisheries Investigations (G.F.U.)

Plankton Routine sampling with stramin net (2 m ring diameter,  $\frac{1}{2}$  hour oblique hauls from about 50 m depth) was made at 3 east-west Standard Oceanographic Sections in Davis Strait off Holsteinsborg, Sukkertoppen, and Godthaab in July and off Godthaab throughout the year. Volume was measured. Invertebrates and fish eggs and larvae were sorted, identified and counted.

FINLAND

(J. Lassig)

Institute of Marine Research, Helsinki

Benthic macrofauna was sampled at 75 stations in the Gulf of Finland and the Baltic proper in March and September in order to follow the occurrence of benthic macrofauna in areas with periodically unfavourable oxygen conditions. In August an intercalibration with the USSR on methods for studying soft bottom macro-zoobenthos was performed in the Gulf of Finland.

Phytoplankton and primary production ( $^{14}\text{C}$  in situ and in vitro) hydrography, hydrochemistry and chlorophyll-a were studied every third week (once during the ice-period) at one station in the western Gulf of Finland. In August an intercalibration with the USSR on methods for studying chlorophyll-a and phytoplankton was performed in the Gulf of Finland.

Zooplankton sampling (Hensen net, mesh size 150  $\mu\text{m}$ , vertical haul 25-0m) has been continued at two coastal stations in the Gulf of Finland, one station in the Archipelago Sea and one in the Bothnian Bay. Samples were taken three times a month, once a month during the ice period.

Institute of Radiation Protection, Helsinki

Benthos studies were carried out in the vicinity of two nuclear power plants, one in the Gulf of Finland, and one in the Bothnian Bay. Samples have been taken twice at 9 stations.

Phytoplankton and primary production studies ( $^{14}\text{C}$  in situ) were performed once or twice a month during the ice-free period around the two nuclear power plants mentioned.

National Board of Waters, Water Research Office, Helsinki

The influence of industrial pollution on the composition of benthic macrofauna were studied off Pori, Rauma and Naantali in the Bothnian Sea and off Kokkola in the Bothnian Bay.

Phytoplankton primary production capacity was measured mainly in August at several coastal stations in polluted areas of the Gulf of Finland and the Gulf of Bothnia. Special investigations were performed off several residential areas.

Water Conservation Laboratory of Helsinki City

Macrobenthos studies were continued monthly during the ice-free period at one station off Helsinki, and three times at 9 stations off Espoo. In addition an extensive sampling programme with ca. 60 stations was carried out in August in the area from the inner bays to the open sea.

Phytoplankton primary production ( $^{14}\text{C}$  in situ and in vitro) and bacteria were studied twice a month during the ice-free period in eutrophied waters off Helsinki and Espoo at several stations from the severely polluted bays to the unpolluted area outside the archipelago.

Tvärminne Zoological Station of the University of Helsinki

Macrofauna was sampled once in the summer from 45 stations and monthly from 2 stations in the Pojoviken and the vicinity of the research station.

Åbo Akademi, Turku

Macrobenthos samples were taken at 10 fixed stations in the archipelago of Åland. Effects of artificial wave exposure of ferry traffic on zoobenthos and phytobenthos were studied.

Primary production and phytoplankton were studied in semienclosed meromictic bays in the Åland archipelago.

University of Turku

Dynamics of Mesidotea entomon (Isopoda) and the biology of Polydora redeki (Polychaeta) were studied in the Archipelago Sea.

Zooplankton was sampled in the Archipelago Sea for analyses of the PCB group components.



## University of Oulu

Studies on benthic macrofauna were continued in the Bay of Liminka.

Zooplankton investigations were performed in the sea area of the northern Bothnian Bay twice a month during May - November.

## FRANCE

(D. Reyss & J.- P. Casanova)

### I Travaux de l'Institut des Pêches maritimes

#### 1. Planctonologie de haute mer (Evaluation des ressources démersales)

Etude sur la reproduction du merlu dans le golfe de Gascogne afin de préciser l'époque du maximum de la ponte de ce poisson et la répartition des oeufs et larves. Les pêches sont réalisées au filet Bongo, quelques traicts au chalut à larves Isaac-Kidd ont également été effectués.

Etude de la distribution des euphausiacés et mysidacés principale source nutritive des jeunes merlus. Cet inventaire était entrepris dans le cadre des travaux des nurseries de merlus sur le plateau continental du golfe de Gascogne. Les pêches ont été effectuées au filet Hensen entre le fond et la surface.

#### 2. Planctonologie côtière (Etudes relatives aux centrales thermiques nucléaires)

Les recherches engagées par l'ISTPM sur les sites de centrales thermonucléaires littorales Gravelines (Nord), Paluel, Penly (Seine Maritime) Flamanville (Manche), Plogoff (Finistère) sont orientées plus particulièrement vers l'étude dynamique des espèces présentant un intérêt halieutique.

L'objectif général se résume ainsi:

- participation à l'analyse des écosystèmes côtiers.
- études des peuplements zooplanctoniques liés à la biologie des ressources halieutiques essentiellement les principales espèces de crustacés et de poissons d'intérêt économique, actuel ou potentiel, représentées à l'état d'oeufs ou de larves planctoniques.
- faune planctonique en association avec les différentes phases du cycle biologique de ces espèces.

L'échantillonnage mensuel s'effectue au filet Bongo (315 $\mu$  et 500 $\mu$  ).

### II Travaux de Laboratoire de Biologie animale (Plancton) Marseille

#### 1. Poursuite des travaux en cours

Copépodes de la côte atlantique du Maroc (indices de diversité aux différentes saisons) (M.-L. Furnestin et M. Belfquih).

Etude infraspécifique des Hoplophoridés (Décapodes pélagiques) des croisières du "Dana" (1922-1930) dans l'Atlantique. Relations écologiques (J.-P. Casanova).

Le zooplancton des côtes nord-ouest africaines (Campagnes CINECA, août 1973, "Thalassa" et "Capricorne"): composition chimique (C, N, P et métaux lourds) et faunistique. Sa place dans les chaînes alimentaires (B. et J.-P. Casanova, F. Ducret, J. Rampal).

Histologie et ultrastructure des yeux des Chaetognathes Pterosagitta draco et Eukrohnia fowleri (spécimens d'Atlantique tempéré et tropical) (F. Ducret).

Ecophysiologie de la nutrition chez les Copépodes en milieu expérimental. Différenciation histologique (ultrastructure) et histochimique des diverses catégories cellulaires du tube digestif (J. Arnaud, M. Brunet, J. Mazza).

2. Synthèse des connaissances sur les relations éco-biogéographiques entre les faunes planctoniques de Méditerranée et du proche Atlantique (M. L. Furnestin).

### III Travaux du Centre National pour l'Exploitation des Océans - Centre Océanologique de Bretagne

#### 1. Ecophysiologie du plancton

Description des relations trophiques des organismes, de la modification des peuplements et de leur niveau d'activité physiologique générale, d'après l'expérimentation au Laboratoire et les informations obtenues au cours de campagnes à la mer. Application à l'étude des communautés planctoniques des côtes du Nord Finistère, 3 mois après la catastrophe de l'"Amoco-Cadiz".

2. Ecologie abyssale (Détermination de l'importance des différents maillons de la chaîne trophique):

- benthos abyssal de la faille Véma: microdistribution et biomasse (comparaisons avec le golfe de Gascogne);
- densité des principaux taxons (mise au point de méthodes d'évaluations quantitatives);
- synthèse des connaissances générales sur les communautés benthiques abyssales atlantiques.

#### 3. Ecologie quantitative

- recherche méthodologique: choix, adaptation et création d'objets mathématiques répondant aux problèmes écologiques d'intérêt général.
- applications des connaissances théoriques à l'analyse de situations écologiques concrètes:
  - sur les futurs sites de centrales nucléaires;
  - sur la biologie de 2 espèces, le pétoncle Chlamys varia et la langoustine Nephrops norvegicus.

#### 4. Physiologie de la reproduction chez les Pénéides:

Penaeus japonicus (élevage, génétique, nutrition, croissance)  
P. vannamei (observations depuis juillet 1977)

### IV Travaux de la Station Biologique (Benthos) Roscoff

Depuis mars 1978, les travaux sont orientés vers les effets produits par les hydrocarbures déversés par l'"Amoco Cadiz" sur les peuplements benthiques.



### 1. infralittoraux

- étude quantitative et dynamique en baie de Morlaix avant et après la pollution, beaucoup plus nocive pour les peuplements de sables fins à Abra alba (grande sensibilité des Amphipodes Ampelisca notamment) que pour ceux de sables grossiers à Amphioxus);
- en baie de Lannion: fortes mortalités chez certaines espèces de sables fins (Echinocardium cordatum) et raréfaction des Amphipodes;
- dans l'Aber Wrac'h: disparition de la quasi-totalité des populations de Crustacés Péracarides dans les sédiments fins.

2. circalittoraux: aucun effet sensible sur les peuplements du large de la région de Roscoff ni même au nord de l'épave du pétrolier.

### FEDERAL REPUBLIC OF GERMANY

(M. Gillbricht)

### Biologische Anstalt Helgoland

Routine investigations in measuring hydrographical, chemical and biological parameters at Helgoland Roads were continued. Five times a week temperature, salinity, nutrients ( $PO_4$ ,  $NO_3$ ,  $NO_2$ ,  $NH_4$ ,  $SiO_2$ ) chlorophyll a, and phytoplankton (inverted microscope) were measured. Further weekly determinations were made of the bacterial numbers (pour plate method) in the surface film and at a depth of 1 m, the BOD and the surface tension. The studies on distribution and ecology of Noctiluca miliaris were continued.

