

BIOLOGICAL OCEANOGRAPHY COMMITTEE

K. SHERMAN

1985



THÜNEN

Digitalization sponsored  
by Thünen-Institut

Belgium

(R. De Clerck and Ph. Polk)

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

Zooplankton Research (Daro, M. H.; Borremans, C.; Bogaert, M.)

This research is a part of a general research program on the functioning of marine ecosystems. Comparisons are made between different ecosystems of the Channel and the North Sea (English and Belgian and Dutch coast, Southern Bight, Northern North Sea). More attention is given to the role of grazing in these systems. Shipboard experiments were carried out and we could show that the deeper and more stratified the water column is, the more important is the role of the zooplankton by its grazing activity. The vertical distribution and day/night vertical migrations seem to also play a role in the grazing pressure on the phytoplankton.

Practical applications of this research are found in our study on the transfer of heavy metals and PCB's through the first levels of the food chain: in shallow water contaminants are more attached to the particulate matter (organic or net) where phytoplankton is the most important carrier. In deep ecosystems, phytoplankton passing through zooplankton and contaminants will reach the bottom in the form of fecal material.

The geographical distribution of fish larvae and eggs (coastal and pelagic) is also a part of the zooplankton section, as well as their feeding behaviour and diet (by stomach analysis).

Copepod Population Dynamics (Bergmans, M.)

Laboratory studies of the life cycle of Tisbe species (Copepoda, Harpacticoida) are conducted with a view to understanding population processes in the field.

Special attention is given to the possibility of fine-tuning of certain demographic traits (such as the primary sex ratio or the age-specific net maternity distribution) as a function of demographic conditions.

Non-Living Particular Organic Matter (Pissierssens, P.)

Little is known about the role of Non-Living Particular Organic Matter (detritus) in the food mass of marine copepods. Therefore, our research is concentrated on three aspects:

1. study of the NLPOM distribution in the Belgian Coastal Zone
2. estimation of the contribution of the NLPOM to the total food mass of marine copepods.
3. study of the origin and composition of the NLPOM.

Impacts on the Environment of the Cooling Systems in Power Plants  
Ecological Aspects. Bibliography Work (Bossicart, M.; Joiris, C.)

Primary Production (Joiris, C. and A. Bertels)

1. Incubation under fluctuating light conditions, in order to obtain a better evaluation of the real in situ net production.
2. Determination of phytoplanktonic respiration in order to determine its relative role in total planktonic respiration.

Seabirds Quantitative Distribution, in Connection with  
Oceanological and Ecological Parameters (Joiris, C.)

Marine Ecotoxicological (Joiris, C., Delbeke, K.)

1. Estimation and comparison of transfer mechanisms of organochlorine residues (mainly PCB's) and mercury in marine ecosystems (particulate matter, zooplankton, fish, seabirds, and sediments).
2. Comparison of contamination levels of different ecosystems (Atlantic and coastal North Sea).

Canada

(M. Sinclair)

The following is a 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 (MEL), Bedford Institute of Oceanography, P. O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2  
(Dr. K. H. Mann, Director)

The Marine Ecology Laboratory (Biological Oceanography Division) was involved in several major oceanographic cruises this year; operations were carried out on the Scotian Shelf (two cruises), Grand Banks (two), Georges Bank (one), the Labrador Sea (two), and Hudson Strait (one). These cruises have continued to add to the Laboratory's archives of comparative data on primary and secondary production processes. The interaction of physical and biological processes was stressed.

