

BIOLOGICAL OCEANOGRAPHY COMMITTEE

by

VAGN HANSEN

1982

Belgium

(R. De Clerck and Ph. Polk)

Laboratory of Ecology and Systematics, V.U.B., Brussels.

The study further concerned the interactions between the compartments in the plankton of different water masses.

1. Phytoplankton.

Study of the primary production in enclosed areas, near-shore and open sea.

Biomassa measurements of the phytoplankton compartment.

Activity studies : - light-dependance of the particulated and extracellular production of the phytoplankton.

- kinetically (quantitative) determinations of the phytoplankton extracellular organic matter, and phytoplankton respiration measurements.

2. Zooplankton.

Study on population dynamics of Copepodes : modelling of lanctonic populations, population genetics of Harpacticoids.

Vertical migration behaviour.

Grazing activities of the dominant species in enclosed areas, near-shore and open seas.

Distribution patterns of fish eggs and fish-larvae. Feeding behaviour in fish-larvae.

3. Bacterio-plankton.

Determination of dissolved organic matter ; sugar, carbohydrates, BOD, IOC. Study of activities : total planktonic respiration ; specific heterotrophic activities : incorporation of radioactive substrates.

Canada
(A.R. Longhurst)

The following is a brief summary of some of the relevant activities in Canada; for further details, please consult the individuals named in each section.

DEPARTMENT OF FISHERIES AND OCEANS

Marine Ecology Laboratory, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, B2Y 4A2
(Dr. K.H. Mann, Director)

This laboratory participated in a number of joint cruises during the year: to Hudson Strait, the Mid-Atlantic Ridge, the Polar Front, the Scotian Shelf, and the Straits of Messina. These cruises have added substantially to the archives of comparative data from various environments on primary and secondary producers, their size class distribution, their nutrient relationships, and their relationship to physical features of the marine environment. On the cruise to Hudson Strait measurements of phytoplankton production and zooplankton biomass were taken along the longitudinal axis of the Labrador Shelf, CTD measurements were taken over the Labrador Shelf-Hudson Strait-Hudson Bay area to investigate mixing in Hudson Strait (specifically to discover where the TS properties observed on the Labrador Shelf are first formed) and several strings of current meters were moored in Hudson Strait and subsequently recovered. It is expected that this work will throw light on the influence which the freshwater runoff of Hudson Bay exerts on the fisheries of the Labrador Shelf and Northern Grand Bank.

The theme of a number of the other cruises has been a study of the influence of turbulence on primary productivity. The Straits of Messina provide data from an area of strong vertical mixing, and comparative data have been obtained from other areas. A very intensive series of observations has been obtained from Bedford Basin, close to the laboratory. Very detailed measurements of turbulence in vertical profiles were made with OCTUPROBE, designed in the Atlantic Oceanographic Laboratory of the Bedford Institute of Oceanography, while simultaneous measurements were made of the physiological properties of phytoplankton.

Another objective of various cruises has been to obtain data on the contribution of picoplankton to total primary productivity. After last year's important finding that in oligotrophic waters more than half of the primary production in the water column may be attributed to particles of less than 1 μm , further work has shown that these particles (believed to be cyanobacteria) make a significant contribution in all waters examined including the Arctic.

The last few cruises of the Scotian Shelf Ichthyoplankton Program were conducted during 1982. Work will continue on sample analysis, archiving and analysis of material from a five-year series of stations at which ichthyoplankton, zooplankton, chlorophyll and nutrients were sampled in a standardized manner. Already, the work has yielded a much improved picture of the geographical distribution of early life history stages of fish, and of the attendant biological oceanographic phenomena.

Work with the ECOLOG dual-beam acoustic fish detection device has continued, with cruises on the Scotian Shelf, to Chedabucto Bay and to western Nova Scotia. The system is still being tested to its limits, but it appears to give better resolution within fish aggregations than any other system, and to yield data on size frequency distributions. It will be used in a multi-disciplinary study of the biological oceanography and fisheries ecology of Brown's Bank, to begin in 1983.

A new program on deep ocean benthic ecology was launched with a cruise to the Nares Abyssal Plain. The objective is to obtain sufficient understanding of biological fluxes to be able to make risk assessments in connection with proposals to dump radionuclides in the deep ocean. Samples were collected with a box corer and with an epibenthic sled. Time lapse photographs of amphipods consuming bait provided an indirect estimate of metabolic rates.

Centre Champlain des Sciences de la Mer, Québec,
Québec, G1K 7Y7
(Dr. J. Piuze, Directeur)

Au laboratoire du Centre Champlain des Sciences de la Mer, les études se sont poursuivies pour étudier la production et l'écophysiologie du phytoplancton en milieu estuarien. Ces travaux ont indiqué que les variations de la température, des débits d'eau douce et des conditions de lumière et de stratification de la colonne d'eau sont les principaux facteurs hydrologiques responsables de la grande hétérogénéité spatiale et temporelle observée chez le phytoplancton. D'autres travaux ont également été effectués pour tenter de caractériser la productivité hétérotrophique dans ce milieu estuarien et pour étudier la croissance et la physiologie de la microflore dans la glace en période hivernale.

Par ailleurs, une étude de la répartition des euphausiides dans l'estuaire du Saint-Laurent a montré qu'en été les populations d'euphausiides sont principalement localisées dans une étroite bande longitudinale le long de la côte nord et que les populations (*Thysoaessa raschii* et *Meganyctiphanes norvegica*) sont séparées verticalement, étant associées à des bandes de température différentes. Des hypothèses reliées à l'interaction entre la circulation résiduelle et les migrations verticales ont été avancées pour expliquer cette répartition et un programme sera entrepris pour essayer de vérifier ces hypothèses.

Marine Fish Division, Fisheries Research Branch, Halifax,
Nova Scotia, B3J 2S7
(Dr. J.E. Stewart, Director)

Through the year there was an emphasis on the development of data management systems for major data sets.

An SZK management system was developed for the five years of Scotian Shelf Ichthyoplankton Program biological and hydrographic data. First results from this survey were distribution patterns of fish eggs and larvae on the Scotian Shelf. There was development and testing of an integrated (MINISIS, HP 3000) system for administration and data analyses of tagging experiments. International Observer Program data were also mounted on a SZK data system.

A detailed study of fishing patterns in the complex ground-fish fishery of SW Nova Scotia was carried out using observers on vessels and the impacts of mesh regulation on the fishery analyzed.

The Division played a leading part in the development of the southwest Nova Scotia Fishery Ecology Program which will be a major focus of research activity in the Scotia-Fundy Region during the next five years. The program includes participants from Marine Ecology and Atlantic Oceanographic Laboratories at Bedford Institute of Oceanography, other Divisions of the Fisheries Research Branch, Dalhousie and Guelph Universities.

Fisheries and Environmental Sciences Division, Fisheries Research Branch, St. Andrew, New Brunswick, E0G 2X0
(Dr. J.E. Stewart, Director)

Paralytic shellfish poisoning (PSP) continues to be a problem with widescale closures of clam fishing areas in the late summer. Research is designed to understand the biology of the causative organism Gonyaulax excavata, particularly the distribution of resting cysts and factors controlling encystment. A laboratory experiment was initiated to test whether ozone treatment of clams can remove the PSP toxins.

Population estimates of alewife, shad and salmon were made in the Annapolis River which is to be the site of a small demonstration scale tidal power plant and also in Minas Basin. Tagging methods have been used to demonstrate the migratory routes used by shad in the Bay of Fundy.

A benthic study in collaboration with Marine Ecology Laboratory was completed and provided geographic coverage of macrobenthic production for the Bay. The relationship found between current speed and suspensionfeeder production can be used predictively. Laboratory mussel growth and seston depletion experiments confirm the field observations with growth being dependent on current speed.

A benthic project was begun as part of a collaborative program involving Fisheries Research Branch, Marine Ecology Laboratory and local universities. The overall aim is an in-depth study of haddock ecology in this area.

Northwest Atlantic Fisheries Centre, Fisheries Research Branch, St. John's, Newfoundland, A1C 5X1

The Flemish Cap Project began in 1978 and has been carried out cooperatively by Canada and the USSR with project results and progress being reported annually through the Scientific Council of NAFO. Results to date include annual biomass estimates of the 3 M cod stock, documentation of larval redfish dynamics, a good initial understanding of the physical and biological oceanography of Flemish Cap and knowledge of the early life history and feeding biology of cod on juvenile redfish. A review and analysis of future research plans were carried out and summarized in a document titled "Prospectus on Future Research for the Flemish Cap Project" (SCR Doc. 82/X1/2) submitted to NAFO.

Further research was undertaken in 1982 utilizing otoliths to determine daily growths in larval Sebastes spp.

A "Southeast Shoal (Grand Banks) Larval Yellowtail Study" proposal has been finalized for 1983. The project will examine larval yellowtail flounder, Limanda ferruginea, and involves studying specific aspects of growth, feeding, distribution and abundance related to biological and physical oceanographic conditions. The study is designed to provide some basic understanding of the processes involved in determining the early life history of larval fish and subsequent year-class strength.

Several cruises to investigate the distribution and abundance of larval herring and capelin were carried out in Trinity and Fortune Bays, Newfoundland, in 1982. Extensive oceanographic data were collected which will assist in the interpretation of larval growth and survival as well as the influence of oceanographic conditions on fish distribution.

In the past year collaborative efforts were maintained with Memorial University of Newfoundland relative to canyon processes as these affect the physical water structure and adjacent shelf productivity.

A complete annotated species list of copepods has been prepared in conjunction with J. Tremblay, University of Guelph, which updates the Atlantic Section of "A Synopsis of Canadian Marine Zooplankton", published in 1971.

Centre de Recherche en Ecologie des Pêches, Direction de la Recherche sur les Pêches, Rimouski, Québec, G5L 3A1
(Dr. P. Béland, Directeur)

Ce nouveau laboratoire mis en place à l'été 1982 a poursuivi la majorité de ses recherches dans le nord-ouest du Golfe Saint-Laurent.

On a déterminé que la résistance osmotique des populations naturelles d'oursins peut servir d'indicateur de l'importance des fluctuations de salinité en un lieu donné. Les données d'une étude en bassin et en nature montrent que le taux de survie dépend de la taille. On a mesuré que l'eau douce des rivières Mingan et Romaine en crue printanière peut abaisser la salinité au large entre 0% et 20% jusqu'à une profondeur de 5 mètres.

Les fréquences de taille dans les populations d'oursins aux divers étages en divers points des Iles Mingan correspondent à la récurrence de profils de salinité plus ou moins accusés.

Une première analyse sur plusieurs années des organismes fixés aux bouées de navigations dans le Golfe semble relier les densités observées de quelques taxons aux débits d'eau douce du fleuve Saint-Laurent. La poursuite du projet au cours des années futures permettra de mieux cerner les causes de ces fluctuations de densités.

Il a été vérifié que le buccin (Buccinum undatum), un prédateur important, a un rôle déterminant dans la structuration des communautés benthiques. Lors d'une étude en cours sur les paramètres de son cycle vital (croissance, mortalité, reproduction) nous avons noté que l'espèce ne fait pas, en Minganie, de migrations saisonnières, comme on l'a souvent postulé. En outre, nous avons mesuré adéquatement l'effica-

cité et l'aire d'attraction de l'engin de pêche utilisé commercialement.

On a aussi constaté qu'une substance contenue dans la carapace des larves pélagiques de crustacés benthiques émet de la fluorescence à la même longueur d'onde que la chlorophylle A. Il faudra vérifier si cela peut, à certaines saisons, constituer en océanographie une source d'erreur dans le dosage routinier par fluorométrie de la chlorophylle présente dans la colonne d'eau. Plusieurs de ces projets seront poursuivis en 1983. Une étude sur la distribution verticale des larves de homard révèle que l'on sous-estimait de 3% à 30% l'abondance des différents stades larvaires par l'échantillonnage traditionnel du premier mètre de la colonne d'eau.

Arctic Biological Station, Fisheries Research Branch,
Ste. Anne de Bellevue, Quebec, H9X 3R4
(Dr. A.W. Mansfield, Director)

Studies by the Arctic Biological Station of a coastal arctic ecosystem were continued in Frobisher Bay, in the eastern Canadian arctic. Major activity took place during the open-water period in summer, with additional observations through the ice cover in winter.

Experimental observations were continued on activity rates of pelagic bacteria during the open-water season. Field work on in situ primary productivity of phytoplankton and seaweeds and on the vertical distribution of phytoplankton was carried out. Both field and laboratory experiments were conducted on the effects of light and temperature on the synthesis by phytoplankton of polysaccharides, lipids and proteins. Additional data were assembled from the sea ice on the vertical distribution of diatoms and animals of several taxonomic groups which are found in large numbers living in the ice during several months of each winter.

A study of zooplankton feeding was begun. Examination of certain ecological and physiological features of dominant macrozooplankton species was continued, including the rate of lipid and caloric energy accumulation and utilization by the locally dominant ctenophore, Mertensia ovum. Work on respiratory metabolism of the same species was carried out.

The relation between zoobenthos production and detrital fall-out was a continuing study. Data were accumulated on caloric and ash determinations of a number of important benthic animal species. Bacterial activity in sediments was also examined.

At Cape Hatt, northern Baffin Island, sea ice bacteria were sampled and in situ experiments carried out on bacterial and plant activity in the ice. Farther afield, data were assembled on zoobenthos distribution in a number of arctic localities.

UNIVERSITE DU QUEBEC A RIMOUSKI

Département d'Océanographie, Université du Québec à Rimouski,
Rimouski, Québec, G5L 3A1
(Dr. Jean-Rock Brindle, Directeur)

La majorité des projets de recherche (1980 à 1982) des chercheurs de l'UQAR ont été effectués dans l'estuaire et le golfe du Saint-Laurent ainsi que dans le fjord du Saguenay.

Une équipe, formée en 1979, a développé des recherches portant sur la compréhension du fonctionnement des écosystèmes benthiques littoraux de substrat meuble sur les deux rives de l'estuaire du Saint-Laurent. Ces études concernent particulièrement la structure et la dynamique des communautés prises dans leur ensemble mais aussi l'écologie et la dynamique de certaines espèces en particulier. Outre les deux professeurs concernés, l'équipe regroupe dix étudiants inscrits à la maîtrise en océanographie et, dont les projets de recherche s'inscrivent dans la problématique de base.