At two cruises in the North Sea intensive microbiological and chemical investigations were conducted between Helgoland and  $60^\circ 30'$  N latitude.. The same research was done shortly after the "Amoco Cadiz" tanker accident in the British Channel and adjacent waters.

Production biology in two different water bodies was investigated in the Belgian coastal water (off Ostende) and the Straits of Dover (off Calais) during a 3 weeks cruise. Seston and plankton standing stocks, primary production and excretion of the phytoplankton, zooplankton grazing and bacterial activity were measured along with hydrographical parameters and micronutrients.

In the Wadden Sea of Sylt (German Bight) ecological investigations were continued. Hydrographic parameters, micronutrients and seston and plankton concentrations were measured. Primary production and respiration of some zooplankton species were determined. Particle concentrations were also measured using a Coulter Counter.

### Institut für Meereskunde, Kiel

The institute's activities in plankton research can be divided in main geographical areas:-

### Kiel Bight, Baltic Sea

Monthly observations at a fixed station carried out over a period of 19 years by the late Prof. Krey and covering hydrographic and planktological data including nutrients were published in a data volume. The process of remineralisation in the water column was investigated by comparing the differences in nutrient concentration in transparent and dark in-situ plastic bags. All nutrients originating from the decomposition of phytoplankton and particulate matter were apparently consumed by heterotrophic microorganisms. The addition of N and P was sufficient to increase heterotrophic activity several times over. Another study is focussed on nutrient regeneration in sediment in relation to the amount of sedimented organic matter. Ecosystem modelling in respect of Kiel Bight conditions were continued and a special statistical method for the analysis of ecosystem structures developed.

Of special interest during summer are the conspicuous blooms of blue-green algae (Nodularia spumigena and Anhanizomenon flos aquae). The question under investigation is their origin and their possible role as indicators of an increasing eutrophication of the Baltic. Their mass occurrences can be observed on satellite photos.

During September zooplankton, fish fry, and jelly-fish were investigated.

### North Sea

RV "Poseidon" undertook an investigation of fish fry and fish stock.

### Upwelling off NW-Africa

Size analysis of particulate matter showed the predominance of small particles in the size group  $55 - 1 \mu\text{m}$ , suggesting that the main energy transfer from primary to secondary producers takes place between this size class and filter-feeding herbivores such as copepods and euphausiids. Another study deals with the species composition of phytoplankton and the hydrographic structure of the water masses. The feeding appendages of 15 dominant copepod species were analyzed. 47% were found to be herbivorous, 27% omnivorous and 26% carnivorous. The herbivorous species Calanoides carinatus appears to be specially adapted to feed on small phytoplankton cells.

### Upwelling off Oregon

In close cooperation with American colleagues, feeding experiments with predominant copepod species were carried out.

#### Upwelling off Peru

The chemical composition of phytoplankton and particulate matter was studied here as well as the sedimentation of organic matter. Free-floating sediment traps were employed which have the advantage over moored traps of eliminating the influence of currents to a large extent. Only 12% of organic matter produced within the euphotic zone was found to sediment. This indicates a high utilization efficiency by herbivorous zooplankton and anchovetas.

#### Upwelling off Portugal

The effect of upwelling has been investigated with respect to fish and fish fry.

#### Antarctic

During the second German Antarctic Expedition in January/February 1978, one main objective was to study the food relationship between phytoplankton and krill. Primary productivity measurements showed that almost 90% of total production originated from phytoplankton cells smaller than 20  $\mu\text{m}$ . It is suspected that grazing pressure exerted by krill consuming the larger cells may be responsible for this finding.

#### Harrington Sound, Bermuda

In addition to the long-term study of a shallow water ecosystem in a boreal climate in the western Baltic, a warm water system is being studied in Bermuda. A similar remineralization experiment was carried out here with comparable results. Another study deals with the seasonal succession of species in the phytoplankton community.

#### Senckenberg am Meer, Wilhelmshaven

Investigations in different coastal regions with respects to geology (sediments) and biology (benthos) including pollution problems were continued. Most samples were taken from the Jadebusen and the neighbouring wadden sea completed by measurements in the North Sea region and on the east coast of North America.

"Forschungsstelle Norderney" continued its investigations of the benthos communities in the East-Frisian Wadden Sea and their changes under the influence of increasing eutrophication.

Institut für Hydrobiologie und Fischereiwissenschaft, Hamburg

In 1978 the material was worked up which was sampled in 1977. This is in detail macrobenthos and zooplankton from the upwelling area off Northwest Africa caught by bottom grabs, dredges, trawls and a photosledge respectively by a multiple opening/closing net for the collection of copepods.

Further on benthos and zooplankton material from the Central Red Sea was studied during 1978. The institute was also engaged in studies in the distribution of plankton and seston in the Elbe. Remote sensing by aircraft was combined with shipbased ground truth measurements.

Institut für Meeresforschung, Bremerhaven

The investigations of the institute were continued during 1978. This work includes the ecology of bottom organisms in the German Bight and in the estuar of the Weser river with the special problems of long term variations and of distribution patterns.

These projects were combined with hydrographical investigations, with taxonomical work and especially with experiments with respect to ecological problems.

Much of the work of the institute is directly or indirectly related to studies on the extent and effects of marine pollution, organisms of micro-, meio- and macrobenthos being important accumulators, indicators and decomposers of pollutants. See Administrative Report of Environmental Quality Committee.

ICELAND

(I. Hallgrímsson and T. Thordardottir)

Zooplankton

In March zooplankton was sampled in the Irminger Sea at the Icelandic and East-Greenland shelves. This sampling was carried out with a 1 metre net from depths of 900 - 1200 m to the surface.

In April-May sampling was carried out in the uppermost 50 metres in the Irminger Sea SW and W off Iceland as well as at the East-Greenland shelf.

In the same period the shelf area W and S off Iceland was surveyed, 50-0 metres.

In May-June a routine environmental survey was carried out around Iceland, mostly on the shelf area, where zooplankton was sampled in the uppermost 50 metres.

In July, a shrimp larvae survey was worked off the W coast and in places of that coastal area.

In June-July the off-shelf area along the Reykjanes ridge and the deep water east of it were surveyed. The sampling was worked with a Hansen net from 50-0 m and 1000 - 0 m.

In late August the waters off the NE coast were surveyed.

As previously, the continuous plankton survey between Reykjavík and New York and Reykjavík and Sule Skerry, worked in cooperation with the Institute for Marine Environmental Research, Plymouth, were still in progress.

### Phytoplankton

The investigations on phytoplankton were carried out in similar way as before. Measurements were made on primary productivity and on chlorophyll a. Samples were taken to study the abundance and composition of phytoplankton and Secchi disc readings were made whenever possible.

The studies were carried out mainly in the same areas and time intervals as in preceding years. During the period 22/4 - 10/5 the area off the west, south and south-east coast, from Ísafjörður to Berufjörður, was surveyed two times. The coastal and oceanic waters all around Iceland were surveyed during the traditional spring survey 23/5 - 14/6. Within this period the waters off the south and south-east coast (Selvogsbanki - Krossanes) were surveyed two times. During the 0-group surveys 10/8 - 29/8 the area investigated was nearly the same as in the spring survey.

Additional data on chlorophyll a were gathered in the waters west and southeast of Iceland 30/3 - 11/4 and during the period 10/9 - 27/9 in the waters off the northwestern peninsula. Further, several measurements of chlorophyll a were made at different times of year at two nearshore localities, the one near Ísafjörður, the other near Húsavík.

Alltogether primary productivity was measured in 1432 samples and chlorophyll a in 608 samples in 1978.

IRELAND

No Report Received

NETHERLANDS

(W.W.C. Gieskes)

The Dutch Wadden Sea ecosystem is affected by organic matter flushed in from the North Sea. The contribution of organic matter generated during the phytoplankton spring bloom appeared to be of major importance in this respect. The tendency of increasing primary production, related to increasing eutrophication of the North Sea during the last decades, does not seem to be reflected in an increase of secondary production of the Wadden Sea benthos. This implies that either food is not a limiting factor, or part of the available organic matter cannot be used as food. Special attention has been paid to physico-chemical identification of this matter.

In contrast to the situation in the Wadden Sea food is probably a factor limiting benthos populations in the North Sea. Population density of the benthos was highest along the coast and in the mud bottom of the area north of 53° 30' N. At this latitude a front separates the mixed water of the Southern Bight from the water of the central North Sea where for a large part of the year the water column is stratified.

The pelagic ecosystem of the North Sea was again compared with the system in the upper 100 meters of the stratified tropical Atlantic. The close coupling in the oligotrophic Atlantic of heterotrophic consumption with primary production of organic matter was particularly striking. The simulation model of the pelagic system of the southern North Sea was translated into CSMP. The model will be used to characterize a system's behaviour, to recognize the properties that are the origin of stability and continuity, and to formulate differences between the ecosystems that are investigated.

The very large number of chlorophyll surveys in the southern North Sea made during the last decade justified the production of an animated film showing the changes in phytoplankton distribution in the course of a year. The wax and wane of large patches is visualized very well in this film.

NORWAY

(G. Berge)

1. Institute of Marine Research, Bergen, and Biological Station Flødevigen, Arendal

1.1 Phytoplankton

1.1.1 The monitoring of primary production and standing stocks of phytoplankton over the coastal banks off western and northern Norway continued for the 3rd year, covering the season three times at six sections across the Norwegian economic zone. The results are being combined with the previous material in a study of the



annual primary production and its fluctuations. The study constitutes a component of a biological baseline and monitoring study related to the oil exploitation programme on the shelf. The following parameters are included: primary production rates, chlorophyll a, zooplankton, turbidity and chlorophyll in vivo fluorescence were continuously recorded at the 5 m level (IMR).