Field and laboratory studies have maintained a strong emphasis on the ecology of the microplankton. The final phase of the field work on the dynamics of the Grand Banks microplankton ecosystem, supported by OERD, was completed. Here, as postulated in 1984, microheterotrophs (protozoans and bacteria) were important, consuming up to 70% of the primary production in spring and from 15-20% in the warmer months. Similar studies were carried out in the tidal front area on the northern edge of Georges Bank, emphasizing the production by picoplankton, their utilization by microheterotrophs, and the relationship of the system to the physical regime that controls the distribution of the organisms within the water column and regulates their nutrient supply. The distribution and growth of picoplankton, microplankton, and larger zooplankton were examined on two cruises on the Labrador Shelf. The regulation of zooplankton grazing by light and food supply was emphasized in contrasting environments, suggesting that when food is abundant diel rhythms prevail, with most consumption at night, while continuous feeding is the rule when food is limiting.

A laser-based flow cytometer-sorter is being assessed in studies of microplankton organisms. The ability of this instrument to characterize, enumerate, and sort fluorescent organisms at high rates yields information unobtainable by conventional means. To date, emphasis has been given to the study of organisms possessing autofluorescent pigments. Flow cytometric studies of such organisms in Bedford Basin and in laboratory culture are ongoing.

Following 1984 observations in the Arctic which suggested a dominant role for tidal energy in regulating the vertical distribution of zooplankton in the water column and in maintaining their food supply by nutrient enrichment of the epontic algae while eroding the attached forms into the water by turbulence, emphasis was placed on determining turbulent shear and velocity profiles with millimeter resolution in the near-ice zone through a joint Dalhousie University-Fisheries and Oceans instrument development and experimental program. These measurements permit the calculation of nutrient

flux to the ice algae. Regardless of their position in the water column, most zooplankton utilize ice algae which is sedimenting from the ice, suggesting a much greater role in maintenance of animal growth in the fast-ice season for the epontic production than hitherto realized.

BIONESS sampling combined with observations by the multiple-frequency acoustic system were carried out during June and September in the region of the Shelf break with the purpose of determining the biomass and exact vertical position of the various components of the zooplankton and micronekton communities relative to one another and to the other biological and physical features of the water column.

In September a major interdisciplinary cruise was undertaken to the Labrador Shelf. Earlier studies within MEL suggested that mixing in the Hudson Strait and Ungava Bay produces nutrient-enriched surface waters during the summer which are carried by the mean circulation onto the Labrador Shelf. It was hypothesized that this nutrient flux results in increased primary production, and as a food chain develops it is advected southward by the Labrador Current. This would result in an increase in the relative importance of larger size particles to the south along the Labrador Shelf. The cruise was an attempt to test this hypothesis by measuring biomass as a function of size (particle size spectra) both along and across the Shelf. Bacteria and phytoplankton size particles were measured using a Coulter Counter; zooplankton were collected in vertical net hauls and a large-mesh Tucker trawl, and size fractionated and fish abundances were determined using acoustical methods (ECOLOG). Such data, together with information on the temperature, salinity, currents, nutrients, and chlorophyll, were collected on ten transects over the Labrador Shelf from Hamilton Bank in the south to Cape Chidley in the north. At selected sites benthic samples were taken for benthic particle size spectra determinations. This voyage represented the first-ever cruise dedicated to measuring spectra over such a wide range of particle sizes.

An investigation was initiated on the variability of sea-surface temperatures (SST) for selected areas of the northwestern Atlantic (north of 30°N and west of 40°W) using data collected in the 1940-1980 period, principally by merchant ships, and archived at the National Climatic Center, Asheville, North Carolina. Analyses of SST's include space-time plots of annual anomalies, correlations among monthly anomalies, and computation of empirical orthogonal functions by seasons. SST anomalies show persistence from season to season, particularly from winter to summer, and are coherent over a large geographical area. The role of freshwater discharge, wind effects, and offshore forcing in producing the observed variability is currently being examined.