Les buts généraux de la programme de recherche océanographique sont les suivants: étudier la dynamique de circulation et le processus de mélange estuarien dans l'estuaire maritime et la partie occidentale du golfe du Saint-Laurent en utilisant une approche descriptive et théorique, et mettre ces processus en relation avec la distribution et la dynamique de la communauté planctonique ainsi que le transport de matières nutritives et polluantes entre l'Estuaire et le Golfe.

MCGILL UNIVERSITY

Institute of Oceanography, McGill University, Montréal,
Québec, H3A 2B2
(Dr. R.G. Ingram, Chairman)

Studies have continued in the Gulf of St. Lawrence of the ice biota (principally diatoms), the distribution of oxygen (especially the association of the oxygen minimum layer with nutrient levels), the benthic environment and the movement of water masses in the north-eastern Gulf. In the western Arctic, involvement has been in ecological studies of the Arctic fox which in certain areas depends entirely upon marine sources of food. Work on an isopod crustacean which lives in both fresh and salt water in the western Arctic is nearly completed. In the eastern Arctic, work has continued on the biology of an unusual landlocked mussel (Mytilus) and in changes in marine climates -- the northwest Atlantic-Subarctic region -- as evidenced by changes in the marine fauna since 1920.

Studies on the functional morphology of feeding and locomotion in harpacticoid copepods (Crustacea) have continued. A joint project with ecologists at Harvard University and the University of Rhode Island began in 1982 to study the effects of oil pollution on marine faunas and floras as part of the on-going MERL program of URI. This joint venture was funded by USA/NOAA. The energetics of secondary planktonic

production in the estuary of the St. Lawrence River continues to be studied. A study of the microbiology of suspended solids in the Gulf of St. Lawrence has begun. The perceptual basis of first feeding by fish will be studied starting in 1983 as will the ecology of deep water Crustacea in an Arctic fjord.

A number of investigations concerning sponges (physiology and ecology) were also completed. This work took place in both fresh and marine waters (Atlantic and Pacific Oceans).

Research programs on the determination of biomass and production of coral reef zooplankton as a food source for reef corals and the degree to which reef plankton biomass can supply the nutritional requirements of corals have continued. It is now generally accepted that reefs harbour a resident population of zooplankton, resident taxa which are components of the reef itself and not of the surrounding ocean. From collections made with anchored, inverted plankton nets, the resident benthic and epibenthic zooplankton will be sampled, defined, distinguished from the oceanic population and its biomass estimated. For a few numerically abundant species, rates of production will be determined from cohort analysis and trophic relationships investigated. The second part of the study will consider the biomass and composition of zooplankton captured by reef corals.

DALHOUSIE UNIVERSITY

Department of Oceanography, Dalhousie University, Halifax,
Nova Scotia B3H 4J1
(Dr. R.O. Fournier, Chairman)

The Department of Oceanography has five full-time faculty members in biological oceanography plus one Research Associate, one Postdoctoral Fellow and about 30 graduate students. The research of this entire group is focused to some extent around the major interests of the faculty, which is briefly described below.

Zooplankton research has just been completed in the Gulf of Maine using a ship of opportunity to monitor zooplankton growth and abundance over a period of one year. In addition observations were made on the mechanisms and rates of feeding of the Antarctic Krill Euphausia superba. These later observations were carried last winter at the Polish Research Base Arctowski. Additional studies include an investigation of the metabolic costs borne by copepods feeding on phytoplankton, an analysis of zooplankton taxonomy and distribution in waters over the Scotian Shelf and slope, a study of the feeding rates of oligotrichous ciliate microzooplankton, an analysis of the mechanism of food retention by euphausiids and finally a consideration of the importance of lipid reserves in growth and fecundity of Calanus.

Fishery investigations include a study of the relationship between distribution and production of zooplankton and herring off southwestern Nova Scotia. Additional studies include a study of the importance of fish predation on larval

fish mortality, on investigation of the factors affecting the growth of larval haddock, a study of fish production in the Amazon Flood Plain, and finally on experimental assessment of the energetics and growth of cod.

Studies on benthic ecology have focused on the use of the stable isotope Carbon-13 as a means of identifying food chain length and complexity. Additional studies include investigations on the relationship between bottom currents, sediment texture and food availability for animals, an investigation of the food resources available to the American lobster in various environments, an experimental study of bottom roughness (especially animal tubes) and its effect on supply of organic matter to the bottom, and finally on investigation of benthic invertebrate patch size and food input to those organisms.

One group is concerned with developing mathematical representations of ecological systems. This approach has been extended to studies of warm core rings of the Gulf Stream plus a study of the importance of predation as a mechanism to shape particle size spectrum in the marine environment.

The final group working on phytoplankton has been concerned with physical-biological interactions on the Scotian Shelf. Specifically, this has involved studies of fronts, upwelling, tidal mixing and cross shelf advection. Additional studies include an investigation of the rate of nutrient regeneration in the plankton across the shelf, a study of the co-occurrence of bacteria and phytoplankton and their functional interaction, an investigation of the quantity, quality and rate of formation of chlorophyll degradation products and finally an examination of the carbon: nitrogen ratios in phytoplankton subjected to varying temperature and light stresses.

Denmark

(Vagn Hansen)

The Danish Institute for Fishery and Marine Research

In April 1982 the methodology on in situ patch measurements was tested. An identified phytoplankton patch was mapped out in a lagrangian system referring to a buoy fixed to the water masses by a paracut in 15 meters depth. Stations were taken for each 2 nm in 8 directions from the fixpoint till 10 nm. The NE quadrant was enlarged to 20 nm distance. The stations were started with optical measurements, light absorption and fluorometry "in situ". Depending on the optical observations some depths were chosen for sampling nutrient, chlorophyll and coulter counting. The samples were pumped up through a cable hose with a submerged pump and CTD probe installed.

Similar observations were made on an anchored station with 2 - 3 hours frequency during 2 - 3 days.

On two cruises in April and November the northgoing current off the west coast of Jutland was investigated optically, by a CTD probe, nutrients, coulter counting and chlorophyll a measurements.

Experimental work in 1982 was reduced to a minimum since almost all available man power was used to establish the research facilities at Hirtshals Laboratory and in the laboratory in Charlottenlund.

Process-oriented studies using e.g. a submersal pump was initiated at peak-stations during the Danish participation in the International Larval Herring Survey.

Preliminary investigations of plankton production in a new 92 m³ out door tank were carried out.

Studies of larval feeding behaviour in different food environments were initiated with various techniques. In particular, the process of first feeding for larval herring was studied in detail. The background variability in the development of fish larvae were studied and the techniques for handling herring eggs and hatching the larvae were improved in cooperation with dr. Harald Rosenthal.

Ongoing work on particle counters was expanded and includes laser techniques, ultra sonic and coulter counter principles.

The complete work of the experimental department in 1982 was oriented towards creating the basis for beginning to utilize the facilities in 1983/84.

Marine Biological Laboratory, Copenhagen University, Elsinore.

General marinebiology and ecology

The research has been focussed on bivalves, a.o. a revision of the family Mytiliidae (systematics and ecology). Several mytiliid species new to science have been found. Another project deals with the identification of recently metamorphosed bivalves. A catalogue of 70 species is in progress.

The feeding of sand-living amphipods, the amount of food consumed in relation to food availability is checked and correlated to stages in lifecycles and variation in the environmental factors.

Marine parasitology

The work is continuing on the lifecycles of digene trematodes. It has for instance been found that the cercaria stage of one species is developed in redia in a polychaete (most species known is developed in gastropods and molluscs). The cercaria penetrates the skin of flatfishes. After a couple of months the first trematods can be found in the blood vessels in the gills and in the heart. The parasite can be lethal to the fish.

Work on parasitic turbellarians continues. The reproductive biology of both parasite and host is investigated by field collections and by experiments in the laboratory.

Ecophysiological investigations has concentrated on decapod crustaceans. Brackish water shrimps has been tested with regard to tolerances to changes in salinity, temperature and oxygen tensions. Specially extreme combinations of these factors was of interest. Blood samples of the shrimps was analysed for blood pigment, ions, amino acids, a.s.o. In lobsters the amount of blood pigment, the moult frequency and duration of the va-

rious moult stages was investigated for lobsters given different types of food. Ventilatory and circulatory behaviour of juvenile lobsters in low oxygen tensions was another project.

Accumulation of cadmium and phenol in various organs and the effect of these pollutants on physiological mechanisms has been investigated in shrimps and crabs.

Grønlands Fiskeriundersøgelser. Greenland waters. (E. Smidt)

Zooplankton

The standard sampling programme was continued using stramin net (2 m diameter ring, mesh aperture 1 mm) and with Bongo sampler (60 cm diameter ring, mesh aperture 0.5 mm) was made in July at the Standard Oceanographic Sections in Davis Strait from Fylla Bank to Egedesminde, in the area west of Disco, and in Disco Bay. Half hour oblique hauls were made from about 50 m depth. The catches have been analyzed by volume, fish eggs and larvae sorted out, identified and counted. The dominant zooplankters have been estimated qualitatively and quantitatively.

Institute of Genetics and Ecology, Aarhus University, Aarhus

One main project of the laboratory is the microbial cycling of nitrogen, sulfur and carbon in marine sediments. Studies are carried out in laboratory sediment systems and in shallow water estuarine sediments as well as in offshore waters in order to quantify the total mineralization in sediments and the relative importance of nitrate and sulfate reduction, methanogenesis and aerobic mineralization.

Other projects are concerned with the mechanisms of speciation, microevolution and interspecific interactions in marine sibling species. Main emphasis is on marine Gammarus in inner Danish waters and in the Baltic.

During the last years projects have been initiated to study bacterial production and turnover due to protozoan grazing in the pelagial. Finally the department contributes in a study of the ecology of the Wadden Sea.

Finland

(J. Lassig)

Institute of Marine Research, Helsinki

Intense studies on phytoplankton, primary production, chlorophyll a and related parameters were carried out in the western part of the Gulf of Finland. Monitoring of the above parameters was continued in the entire Baltic Sea according to the Baltic Monitoring Programme (Helsinki Commission).

Zooplankton was sampled at coastal stations in the Gulf of Finland, the Archipelago Sea, and the Bothnian Bay. Zooplankton monitoring was continued in the entire Baltic Sea according to the Baltic Monitoring Programme.

Benthic macrofauna communities were studied in the deep areas of the Baltic Sea. The stations of the Baltic Monitoring Programme were included in the survey.

The production and decomposition of organic matter in the pelagial were studied in the Gulf of Finland in cooperation with Ivärminne Zoological Station of the University of Helsinki.

Institute of Radiation Protection, Helsinki

Studies on phytoplankton, chlorophyll *a*, primary production, and zoobenthos were carried out in the vicinity of two nuclear power plants, one in the Gulf of Finland and one in the Bothnian Sea.

National Board of Waters, Water Research Office, Helsinki

The influence of industrial pollution on the composition of benthic macrofauna was studied at several localities along the coast in the Gulf of Finland, and in the Gulf of Bothnia.

Phytoplankton primary production, chlorophyll *a* and phytoplankton were measured at coastal stations in both polluted and unpolluted areas of the Gulf of Finland and the Gulf of Bothnia. Special investigations were performed off several residential areas.

Causes and effects of the decrease of *Fucus vesiculosus* were studied in the Archipelago Sea and the Gulf of Finland.

Water Conservation Laboratory of Helsinki City

Monitoring of phytoplankton, primary production, chlorophyll *a*, bacteria, and benthic macrofauna was continued in the sea area of Helsinki and Espoo.

Bioassays for growth-limiting nutrients were carried out using natural phytoplankton populations and *Chlorella* sp.

Ivärminne Zoological Station, University of Helsinki

The research carried out at the station included a broad spectrum of studies on brackish-water ecology, dealing with different compartments of the ecosystem, studies on basic physiology of brackish-water animals, population genetics of Baltic molluscs, and effects of pollutants on coastal species.

Husö Biological Station, Åbo Akademi

Pelagic production ecology was studied in coastal inlets in the Archipelago of Åland. Macrobenthos samples were taken at several fixed stations in the same region.

Archipelago Research Institute, University of Turku

The work at the station included basic research on the ecosystem of archipelago waters, eg. production ecology of zooplankton and population dynamics of typical coastal species. [Examples of applied research were studies of fouling as well as effects on biocenoses caused by man. Studies on the effects of aquaculture on the environment were started.

Perämeri Research Station, University of Oulu

A base-line survey of meiofauna and studies on the population dynamics of benthic macrofauna were continued.

France

(N. Lacroix)

MINISTÈRE DE LA MER

INSTITUT SCIENTIFIQUE ET TECHNIQUE DES PECHES MARITIMES (ISTPM)

. Recherche au niveau de la gestion des stocks halieutiques : étude de l'ichthyoplancton pour la détermination des stocks de géniteurs. Participation aux travaux internationaux en ce qui concerne les larves de hareng en mer du Nord.

. Structure et évolution d'une fraction des peuplements zooplanctoniques, essentiellement oeufs et larves d'espèces exploitable (crustacés et poissons) en relation avec l'installation sur le littoral de centrales électriques de grande puissance. Les secteurs étudiés comprennent les côtes de sud de la mer du Nord, de la Manche et du nord du golfe de Gascogne.

. Etude de la production phytoplanctonique et de la biomasse bactérienne du bassin de Marennes-Oléron (zone estuarienne du golfe de Gascogne). Valeur nutritive du milieu pour les mollusques.

. Bilan des phénomènes d'eaux colorées et des perturbations observées dans le phytoplancton côtier du littoral français.

. Etudes sur l'utilisation des cultures d'algues marines unicellulaires en écotoxicologie en vue d'une normalisation ISO.

. Recherche d'un test de toxicité normalisé utilisant un micro-crustacé marin (copépode).

CENTRE NATIONAL POUR L'EXPLOITATION DES OCEANS (CNEXO)

. Ecosystème benthique profond : analyse des possibilités de réaction de l'écosystème à une perturbation, voies d'échange et bilan énergétique des populations de l'interface eau-sédiment.