1.1.2 A long-term programme on environmental conditions in the Norwegian fjords (IMR) was continued. About 30 fjords along the whole Norwegian coast were surveyed in November - December and samples for analysis of nutrients, oxygen, salinity, temperature, chlorophyll a and particle size frequency were collected (IMR).

1.1.3 Continuous and simultaneous measurements of water transparency and chlorophyll in vivo were carried out during the biological spring and summer season at all the Institute's cruises. The results confirmed again the usefulness of the relationship between the two parameters to identify and roughly quantify the presence of planktonic and non-planktonic particles affecting the transparency of the water. Further, on the basis of statistically established relationships between the chlorophyll in vivo fluorescence and the production capacities maps are constructed to indicate the primary production rates (IMR).

1.1.4 The baseline studies of phytoplankton, zooplankton, ichthyoplankton and fish productivity in the Oslofjord and adjacent coastal waters were completed after five years performance. During 1978, 7 surveys of the area were carried out. The results were published in *Fisken og Havet*, Serie B, and in a report to the Norwegian Authority of Waterways and Electro-power (BSF).

1.1.5 Effects of Ekofisk crude oil on phytoplankton has been studied on diluted natural populations and on unialgal cultures (BSF).

## 1.2 Zooplankton

### 1.2.1 Permanent stations.

Regular sampling by Juday 36/180  $\mu$  nets continued at 6 permanent oceanographic stations along the coast. The programme has been operated since 1949. Zooplankton volumes, species composition and stages developments are recorded.

1.2.2 As a component of the Joint Coastal Current Programme as well as the Biological Baseline and Monitoring Programme (see 1.1.1) related to oil exploration and exploitation north of N 62°, zooplankton sampling was made in duplicate at 402 stations on five sections across the shelf. The stations were each operated 4 - 7 times during the year. Additionally, once a week vertical hauls 200-0 m and 50-0 m were made from weather ship "Ami" at N71°30' and E19°00'. The material was worked as for 1.2.1.

1.2.3 Investigations in connection with commercial exploitation of zooplankton (Calanus) continued. In May, Calanus off Bergen was sometimes concentrated at the surface up to 3 ml/m<sup>3</sup> displacement volume. In the layers below, the ctenophore (Bolinopsis infundibulum), was very abundant. In the Masfjord north of Bergen zooplankton in May increased to 20 ml/m<sup>3</sup> in 5 m and 13 ml/m<sup>3</sup> in 10 m, and at the aquaculture station at Matredal maximum volumes of 80 ml/m<sup>3</sup> were recorded. Commercial catches depend upon demand, - annual catches at present approaching 100 tonnes.

### 1.3 Ichthyoplankton

1.3.1 All fish eggs and larvae collected by the Institute since 1976 have been identified and recorded. This is partly a component of a biological baseline and monitoring programme preceding the planned oil exploitation programme on the shelf north of N62°, (see 1.1.1 and 1.2.2). The recordings also go towards an increased knowledge about spawning seasons and behaviour of the larvae of different fish species. About 5000 samples have been worked up since 1976.

## 2. University of Bergen, Institute of Marine Biology

2.1 Studies in the land-locked fjord system Lindåspollen, have continued, with particular emphasis on improvements to the plankton model of the system, on the production of benthic diatoms, and on the population biology of the mussels, which are important grazers in the area.

2.2 In the open fjord system Korsfjorden, primary production has been further studied in relation to light levels and with respect to size fraction, and the vertical distribution of zooplankton at various times of year and times of day has been analysed as part of an assessment of grazing pressure.

2.3 A study under way on the food organisms recorded in the stomachs of demersal fish and an investigation of the occurred and diversity of epibenthic crustaceans are both aimed at elucidating plankton-benthos relationships in Norwegian fjords.

2.4 The usefulness of biochemical estimates (nucleic acids, adenine nucleotides) in ecological studies has been further investigated with particular emphasis on possible distinctions between different components of a community.

2.5 A report describing the present status of the zooplankton and benthos of Ryfylkefjordene in SW Norway is being compiled, in anticipation of changes in the system as a consequence of a hydroelectric development.

## 3. Norwegian Institute for Water Research (NIVA), Oslo

### 3.1 Phytoplankton

3.1.1 Eutrophication effects in the Oslofjord were studied by means of chlorophyll measurements of quantitative field samples and growth potential experiments in the laboratory. Quantitative samples and net samples were also collected and stored for later analyses.

3.1.2 In order to study pollution effects in the heavily polluted Frierfjord and surrounding areas chlorophyll measurements were made of quantitative samples, which were also collected and stored together with net samples for later treatment.

3.1.3 Phytoplankton in the Hellefjord by Kragerø was studied by means of quantitative chlorophyll measurements.

## 4.j University of Oslo, Institute of Marine Biology & Limnology

### 4.1 Phytoplankton

#### 4.1.1 Phytoplankton surveys

4.1.1.1 The investigation of the spring phytoplankton in the spawning areas of cod and herring (Lofoten to More) was continued, in collaboration with



the Marine Research Institute of the Fisheries Directorate, Bergen. This investigation is part of the Norwegian IBP/PM programme. A first report has been published. Two more reports were prepared (T. Braarud, I. Nygaard).

4.1.1.2 Phytoplankton was examined as part of oceanographic surveys carried out in connection with the hydroelectric power-plant projects. The final report will be ready before July 1979.

4.1.1.3 A survey of dinoflagellate cyst distribution along the Norwegian coast was continued (B. Dale). Will be continued in 1979.

#### 4.1.2 Special phytoplankton studies

4.1.2.1 Taxonomic studies on coccolithophorids, by means of transmissinn and scanning electron microscopy, was continued (K. R. Gaarder, in cooperation with B. R. Heimdal, Bergen).

4.1.2.2 Morphology, taxonomy, and distribution of the diatom genus Thalassiosira were studied by means of light and electron microscopes (G. R. Hasle, in cooperation with Dr. G. A. Fryxell, Texas, and Drs. R. R. L. Guillard and L. Murphy, Woods Hole, USA).

4.1.2.3 Investigation of seasonal and spatial distribution of the diatom genus Thalassiosira in Norwegian and adjacent waters is in progress (G. R. Hasle, E. Syvertsen).

4.1.2.4 An investigation of the annual cycle of solicon in the water and plankton of the Oslofjord was concluded. Studies were continued on the nutrient status of Oslofjord phytoplankton as evaluated by various physiological and biochemical criteria (E. Paasche, students).

4.1.2.5 A summary of dinoflagellate blooms in Norwegian waters was prepared (K. Tangen).

4.1.2.6 Taxonomy and morphology of dinoflagellates were studied by means of light and transmission and scanning electron microscopes (J. Throndsen, B. Dale, K. Tangen).

4.1.2.7 A report on a smaller field investigation of phytoplankton composition and distribution at an inshore locality in southern Norway is in preparation (student).

4.1.2.8 Results have been published on the role of cysts in toxic dinoflagellate blooms (B. Dale, in cooperation with Bigelow Institute for Ocean Sciences).

4.1.2.9 An introduction to living and Quaternary dinoflagellate cysts is in preparation (B. Dale).

4.1.2.10 Pigmentation and morphology (including fine structure) of small unarmoured dinoflagellates have been studied (K. Tangen, T. Bjørnland).

4.1.2.11 Influence of growth conditions on diatom frustule morphology, and diatom resting spore formation and morphology were investigated (E. Syvertsen).

- 4.1.2.12 Vertical movement of ultra- and nanoplankton flagellates were studied in artificial water columns (J. Throndsen).

The projects 4.1.2.1., 4.1.2.2., 4.1.2.3., 4.1.2.4., 4.1.2.6., 4.1.2.10., 4.1.2.11., and 4.1.2.12. will be continued in 1979.

#### 4.2 Zooplankton

- 4.2.1 Work on the dependence of the Inner Oslofjord zooplankton on recruitment from outside was completed.
- 4.2.2 Hyponeuston investigations based on the application of new gear were continued.
- 4.2.3 The entire life history of the eye-maggot of the sprat, Lernaeenicus sprattae (Sowerby) (Copepoda, Lernaeoceridae) has been revealed. Planktonic stages were collected by means of a new neuston net, other stages were collected from Sprattus sprattus L. caught by means of a beach seine. All the material was collected in the Oslofjord.

#### 4.3 Phytobenthos

##### Special phytobenthos studies

- 4.3.1 Investigation of the morphology and taxonomy of species of a new diatom family, Cymatosiracea, is in progress (G. R. Hasle, in cooperation with Prof. von Stosch, Marburg).
- 4.3.2 Experimental taxonomy and life history studies of selected red algae (J. Rueness, M. Rueness).
- 4.3.3 Autecological studies of selected algae in the inner Oslofjord (T.E. Lein, J. Rueness, students).
- 4.3.4 Small-scale surveys of algal flora and vegetation in fjord areas outside the Oslofjord (students, J. Rueness).

All the 4.3 projects will be continued in 1979,

#### 4.4 Zoobenthos

- 4.4.1 Work was started on the problems with biological interactions (predation, competition and succession) as background noise in biological monitoring studies. Field manipulative experiments on subtidal sediment and on a subtidal rocky bottom communities were carried out by means of SCUBA diving. (J. S. Gray and collaborators).