Process-oriented ichthyoplankton/recruitment studies were conducted on the Scotian Shelf. Target species include the egg, larval, and pelagic juvenile stages of cod, haddock, hake, and sand lance. Evidence is mounting which shows that the gadids exhibit larval drift from the offshore banks to the coastal waters. The ecological advantage of this spatial pattern appears to be related to the availability of concentrated food resources inshore. Additional survey work with the ECOLOG dual-beam acoustic fish-detection system was undertaken, and analysis of the field data in conjunction with laboratory studies has revealed a hitherto unsuspected bias in target

strength estimates. This has been identified and measured by the dual-beam system and a field calibration correction developed. The results permit a significant improvement in precision and in detail with which surveys are interpreted. Microstructural analysis of otoliths is planned to assess the spatial variation in age and growth. The population dynamics of the egg and larval stages of capelin are currently under study on the Southeast Shoal, Grand Banks. The submersible PISCES and support vessel PANDORA were commissioned to locate spawning beds and to assess the influence of air-sea interactions on larval emergency timing. Our working hypothesis is that the intensity of recirculation of waters over the Southeast Shoal is a significant regulator of larval survival and recruitment variability in the offshore spawning stock of capelin.

A major cruise to the Labrador Shelf was undertaken to investigate the effects of nutrient inputs from the Hudson Bay on the food chain which develops on the Labrador Shelf and is advected south toward the Grand Banks by the Labrador Current. The particle size spectrum of plankton and fish was measured along and across the Shelf using a variety of sampling and analytical techniques ranging from counting and sizing of bacteria and phytoplankton by electronic methods to measuring fish abundances with ECOLOG. Results from the data analysis will be reported over the next year.

During the cruise an extensive investigation of a tidal front in the Ungava Bay was also undertaken. Vertical and horizontal distributions of zooplankton and fish larvae were measured to determine the impact of frontal systems on higher levels of the food chain. The MINIBIONESS and ECOLOG were used extensively for sampling zooplankton and fish.

Field observations and experiments undertaken within the Deep Ocean Ecology Group during 1985 have focussed on determining rates of ecological processes which influence fluxes of natural materials and radionuclides in abyssal environments. Two cruises were conducted using the submersible PISCES IV and the ship PANDORA. An instrument tripod which allows simultaneous measurements of particulate and dissolved material fluxes across the sediment water interface was deployed and retrieved by submersible on the continental shelf.

Technique development and application to assess the relative size distribution of meiofauna and bacteria in shelf, slope, and abyssal sediments continued. Energy-dispersive electron analyses of bacteria colonizing surfaces were carried out, and microelectrodes were used to monitor microgradients of oxygen and carbon dioxide which were generated by bacterial metabolism on the surfaces. As a result, in situ measurements of the community metabolism associated with the fluxes of natural materials and radionuclides across surfaces are now possible.

Participation in the NEA Seabed Working Group continued with the Annual Meeting held in Halifax, N. S., in late April 1985. A synthesis of information to estimate rates of biological transport of radioactive waste was prepared.

Centre Champlain des Sciences de la Mer, Ministère des Pêches et des Océans,  
B.P. 15500, Québec, Province de Québec G1K 7Y7.  
(Jean-Claude Thériault, Directeur)

La division d'océanographie biologique a continué ses recherches visant à étudier les processus de production primaire et secondaire dans l'estuaire et le golfe du Saint-Laurent ainsi que dans la Baie d'Hudson.

#### Bactérioplancton:

La répartition et la dynamique des bactéries dans l'estuaire du Saint-Laurent a été étudiée afin de la comparer avec les observations provenant d'autres estuaires. Grâce à la modélisation mathématique, l'importance relative de divers processus physiques (advection et diffusion) et biologiques (croissance) ont été mis en parallèle afin de mieux comprendre les facteurs contrôlant l'abondance et la répartition des bactéries estuariennes. Enfin, la biomasse et la production bactériennes ont été comparées à celles du phytoplancton afin de déterminer l'importance trophique des bactéries dans l'écosystème estuarien.