- . Ecosystème pélagique : étude des processus de production à partir de l'utilisation du matériel organique particulaire par le zooplancton et sous l'influence des structures physiques.
- . Etude de l'écosystème pélagique du front thermo-halin Liguro-provençal ; étude du cycle annuel des populations planctoniques des côtes nord-Finistère ; étude des fronts thermiques en mer d'Iroise : programme SATIR.
- . Communautés liées à l'hydrothermalisme sous-marin : aspects descriptifs et fonctionnels : liaisons entre les rythmes biologiques et celui des émissions hydrothermales.

UNIVERSITE DE PROVENCE - AIX MARSEILLE

Laboratoire de Biologie animale (plancton) Marseille

- . Etude infraspécifique des Hoplophoridés (Crustacés décapodes pélagiques) des croisières du "Dana" (1922-1930) dans l'Atlantique. Relations écologiques.
- . Ecophysiologie : poursuite des recherches ultrastructurales et cytochimiques sur la digestion et l'ovogénèse des Copépodes pélagiques.
- . Ultrastructure comparée des yeux du Chaetognathe benthique Spadella cephaloptera ; comparaison avec ceux des espèces pélagiques.
- . Etude du plancton de la mer Rouge : chaetognathes, thécosomes et euphausiacés (campagne de la Thalassa en 1977).

Station marine d'Endoume

- . Dynamique de la production organique primaire dans les systèmes d'apport nutritif directs, principalement d'origine profonde (upwelling côtiers, divergences du large) et secondairement d'origine terrestre (systèmes de dilution locaux). La dynamique des écosystèmes est analysée par le biais d'une approche théorique (modélisation faisant intervenir les données de cinétique d'assimilation du C et de N et les données hydrodynamiques). Les incidences des facteurs de pollution sur l'écosystème et les compositions du plancton marin sont examinées au moyen d'analyses statistiques.
- . Etude de l'évolution dynamique dans le temps et dans l'espace, des peuplements macrobenthiques, notamment des substrats meubles, en fonction des variations naturelles (climatiques, courantologiques, sédimentologiques ou des perturbations apportées par l'activité humaine).
- . Mise en évidence expérimentale (in vivo et in vitro) des processus biologiques et physiologiques conduisant aux déséquilibres des populations et communautés telles qu'elles sont observées dans le milieu naturel.
- . Etude des peuplements installés sur substrat dur ; inventaires, dynamique, évolution en fonction des conditions et des transformations (naturelles et dues à l'homme) du milieu.
- . Evaluation du flux d'énergie transitant dans le réseau trophique lié aux biocoenoses benthiques de fonds meubles. Relations Benthos/Pelagos - Microphytobenthos/Meiobenthos - Meiobenthos/Macrobenthos - Meio-macrobenthos/Mégabenthos vagile. Au sein du macrobenthos relations Proies/Prédateurs.

. Etude de l'activité des micro-organismes marins dans les eaux côtières et lagunaires et dans les milieux marins perturbés, au moyen de méthodes expérimentales pratiquées in situ et in vitro.

Distribution et évolution des constituants biochimiques de la matière organique dans l'eau et les sédiments marins, en relations avec l'activité biologique.

. Etude systématique, écologique et dynamique de la phase embryonnaire et larvaire des téléostéens en milieu naturel. Transferts d'énergie à partir du comportement alimentaire, des besoins nutritionnels et des rendements énergétiques Etude éco-physiologique : adaptations enzymatiques, rythmes alimentaires et équilibre hydrominéral.

. Systématique évolutive d'invertébrés (Spongiaires, Brachiopodes, Phoronidiens) basée sur la taxonomie, l'écologie et la cytologie comparée des formes actuelles, et leurs relations avec des formes fossiles apparentées. Interactions entre hôte et parasite dans une association de type parasitaire.

UNIVERSITE DE NANTES

Laboratoire de Biologie de Nantes

. Etude du fonctionnement d'un écosystème estuarien (Loire). Distributions saisonnières de l'ichthyofaune reliées aux conditions hydrologiques du fleuve.

. Mise en évidence d'un certain nombre de corrélations entre les compositions qualitatives et quantitatives des divers peuplements des grandes vasières estuariennes avant modification du milieu par des travaux d'aménagement.

. Etude des écosystèmes littoraux (dont marais littoraux).

. Recherches dans la zone ostréicole de la baie de Bourgneuf : identification du phytoplancton et du microphytobenthos. Culture de diatomées (en laboratoire) pour la nourriture des huîtres. Cycle annuel du phytoplancton dans la baie de Bourgneuf et recherches sur la fertilité potentielle de ces eaux.

UNIVERSITE DE BRETAGNE OCCIDENTALE

Laboratoire d'Océanographie biologique, Brest

. Recherches sur la connaissance de l'écosystème côtier et de son fonctionnement : étude du benthos de la plate forme continentale nord-Gascogne, recherches sur la macrofaune, le microphytobenthos et le meiobenthos. Ce secteur fait l'objet d'un suivi écologique à long terme afin de comprendre le fonctionnement normal de l'écosystème benthique et de dégager les fluctuations temporelles.

. Recherches sur le pélagos. Les études sont réalisées dans la zone du front thermique ouest-Bretagne. Confrontation des données de terrain avec les résultats de télédétection satellitaire (programme SATIR).

UNIVERSITE PIERRE ET MARIE CURIE - Paris

Laboratoire Arago, Banuyls-sur-Mer

. Etude de l'écosystème pélagique :

- production primaire pélagique : structure et rendements des communautés phytoplanctoniques naturelles du point de vue de l'assimilation du carbone : utilisation de la lumière - efficacité du système pigmentaire - rôle des éléments nutritionnels et des vitamines. Cette approche vise à définir avec précision les éléments limitant la photosynthèse pélagique dans les régions de remontée d'eau profonde et les zones de divergences :

- production secondaire pélagique : bilan énergétique au niveau trophique. Structure quantitative et qualitative des communautés de copépodes pélagiques dans différentes aires géographique: recherches de constantes écologiques - indice de stabilité des biomasses - constitution élémentaire - valeur calorifique - détermination des conditions trophiques et de l'état des communautés - étude fine des différents paramètres de la production secondaire en zone néritique : dynamique de population et production, respiration, croissance et reproduction.

. Etude de la structure et du fonctionnement de l'écosystème benthique. Production, bilan et flux énergétique aux différents échelons. Dynamique des populations des espèces principales et cycles biologiques *in situ*. Budgets énergétiques - Relations eau surnageante - sédiments - matière organique - bactéries - mangeurs de dépôts et filtreurs. Relations meiofaune - prédateurs.

. Recherches en biologie cellulaire. Cytologie ultrastructurale des Dinoflagellés libres et parasites.

Station marine de Villefranche-sur-Mer

. Etude de la dynamique des populations en microécosystèmes ;

biologie et écophysiologie du zooplancton et du phytoplancton ;

recherche sur les complexants d'origine planctonique dans l'eau de mer ;

acquisition et traitement statistiques des données océanographiques ;

biochimie des transferts trophiques ;

écologie du microzooplancton ;

reproduction des organismes marins ;

Station biologique de Roscoff

. Etude des écosystèmes benthiques de la Manche en conditions naturelles ou perturbées.

. Etude d'écosystèmes littoraux et estuariens (baie de Morlaix) : rôle du phytoplancton, du microphytobenthos, des bactéries, du microbiotecton et de la meiofaune.

- . Etude des acides gras des microvibrions marins.
- . Etude comparée de chlorophycées marines des côtes françaises se rattachant aux genres Ulothrix et Urospora. Les résultats obtenu portent sur les modalités de reproduction en fonction des facteurs du milieu.
- . Etudes des peuplements d'algues benthiques de la Manche et de l'Atlantique-nord.

UNIVERSITE DES SCIENCES ET TECHNIQUES DE LILLE

Station marine de Wimereux

- . Etude de l'hydrobiologie du détroit du Pas-de-Calais, connaissances physicochimiques et productivités pélagiques (phyto- et zooplancton). Etude des peuplements benthiques.
- . Recherches molysmologiques dans les zones littorales proches de Calais - Dunkerque (Manche orientale).
- . Etude de la nocivité de différents polluants sur les chaînes alimentaires.

AUTRES ETABLISSEMENTS

COLLEGE DE FRANCE

Laboratoire de Biologie marine - Concarneau

- . Alimentation des principales espèces benthiques d'intérêt économique (morue, lieu noir, églefin, merlan, cardine) dans la zone géographique comprise entre les Shetland et le golfe de Gascogne.

INSTITUT OCEANOGRAPHIQUE: Paris

- . Etude de la toxicité de différents hydrocarbures aromatiques polynucléaires sur le plancton.
- . Recherches sur les processus d'adaptation à la lumière chez les copépodes marins, (Pontellidés). Influence du facteur lumière sur les migrations verticales de ces espèces.
- . Recherches photochimiques : étude de la phototransformation de certaines des fractions de la matière organique dissoute des eaux de mer.

German Democratic Republic

Ref. seperate report.

Federal Republic of Germany

(J. Lenz)

Institut für Meereskunde an der Universität Kiel

The Institute with its 5 biological departments is engaged in a great number of activities falling into the scope of biological oceanography. After running for almost a decade, the 'Sonderforschungsbereich (SfB) 95', came to an end in 1982. This interdisciplinary group of research scientists from Kiel University concentrated their work on the biological, physical and chemical processes governing the interaction between water column and sediment surface. Though permanent station 'Boknis Eck' in the western Kiel Bight, Western Baltic, formed the main study site, the group's activities extended to subtropical and tropical regions and even to Antarctica. The following enumeration of recent and current research activities of the Institute is grouped under pelagic and benthic zones of the sea.

Planktological investigations

A study on the ecological role of *Aurelia aurita* in Kiel Bight with special emphasis on its metabolic rate and contribution to the pelagic and benthic food web through production of a great number of protein-rich planulae larvae was initiated. Another study dealt with the reproduction of the copepod *Dithona similis* in autumn and winter. In connection with experimental work on oil pollution effects in phytoplankton, an annual cycle of primary production, separated into nanoplankton and net plankton was measured in Kiel Fjord.

Neuston films observed in Kiel Fjord were investigated for their microbial populations during the course of a year. The significance of pelagic bacteria as food organisms for proto- and microzooplankton was investigated by analysis of water samples and experimental work with bacteria populations marked with a radio tracer.

Eutrophication studies were carried out in close cooperation between planktologists and microbiologists in the Schlei Fjord, Western Baltic. A joint cruise with RV "Poseidon" from Kiel to the Gulf of Bothnia in August/September focussed on population characteristics of bacteria and phytoplankton in different water masses of the Baltic in dependence on physical and chemical environmental conditions.

During another cruise of RV "Poseidon" to the Baltic Proper in May, an intensive planktological sampling programme was carried out at the Bosex Station in the Gotland Sea, the aim being to investigate the fate of the phytoplankton spring bloom with special emphasis on its downward transport.

An atlas of satellite photos of the Baltic Sea was prepared to demonstrate the dependence of phytoplankton distribution on hydrographic features in this area.

An experimental study on the natural fluorescence of phytoplankton as a possible signal for use in satellites was started by sampling ground truth data in conjunction with aerial observations in Kiel Bight.

In the Wadden Sea area of the North Sea close to the Island of Sylt, the typical mass development of the haptophycean alga Phaeocystis pouchetii and its influence on the dominating copepod species Acartia ssp. and Iemora longicorins were investigated.

Studies on the abundance of fish larvae and their food supply in form of zooplankton biomass were carried out in Kiel Bight, the North Sea and the North Atlantic west of Ireland. The latter two programmes were part of international surveys within the framework of ICES.

Benthological investigations

A biomass survey of benthic macroalgae in Kiel Bight with an estimation of their contribution to primary production in the area was completed. The influence of a sedimented phytoplankton spring bloom on microbial activity and metabolic rates in the sediment was investigated at Boknis Eck, Kiel Bight. At the same place, a regular monitoring of the macrobenthos community was carried out.

A special study dealt with the recolonization of the deeper parts of Kiel Bight, which suffered from a severe oxygen depletion in the autumn of 1981.

Another area of study were tidal flats in the River Elbe estuary where biomass, species composition and primary productivity of benthic microalgae were measured during an annual cycle.

Another project focussed on the interaction and food relationships of phyto- and zoobenthos at several experimental stations on North Sea tidal flats in the vicinity of the Island of Sylt. The measurement of in-situ respiration in different containers together with laboratory measurements of single components of various benthic communities lead to computations of energy budgets on an annual basis.

Zoologisches Institut, Universität Kiel

Marine research focusses mainly on the structure and response of benthic communities to varying environmental conditions.

The main place of investigation is the highly polluted Flensburg Fjord, Western Baltic, where the influence on the benthos fauna of organic enrichment of the sediment and oxygen depletion is closely studied. Monitoring sampling programmes are combined with experimental field work to study the behaviour and reaction of the fauna exposed to these environmental conditions in the fjord. The distribution and ecology of Asteria rubens and Metridium senile was studied in detail.

Another field of research are the special adaptation mechanisms of those animals able to colonize the extreme environment of the supralittoral 'Black Zone' on rocky shores.

Experimental work on the biology and behaviour of benthic amphipoda as well as on the life cycle of Crangon crangon with special emphasis on their larvae supplement the marine studies.

Biologische Anstalt Helgoland

Routine measurements of hydrographical, chemical and biological parameters have been continued at Helgoland Roads ($54^{\circ} 11,3' N$ $07^{\circ} 54,0' E$). Five times a week, temperature, salinity, nutrients (PO_4 , NO_3 , NO_2 , NH_4 , SiO_2), yellow substances ('Gelbstoff') and biomass as organic carbon, derived from microscopic counts (inverted microscope), were measured. In addition once a week, bacterial numbers (Pour plate method) in the surface film and at a depth of 1 m were determined and BOD, TOC and surface tension measured. In the 1 m samples also luminescent bacteria, yeasts and oil degrading microorganisms were counted.

Monthly cruises from Helgoland to the estuaries of the Elbe River, the Eider River, and the Weser River for hydrographical, chemical and biological investigations have been continued.