#### 5. University of Oslo, Biological Station, Drøbak

##### 5.1 Phytobenthos

- 5.1.1 Community structure in littoral algal communities in the inner Oslofjord. Grazing by Littorina as a regulatory mechanism (T. E. Lein). Work will be continued in 1979.

5.2      Zoobenthos

- 5.2.1      Long-term studies on the general biology of Myxine are being carried out (F. Walvig).

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

- 6.1      Length growth of littoral fucoid algae and Mytilus edulis in relation to natural environmental factors and heavy metals (Pb, Hg, and Cd) have been studied.
- 6.2      Studies of the growth rate of diatoms in situ dialysis cultures in the Trondheimsfjord. Studies on the variation in growth rate and chemical composition of diatoms as a function of nutrient supply, daylength and light intensity.
- 6.3      Continuous bioregistrator for measuring growth rate of phytoplankton. The dialysis culture technique has been developed further, and a special continuous turbidostat has been tested for measuring growth rates. This apparatus has also the potential of measuring growth rates in the sea. The machine can also be used in the laboratory for different algal physiological purposes.

7.      Nordland Distriktshøgskole, Bodø

7.1      Zooplankton

- 7.1.1      Aiming at a better understanding of the availability of suitable food for the cod larvae in Lofoten, zooplankton was sampled using Bongo nets in the upper 25 m in April - May. (S. Skreslet).

8.      University of Tromsø (Institute of Biology and Geology)

8.1      Phytoplankton

- 8.1.1      Studies of primary production, standing crop, as well as the abundance and species composition of phytoplankton were continued in 1978. Investigations were made contemporaneously of temperature, salinity, light, and particulate material.

8.2      Zooplankton

- 8.2.1      Ecological studies of zooplankton population dynamics and production in Balsfjord, started in 1976, have been continued during 1978.
- 8.2.2      Investigations of seasonal changes in basic biochemical body components and "condition" of the zooplankton have further been continued in 1978 with Calanus finmarchicus, Sagitta elegans, Metridia longa, Thysanoessa inermis, T. raschii, and Meganyctiphanes norvegica.
- 8.2.3      Zooplankton sound scattering layers are being examined using Simrad EK 120A and EK 38A echosounders coupled with a Scase echointegrator system.

### 8.3 Hyperbenthos

Studies have also been started on the hyperbenthos (which includes a rich zooplankton component).

- 8.3.1 Biochemical studies on the deepwater prawn Pandalus borealis were started in 1978.

## POLAND

(K. Siudziński)

### Department of Oceanography of Sea Fisheries Institute in Gdynia

In 1978 (18 April - 30 April) the RV "Wieczno" conducted a preliminary plankton and hydrographic survey of Flemish Cap (46°00'N - 48°20'N; 43°30' - 46°30'W) in conjunction with the ICNAF International Flemish Cap Experiment and in cooperation with St. John's Newfoundland Laboratory.

92 stations were occupied and examined for T, S, and XBT measurements, and for ichthyoplankton on 56 stations with oblique tows to depth of 200 m using paired Bongo nets (333  $\mu$  mesh size). Identification of the ichthyoplankton is in progress.

Preliminarily, the larvae of Sebastes marinus were found on 48 stations, mostly as dominant species.

RV "Wieczno" took also part (14 - 31 October) in a Joint Polish/US Larval Survey off the New England Coast. The data were contributed to the international pool of information on the distribution of phytoplankton, ichthyoplankton and macrozooplankton in relation to the hydrographic situation in the study area, particularly Georges Bank, Nantucket Shoals and western part of Gulf of Maine. In addition to macroscale surveys, a microscale-patch study was conducted in October 1978 to investigate patches of herring larvae in Nantucket Shoals, their zooplankton food, and the growth, survival and dispersal of larvae in relation to circulation.

In all 139 stations were occupied and examined for T, S, O and Plankton using Nansen bottles, XBT and paired 61 cm Bongo nets (333 + 505  $\mu$  mesh size).

### Department of Baltic Fishery of Sea Fisheries Institute in Gdynia

The long-term and complex observations on hydrographic conditions and plankton were continued in 1978 in the southern Baltic on standard stations along the transect through Arkona Sea, Bornholm Basin, Slupsk Furrow and Gulf of Gdańsk.

The research included, apart from hydrographic conditions, observations on primary production intensity and concentration of chlorophyll, measured with standard methods; quantitative and qualitative distribution of phyto-, zoo-, and ichthyoplankton using Hensen, Bongo, Nansen, and Copenhagen nets; zooplankton biomass determined by volumetric method.

Samples were collected every month, except for January, February, April, October, and December at 57 stations for plankton studies and at 185 stations for hydrographic observations.

Centre of Fisheries Hydrobiology of Sea Fisheries Institute in Gdynia

Experimental studies on adaptation and feeding of rainbow trout in brackish waters.

Branch of Sea Fisheries Institute in Swinoujście

Complex hydrobiological investigation on Pomorska Bay and Firth of Szczecin.

Research Institute on Environmental Development in Gdańsk

Preparation and coordination of National Monitoring Programme on the Baltic in conjunction with the Interim Helsinki Commission.

Agriculture Academy in Szczecin

Biological capacity of the Baltic coastal zone.

Institute of Oceanography of the Gdańsk University

Baltic

Monitoring of main elements (phyto-, and zooplankton, chlorophyll a and benthos) of coastal the biocoenosis of Gulf of Gdańsk by means of standard methods.

Studies were carried out in the period March - December at 15 stations:

- Field and laboratory studies on the rate of photosynthesis of some macroalgae and phytoplankton communities from Puck Bay in relation to temperature and light intensity;
- Population dynamics of benthic species prevailing in the Gulf of Gdańsk e.g., Cardium glaucum, C. hauniense, Mytilus edulis (age frequency, growth and larval development in experimental conditions).

Arctic waters

Studies on composition of Spitzbergen coastal amphipod studies, and on composition of dominant benthic amphipods from Harnsund Bay.

Biological station of Gdańsk University in Górki Wałchodnie

Ecophysiological experimental studies on Baltic crustaceans.

PORTUGAL

(M.T. Neto)

1. Plankton

Upkeep of the phytoplankton cultures stock. Cultures of some Chlorophyta in 10 l volume to support herbivorous cultures (Ma. A. Sampayo).

Upkeep of the zooplankton cultures stock (copepods and rotifers). Culture of Brachionus plicatilis in 12 l aquaria to feed fish larvae, as an aquaculture

support (Ma. H. Vilela).

Continuation of the study of phyto- and zooplankton samples collected from March 1976 till December 1977 in "musgos", a fishpond on the right side of the Sado estuary (Ma. H. Vilela and Ma. A. Sampayo).

Study of phytoplankton integrated in the programme "Environmental study of the Tejo estuary" coordinated by Comissão Nacional do Ambiente (Ma. T. Moita and A. Rodrigues).

Study of zooplankton integrated in the programme "Environmental study of the Tejo estuary" coordinated By Comissão Nacional do Ambiente (Ma. L. Shirley).

Studies of plankton - qualitative, quantitative and estimates of primary production of the Sado estuary (Ma. C. Peneda, coordinator).

Phytoplankton and nutrients in the Tejo estuary, Esteiro do Corroios (Ma. L. Cabeçadas and F. M. Catarino).

Study of the phyto-, zoo- and ichthyoplankton from Ferrel, near Cabo Carvoeiro, collected from October till December 1978 (Ma. G. Vilarinho, Ma. C. Monteiro, T. Neto; I. de Paiva and Ma. H. Afonso).

Study of zoo- and ichthyoplankton related with Sardina pilchardus spawning and breeding areas between Cabo da Roca and Ponta da Arrifana (Ma. H. Afonso, P. Lopes, Ma. E. Cunha, Ma. F. Quintela, Ma. T. Rodrigues and F. Varela).

## 2. Benthos

Study of the benthonic fauna of Tejo estuary, integrated in the programme "Environmental study of Tejo estuary" coordinated by Comissão Nacional do Ambiente (L. Saldanha + Ma. J. Rosado Costa).

Estuarine biocenoses identification and substrate characterization from Sado estuary (Ma. C. Peneda, coordinator).

Salt marsh structure and vegetation production from Corroios (Tejo estuary) (Ma. J. Caçador + F.M. Catarino).

Halophile vegetation cartography from Tejo estuary (Ma. J. Ramos and F. M. Catarino).

## 3. Stomach contents of fishes

Study of stomach contents of Sardina pilchardus, Micromesistius poutassou, Macrorhamphosus gracilis and M. scolopax.

## SPAIN

(J. Corral)

## Instituto de Investigaciones Pesqueras

### Phytoplankton

The pigment complex of the algae B-3 Nannochloris sp. has been studied. Thin layer chromatography made possible the isolation and identification of chlorophyll a and several fractions, which  $R_f$  seem to be those of  $\alpha$  and  $\beta$  carothens, violaxanthine, vaucherxanthine and seoxanthine as well as other unidentified fractions.



Similarly, experiments aiming at the nutrient concentration necessary for its normal development have been made.

Other aspects studied through 1978 were:

Coastal phytoplankton heterogeneity, statistical analysis of C and N particulate data, productivity and chlorophyll concentration in the upwelling zone in NW Africa, principal components applied to the analyses of an annual oceanographic cycle, and pigments and primary production in nerithic water from the Gulf of Vizcaya (the two last ones in collaboration with the University of Barcelona).

Ultrasonic treatment of cultures of Phaeodactylum tricornutum, Dunaliella tertiolecta and Anfidium hoefleri showed that the fluorescence measures obtained increased 20 or 30% due to the destruction of cellular membranes that absorb excitation radiations as well as emission ones.