#### Phytoplancton:

1. Au cours de l'hiver 1985, nous avons entrepris, dans la Baie d'Hudson, un programme de recherche de trois ans (1984/87) portant sur la croissance de la microflore à l'interface glace/eau. Les buts spécifiques de ce programme de recherche sont de comprendre l'importance des deux types de facteur qui conditionnent le développement de la flore éponctique: (a) les facteurs internes aux cellules (adaptations physiologiques) et (b) les apports d'énergie solaire (venant du dessus) et des éléments nutritifs (venant du dessous). De plus, nous nous intéressons à l'importance de cette flore en terme de flux continu de nourriture pour les organismes brouteurs et d'apports de matières organiques dans les sédiments ainsi que de l'effet de la soudaine injection de cette importante biomasse dans la colonne d'eau lors de la fonte des glaces à la fin de l'hiver.
2. En collaboration avec le Bigelow Laboratory for Ocean Sciences, nous sommes intéressés à l'application de la cytométrie en flux dans la recherche océanographique. Nous avons exploré la possibilité d'utiliser cette nouvelle technologie dans l'étude des besoins nutritifs des organismes phytoplanctoniques des eaux oligotrophiques et des milieux côtiers.
3. Le rôle biologique du phytoplancton et de ses produits d'excrétion sur la synchronisation du déclenchement de la ponte d'invertébrés dans l'écosystème marin a fait l'objet d'un programme d'étude. Les premiers résultats montrent que la maturité de l'oursin vert et de la moule bleue se produit tôt au printemps mais que les gamètes ne sont pas relâchées avant que la concentration de chlorophylle a n'atteigne  $2 \text{ mg.m}^{-3}$ . Un agent actif, responsable du déclenchement de la ponte et excrété par le phytoplancton a pu être extrait. Ce produit présente les caractéristiques d'un composé polaire, stable à la chaleur et d'un poids moléculaire inférieur à 3500.

4. Un programme de recherche de 3 ans (1985/87) sur la dynamique phytoplanctonique en zone frontale fut entrepris en juin 1985. Le front étudié se situe dans la partie nord-ouest du Golfe du Saint-Laurent. Les principaux buts du projet sont de déterminer l'influence des différents régimes hydrodynamiques caractéristiques des zones frontales (mélange, stratifié et intermédiaire) sur la composition spécifique, la biomasse et la productivité de la communauté phytoplanctonique. Nous portons un intérêt particulier sur la répartition verticale fine des différents éléments de la chaîne trophique planctonique (phytoplancton, protozoaire et microzooplancton) et sur la dynamique des nitrates (consommation, advection) et de l'ammoniaque (consommation, régénération et excrétion). L'analyse préliminaire des résultats révèle des biomasses phytoplanctoniques jusqu'à 25 fois supérieures dans le front que dans les régions adjacentes. Une analyse plus complète des résultats nous permettra d'établir si ces fortes biomasses résultent d'une accumulation passive ou d'une augmentation de la croissance phytoplanctonique.
5. Au cours de l'été 1985, un programme d'échantillonnage a été entrepris dans la région de Rimouski, en vue de déterminer la distribution et l'abondance de *Protoгонyaulax (=Gonyaulax) tamarensis*, organisme responsable de la toxicité des mollusques. Un important bloom de *P. tamarensis* a été observé au début de juillet tandis qu'un second le fut tôt en septembre. Durant ces périodes, les communautés de microplancton étaient dominées par des microflagellés, des ciliés et de grosses dinoflagellées. Plusieurs clones de *Protoгонyaulax* ont été isolés au cours de la saison d'échantillonnage et les profils des protéines totales ont été déterminés par électrophorèse. Ces produits ont été classés selon leur masse d'eau d'origine et les variations entre les populations séparées géographiquement et temporellement ont été analysées.