The long-term ecological studies on seasonal and spatial distribution of *Noctiluca miliaris* in the German Bight have been continued. Seasonal fluctuations and annual abundance of this dominant dinoflagellate have now continuously been recorded over a period of 14 years at Helgoland Roads.

Horizontal and vertical distribution of seston and plankton was measured in the German Bight east of $6^{\circ} 25' E$ and south of $55^{\circ} 10' N$. During a cruise of RV 'Valdivia' (University of Hamburg) from 17 to 28 August, 1982, 60 stations (10 nautical miles apart) were visited twice - before and after a storm. Suspended particulate matter and its organic component as well as phytoplankton stocks were measured in vertical casts.

The ecological studies in the Königshafen (Northern Wadden Sea of Sylt, German Bight) were carried on. Several times a year, phytoplankton, mesozooplankton, seston components together with hydrographical and chemical parameters (temperature, salinity, phytoplankton nutrients, oxygen) were measured during the course of a tide.

Institut für Hydrobiologie und Fischereiwissenschaften, Universität Hamburg

Studies on estuarine plankton communities are part of the long-term research activities of the Institute.

In 1981, an intensive field sampling programme combined with experimental work was initiated in the Schlei Fjord, Western Baltic. This programme deals with the population dynamics of two dominating copepod species, *Eurytemora affinis* and *Acartia tonsa*, in relation to seasonal changes in the environment and predation pressure. The general aim is to evaluate the interrelation between the invertebrate and the larval fish populations in this highly eutrophic fjord.

Institut für Meeresgeologie und Meeresbiologie des Forschungsinstitutes Senckenberg, Wilhelmshaven

Biological work of the Institute concentrates on studying benthos communities especially in onshore areas of the German Bight, North Sea.

Macrofauna abundance, distribution, diversity, fluctuation and population dynamics were studied in fore-shore sediments off the Island of Norderney by means of monthly samples taken at 9 stations of different depths. A similar sampling programme focusing on the endobenthic community in the transition zone between salt marsh and tidal flat environments was carried out at the Island of Mellum where core samples were taken at 3 stations at monthly intervals.

Biological monitoring using a 2 m beam trawl for dredging was carried out in the Jade Bay by visiting 9 stations at monthly intervals.

Since 1967, annual samples are taken south of Helgoland to study long-term changes in the bottom fauna community. In addition, grab and dredge samples were collected from the Steingrund north-east of Helgoland.

Special studies concentrate on population dynamics of the 3 mollusc species Ensis directus, Cerastoderma edule and Mytilus edulis by monthly measurements.

Remark

No response to our request for contributions was received from 50% of the institutions or heads of departments concerned with marine research in the field of biological oceanography. For this reason, the report is not a complete one.

Iceland

(Th. Thórdardóttir and I. Hallgrímsson)

Phytoplankton

As in previous years primary productivity (P_{max}) and Chl a measurements were carried out in both coastal and oceanic waters around Iceland during May-June and August. During 13-15 April and 6-12 May the measurements of primary productivity and Chl a in connection with investigations on spawning and hatching of the main fish stocks were limited to the shallow grounds off the southwest coast (Selvogsbanki and Faxaflói). By working a dense station grid particular attention was paid to the effect of dilution by run off from land on the standing stocks of plants and animals.

Two surveys were undertaken to get further information on the annual cycle of primary productivity in the different areas around Iceland. The first survey (14-28 April) was to areas off the north and east coasts and the second one (7-18 Sept.) to the area south and west of Iceland. Weekly sampling of surface water for CHL a measurements in Isafjardardjúp and at Grímsey were continued for the third year.

Benthic algae

Since 1976 research on benthic algae has been carried out at the Marine Research Institute. The investigations have been connected with the utilisation of algae in Breidafjörður, NV-Iceland. Last year the regrowth of Ascophyllum nodosum after harvesting was studied and measurements were made on the growth pattern of Laminaria spp.

Zooplankton

From April to June regular zooplankton sampling was carried out in Icelandic waters both inshore and offshore; totally 670 stations were worked. These surveys were in general continuation of previous sampling and included observations of fish eggs and larvae as well as shrimp larvae.

The sampling were carried out with Hensen and Juday nets, Icelandic High Speed Samplers and Gulf III samplers. Furthermore, experimental zooplankton pumping from various depths was worked.

As previously fish larvae sampling was also carried out in spring in the Irminger Sea and in East-Greenland waters.

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.

Ireland

(Prof. B. Mck. Bary and Dr. M.M. Parker)

1. Phytoplankton.

Studies of phytoplankton population and related physiochemical features, especially in relation to exceptional blooms were carried out in 1982 on the West Coast by the Shellfish Research Laboratory (Carna, Co. Galway), and the West and Southwest Coasts by the Department of Oceanography at University College, Galway. The latter also include research into primary productivity in the differing environmental conditions encountered (C.Res. 1980/2:29). The effects of dinoflagellate blooms on rocky shore organisms are being

studied by the Zoology Department at University College, Cork. At a fish-farm site in Dunmanus Bay on the South-west Coast, the Department of Fisheries ran a study on the development of exceptional blooms of *Gyrodinium aureolum* and their effects on caged fish. It is hoped that reports of these activities will be available for the Special Meeting on Exceptional Marine Blooms in 1984 (C.Res. 1982/2:1). The need for improved diagnostic keys, especially to the dinoflagellates is considered urgent (c.f. C.Res. 1982/1:6).

2. Benthos (C.Res. 1981/2:6, 1982/2:15)

The Benthos Research Team at the Zoology Department, University College, Galway is continuing extensive and intensive studies of both hard and soft bottom communities in Galway Bay and Kinsale, with particular attention being paid to the biology and autecology of key species. The team is participating in the EEC's Cost 47 project on coastal benthic ecology. The Microbiology Department at UCC is continuing study on heterotrophic oxygen uptake at the seabed. At University College, Cork the Zoology Department is studying Cyclic Phenomena in rocky shore biota and the ecology of the benthos in the unique enclosed marine lake, Lough Hyne. Also in Cork Harbour, a study on intertidal meiofauna dynamics, funded by the Department of Fisheries, is nearing completion.

Benthos surveys by the Department of Fisheries form part of the monitoring programme for marine waste disposal sites; this is reported on further in the Administrative Report of MEQC.

3. Other relevant work in progress

Simultaneously with phytoplankton sampling, the Oceanography Department at University College, Galway carries out zooplankton sampling. In particular studies of population fluctuation, an environmental relations of *Calanus finmarchicus* and *C. helgolandicus*, of occurrences of fish larvae in oceanic and neritic waters, and of planktonic indicators of two-way flow through a strait are in progress.

Netherlands

(J.J. Zijlstra)

Fisheries laboratory, IJmuiden

Phytoplankton studies

Phytoplankton investigations in the Dutch coastal area were continued in 1982.

The springbloom, characterized by a high species diversity of the diatoms, was followed by dominance of the Haptophyceae : Phaeocystis pouchetti.

In the early summer a moderate bloom of Rhizosolenia delicatula was observed, but the abundance stayed at a much lower level that had been recorded for the period 1976-1981.

After a poor period for phytoplankton in July, the second development by Rhizosolenia delicatula in September was accompanied by Dinophysis acuminata. The observed maximum cell number of this toxic dinoflagellate never exceeded 2000/l. This concentration appeared to have been too low to infest mussels from the Dutch Wadden Sea for consumption.

Stomach content studies

After the large scale sampling programme of fish stomachs in 1981, it took most of 1982 to make up arrears in the analysis of the 10 000 cod stomachs collected and in the input of the data in the computer. In addition much time has been spent in the development of software to analyse the data and the first results are becoming available.

Further studies have been made on the occurrence of cod and plaice eggs in herring stomachs. Some 1500 stomachs were collected during the ICES Young Fish Survey in February over a wide area in the North Sea. It is planned to use the estimated egg consumption rates in connection with the distribution of herring and estimates of egg production to make a quantitative estimate of the egg predation rate at the population level.

Netherlands Institute for Sea Research (NIOZ), Texel

Studies were mainly concentrated on the dynamics of the lower part of the food web, with special attention to the carbon budget, primary production, zooplankton, microbiology, and the benthic fauna. In some cases larval and immature fish were considered in the systems studied, in addition to birds. Geographically the investigations were concentrated in three areas, i.e. the Wadden Sea, the eastern part of the central North Sea and the northequatorial current in the tropical Atlantic.

In the western part of the Wadden Sea an attempt was made to determine spatial differences, along an axis perpendicular to the coast, in the primary production rate in the course of the year, in relation to nutrient concentrations and light conditions. Long-term investigations on the population dynamics of benthic invertebrates on a tidal flat were continued, and extended by studies on the predation-pressure on that fauna exerted by wading birds. These investigations, covering a period of 14 consecutive years were supplemented by a survey of the subtidal benthic macrofauna of the western Wadden Sea. A special study was devoted to the effect of oil-pollution on the benthic community of a tidal flat, by introducing oil on experimentally controlled indoor tidal flat systems.

Investigations on the population-dynamics of juvenile plaice in the western Wadden Sea concentrated on the effect of jellyfish predation on the abundance of late larval stages, entering the area between March and May.

The data collected during a special project of 10-years duration in the Ems-Dollard estuary, were utilized to model the ecosystem, which is heavily polluted by organic waste from agricultural industries.

In the North Sea research efforts during 1981 and 1982 were concentrated on the physical, chemical and biological properties of an area in the eastern part of the central North Sea, where summer stratification occurs. The physical studies tried to analyze the factors responsible for the wax and wane of the stratification in the area, whereas the chemical and biological investigations were extended to assess the consequences of stratification. The studies included changes in nutrient levels, primary production, pigment characteristics, bacterial counts, biomass and activity, zooplankton and composition and activity of the benthic system. Special attention was devoted to a frontal zone along the southern edge of the stratified area, where strong gradients in sediment characteristics and in the benthic fauna were observed. The relationship between the pelagic tidal front and the observed gradients in the benthic system will be an important subject for the future studies.

In March 1982 an integrated study was made of the pelagic ecosystem (upper 300 meters) in the eastern part of the north-equatorial current (20°NL , between 18° - 40°WL). These investigations are a follow-up of earlier studies in the same area in 1977 and 1978 and are directed on analyzing the carbon-budget in a permanently stratified oligotrophic part of the ocean. The studies include a.o. CTD- and nutrient observations, primary production estimates, algal assemblage, size-spectrum of algae, the presence of cyanobacteria, microbiological characteristics and micro- and macro-zooplankton and nekton studies. During the 1982-exercise the dynamics of the system were followed during three 6-day periods, in which the ship remained in an area marked by drifter buoys.

Delta Institute for Hydrobiological Research, Yerseke

Ecosystem-studies in Lake Grevelingen, an enclosed salt-water basin in the southwestern part of the Netherlands, were continued. The lake has been created by damming a large tidal inlet in 1971. Studies since that period were directed at describing and analyzing the changes resulting from engineering works. The investigations included primary production and food-chain studies and are set up to conduct a carbon budget. Changes occurring in the lake are mainly due to the extinction of tidal movements, but also partly because of larger salinity-fluctuations since the construction of the enclosing dam. A spectacular result of the engineering work was the appearance and subsequent growth of sea-grass fields.

A similar study was started in the eastern Scheldt area, situated in the same general area. Here base-lines studies were made to provide a picture of the present situation, which will be compared to changes occurring after the construction of storm-surge barrier, planned for 1986.

Norway

Ref. separate report.

Poland

(K. Siudziński)

Sea Fisheries Institute, Gdynia

Baltic

In 1982 plankton and benthos studies were continued as follows:

1. P h y t o p l a n k t o n
 - Study of seasonal changes of primary production and distribution of chlorophyll in the Gdańsk Bay.
 - Seasonal changes of vertical distribution, abundance and phytoplankton species composition in euphotic layers of Gdańsk Bay.
 - Diurnal fluctuations of phytoplankton biomass.
2. Z o o p l a n k t o n
 - Seasonal changes of the vertical distribution and composition of mezozooplankton in the Gdańsk Bay.
 - Diurnal fluctuations of zooplankton concentrations at the Gdańsk Deep.
 - Seasonal structure of ichthyoplankton community of the Polish economic zone.
3. M a c r o b e n t h o s
 - Structure of benthic macrofauna communities in the Gulf of Gdańsk.
 - Energetic value of Mesidotea entomon in the Gulf of Gdańsk.
 - An attempt to estimate the influence of fish farming in cages on the bottom fauna in the Jama Kuznicka/Puck Bay/.
4. E x p e r i m e n t a l s t u d i e s
 - Influence of different hydrocarbons /oils/ on some Baltic animals /Bioassays/.

Most of effort during 1982 was devoted to data analysis of the July's 1981 cruise of r/v "Professor Siedlecki" within the whole Polish economic zone. 35 research papers are included in the "Cruise Report" named "The health of Polish Fishery Zone".

Antarctic

In 1982 the "Food conditions for herbivorous filter-feeding zooplankton in the Southern Drake Passage and in the Bransfield Strait in summer season 1981" was elaborated.

- Formation of antarctic krill Euphausia superba concentration in relation to social behaviour and hydrodynamic processes.
- Form of antarctic krill Euphausia superba aggregations.

Institute of Oceanography of the Gdańsk University

- Changes in sea shore biocenosis zone Gulf of Gdańsk.
- Influence of chosen physiological and chemical factors on production processes of Baltic algae.
- Oceanographic investigations of Hornsund /South Spitsbergen/.
- Ecophysiological processes /respiration, production, assimilation, filtration/ of some Baltic Crustacea and Mollusca.

Institute of Fisheries Oceanography of Agriculture Academy in Szczecin

- body length and weight of the dominant copepod species in the southern Baltic Sea.
- relationship between body volume and length of marine Cladocera in the eastern sector of the southern Baltic Sea.
- distribution and composition of meiofauna in the southern Baltic Sea.
- in the material of r/v "Professor Siedlecki" cruise in 1981 new species of bottom copepods for the southern Baltic Sea fauna: Robertqurneya spinulosa Sars, 1911 and Amphiascoides dobilis Giesbrecht, 1881, were found.

Portugal

(T. Neto)

INSTITUTIO NACIONAL DE INVESTIGAÇÃO DAS PESCAS: Lisboa

Upkeep of the phytoplankton cultures stock (phytoflagellates, diatoms, dinoflagellates, chlorophyceae); development of 10 to 100 litre monoalgal cultures to feed the zooplankton cultures (Ma. A.M. Sampayo et al.).