The rate of primary production, excretion and pigment dynamics in relation with abiotic parameters has been studied in cultures of the diatom Phaeodactylum tricornutum.

#### Zooplankton

The populations of copepods of the CINECA area (zone between Straits of Gibraltar and South Senegal) have been studied, determining vertical and horizontal distribution and other ecological aspects of each species out of the 418 found.

A study on the annual cycle of the population of copepods living in nerithic waters of Vizcaya has been undertaken. This work demonstrates quantitative variations through the year, with maximums found in spring and summer. Seventeen out of the 60 species found make up 99.23% of the total number of the individuals, being perennial for that zone.

A study of the trophic relations in zooplankton, mainly referred to fish larvae, crustaceans and molluscs has recently been started.

The analysis of different anatomic and morphological parameters in Artemia salina has proved the existence of three well distinguished groups: a diploid bi-sexual race, another telitoe and tetraploid, and a third one which is telitoe and diploid. A strong influence of salinity has been observed in the growth of this species with similar relations within races and different ones between them.

Other research was aimed at the growth of three species of rotifers and a harpacticoid in order to know physical and chemical parameters for their normal development.

#### Instituto español de Oceanografía

##### Phytoplankton

Studies on periodic nutrient intrusions are being continued in the area of Galicia as well as in the Rias of Arosa and Muros, where they are related to phytoplankton dynamics.

The comparison between phytoplankton communities of the two Rias, Arosa and Muros, has been carried out with calculation of biomass (cells/cm<sup>3</sup> and chlorophyll/litre), community structure (diversity, number of species, etc.), finding differences between the two areas.

Nutrient regeneration studies in sediments have been started in order to know the exact origin of these in relation to areas of mussel aquaculture. The studies of

nutrients and phytoplankton have been extended to the shelf.

In the oligotrophic area of Canarias, nutrient, primary production and particulate organic carbon studies are being continued as well as comparison of production of net phytoplankton and nanoplankton.

#### Zooplankton

In the area of Galicia, studies of the structure, biomass and elemental composition (C, N and P) of zooplankton communities are being continued. Determinations of caloric content in zooplankton have been made in order to establish relations between dry weight, ash-free dry weight, C, N, and calories per cubic metre. Mean values of biomass have been found for each season in Rias of Arosa and Muros and similar data are gathered in the Platform.

The pooling of fatty acids in zooplankton has been started in collaboration with the University of Rhode Island in order to know the temporal pattern of this biochemical parameter.

A study on the annual variations of biological parameters, nutrient, light, phytoplankton, zooplankton, bacterioplankton, animal benthos and phyto-benthos is being carried out in the northern zone of Spain near Bilbao.

#### Microbiology

Bacterian heterotrophy studies (maximum potential uptake, turnover time, etc.) have been made in the area of Galicia and techniques have been found to determine bacterian biomass through ATP methods and epifluorescence counted.

#### Infaunal benthos

Studies of the composition and structure of the infaunal communities and their relation with some parameters in the Rias of Pontevedra, Arosa and Muros are made. Presently, polychaeta are being studied and the study of nematodes is being undertaken. A typical species of polychaeta living inside a tube has been found in the high organic pollution zone due to a cellulose factory.

#### Epifaunal macrobenthos

The studies of the communities of fish, crustaceans and benthic echinoderms in the Rias of Arosa and Muros are now being carried out in order to know the spatial and temporal distribution patterns in relation to sediment characteristics and the situation of mussel culture areas.

#### Sweden

(L. Hermroth)

It is evident that the year of 1978 was a year of very little field activity. Most colleagues report either lack of funds or a period of compiling results. Below is a summary of the activities :

#### Gulf of Bothnia

In the southern part, Öregrundsgrepen, the University of Uppsala has performed a programme aimed at measuring the annual primary production of the area. In the same area, the Institute of Marine Research in Lysekil has made occasional sampling of herring larvae using Bongo-nets and IKMWT.



### Baltic proper

In the Askö area, weekly to bi-weekly sampling from the Askö laboratory has been carried out for a number of parameters, e.g. primary production, secondary production, chlorophyll content, distribution of pelagic bacteria, phytoplankton, zooplankton and ichthyoplankton.

In connection with the "Tsesis" oil spill, which was a serious accident south of Stockholm, a comprehensive pelagic and benthic research programme has been carried out by the Askö laboratory.

From the Institute of Marine Research in Lysekil, a number of cruises for herring larvae sampling has been performed. It is mainly the coastal waters along our southern and eastern coast that has been covered and the gears used have been Bongo-net and IKMWT.

### Kattegat and Skagerrak

During February, April and September, ichthyoplankton surveys have been carried out by the Institute of Marine Research in Lysekil. The gears used have been Bongo-nets and IKMWT.

Macrobenthic studies in the Skagerrak have been performed by the Kristineberg Marine Biological Station.

The same station has carried out a project covering the dynamics of the pelagic ecosystem in the Gullmar-fjord. The sampling has been weekly and the parameters investigated were : hydrography, currents, light, primary production, chlorophyll content and composition of the pelagic flora and fauna including ichthyoplankton.

### United Kingdom

#### 1. England and Wales

(D.J. Garrod and G.A. Robinson)

#### 1. Lowestoft, Fisheries Laboratory

##### A. North Sea Studies

- (i) Further analyses of the material collected from the year round series of surveys off the north east coast of England have been completed. These have included multivariate analysis on the estimated abundance of fish eggs and larvae, to illustrate seasonal and spatial variation in relation to environmental conditions. Seasonal succession of species spawning in the same area has also been examined, by plotting the seasonal variation in the biomass of fish eggs and larvae. These surveys have also provided new information on the hatching areas of the edible crab Cancer pagurus, which does not fit in with previous ideas of a return inshore of the females to hatch, after their offshore migration to spawn. These data have been reported in ICES C.M.1978/K:3. The seasonal and spatial distribution of lobster larvae has also been recorded from the area for the first time and reported in J. Cons. int. Explor. Mer. 38(2): 234-243.

A preliminary two-dimensional model of primary and secondary production, based on the north east coast survey data, is functioning and providing new insight into our understanding of the basic causal mechanisms involved.

Predation/feeding studies linked to the north east coast surveys have progressed along two lines. Firstly the stomach contents from 3500 fish taken in the mid-water trawl, have been examined, with particular emphasis on potential plankton feeders. Many of the species examined take considerable quantities of fish eggs and larvae in their diet. Secondly the stomachs from twenty-two species of fish larvae have been examined, and their contents identified in detail. Copepodites and copepod nauplii featured in the diets of most species, whilst appendicularia were more important in the diet of flatfish. *Lamellibranch* larvae, Cladocera and polychaete larvae were also important. Yolk sac larvae of most species had eaten mainly diatoms, dinoflagellates, tintinnids and small copepod nauplii.

(ii) Data from the pilot study of a plaice egg patch, carried out in the southern bight of the North Sea in February 1978 have been processed. Estimates of rates of drift of the egg patch have been made for comparison with rates estimated by current meters and movements of a patch of Rhodamine 'b'. Analysis of all other fish eggs and larvae from this survey have also been completed.

(iii) Studies of the biological production in the vicinity of hydrographic fronts, which began with data from the 1976 north east coast survey, have continued. A survey in May/June 1978 has provided additional material which is being analysed as part of the investigation of the north east coast oceanographic front. The HIAC particle size counter, linked to a shipboard on line sampling system, was successfully used on this survey, and the instrument continues to look extremely promising for a variety of purposes. However difficulties still remain in the development of a pump sampler for vertical sampling at discrete depths.

(iv) RV CORELLA and RV CLIONE each carried out one cruise within the international herring larval survey of the North Sea and adjacent waters, in August/September.

(v) One survey by RV CORELLA was carried out in April to examine the distribution and species composition of *Ammodytes* larval production in the outer Dowsing area. This survey will complement the data already processed from earlier surveys in the same area.