Studies on physiological aspects of some phytoflagellates (Ma. A.M. Sampayo).

Studies on the nutritional value of the phytoplankton cultures (Ma. A.M. Sampayo, M.F.G. Martins and V. Brotas G.).

Study on a Noctiluca scintillans red water event on the Algarve coast July 1982 (Ma. A.M. Sampayo and Ma. J. Brogueira).

Phytoplankton studies on Cascais Bay (Ma. A.M. Sampayo and Ma. T. Moita).

Study of the primary productivity off the Portuguese coast during 1981 (M.E. Mergulhao and Ma. G. Vilarinho).

Study of the phytoplankton caught by the N.E. "Noruega" during 1981 off the Portuguese coast (Ma. C. Monteiro).

Upkeep of the zooplankton cultures stock (Copepods and rotifers) (Ma. H. Vilela et al.).

Study of phytoplankton integrated in the program "Environmental study of the Tagus estuary" coordinated by Comissao Nacional do Ambiente (Ma. T. Moita).

Production experiments with the rotifer Brachionus plicatilis feeding on sole alive microalgae and on fresh and lyophilized baker's yeast in association with microalgae, in five and twelve litre aquaria respectively (Ma. H. Vilela).

Food quality essay with Tigriopus brevicornis in fifteen litre aquaria, using sole Platymonas suecica and this microalga associated with baker's yeast, artificial food fish and terrestrial vegetables (Ma. H. Vilela). Cyst processing and hatching efficiency of Artemia from several Portuguese salt ponds (Ma. H. Vilela and L.F. Narciso).

Red water studies in the Portuguese coast (Ma. T. Moita and M.E. Cunha).

Study on the distribution of zooplankton collected by the N.E. "Noruega" off Madeira in June and November/December, 1982 (M.E. Cunha).

Zooplankton community analysis of Ria de Faro-Olhão (1980)(M.E. Cunha).

Study of ichthyoplankton related with Sardina pilchardus (W.) spawning and breeding areas between Cabos Espichel and Sardo (Ma. H. Afonso, Ma. F. Quintela, Ma. T. Rodrigues and F. Varela).

Study of fish eggs and larvae collected by N.E. "Noruega" off the Portuguese coast during 1981 (A. Farinha and I. Menezes).

Study of zooplankton collected by the N.E. "Noruega" with a WP-2 net along the coast of Portugal in 1979 and 1980 (I. de Paiva and T. Neto).

Studies of the population dynamics of three rocky intertidal species: Patella vulgata, P. depressa and P. aspera.

Study of Gibulla and Monodonta species of the portuguese coast (M. Guerra and Ma. J. Gaudêncio).

Spain

(E. López-Jamar)

Instituto Español de Oceanografía, La Coruña.

A) PHYTOPLANKTON AND PRIMARY PRODUCTION.

- 1) Red tide monitoring program (Instituto Español de Oceanografía, La Coruña and Vigo Laboratories).

This program continues the activities on isolation and culture of presumably toxic species. Sampling is periodic during the whole year: monthly in winter, biweekly from March until May, and weekly (sometimes daily) in summer and autumn. The areas studied are the Rías of Ares y Betanzos, Muros, Arosa, Pontevedra and Vigo.

- 2) Cooperative program "Biological Investigations in the Galician Rías".

This study deals with the relationships between coastal upwelling and primary production, as well as succession and composition of phytoplankton communities. The effect of the intense mussel culture on the phytoplankton is also being studied.

B) ZOOPLANKTON

- 1) Cooperative program "Biological Investigations in the Galician Rías".

(Instituto Español de Oceanografía, La Coruña and Laboratories).

A study of the secondary production of zooplankton was carried out on the Galician Shelf (from Cape Finisterre to the Ría de Vigo). Filtration rates were estimated using three different methods: cell number decrease, chlorophyll decrease and C^{14} . Respiration rates were also estimated. Species composition and biomass (micro and macrozooplankton) were studied. A study on seasonal and spatial variation of zooplankton in La Coruña Bay was recently started.

- 2) Zooplankton in the Ría de Huelva (SW Spain) (Instituto Español de Oceanografía, Málaga Laboratory):

The zooplankton communities of the Ría de Huelva were studied, as a part of a more general investigation of the contamination in this area. Diversity is usually low (minimum values of $H' = 0.28$). The copepod Acartia grani dominated in the polluted inner Ría.

C) BENTHOS.

- 1) Infaunal benthos (Instituto Español de Oceanografía, La Coruña and Málaga Laboratories).

The COST 47 program, which deals with long-term variations of benthic communities, is being continued. Two Amphiura communities (Amphiura filiformis and Amphiura chiajei - Maldane glebifex) are studied, and the dynamics of these three species are followed.

A study on the infaunal benthos of La Coruña Bay has recently started. The bivalve Thyasira flexusa is dominant in the harbour area (ca. 20,000 individuals m^{-2}). The sand community outside the harbour is a Hyalinoecia bilineata - Abra alba community.

A study of the infaunal benthos of the Ría de Huelva was realized. In the very polluted sediments of the inner Ría, the polychaete Nereis diversicolor is the only infaunal organism present. There is an increasing diversity gradient from the inner to the outer Ría.

- 2) Megabenthos (fish and crustaceans) (Instituto Español de Oceanografía, Vigo and La Coruña Laboratories).

Spatial and temporal variation of the megabenthic communities (fish and crustaceans) of three Galician Rías (Arosa, Muros and Pontevedra) was studied, estimating the factors affecting their distribution and abundance.

Sweden

(R. Rosenberg)

FISHERY BOARD OF SWEDEN - INSTITUTE OF MARINE RESEARCH

In last years report research activities at different institutes were presented. During 1982 the effects of eutrophication in the Baltic and in the Sound, the Kattegat and the Skagerrak have

been discussed by the marine scientific community and administrators at a number of meetings in Sweden. The Swedish Environmental Protection Board has recently decided to give economical support to a scientific project for four years starting in 1983. The research activities will be concentrated in two eutrophication gradients, one in the Baltic and one in the Kattegat. A detailed programme will be presented later in 1983.

UNITED KINGDOM

1. England

(J.D. Riley)

MAFF Fisheries Laboratory, Lowestoft.

1. A new encased plankton sampler, 75 cm diameter, 2.75 m long and fitted with a conical nose cone, is now operational. Flowmeters of new design have been calibrated and are interfaced with the "Guildline" CTD underwater sensing units multiplexing system. The acceptance characteristics and flowmeter calibrations for this and other tow nets, including the Dutch and Scottish modified Gulf III's are being prepared for publication.

2. Larval distribution and abundance estimates were made on several fish stocks using high speed townets in double oblique hauls.

(a) In January-February the abundance of young herring larvae was measured in areas VIIId and IVc as part of an ICES programme. Patches of only moderate densities were described in the extreme eastern end of the English Channel and in the centre of the Southern Bight.

(b) In two cruises in August-September the distribution of yolk sac herring larvae off the English NE coast was used to pinpoint spawning areas.

(c) In October, the western part of the central North Sea was surveyed, again as part of an ICES programme, to measure the larval abundance of the autumn spawning stock. Up to 300 larvae < 10 mm long were taken at stations inshore between Bridlington Bay and Whitby.

(d) Three cruises between 5 April and 7 July completed 5 survey grids in the Irish Sea to describe the distribution and daily production of young Nephrops norvegicus larvae. All showed peak production centres located 25-60 Km NE or E of Dublin Bay. Sample analysis for eggs and larvae of other species is in progress.

3. Distribution and abundance data were obtained from two additional cruises:

(a) In late February a partial survey of the western English Channel was made to extend the seasonal cover achieved by the 1981 surveys for the spawning of Solea solea, Dicentrarchus labrax and Sprattus sprattus. Problems arose in the distinction between S. solea and Microchirus variagatus eggs. Eggs of

M. variagatus will be reared under controlled conditions at the earliest opportunity, to confirm the identification features used.

(b) A grid of stations in the Celtic Sea based on the ICES rectangles of areas VII E-H were sampled in late June, to compare the ichthyoplankton with a simultaneous ground fish survey and to describe the fish spawning areas in this relatively little studied sea.

4. Spawning behaviour of plaice was studied in the Southern Bight in January by intense sampling of Stage 1A eggs. In a period 6-16 January prior to peak spawning, little change in the abundance of 1A eggs was recorded over the period which included a full moon on 9 January. Sampling hourly for 24 h at the centre of spawning did not demonstrate a diurnal pattern of spawning, measured as the abundance of very young eggs (up to 16 cell stage).

Department of Marine Biology

Marine Science Laboratories, Menai Bridge: Wales

During 1982 members of the Department of Marine Biology at Menai Bridge have continued observations on the front, lying approximately along the line $54^{\circ}00'N$ $5^{\circ}00'W$ to $53^{\circ}25'N$ $6^{\circ}00'W$ in the Irish Sea. During six cruises of R.V. Prince Madog hydrographic sections across the front have included quantitative zooplankton hauls, bacterial counts and determinations of bacterial activity in terms of uptake of radiocarbon labelled urea and glucose. It was found that zooplankton species have different and characteristic distributions in relation to the front and that bacterial numbers are somewhat higher or above the thermocline on the stratified side of the front than elsewhere. Following the deflection of nitrate from the photic zone on the stratified side turnover rates of both urea and glucose in the region of the front are greatly enhanced. These results confirm the picture of increased rates of nutrient cycling at fronts which was indicated by previous studies on the western Irish Sea front and one in Liverpool Bay.

Institute of Oceanographic Sciences, Wormley

1. Analysis of the biological data and material collected in the vicinity of the oceanographic front to the S.W. of the Azores which is part of the eastern boundary of the $18^{\circ}C$ water has progressed steadily. The relationship between the physical structure and the distribution of chlorophyll fluorescence was studied using the undulating 'Sea Soar' instrument package. This clearly demonstrated how the sub-surface chlorophyll maximum underlay the stability maximum. Both phytoplankton standing crop and productivity were higher in the water typical of the Eastern Atlantic than in the surface waters overlying the $18^{\circ}C$ water, although they were still extremely low by temperate standards. This was also reflected in the plankton and micronekton standing crops, but there were relatively small changes in community structure despite quite marked differences in the temperature profile across the front.

2. Samples to study daytime vertical profiles of plankton and micronekton were collected during May in the Gulf of Guinea, and

a series of samples were also taken to examine the relationship between diel vertical migration and absolute light intensity. This latter series was the continuation of a long sequence of programmes carried out by IOS to examine aspects of diel vertical migration within a range of oceanic communities.

3. Studies on the benthic communities in the Porcupine Seabight region to the south-west of Ireland have continued. It is hoped that complete seasonal coverage of samples will soon be accomplished from depth ranges of 1000-4500 m, stretching from just beyond the edge of the shelf-break to the edge of the abyssal plain. Considerable amounts of data have been accumulated on the benthopelagic fish communities, the composition of the populations of benthic scavengers, and the ecology of the echinoderms, including information of biomass parameters and calorific content of a wide variety of organisms. The most notable observation made this year, was the arrival of copious quantities of phytoplankton detritus on the sea bed at depths of 2000 m within about 20 days of the start of the spring bloom. The arrival was followed using a time-lapse camera system 'Bathysnap' which is also providing information on the activities of many of the megabenthic organisms of the region. Another study nearing completion is on the structure of midwater communities within 100 m of the sea bed on the slope of the Goban Spur to the south of the Porcupine Seabight. This has shown that midwater mesopelagic species occur at high concentrations at much greater depths close to the slope than in deep water oceanic regions. Thus observations of benthopelagic fishes predating mesopelagic species may not result only from the vertical migration of these fishes up into midwater.

4. Another major study completed during the year was the description and modelling of the onset of the spring bloom over the Nympe Bank in the Celtic Sea in April 1980. A physiological model of the relationship between primary production and light irradiance has been developed, in conjunction with Dr. I. Platt of the Bedford Institute. By introducing an empirical influence of photoinhibition based on electron flow being reduced by an exponential function of irradiance, good fits of a large variety of observed photosynthesis-irradiance curves has been obtained.

5. Spectral data on the composition of the light of bioluminescent marine organisms have been collated and analysed. The wide range of emission spectra between species and the individual variation within species are difficult to interpret in selective terms. A system for continuously monitoring surface bioluminescence is being developed.

Marine Biological Association of the United Kingdom, Plymouth

1. Properties of shelf seas

An examination of the distribution of chlorophyll 'a' in mixed, frontal, stratified and shelf break "upwelling" situations has been continued with the aim of determining the extent to which phytoplankton growth is controlled by water movement and turbulence and other physical and chemical parameters.

2. Chemical aspects of phytoplankton production

In the past year work has developed on the relations between levels of nutrients, metals, vitamins and chelating

substances, and the growth, species distribution and succession of marine phytoplankton particularly that in the English Channel.

3. Population ecology - dynamic aspects

Work on fluctuations in the macroplankton populations of the western English Channel over the past 60 years has continued. In 1981/82 the plankton showed a return towards a more southerly character, with influxes of Biscayan species and a reduction of *Sagitta elegans*. However, this could be a temporary reversal, since inshore fish populations showed continued increases in cold water elements.

4. Food chains in the plankton

Studies during the year have concentrated on the role of lipids as a food reserve in marine copepods, using *Calanus helgolandicus* as a typical species. Additional investigations have been made of the fate of lipids in the gut and faecal pellets of copepods in relation to the inputs of organic compounds to marine sediments.

5. Plankton production at the thermocline

Work has developed on the ecology of phytoplankton populations associated with the seasonal thermocline and frontal systems in the western English Channel. Particular use has been made of Coastal Zone Colour Scanner (CZCS) remote sensing data. In addition studies have advanced on the role of these phytoplankton populations as a source of food for herbivores and their significance for the early feeding biology of larval fish.