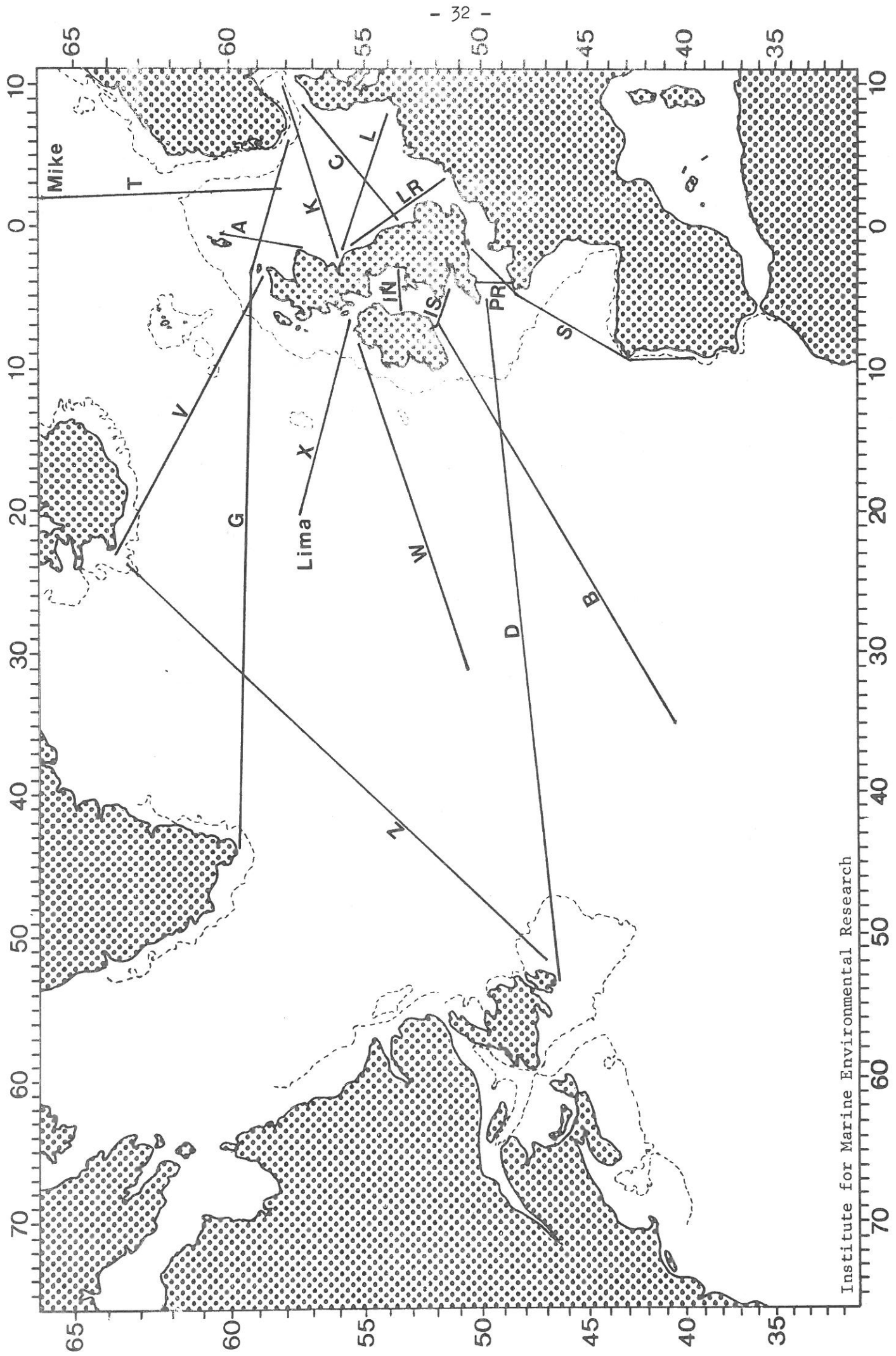
B. Western Approaches

(i) On one cruise of RV CIROLANA in May, four twenty-six hour stations were occupied in different positions within the mackerel spawning area along the edge of the continental shelf. The Lowestoft multiple changing net was used to examine the diurnal changes in the vertical distribution of mackerel eggs and larvae between the surface and 200 metres.

The Continuous Plankton Recorder Survey. (G.A. Robinson)

The survey by the Continuous Plankton Recorder was continued on the same basis as in previous years. Recorders were towed at a depth of 10 m at monthly intervals along the standard routes shown in Figure 1. In addition, three routes were operated by the U.S. National Marine Fisheries Service.

During 1978 Recorders were towed for 101400 miles by 24 ships of eight nations (Denmark, France, West Germany, Norway, Iceland, the Republic of Ireland, the Netherlands and U.K.). The CPR survey began in 1930 with three routes in the southern North Sea; since 1948, the plankton has been collected and the results processed in a constant manner. Measurements of temperature were taken on the K, L, LR, C, IS, IN and PR routes. An inventory of the survey is produced every year and is available on request to the Director, Institute for Marine Environmental Research, Prospect Place, The Hoe, Plymouth, PL1 3DH. Details of the data processing procedures are given by J M Colebrook in Bull. mar. Ecol., 8, 193-142.



Legend to Figure 1. The Continuous Plankton Recorder Survey, 1978; the routes are identified by code letters.

## 2. Scotland

(R. Jones)

### 1. Marine Laboratory Aberdeen

#### FLEX '76

Charts were prepared to show the horizontal variations in temperature, salinity, nitrate and chlorophyll, in preparation for the April 1978 meeting in Hamburg. Detailed analysis of the 68  $\mu$  zooplankton samples collected on a central transect of the FLEX box and around the 'Meteor' position, was undertaken. The results, together with those previously outlined in the Draft FLEX Atlas, are to be presented at the May 1979 Plymouth meeting. An inventory of all data collected by UK institutes during FLEX 76 has been compiled and edited.

#### Scyphomedusae of the North Sea

The eighth survey of the distribution and abundance of scyphomedusae was carried out as part of the 1978 international O-group gadoid survey.

#### Ecology of larval gadoids

As a continuation of the 1974-1975 study of larval gadoids, a survey was done in May 1978 in the area east and north of Shetland. Although work was hampered by excessive clogging of the plankton samplers due to phytoplankton and larvacea etc. a considerable number of samples were obtained and these are at present being analysed.

#### Ecology of O-group gadoids during early winter

A further cruise was planned for late October/November but this was severely curtailed by shipboard mechanical problems. The few data which were obtained confirmed previous conclusions that by November, a large proportion of cod and haddock are demersal, but that an appreciable proportion of the

whiting are still pelagic.

#### Growth of herring in large plastic enclosures

Further experiments were done on the growth of larval herring in large plastic enclosures containing natural populations of phytoplankton and zooplankton.

#### Studies of *Bolinopsis infundibulum*

Investigations were confined to an intensive 3 week field study at Loch Ewe during which it was hoped to complete aspects of the work started in earlier years. Emphasis was placed on gut content analysis in relation to simultaneous zooplankton sampling. Measurements were made of respiration, and of the rates of digestion of various items of the diet.

#### Copepod feeding studies

Measurements of the feeding, and metabolic rates of *Oithona* were carried out as part of a wider study of the ecology and feeding behaviour of this animal.

#### Benthos studies

Benthos studies were mainly confined to inshore waters. Samples were mainly taken from Loch Ewe, from a number of beaches on the Scottish east coast, and from the Firth of Forth sewage sludge dumping grounds.

#### Modelling

Simulation studies have been done on the effect of vertical processes on plankton patchiness; on fish larval growth; and on predator-prey relationships.

### 2. Dunstaffnage Marine Research Laboratory, Oban (SMBA)

During 1978, SMBA biologists took part in 5 cruises of the RRS 'Challenger' to the slope west of the Hebrides, the Rockall Trough and the Porcupine Bight.

The principal objectives were (1) seasonal studies of the biology of deep-sea slopedwelling fish, especially macrourids. (2) Seasonal studies of abyssal macrobenthos and (3) Seasonal studies of shelf and abyssal meiobenthos.



U.S.A.

(K. Sherman + G. Grice)

Ichthyoplankton-Zooplankton Assessments

During 1978 the laboratories of the National Marine Fisheries Service, Northeast Fisheries Center at Woods Hole, Narragansett, and Sandy Hook, continued studies of linkages between plankton production and fish stocks. Seven MARMAP surveys of ichthyoplankton, zooplankton, chlorophyll, and hydrography were made over the continental shelf from the Gulf of Maine to Cape Hatteras (4 spring, 1 summer, 2 autumn) in cooperation with the German Federal Republic, Poland, and the Soviet Union. An intensive international multiship larval fish study was completed in autumn in the Georges Bank area. Biologists and physical oceanographers from five countries (U. S., Canada, German Federal Republic, Poland and U.S.S.R.) and 8 vessels participated. Operations included (1) mapping the patches of larval herring and zooplankton with sufficient resolution to provide estimates of short-term population changes and the influence of the local physical structure of the patch as it dispersed, (2) vertical and horizontal fine scale structure of predator-prey distributions, (3) fine scale primary and secondary productivity measurements, (4) physical processes responsible for the patch dissipation, and (5) broad scale, standard plankton-hydrography surveys of the entire region. In addition, three moored current meter arrays were placed in the study areas and a grid of 49 stations was sampled once every four days. The international surveys of larval herring were continued in 1978 from September through December on Georges Bank with vessels of the German Federal Republic, Poland, and the U.S.S.R. participating. An initial analysis of larval herring from the 1971-77 international time-series surveys has been completed. A report on the abundance of herring larvae in relation to spawning stock-size and recruitment, and the role of the ecological factors influencing larval survival is being prepared for the upcoming ELH Symposium. Staff at the Sandy Hook Laboratory initiated a study of the size of the spawning stock of mackerel (Scomber scombrus), yellowtail flounder (Limanda ferruginea), and sand lance (Ammodytes sp.) based on estimates of the production of fish eggs and larvae. The estimate of the 1977 Atlantic mackerel spawning population of the east coast of the U. S. calculated using total seasonal egg production compared favorably with an estimate derived through cohort analysis of commercial and research trawl collections. Studies on larval fish physiology were continued at the Narragansett Laboratory. An in situ experiment using an environmental chamber to monitor growth and survival of laboratory produced winter flounder larvae was completed in Narragansett Bay. A stochastic dynamic model of growth and mortality of winter flounder reared in the laboratory under experimental conditions was developed to investigate the role of starvation as a regulatory mechanism of mortality in the larval stage. Studies of RNA/DNA as indicators of the physiological condition of fish larvae were continued. The RNA-DNA ratio was related to both food availability and growth rate in laboratory reared cod and winter flounder larvae and promises to be a useful index of condition in larval fish. Preliminary results of a joint research effort between NMFS and the University of Rhode Island using electronic scanning techniques show that counts and measurements of plankters can be made about 10 times faster than by conventional methods and that major groups of plankton can be electronically classified via shape factors derived from morphometric ratios. Scientists at the Woods Hole Laboratory continued testing several hypotheses dealing with possible oceanographic processes controlling the high primary production, 450 gC/m<sup>2</sup>/yr, on Georges Bank. In addition, a multispecies ecosystem simulation model of the food chain dynamics of a coastal fishery is under development;

simulations are being run to improve our understanding of the biological and environmental changes on population levels of plankton, benthos, and fish and their implication to management policies. The NEFC Modelling group is developing a multispecies model of fish production designed to simulate dynamics of ecosystems with a focus on fish populations. The review of these models culminated in a two-day workshop at Harvard in December under the sponsorship of the New England Regional Fishery Management Council, Northeast Fisheries Center, and Harvard University. The general characteristics of the models were compared and their advantages and disadvantages were reviewed with respect to validity and predictive power, input data required, cost and ease of use, nature of assumptions and clarity of description of biological processes.