Institute for Marine Environmental Research

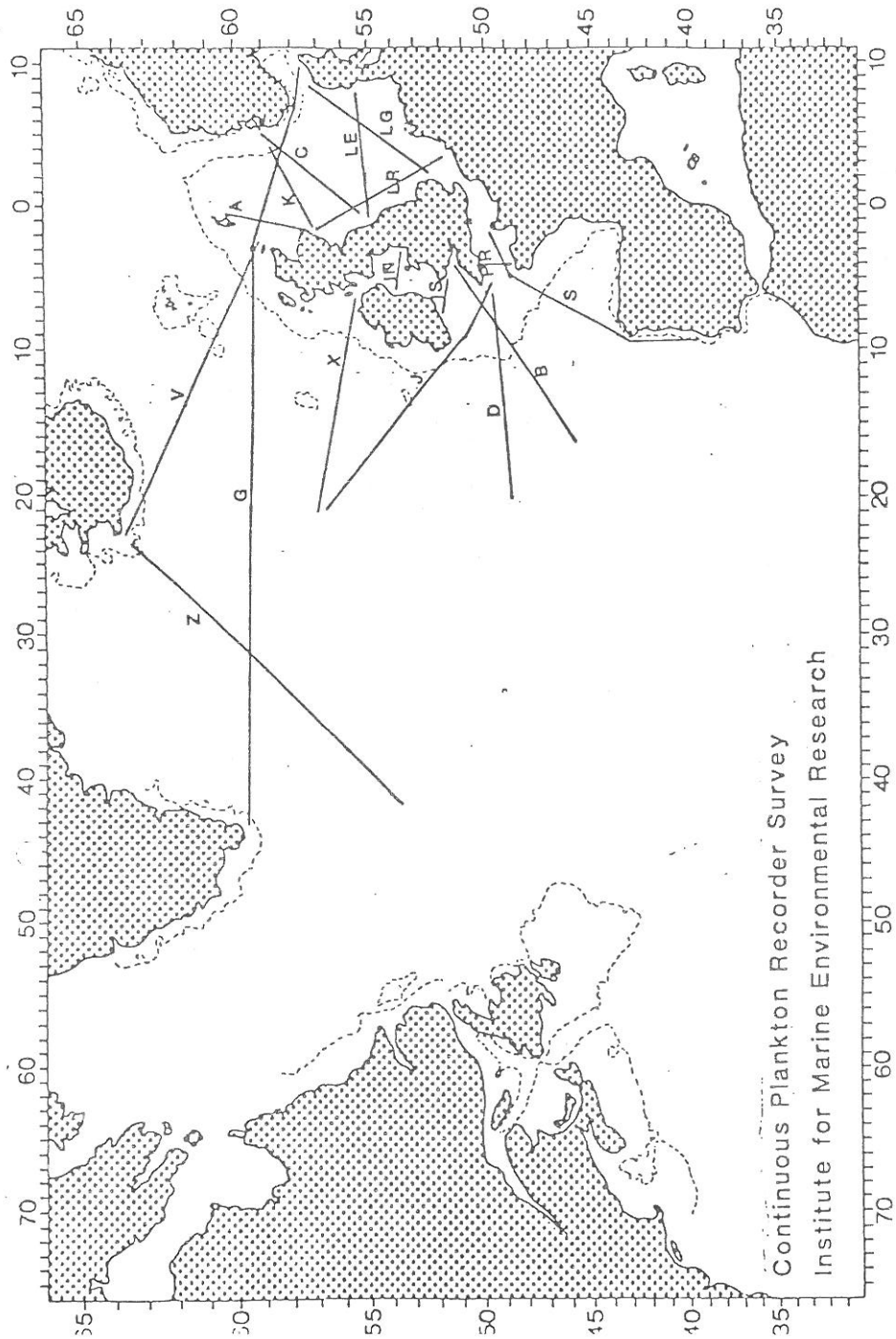
1. The Continuous Plankton Recorder Survey

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. During 1982, Recorders were towed 72,8000 miles by 20 ships of eight nations (Denmark, France, Iceland, Netherlands, Norway, Republic of Ireland, Sweden and the U.K.). The CPR survey began in 1931 with three routes in the southern North Sea. Since 1948, plankton has been collected, analysed and the results processed in the same way to give a time-series of 35 years (or 420 months). 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, U.K. Details of data processing procedures are given by J.M. Colebrook in *Bull. mar. Ecol.*, 8, 133-142.

Legend to Figure 1. The Continuous Plankton Recorder Survey, 1982. The routes are identified by code letters.

2. Plankton modelling experiment, Celtic Sea

The flow of carbon through the primary and secondary trophic levels was studied during four cruises at a site in the Celtic Sea (07° 00'W, 50° 30'N). Measurements were made of primary production (partitioned into different size classes of phytoplankton) and light in the water column; the vertical distribution of phytoplankton, bacteria and flagellates; the release of dissolved organic matter by phytoplankton and uptake by bacteria; the vertical distribution and diel migration of the zooplankton; length/dry weight, gut contents, carbon, nitrogen,



Continuous Plankton Recorder Survey
Institute for Marine Environmental Research

FIGURE 1.

ash content, calorific value and lipid reserve of Calanus helgolandicus; feeding and assimilation rate and absorption rate and absorption efficiency of Calanus.

3. Fish eggs and larvae

The vertical distribution of eggs of pilchard and sprat in the English Channel was studied through hauls by the Longhurst Hardy Plankton Recorder. Experimental studies of density and development of the eggs were made at intervals throughout the year.

2. Scotland

(R. Jones)

1. Marine Laboratory Aberdeen

Schizophomedusae

Schizophomedusae were collected, as in previous years, during the International 0-group gadoid survey in the North Sea. Estimates of abundance and distribution of the commoner species, Aurelia and Cyanea, have been derived and compared to those in earlier years.

Enclosure experiments

In 1983, the Loch Ewe enclosures were used to investigate four problems:

- a) the effects of soluble organic enrichment on bacterial and microflagellate production. Two sources of organic enrichment were used, soluble hydrocarbons associated with oily production water, and the natural increase in soluble organic material associated with the spring bloom. In each case the organic carbon source promoted an increase in the activity and biomass of bacteria followed by microflagellates.
- b) The effects of Forties production water on a four trophic-level food web of microorganisms, phytoplankton, zooplankton, and fish larvae. Both growth, and biomass measurements were carried out on each trophic level to assess the impact of the production water each trophic level and through interaction, between trophic levels.
- c) the effect of oily production water on the growth and survival of cod and herring larvae. No significant effects were apparent at the pollutant concentrations used.
- d) A comparison of growth and survival of cod and herring larvae. In both polluted and control enclosures, larval mortality rates were 8% per day for cod, in contrast to approximately 2% for herring in a comparable system. Larval growth rates of both fish species were similar, with cod increasing in weight at 10% per day, compared to 9% for herring. Cod, from gut content analyses, were much more specific feeders on copepod nauplii than were herring of the same age.

Theoretical studies of energy flow through food webs

further work has been done on the simulation of primary production, nutrient recycling, and of energy flow through simple food webs.

2. Dunstaffnage Marine Research Laboratory, Oban (SMBA)

Deep-sea studies on the Rockall Trough and Porcupine Sea Bight

The seasonal sampling of the demersal fish populations at deep stations in the Rockall Trough and at two transects in the Porcupine Sea Bight continued during 1982. The macro- and megabenthos at the two SMBA permanent stations in the Rockall Trough was sampled during the year with the main emphasis changing from echinoderms, to the growth and reproduction of the bivalve populations. The meiobenthos programme in the Rockall Trough, Porcupine Sea Bight and the Porcupine Abyssal Plain continued in collaboration with microbiologists from a number of institutes.

U.S.A.

(K. Sherman and G.D. Grice)

Fisheries Ecosystems Investigations

NMFS, Sandy Hook Laboratory:

The sixth consecutive year of MARMAP plankton surveys was completed in coastal waters from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia, by the survey group at the NMFS Sandy Hook Laboratory. During 1982 six surveys were conducted to measure changes in key structural components of the shelf ecosystem. From 1977 through 1982 survey measurements and observations were made of primary productivity (^{14}C), chlorophyll *a*, phaeophytin, nutrients, zooplankton, ichthyoplankton, sea birds, marine mammals, and water column temperature, salinity and dissolved oxygen. Ichthyoplankton results for 1982 indicate that for the third consecutive year no Atlantic herring larvae were found on Georges Bank, the principal area of larval production off northeastern United States during the 15-year period prior to 1975. We also observed a sharp decline in the production of cod and haddock larvae on Georges Bank during the 1982 spawning season. An analysis of numerically dominant ichthyoplankton larvae taken on MARMAP surveys was completed. The results indicate that spawning patterns are related to circulation and bathymetry and that most spawning is in synchrony with seasonal production cycles of nutrients, phytoplankton and zooplankton. Information on fish eggs and larvae from MARMAP surveys was used to derive fishery-independent estimates of adult spawning biomass for bluefish, silver hake and sand lance. Our assessment for sand lance showed a 50-fold increase in the adult spawning biomass during the late 1970's, i.e., 54 thousand metric tons in 1974 to 2.6 million metric tons in 1978, and supported our earlier report of a population explosion that began in 1975.

A guide to the early stages of marine fishes occurring in the western North Atlantic Ocean was completed and will be published in the Journal of Northwest Atlantic Fishery Science.

NMFS, Narragansett Laboratory:

A general model for the relationship between temperature, RNA-DNA ratio, and growth rate of larval fish was developed. The model was based on data from 7 species of temperate marine fish larvae reared in the laboratory at a variety of temperatures and feeding levels. Variations in temperature and RNA-DNA ratio explained 92% of the variability in growth of the seven species. The model has been used to estimate the growth rate of cod, haddock, and sand lance larvae. Estimates of growth in dry weight ranged from negative to 24% per day. Sand lance (Ammodytes americanus) were spawned in the laboratory and reared to metamorphosis. The embryonic stage was long (67 days at 4°C) and hatching extremely protracted (65 days at 4°C). The larvae appeared well adapted for growth at low temperatures and plankton densities. In a study of the viability of striped bass early life history stages from several east coast river systems, a correlation was observed between mortality of larvae reared in the laboratory and the concentration of a variety of organic contaminants in the adult female. Microzooplankton collections during MARMAP recruitment process cruises were continued in 1982. The types, number, size, biomass, and selection of food items by the larvae of Atlantic cod and haddock were determined by examination of gut contents from co-occurring larvae captured in plankton samples from Georges Bank. The multicomputer plankton analyzer developed for NOAA by the Graduate School of Oceanography and Electrical Engineering Departments of the University of Rhode Island has been installed in the Narragansett Laboratory. The software of this system is currently being modified to change its operation from a research mode to a production mode. The analyzer is expected to be able to process a plankton sample in 10-15 minutes. The output will include maximum length, maximum width, area, perimeter as well as Fourier descriptors and moment invariant functions for each animal. A study on shelf-wide primary production estimates for the Northwest Atlantic was completed dealing with phytoplankton primary production (netplankton, nanoplankton, and release of dissolved organic carbon) on the Northwestern Atlantic shelf. Investigations were begun on the utility of using remotely sensed satellite images in larval recruitment studies at NEFC.

NMFS, AEG Narragansett:

The year 1982 marks the 10th year of cooperation between the United Kingdom's IMER and the NMFS Atlantic Environmental Group (AEG) to expand the continuous plankton recorder (CPR) survey off the east coast of North America. The program at AEG consists of monthly sampling along two standard transects: (1) Massachusetts to Cape Sable, N. S., initiated (by IMER) in 1961; and (2) New York to Bermuda, initiated in 1976. The data form the basis for studies of short- and long-term changes in the distribution and abundance of plankton in relation to changes in their environments.

NMFS, Woods Hole Laboratory:

Analysis of the prey field of larval herring (Clupea harengus) on Georges Bank during three autumn periods, 1974-1976, revealed that larvae preyed on the synchronously developing juvenile and adult stages of the dominant copepods. Five multidisciplinary

cruises were carried out during spring and summer 1982 to investigate the growth and survival of cod and haddock larvae on Georges Bank in relation to the fine-scale distribution of their prey, as well as the possible loss of larvae by the entrainment of shelf water from warm-core rings passing just south of the Bank. Fisheries ecosystem modelling studies were continued by the Ecosystem Dynamics group with a focus on refining estimates of daily rations of principal fish species on the northeast shelf. Also a multispecies predator-prey model called "GEORGE" was used to simulate recruitment success under changing dominant predator species. Production of reports on the 20-year data base on megabenthos of the northeast continental shelf was continued. The latest report to be completed was entitled "Distribution and Abundance of East Coast Bivalve Mollusks Based on Specimens in the NMFS Woods Hole Collection" by R. Theroux and R. Wigley. The results of direct current measurement observations made over an annual cycle on the northeast edge of George Bank and in Nantucket Shoals were examined for incorporation into models of Georges Bank circulation in relation to larval fish growth and survival. The potential impacts of warm-core ring entrainment events on shelf ichthyoplankton were investigated.

NMFS, Miami Laboratory:

The Miami Laboratory, Southeast Fisheries Center coordinated ichthyoplankton cruises in the Gulf of Mexico during May, June, and July 1982. These cruises were part of a Gulf-wide resource survey termed SEMAP, which included collection of other resource information besides ichthyoplankton. The ichthyoplankton survey provided coverage of the entire Gulf utilizing vessels from the NMFS; the States of Florida, Texas, Louisiana, and Mississippi; and the Instituto de Pesca of Mexico. The U.S. waters were sampled by the U.S. vessels and Mexico's waters by Mexican vessels. All of the samples have been sent to the Polish Sorting Center for sorting and identification. Studies have continued on the estimation of bluefin tuna spawning stocks based on larval abundance. From 1977 to 1981 five cruises of the Oregon II have taken place to study bluefin tuna spawning. Ichthyoplankton assemblages have been studied also from these cruises. The ten most abundant families overall were the Myctophidae, Gonostomatidae, Bregmacerotidae, Scombridae, Paralepididae, Stromateidae, Gobiidae, Bothidae, Serranidae, and Synodontidae. Research continued on recruitment pathways in the area of the Flower Gardens Reef off the coast of Texas in the Gulf of Mexico. Sampling was completed in 1982 and samples are being analyzed at the present time. An ecosystem model was developed to address questions regarding the practice of discarding demersal fish caught incidentally in shrimp trawls operating in the northern Gulf of Mexico. The principal questions were: (1) does the discarding practice have an ecological influence on shrimp production? and (2) how would shrimp production be affected if discards were reduced? Model simulations indicated that discards may influence shrimp production, but the effect of reducing discards depends on the manner in which the reduction is made. The Southeast Fisheries Center is conducting an estuarine ecosystem study in cooperation with NASA and the Louisiana Department of Wildlife and Fisheries. The Louisiana agency is providing approximately 15 years of estuarine environmental and stock biomass and abundance data. NASA is developing and quantifying a model to estimate detrital export to estuaries on the basis of remotely-sensed data from satellites. The role of the Southeast

Fisheries Center in the study is: (1) to develop an ecosystem model that simulates shrimp production by an estuary as a function of detrital export, salinity patterns, and other environmental factors, and (2) to determine the sensitivity of shrimp production to detrital export in the model.

NMFS, Beaufort Laboratory:

During 1982, research was continued on the ecological factors controlling the growth and survival of larval and juvenile estuarine-dependent fishes. Field research was conducted in the northern Gulf of Mexico in cooperation with NOAA's Atlantic Oceanographic and Meteorological Laboratories (Miami, Fla.), and emphasized the food webs supporting the growth and survival of larvae of gulf menhaden (Brevoortia patronus), Atlantic croaker (Micropogonias undulatus), and spot, (Leiostomus xanthurus). Morphometric analyses to assess nutritional condition and otolith aging techniques to compare growth and condition of larvae are being used as potential means of detecting pronounced disruptions in planktonic food webs should they occur. Lab-spawned and reared larval spot were transported to the Gulf of Mexico in December, 1982, for shipboard experiments on food preferences and feeding rates. Laboratory experiments were continued to describe effects of starvation and growth rates of gulf menhaden. Investigation of the role of chaetognaths as predators on larval fish off North Carolina was continued. Research on estuarine-dependent juvenile fish includes evaluations on temporal-spatial distributions, abundance and composition of fishery communities in several estuaries in North Carolina, and also on measuring growth, feeding habits and foraging behavior. Research on feeding habits of Atlantic menhaden juveniles demonstrated that these fish are dependent on wetland plant-produced detritus as a major food source. As a consequence, laboratory and field research has been initiated on the rates of detrital decomposition and its nutritional quality relative to fishery organisms to digest detritus. In addition, post larval and/or juvenile Atlantic menhaden were sampled monthly in two North Carolina estuaries and two Virginia estuaries during 1982 for the fourth consecutive year, following prerecruit menhaden from estuarine entry to estuarine emigration and subsequent fishery recruitment.

NMFS, Galveston Laboratory:

During 1982, studies of impacts of strategic petroleum reserve brine disposal on shrimp populations of the Texas and Louisiana coasts were completed. They included spawning site surveys and investigations of growth, mortality and migration of brown shrimp (Penaeus aztecus) and white shrimp (P. setiferus). Results of these studies, conducted from 1979-1982, indicated that concern about impacts from offshore brine disposal on white and brown shrimp spawning, growth, mortality, and migration need not play a major role in siting of such facilities, since no significant regional impacts of brine disposal on shrimp populations were detected. In 1982, the second and final year of research was completed at the Flower Garden Banks, a unique reef area associated with salt domes near the edge of the Outer Continental Shelf off the upper Texas coast, where increasing offshore drilling operations are in progress. The research focused on characteristics and dynamics of red snapper (Lutjanus campechanus) and other reef fish populations, food chain interactions, benthic macro-infauna communities, reef fish histo-

pathology, microbial communities and ichthyoplankton populations as related to potential and actual impacts of drilling operations and plumes. Since 1978, the NMFS Galveston Laboratory has been involved in an international cooperative research program with Mexico to headstart the endangered Kemp's ridley sea turtle (Lepidochelys kempi). Over 6,812 yearling Kemp's ridley sea turtles have been successfully reared, tagged and released into the Gulf of Mexico.

Plankton Ecology Investigations

At the Woods Hole Oceanographic Institution work continued on the ecological and evolutionary significance of dominant egg production by marine copepods and the distribution and fate of eggs on the sea bottom. These eggs provide an important source of nauplii for recruitment in plankton populations and thereby affect the genetic composition and overall structure of plankton communities. A year-long study of zooplankton production processes of the North Atlantic slope water has been completed. Certain species of the copepod genera Metridia and Pleuromamma breed nearly year round. The behavioral responses of copepods to various feeding stimuli have been investigated using quantitative video techniques. Species used for this work include Centropages typicus, C. hamatus, and Acartia tonsa.

Plankton investigations at the Graduate School of Oceanography, University of Rhode Island, include work on bacterioplankton, phytoplankton, and zooplankton. The biomass and division rates of bacterioplankton have been measured at sea, in Narragansett Bay and at the Marine Ecosystems Research Laboratory. The relationship of bacterial biomass and division rates to the production of dissolved and particulate carbon, and to the grazing rates of ciliates and flagellates is being studied. Work on phytoplankton community succession in Narragansett Bay has continued a 20-year tradition of a weekly sampling program. This has been combined with laboratory studies and computer models to analyze reasons for observed seasonal cycles. Growth rates of dinoflagellates at sea and in Narragansett Bay have continued with emphasis on the New England red tide dinoflagellate, Gonyaulax tamarensis, and on oceanic species in the genera Ceratium and Pyrocystis. Investigations of in situ growth rates, bioluminescence, phosphate and nitrogen kinetics, vitamin requirements, dinoflagellate toxins, and heterotrophic capabilities have been carried out. Studies of the biology of diatom resting spores has continued. The relationships between the plankton cycles and the benthic recycling of nutrients has continued at the Marine Ecosystems Research Laboratory, along with studies of how increased eutrophication affects community structure and metabolism. The bioluminescence of oceanic zooplankton has been examined, with emphasis on larvaceans, tunicates, and ostracods as well as dinoflagellates. Analyses of copepod swimming rates and characteristic patterns of movement during grazing are being related to pollutant concentrations and to the presence of dinoflagellate toxicity and bioluminescence. The distribution of benthopelagic zooplankton in the deep sea are under investigation.

Plankton investigations at the Marine Sciences Research Center, State University of New York at Stony Brook are centered on coastal and estuarine systems. Current studies involve identi-

fication and differentiation of physiologically different strains of chroococcoid cyanobacteria using serological techniques. The diet and feeding rates of larval Ammodytes and Scomber have been determined. The organism responsible for causing shellfish poisoning (Gonyaulax tamarensis) has been observed in Long Island waters and an investigation has been completed on the environmental factors that are responsible for blooms of this species.

Plankton research at Brookhaven National Laboratory in 1982 was focused upon the food chain dynamics of the southeastern Bering Sea and the New York and Middle Atlantic Bights. In both studies field observations of abundance and community-structure of the zooplankton are being combined with measurements of metabolism, egg-production, growth and ingestion to estimate the amount of phytoplankton production transferred to zooplankton. Seasonal and interannual variations in the development of the communities of zooplankton and the effect of those variations on the phytoplankton and the yield to predators such as birds and fish are being evaluated. Research on phytoplankton is attempting to quantify the environmental regulation of growth and light utilization efficiency of phytoplankton populations in coastal areas associated with major estuaries along the coastal boundary of the Middle Atlantic Bight. New fluorometers that will be moored with current meters and transmissometers were designed to estimate vertical and lateral transport of particles derived from phytoplankton. Field observations emphasize variations in the areal influence of estuarine nutrients and particulate matter on the productivity of phytoplankton populations.

At Lamont-Doherty Geological Observatory phytoplankton distribution is being studied in the Middle Atlantic Bight; analysis of chlorophyll *a* data and physical parameters from the shelf edge front will be used to establish the degree to which physical phenomena at fronts control the distribution of phytoplankton. Over the continental shelf, emphasis is on the fate of primary production and the implication of grazing, fecal pellet production and particle decomposition have on overall transport and transfer rates of particulate material. A separate project will characterize benthopelagic zooplankton communities in selected submarine canyons off the eastern seaboard and compare these communities to those found over the adjacent continental slope. Other zooplankton studies include projects on the physiology, life history, and general ecology of the radiolaria, with emphasis on their symbiotic relationships with dinoflagellates and one on planktonic foraminifera with emphasis on environmental factors influencing shell composition, morphology, and the role of symbionts in shell deposition and reproduction. Microbiological research is concentrated on documenting bacterial abundance, biomass and production in estuaries, river plumes and the continental shelf of the Middle Atlantic Bight. Emphasis is on specifying relative distributions of free versus attached bacterial cells and their respective activities.

U.S.S.R.

(S.A. Studenetsky)

The Barents and Norwegian Seas

In 1982 in order to estimate the nutritive conditions of commercial fishes an assessment of euphausiids stocks was carried out in the Barents Sea; a characteristic of spring-summer zooplankton collected on the spawning grounds and routes of larval fishes drift off the northeastern Norwegian coast and in the southwestern Barents Sea was presented; specific groupings of phyto/zoo plankton in different waters were revealed; the dynamics of seasonal changes in the biomass of plankton which influences on the feeding conditions of the pelagic fishes (capelin, polar cod) and also determines their behavior during the period of feeding was investigated; an assessment of shrimp stocks in the Barents Sea was fulfilled; distribution and drift of larval deepwater shrimp in the Norwegian and Barents Seas were studied and also peculiarities of growth and development of larvae under conditions of a "normal" by water heat content year were revealed.

There were collected 125 samples of phytoplankton, 1630 zooplankton samples, 280 samples of euphausiids taken with a trawl-attached net; 3500 specimens of deepwater shrimp were taken for biological analysis; 2900 larval shrimps were determined and measured; a quantitative-weight analysis of feeding was carried out for 450 specimens of capelin and 400 specimens of blue whiting.

Feeding of blue whiting in the Norwegian Sea in relation to the character of plankton distribution was analysed. It was pointed out that there occurred a seasonal change of the object of feeding, so, blue whiting fed on copepods in summer and on euphausiids in winter.

In 1983 investigations on plankton in the Barents and Norwegian Seas will be continued in accordance with the previously adopted program.

In October 1982 off the coast of the archipelago Franz Josef Land Zoological Institute of the Academy of Sciences of the USSR completed round-the year hydrological investigations of the upper part of the shelf (depths up to 5-6 m) which were commenced in August 1981. About 200 hydrological stations were taken with the help of light diving equipment. The aim of works was to study seasonal variations of bottom communities.

The White Sea

Laboratory of marine investigations of Zoological Institute of the USSR Academy of Sciences and White Sea Biological Station carried out hydrological and biological research works for six weeks in the Gulf of Onega of the White Sea aboard R/V "Kartesch". Nine hydrobiological sections (80 stations) were made to carry out complex analysis of the hydrological regime of the Gulf of Onega in relation to the history of its origin and the modern state of its ecosystems. The data to the forecast dealing with the separation of the gulf from the sea in case of the transportation of the portion of north rivers flows to the south slope of the European part of the USSR were obtained.

The Department of invertebrate zoology of Moscow State University and White Sea Biological Station continued studies of shallow water bottom biocenoses off the station with the use of light diving equipment.

Studies of the White Sea hydroids were continued. The fauna of Velikaya Salma area was investigated. The relationship of growth rate of hydroids and food supply and the power of the current was studied. The impact of small doses of heavy metals on the morphology and growth rate of hydroids was investigated. Anomalities of hydroid sprouts were found under the concentrations of zinc ten times lower the established maximum allowable concentrations.

Biology of polychaete Nicomache minor was investigated. For the first time reproduction, larvae, feeding, construction of tubes, regeneration, distribution off the station, factors responsible for the distribution were described.

Ecology of mass species of the littoral zone of the White Sea continued to be studied. Distribution of gastropod Littorina saxatilis, reproduction of isopod Jera albifrons and ecology of polychaeta inhabiting sand littoral zone were studied.

The transformation of the organic substance in the littoral zone was studied together with scientists of marine geology laboratory of Moscow State University. Data on the decomposition of algae and the role of invertebrates in their process were obtained.

Movement pattern of several digging invertebrates of the littoral zone continued to be studied. The character of food, the manner of the seizure of food and its pushing through the intestines as well as the relationship of feeding pattern and movement cycle in Helicryptus spinulosus were studied.

Life cycles and ecology of mass plankton copepods of the White Sea continued to be studied. Peculiarities of reproduction of Pseudocalanus elongatus and its development were studied.

The study of bottom invertebrate larvae off the station was continued; seasonal variations of specific composition of larval plankton were defined; changes of the abundance of mass occurring species larvae during the season were studied; a clear relationship of the appearance, abundance and the development of larvae with temperature was proved.

Data on hydromedusae off the station area which appear in plankton in late August-early September were collected to study intraspecific variability.

Life cycles studies of animal helminths of the White Sea were continued. Parasitological examination of littoral invertebrates as intermediate hosts was done. All examined invertebrates revealed high rate of contamination.

The Baltic Sea

Zooplankton. Seasonal zooplankton surveys were conducted in February, May, August, October-November on standard hydrological stations in ICES areas 25, 26, 28 and 29, in the Gulfs of Riga and Finland - May, August and October-November (areas 28.2 and 32). 780 samples were taken, including 170 samples taken in coastal waters. Fishing gear - Juday net 37/50 with the mesh size of 0.09 - 0.16 mm in the conical end.

Ichthyoplankton. Ichthyoplankton of the Baltic Sea was collected monthly on standard ichthyoplankton stations in areas 25, 26, 28 and 29. 467 samples were taken. Fishing gear - ILCN-80 for eggs and larvae of early stages of development and 10-foot model of Isaac-Kidd trawl for growing larvae and the young with the mesh size of 0.57 mm of the filtering cone.

Nektobenthos (macroplankton). Nektobenthos surveys were conducted in January, June, July and September on standard stations in ILCES areas 26 and 28, and in the north-eastern Gulf of Riga and coastal waters of the Gulf of Finland (areas 28.2 and 32) from May to November - 174 samples were taken. Fishing gear - 10 - feet model of Isaac-Kidd trawl, in the gulfs of Riga and Finland - Rass trawl.

Zoobenthos. The collection of zoobenthos samples in the Baltic Sea, the gulfs of Riga and Finland was done in April - May and August - October. 215 samples were taken. Fishing gear - van-Veen bottom dredge with the covering of 0.1 m².