Although data analyses are not complete, results of a two-year current measurement study across the Northeast Channel shows that inflow into the Gulf of Maine consists of high-velocity intermittent currents coupled to storms and that there is a strong seasonality in flow character. The information is being used to estimate the influence of currents on the retention or removal of fish eggs and larvae from offshore spawning and nursery grounds.

We completed the second consecutive year of intensive plankton surveys in the western North Atlantic, working in close cooperation with USSR and Poland. The systematic multispecies surveys are designed to monitor environmental conditions and changes in the distribution, abundance and production of planktonic organisms with the primary focus on fish eggs and larvae. In 1978 seven surveys of ichthyoplankton, zooplankton, chlorophyll,  $^{14}\text{C}$ , nutrients and hydrography were completed in coastal waters from Cape Hatteras to Nova Scotia. Two fall surveys (October and November) were scheduled to provide support data on the mesoscale distribution of ichthyoplankton for the larval herring patch study on Georges Bank. The others were in February-March, April-May, June-July (2) and August-September.

Results of the 1978 MARMAP winter survey indicate that sand lance larvae continued to numerically dominate the winter ichthyoplankton community, a trend that began during the mid 1970's. In 1976 and again in 1977 sand lance larvae accounted for more than 90% of the young fishes collected throughout the survey area in February and March. In 1978 they accounted for 94% of the larval fish and they were the only species of fish represented in the catch at 62% of the stations where larvae occurred. We have observed geographic shifts in the center of distribution, abundance and production of young sand lances over the past five years. In 1974 abundance levels throughout the survey area were relatively low. Estimates of seasonal production were greatest in the Mid-Atlantic subarea. In 1975 larvae were most abundant off southern New England and the western part of Georges Bank but production was again greatest in the Mid-Atlantic subarea. Abundance and production of sand lance larvae exploded on Georges Bank and southern New England in 1976. The following year the center of larval abundance shifted to shelf waters off southern New England. Production declined sharply, especially on Georges Bank where anomalous winds probably transported larvae off the shelf. As in 1977 the center of abundance and production occurred off southern New England in 1978, where concentrations  $>1000/10\text{ m}^2$  surface area blanketed most of the shelf. Despite the abundance and widespread distribution of larvae, seasonal



production declined throughout the survey areas. The decline is attributed to the apparent lack of successful spawning in December and early January. We caught very few larvae >10 mm.

During 1978 the Plankton Environmental Monitoring Program of the Atlantic Environmental Group NMFS, Narragansett, conducted monthly sampling between Nova Scotia and Cape Hatteras, North Carolina. Continuous plankton and temperature records at 10 meters were gathered between Gloucester, Mass., and Cape Sable, Nova Scotia (1st year), and between New York Harbor and Deepwater Dumpsite 106--one hundred and six miles southeast of New York (3rd year). Continuous plankton records at 10 meters were collected between the mouth of the Chesapeake Bay and the Gulf Stream (4th year). On all of the sampling transects expendable bathythermograph drops were made at 10 m intervals. Monthly sampling of neuston and sea surface temperature continued in the New York Bight and a portion of Georges Bank (4th year).

The Estuarine and Coastal Ecology Division of the Beaufort Laboratory is conducting a series of monthly winter cruises to determine the relationship between chaetognath abundance and larval fish abundance. Laboratory validation and field assessment of aging techniques for early larval fish stages using otoliths is in progress using the sciaenid, Leiostomus xanthurus. A number of physiological studies are continuing, including temperature tolerance of eggs and larvae as modified by parental acclimation temperature, starvation time of first-feeding larvae, food selection and utilization by early larvae, and the effects of heavy metals on the survival of eggs and larvae. Morphometric and meristic descriptions of larvae are completed for Leiostomus xanthurus and in progress for another sciaenid, Micropogonias undulatus, and a sparid, Lagodon rhomboides, using laboratory-reared specimens. The fish spawning and larvae rearing support project is continuing, concentrating on ocean-spawning, estuarine-dependent species. High speed larvae sampling is under evaluation for use in estimating distribution and abundance, and is designed to compare 60 cm and 20 cm bongo nets and high speed sampling gear. Behavioral studies on Paralichthys spp. juveniles have been initiated to assess net avoidance.

The South Carolina Division of Marine Fisheries conducted two MARMAP ichthyoplankton hydrographic surveys from Cape Fear, North Carolina, to Cape Canaveral, Florida.

During 1978 the Miami Laboratory of the National Marine Fisheries Service, Southeast Fisheries Center (at Miami, Florida) conducted an ichthyoplankton survey of the Gulf of Mexico during the month of May. One hundred thirty-five stations were occupied at which 60 cm double oblique bongo tows and 1 x 2 meter neuston net tows were made. These samples have been sorted for fish eggs and larvae and analyses are currently underway to determine the abundance of Atlantic bluefin tuna larvae. In addition to these surveys, research is underway on analyzing results of MARMAP ichthyoplankton surveys carried out in the Caribbean Sea since 1972. Other work also completed is the description of the larvae of Scombrobrax heterolepis, which is commonly confused with the larvae of tunas.

In the Gulf of Mexico, two studies dealing with the effects of petroleum hydrocarbons on salt and the marine ecosystem are underway at the Galveston Laboratory of NMFS. The project will use historical and new data to describe

biological, chemical, and physical characteristics in the marine environments of an active offshore oil field. Studies are underway to measure the concentration of pollutants in major components of the marine ecosystem: water, sediments, suspended particulate matter, and biota (including sessile organisms, pelagic and reef finfishes, and demersal finfishes and macro-crustaceans). Effects of oil and gas field contaminants are being investigated in terms of acute and chronic effects (bioassays), alteration of composition and abundance of the biotic communities, and accumulation of pollutants in biotic and abiotic components of the ecosystem. Special attention is being given to food web dynamics and physico-chemical modes of transport of pollutants into, within, and away from the oil and gas field ecosystem. Staff at the Galveston Laboratory of NMFS is also studying the seasonal abundance, distribution and community composition of major benthic, planktonic, bacterial, and demersal finfish and macrocrustacean ecosystem components and the seasonal variations in inorganic nutrients composition and concentration in the water column. The National Ocean Survey will survey the currents and other hydrographic variables in the area.

#### Plankton Ecology Investigations

At the Bigelow Laboratory emphasis has continued to be placed on physiological aspects of phytoplankton ecology. Tracer techniques and enzymatic approaches have been used to determine biochemical features of carbon and nitrogen assimilation, the flux of organic carbon and rates of respiration. Such measurements have been applied to the temporal and spatial distribution of phytoplankton in the Gulf of Maine, and complement studies of upwelling regions and tropical oligotrophic waters. These studies represent an attempt to determine, at the level of cell physiology, the way in which environmental factors control the growth and distribution of the various species within the plankton. In this broad area, special emphasis has been placed on determining the factors which cause blooms of dinoflagellates, in particular, the red-tide. Other phytoplankton studies have related the distribution of the dominant light-harvesting pigments to the remote sensing of the biological productivity of the oceans.

At Harvard University research continues on the coupling of various terms in the nutrient cycling processes in the sea. Attempts are being made to assess the nutritional sufficiency of surface waters for phytoplankton growth through laboratory and field investigation. Examination of the phytoplankton response to nutrient stress have revealed a strategy which permits the individual organism to opportunistically exploit encounters with temporal "patches" of animal excreta.

Several lines of plankton research continue at the Woods Hole Oceanographic Institution. A multidisciplinary time series study of Gulf Stream cold core rings was initiated in 1976. The purpose of this study is to combine theoretical modelling and field experimentation into a unified attack on the processes of ring decay and the impact of rings on the surrounding Sargasso Sea. The field portion of the study is completed and work now centers on the analysis of phytoplankton and zooplankton samples.

Data analysis is proceeding along several lines. First, the vertical and horizontal distribution patterns of the various species are being categorized and attempts are being made to define the relationships between the distribution of a species and the environmental parameters measured. Second, mathematical models are being developed that are intended to assist in understanding the relative importance of mechanisms which cause cold water species expatriated in rings to become extinct and which should be helpful in evaluating physical models of ring circulation and mixing processes. Third, distribution patterns of two Slope Water species Nematoscelis megalops and Pareuchaeta norvegica are being examined in light of the biochemical and physiological data obtained about them on the four cruises.

Studies of genetic variability and differentiation in the niche components of a number of diatom, coccolithophore and dinoflagellate species are being conducted. New techniques permit successful culture of delicate oceanic species. Endogenous rhythms, diel periodicity in cell division, and adaptations to various light regimes and chemical stresses are being studied in a wide range of phytoplankton species. Physiological responses to Fe, Cu, and Zn availabilities of conspecific clones isolated from oceanic, coastal, and boundary regions are being compared. The overall approach concerns species boundaries and the role of trace metal availability in delineating these boundaries. Zoogeographical and physiological studies on gelatinous zooplankton (ctenophores, siphonophores, salps, and colonial radiolarians) and their associated symbionts continue. The major areas of experimentation are feeding and growth of salps, the swimming dynamics of salps and primary production by zooanthellae of colonial radiolarians. The copepod Labidocera aestiva is being reared in the laboratory under controlled conditions to ascertain the effects of temperature, photoperiod, and diet on the production of resting and subitaneous eggs.

Investigations at the Graduate School of Oceanography at the University of Rhode Island include work on bacterioplankton, phytoplankton, protozoa and zooplankton. Studies on the role of diatom resting spores and the genetic variability of the neritic diatom species Skeletonema are being conducted as well as studies on phytoplankton species succession in Narragansett Bay based on weekly collections carried out over 19 years. Analysis of species succession considers light, nutrients as well as zooplankton interaction and computer modelling. The interaction of bacteria biomass and growth rate with phytoplankton carbon excretion has been studied at sea and in Narragansett Bay as well as the role of protozoa as predators on bacteria and nannoplankton. Growth rates of dinoflagellates in the sea have been investigated along with their bioluminescence, phosphate kinetics, heterotrophic capabilities, vitamin requirements and other factors.

The Division of Oceanographic Sciences of Brookhaven National Laboratory is continuing its program on coastal trophic dynamics in the New York Bight and Georges Bank areas. Investigations on phytoplankton productivity and distribution are directed towards developing models for estimating productivity from a few, well defined, environmental variables. In addition, floristic studies of phytoplankton distribution have been undertaken to relate seasonal variation in physical, chemical, and biological parameters to phytoplankton community structure. These field studies are supplemented with a laboratory

program emphasizing phytoplankton biochemistry and physiology. Fluorometers have been modified for underway towing at various depths and maps of the fluorescence environment can be rapidly constructed. Similar, in situ, fluorometers are being deployed with a moored array of remote devices sensing temperature, salinity, and current vectors. This results in continuous, in situ, fluorescence records synoptic with physical data. Considerable effort is being made to examine the natural pathways and rates of material transfer between phytoplankton and the predominant copepods, and to determine the subsequent fate of the ingested material as it is partitioned into growth, reproduction, metabolism, and feces. Ingestion, respiration, excretion, egg production, and defecation rates were simultaneously measured for Centropages typicus, the predominant copepod in this system during the summer and fall. The distribution and abundance of copepods was also determined, using both net tows and a high yield pumping system. Information on total grazing stress, nutrient recycling, feces production, and other major shelf processes is forthcoming. Laboratory studies of egg production rates by the predominant copepods are completed and plans now are to measure the effects of food and temperature on growth and development.

At the State University of New York - Stony Brook Marine Sciences Research Center a number of studies on plankton are underway. Currently measurements are being made on the recovery of phytoplankton populations in a eutrophic estuary on the south shore of Long Island. The estuary had been exposed to decades of high nutrient loading from nearby duck farms. In Great South Bay research is being carried out on nitrogen cycling between phytoplankton-zooplankton and sediments. Of major interest is the importance of benthic organisms, including eelgrass in the bay nitrogen cycle.

Several members of the Stony Brook faculty are involved in research on the role of tidal and headland fronts in affecting the distribution and productivity of phytoplankton in Long Island Sound.

Field research on plankton at the Lamont-Doherty Geological Observatory is concerned primarily with processes influencing the development and dissipation of phytoplankton blooms in continental shelf waters.

At the Virginia Institute of Marine Science work has been recently completed on the neritic plankton communities in the Middle Atlantic Bight. Three communities were identified: coastal, central shelf and shelf break. Included in this investigation were taxonomic and ecological accounts of decapod larvae, pelagic molluscs, and amphipods. Composition and abundance of zooplankton communities in the lower Chesapeake Bay continues.

Plankton research at the Chesapeake Bay Institute has recently been concerned with further examination of phosphorus uptake mechanisms and membrane carrier systems in phytoplankton. Also in progress are studies employing high pressure liquid chromatography to characterize dissolved organic carbon released from phytoplankton in culture and in natural assemblages. Investigations of the role of micro-zooplankton in the Chesapeake Bay have continued with emphasis being placed on defining broad-scale patterns of distribution and abundance. Projects were also initiated to examine the feeding dynamics (including bacterivorous modes) and growth rates of these forms. Mechanisms



for survival of phytoplankton during several months of sub-surface transport in the deep water of the bay are being evaluated. Also under study is the role of convergence zones in facilitating deep water transport of phytoplankton.

Plankton research at Duke University has concentrated on the processes responsible for large-scale variations in primary and secondary productivity in the east coast continental shelf waters of the U. S. Observations taken during the last decade are being analyzed to determine whether or not the low frequency oceanographic variability has occurred and whether or not that variability might drive the variations in primary and secondary productivity. Other studies that are continuing are: 1) analysis of the spatial and temporal variation of phytoplankton species and chemical composition in small lateral estuaries; 2) investigation of the impact of various food supplies on the reproductive success of copepods; 3) regulation of phytoplankton growth by secondary growth factors and trace metals.

Plankton research at the Skidaway Institute of Oceanography involves field and laboratory studies. The effects of shelf break upwelling on phytoplankton production and zooplankton reproduction and growth in relation to hydrographic parameters was studied in the spring. During summer phytoplankton and zooplankton composition, abundance, and production were investigated over nine days following a set of two drogues in a stranded Gulf Stream intrusion. The field research is a combined effort of physical, chemical and biological oceanographers to describe the effect of the Gulf Stream at the shelf break and on the continental shelf off the southeastern United States. Laboratory research complemented field research and focused on feeding, growth and reproduction of various abundant, mainly omnivorous copepods including juveniles and pelagic tunicates.

Plankton research at the Rosenstiel School of Marine and Atmospheric Sciences includes studies of the feeding and biology of chaetognaths, life history studies of ctenophores and the interaction between harpacticoid copepods and Trichodesmium. Laboratory experiments are also underway to determine the factors that affect survival and growth of larval fishes particularly effects of variable prey and predation.

### Ecosystem Modelling

During December the staff of the Northeast Fisheries Center participated in a multispecies fish modelling workshop sponsored by Harvard University and the Northeast Regional Fisheries Management Council. The models of Andersen-Ursin, and Laevastu-Favorite were discussed with respect to their potential as management tools. The workshop participants concluded that these multispecies models provided useful elements that will be seriously considered by the participants in the development of multispecies fishery models for use in the Northwest Atlantic.

To estimate the feeding conditions of commercial fish, an assessment of winter euphausiids stock in the Barents Sea was made in 1978. Analysis of spring-summer zooplankton, collected on the spawning grounds and on the drifting routes of fish larvae in the areas off the north-eastern coast of Norway and in the south-western Barents Sea was carried out. Distribution, abundance and biology of shrimp larval stages was studied. Food interrelations and nutritive base of capelin and polar cod in the eastern Barents Sea in July-August were investigated. The data collected for many years on phytoplankton, abundance and biomass of zooplankton and distribution of the Barents Sea euphausiids were generalised.

On the basis of the data for 1971-1977 regularities of the phytoplankton development were revealed. Optimum temperature and salinity characteristics of environment which ensure maximum vegetation of the most typical phytoplankton species in the southern Barents Sea were found.

While analysing the data, collected for many years (1959-1977), on the abundance and biomass of zooplankton, a positive relationship between Calanus abundance, plankton biomass and water temperature ( $r = 0.71$ ) and also between summer plankton biomass and survival index of the pelagic young cod ( $r = 0.90$ ) was revealed. This allowed to predict the survival of 0-group cod from larvae in June-July to fingerlings in autumn-winter.

To study the regularities of formation of euphausiids concentrations and the degree of independence of the Barents Sea groupings the data collected in 1953-1978 were generalised.

In the Baltic Sea, the Gulf of Riga and the Gulf of Finland the following work was carried out in 1978.

Composition, distribution and seasonal dynamics of zooplankton were studied. Zooplankton abundance and biomass were assessed by seasons, sea and gulf areas and zones. Dynamics of specific composition was shown.

"Organism-environment" relations (biogens, phytoplankton, zooplankton abundance) were studied. Important influence of phosphates, nitrogenous salts and phytoplankton abundance on dynamics of zooplankton abundance was revealed.

The influence of Kattegat mass transport on the formation of productive zooplankton areas was considered. More considerable influence was observed in south and north-western Baltic in summer.

The influence of water mass dynamics on the formation of productive zones by steep shore slopes was studied. It was observed that zooplankton production in the areas of bottom water rise was higher.

The influence of zooplankton on distribution of herring and sprat during the feeding period were studied. It was shown that areas of maximum abundance of zooplankton coincided with areas of maximum fish abundance.

The influence of food supply on the strength of spring herring year classes in the Gulf of Riga was considered. Strong herring year classes were formed in the years of high productivity of zooplankton in the period of maximum abundance of actively feeding larvae (10-20 mm long).

Population structure and distribution of mysids (nekto-benthos) was studied in the Baltic Sea. Age-length and sex composition was characterised. Their distribution by areas and depths in different seasons was considered.

Composition and distribution of zoobenthos stocks in the Baltic Sea in winter were considered. Zoobenthos and nekto-benthos of small bays of the Gulf of Finland were studied. The influence of pollution on species composition, distribution and biomass of fauna was shown.

The efficiency of feeding of herring and sprat was evaluated (Oct. 1977-June 1978). The catchability of zooplankton nets made of gauze of different thickness was determined.

In 1979 investigations will be carried out according to the previously adopted programme.