Sprat and herring feeding. Samples were taken in January, March - May, July and September in areas 26 and 28. 3 th. stomachs were collected.

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NORWAY
(G. Berge)

1. Institute of Marine Research, (IMR) Bergen and
Biological Station Flødevigen, (BSF) Arendal.

1.1 Phytoplankton

1.1.1 The monitoring of primary production and standing stocks of phytoplankton of the coastal banks off western and northern Norway continued for the 7th year, covering the spring season two times at six sections across the Norwegian continental shelf. 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, hydrography, nutrients and 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 was continued. About 30 fjords along the whole Norwegian coast were surveyed in November-December and analysis of nutrients, oxygen, salinity and temperature were made (IMR).

1.1.3 The study of the phytoplankton and its primary production at the ice edge in the Barents Sea was in 1982 extended to the shallower areas of the Spitsbergen Bank. In the phytoplankton field work, emphasis was also put on determining light-photosynthesis relationships for natural phytoplankton populations. This study is part of an interdisciplinary program designed to investigate the biological production processes in this important fishing area (IMR).

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

1.1.5 Nitrate, ortophosphate, chlorophyll a and fixed samples of phytoplankton are analyzed from stations along the hydrographical section Torungen - Hirtshals in Skagerrak (BSF).

1.1.6 Phytoplankton and photosynthesis experiments were carried out in July/August 1982 in an experimental oil spill study organized by the Norwegian Marine Pollution Research and Monitoring Programme at the Halten Bank, western coast of Norway (IMR).

1.2 Zooplankton

1.2.1 At 6 permanent stations along the coast the bi-weekly sampling of zooplankton by Juday 36/180 μ m nets continued. Zooplankton volumes, species composition and stage development are recorded (IMR).

1.2.2 A programme designed to develop new instruments for acoustic estimation of zooplankton biomass and species continued in 1982. Acoustic observations of zooplankton organisms by means of multiple-frequency sonar systems are compared to subsurface photography and observations with conventional gears (Juday nets, Gulf III and Tucker nets) (IMR).

1.2.3 A study of the zooplankton at the ice edge in the Barents Sea, started in 1979, continued. This study is part of an interdisciplinary programme designed to investigate the biological production processes in this important fishing area (see 1.1.3) (IMR).

1.2.4 An interdisciplinary programme designed to investigate the survival of and feeding in cod larvae was started in 1975 and continued in 1981, with special emphasis on the feeding of larvae in relation to the distribution of food organisms. An in situ particle rate meter and a plankton pump have been used in the study of small scale distribution of zooplankton organisms (IMR).

1.3 Ichthyoplankton

1.3.1 Investigations on the distribution of herring larvae in order to localize the main spawning grounds along the coast continued. Eggs and larvae of other species are also recorded. Three cruises were performed in 1982.

1.3.2 Postlarvae surveys which started off in 1977 was continued. The aim is to establish an index for the abundance of different species.

1.3.3 Investigations on mackerel eggs in the North Sea continued. Based upon intensive egg surveys an index of egg abundance reveal a decline in the spawning stock over the last years. As observed with VPA analysis. however, an increase in egg abundance was found in 1982.

1.3.4 Investigations on Arcto-Norwegian cod eggs and larvae continued in the Lofoten area, with emphasis on the spawning of cod, the distribution and survival of eggs and larvae (see 1.2.4).

1.3.5 A study on the coastal cod stock in the Møre region continued in 1982. As a component of the programme eggs and larvae investigations were carried out.

1.3.6 Investigations on the distribution and abundance of capelin larvae continued in 1982 in cooperation with USSR.

2. University of Bergen

Department of Marine Biology

2.1 Studies in the land-locked fjord system Lindåspollene have continued, with particular emphasis on controlled experiments in plastic enclosures on the pelagic ecosystem. A special study has been made on the diurnal rhythm of processes including the phytoplankton.

2.2 Critical assessment of phytoplankton production estimates has continued. Further information has been obtained on seasonal patterns of primary production in Korsfjorden and other fjords in the neighborhood of Bergen, and on the development of phytoplankton in coastal and offshore areas off western Norway.

2.3 Studies are continuing on the local distribution and composition of the zooplankton in the west Norwegian coastal area, with the aim of estimating the extent to which plankton is advected from one water mass to another.

2.4 The department participated in a study of the effects of an experimental discharge of oil on biological processes, carried out during the period 20 July to 3 August 1982 on the Halten Bank (see also 1.1.6).

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

3.1 Phytoplankton

Within the framework of the National Pollution Monitoring Programme levels of chlorophyll *a* has been used to indicate the degree of eutrophication in several polluted fjords. Quantitative phytoplankton samples were collected in some of these fjords along with nutrients and hydrographical measurements.

Extensive primary productions measurements (Carbon 14) coupled with automatic recording of chlorophyll fluorescence (Variosenso) was performed as part of a baseline study outside a planned gas terminal at Kårstø, south-western Norway.

3.2 Benthic communities

Registration of shore and shallow water communities by diving were routinely applied in recipient studies. The lower limit of benthic algal growth was used to characterize the mean light conditions. Structure of soft bottom fauna was studied at several selected localities under the National Monitoring Programme. Stereophotography at fixed sites down to 30 m took place twice a year in two fjords. Long term effects of oil on marine benthic communities in enclosures are studied at a biological experimental station, Solbergstrand, outer Oslo Fjord.

4. University of Oslo

Department of Marine Biology and Limnology

4.1 Phytoplankton

Investigations were continued in the following areas:

- 4.1.1 Ultraplankton flagellates (J. Throndsen).
- 4.1.2 Dinoflagellate taxonomy and fine structure ; red tides (K. Tangen).
- 4.1.3 Carotenoids of Dinoflagellates and Euglenophytes (T. Bjørnland).
- 4.1.4 Nitrogen turnover in coastal waters: ^{15}N investigations (E. Paasche, S. Kristiansen).
- 4.1.5 Effects of oil pollution on phytoplankton communities (S. Kristiansen, J. Throndsen, in cooperation with staff at the University of Bergen).

4.2 Zooplankton

- 4.2.1 Studies were continued on the occurrence of adults and developmental stages of the eye-magget (*Lernaenicus sprattae*) with special emphasis on its life history strategy (student, Schram).
- 4.2.2 The first one of three papers on larval development and metamorphosis of hesionids (*Polychaeta*) was published (Haaland & Schram, Sarsia 67).

4.3 Phytobenthos

Investigations were continued in the following areas:

- 4.3.1 Taxonomy and life histories of red algae (J. Rueness)
- 4.3.2 Autecological studies of algae in the Oslofjord (J. Rueness).

4.4 Zoobenthos

Investigations were continued in the following areas:

- 4.4.1 Biological interaction as background noise in biological monitoring studies (J.S. Gray & collaborators).
- 4.4.2 Factors controlling community structure in a benthic community of soft-sediments in Oslofjord (J. S. Gray).
- 4.4.3 Classification and dynamics of benthic animal communities in Oslofjord (students, Gray).
- 4.4.4 Reproduction biology, population strategy, energy budget and production of various polychaetes (Gray & collaborators).
- 4.4.5 Methodological and ecological studies of soft bottom Foraminifera (students, B. Christiansen, Beyer).
- 4.4.6 Effects of epibenthic macropredators on community structure in eutrophicated shallow water (J.A. Berge)
- 4.4.7 The effect of eutrophication and pollution on the structure of benthic fish communities in the Oslofjord (R. D. M. Nash).

The following should rather belong in the report of the Environmental Quality Committee:

- 4.4.8 Effects of Ekofisk crude oil on recolonization of artificial oil contaminated sediments in the subtidal of an eutrophicated and non eutrophicated fjord (J. A. Berge).
- 4.4.9 Studies on the effect of oil on the swimming activity of the sand goby, Pomatoschistus minutus (J. A. Berge).

5. University of Tromsø

Tromsø Museum

5.1 Zoobenthos

- 5.1.1 Monitoring of hard-bottom fauna in Balsfjorden, Northern Norway, with special emphasis on effect of sedimentation (B. Gulliksen).
- 5.1.2 Manipulation of hard-bottom communities in Balsfjorden, Northern Norway (B. Gulliksen).
- 5.1.3 Effect of pollution on benthic communities in the Tromsø area (B. Gulliksen, B. Holte, K.-J. Jakola).
- 5.1.4 Mapping of hard-bottom communities around the coasts of Spitsbergen and Björnöya (B. Gulliksen).
- 5.1.5 Under ice fauna studies near Spitsbergen (B. Gulliksen).

5.2 Fish

- 5.2.1 Biology of the halibut, Hippoglossus hippoglossus (T. Haug, B. Gulliksen).

Institute of Biology and Geology

5.3 Phytoplankton

- 5.3.1 The importance of Phaeocystis pouchetii in the Arctic food web (J. P. Taasen, E. Oug).

5.4 Zooplankton

- 5.4.1 Ecological studies on the zooplankton community of Balsfjorden are being continued. At present work is progressing on examining overwintering and reproductive strategies on the dominant species (C. C. E. Hopkins, K. Tande, S. Grönvik).
- 5.4.2 Experimental studies on herbivorous zooplankton (Calanus spp.) are carried out to develop a zooplankton model in the Barents Sea (K. Tande).

5.5 Phycobenthos

- 5.5.1 Quantitative studies of algal communities in the littoral zone (T. E. Lein, 2 students).

5.6 Zoobenthos

- 5.6.1 The population dynamics, production, and ecological energetics of the deep-water prawn (Pandalus borealis) is being studied in Balsfjorden (C.C.E. Hopkins, 1 student).
- 5.6.2 Investigations on the bottom fauna of the Barents Sea and the Spitsbergen area (E. Oug).
- 5.6.3 Population dynamics of Macoma calcaria (E. Oug, 1 student).
- 5.6.4 Intertidal distribution and zonation (E. Oug).
- 5.6.5 Systematics and zoogeography of the Terebellomorpha (Polychaeta) (T. Holthe).
- 5.6.6 Investigations on the deep sea fauna of the Norwegian Sea (T. Holthe).
- 5.6.7 Zoogeography of the Echinoderms of North Norway (T. Holthe, 1 student).
- 5.6.8 Growth of Modiolus modiolus (T. Holthe, 1 student).
- 5.6.9 Systematics of Oweniidae (T. Holthe, 1 student).
- 5.6.10 Reproduction and larval development of echinoderms, particularly star-fishes (I.-B. Falk-Petersen).
- 5.6.11 Ecology of Strongylocentrotus droebachiensis and S. pallidus in the Troms and Svalbard region (S. Lönning Vader, I.-B. Falk-Petersen, W. Vader).
- 5.6.12 Effects of aromatic hydrocarbons on sea urchin embryos (S. Lönning Vader, I.-B. Falk-Petersen, A. Möller Naley).
- ### 5.7 Fish
- 5.7.1 Fertilization and early development of marine fishes (cod, flatfishes, lumpsucker) are studied by morphological (including EM), physiological and genetical methods (S. Lönning Vader, E. Kjörsvik, 1 student).
- 5.7.2 Effects of aromatic hydrocarbons on fish embryos and larvae (S. Lönning Vader, E. Kjörsvik, A. Möller Naley, 1 student).

- 5.7.3 Interactive segregation between small pelagic fishes in a fjord system (S. Grönvik, A. Klemetsen).
- 5.7.4 The importance of zooplankton in the diet of capelin (Mallotus villosus) in Balsfjorden (C.C.E. Hopkins, 1 student).
- 5.7.5 Some aspects of the biology of polar cod (Boreogadus sa-ida) (E. Oug, 1 student).
- 6. University of Trondheim
 - 6.1 Phytoplankton
 - 6.1.1 Variation in growth rate and fluorescence of marine planktonic diatoms exposed to Ekofisk crude oil in outdoor dialysis cultures were studied. (E. Nøst Hegseth in co-operation with Dr. Ing. K. Østgaard).
 - 6.1.2 Observations on the phytoplankton distribution in the Trondheimsfjord, with special emphasis on the first spring bloom, were continued (E. Nøst Hegseth).
 - 6.1.3 Metabolism of 3 - 1,3 glucans in diatoms (S. Myklestad, K. Waarum).
 - 6.1.4 Effects on growth rate and chemical composition of Skeletonema when adapting to different light intensities and photoperiods, and the combined effect of sun/shade adaptation and nutrient deficiency (E. Sakshaug).
 - 6.2 Zooplankton
 - 6.2.1 Seasonal variation in total carbon, nitrogen and ATP of Calanus finmarchicus (L. Jørgensen).
 - 6.2.2 Zooplankton kept in dialysis chambers (L. Jørgensen).
 - 6.2.3 Grazing of Calanus finmarchicus on diatoms in dialysis culture (L. Jørgensen).
 - 6.2.4 Carbon and nitrogen expenditure in eggs and larvae of cod (Gadus morhua) (L. Jørgensen).
 - 6.2.5 Carbon and nitrogen expenditure in eggs and larvae of plaice (Pleuronectes platessa) (L. Jørgensen).
 - 6.2.6 Routine sampling of zooplankton once a month by Nansen 75/180 μ m net continued at three oceanographic stations in Trondheimsfjorden (J.-A. Snelli, T. Strømgren).
 - 6.2.7 Methods for biochemical genetic identification of planktonic fish eggs (with special emphasis on gadoids) by diagnostic enzyme loci have been developed and are now applied on a routine basis (J. Mork, G. Sundnes).
 - 6.3 Phycobenthos
 - 6.3.1 Effects of heavy metals (Cu, Zn, Pb, Hg and Cd) on the shell growth of Mytilus edulis. Temperature strategies of Ascopyllum nodosum (T. Strømgren).
 - 6.4 Zoobenthos
 - 6.4.1 Investigations on deep-water molluscs in the Norwegian Sea outside Troms were continued (J.-A. Snelli together with scientists from Tromsø and Oslo).

- 6.4.2 Bottomfauna in western Norwegian fjords and coastal areas (J.-A- Sneli, T. Strømgren).
- 6.4.3 Investigations on the bottom fauna assumed to be affected by the activity of a paper pulp factory in the inner Trondheimsfjord (J.-A- Sneli, Ø. Stokland).