#### Zooplancton et ichtyoplancton:

1. L'étude de la co-distribution verticale de l'ichtyoplancton et de ses proies en Manche occidentale s'est poursuivie. Les résultats sont interprétés dans l'optique de l'Optimal Foraging Theory. [En collaboration avec le Marine Biological Association of the U.K. (Plymouth).]
2. Un programme intégré d'étude des relations trophiques planctoniques dans une région frontale du Golfe Saint-Laurent a été mis sur pied. Un échantillonnage spatial à haute résolution a permis d'établir l'influence de la structure frontale sur la disponibilité des proies, la survie et la croissance des stades larvaires de plusieurs espèces de poissons.
3. Un deuxième programme visant à tester certaines prédictions de la théorie des stocks de Iles et Sinclair (1982) quant à la distribution géographique des stades larvaires de hareng dans l'estuaire du Saint-Laurent a été développé. Une série de 11 missions d'échantillonnage a été réalisée afin de définir l'existence et la portion exacte du front de marée prédit par Pingree et Griffiths (1980) et de déterminer la distribution des stades larvaires de hareng par rapport à ce front.

4. Un troisième programme mis en marche en 1985 porte sur la dynamique des stades larvaires des nombreuses espèces de poissons qui utilisent le courant de Gaspé comme aire d'alvinage. Deux aspects sont explorés: les variations à courtes échelles spatiales dans la croissance en fonction de la disponibilité des proies et l'impact des toxines produites par Protogonyaulax (abondant dans le Courant en été) sur la survie des stades larvaires.

Marine Fish Division, Fisheries Research Branch, P. O. Box 550, Halifax,  
Nova Scotia, B3J 2S7  
(J. E. Stewart, Director)

The third and final field season of the Southwest Nova Scotia Fisheries Ecology Project (SWEET) was completed. The program focusses on all life-history stages of haddock in the area in order to develop a comprehensive understanding of this important commercial stock. Five synoptic ichthyoplankton surveys were conducted on a standard grid of stations which included Browns and Georges Banks. Oblique and surface bongo tows (0.333-mm nets) and a CTD profile were completed at each station, with chlorophyll and nutrient samples taken at "core" stations. Plankton samples were preserved in alcohol to allow determination of larval ages for dispersion studies. Diel vertical distribution studies were conducted at selected stations using the "Mininess" sampling system. Three tagging cruises were completed which tagged spawning cod and haddock on Browns Bank, on Georges Bank, and in the Bay of Fundy. Complementary electrophoretic, morphometric, and meristic analyses continued and provided preliminary results on haddock stock structure in the area. Two concurrent cruises studied the geographical and vertical distribution of pelagic juvenile cod and haddock in relation to hydrographic and biological parameters. Geographical coverage of the standard grid was completed with a three-step IYGPT trawl set (upper 50 m of water column) and an XBT cast at each station. Diel vertical migration experiments were conducted at thermally stratified and unstratified sites where observations on juvenile fish biological and physical oceanographic parameters were made simultaneously. Catches of juvenile cod and haddock were substantially higher than previously observed in the area. With completion of field observations, most projects within the SWEET have entered the analysis phase. Approximately 30 papers are planned for a synthesis meeting, to be held in 1987.

The annual Bay of Fundy herring survey completed an expanded grid as part of an effort to monitor recovery of the Georges Bank stock. A concurrent cruise was devoted to a larval herring patch study designed to provide fine-scale definition of larval herring distribution. Depth-stratified Mininess samples were taken at three sites transecting a dense patch to define spatial and vertical distribution of larvae in relation to hydrographic features.

Further work on juvenile gadoids similar to that conducted under the SWEET was done during the annual cooperative Canada-USSR juvenile silver hake survey on the Scotian Shelf. Diel vertical migration and feeding of silver hake were determined at contrasting sites with objectives and methods similar to those for juvenile cod and haddock described above.



Examination of changes in hydrographic conditions on the Scotian Shelf and comparisons with changes in groundfish distributions and abundance continued. A paper was produced for the NAFO Special Session on Surveys which suggests that cod densities were particularly high in a band of minimum (bottom) temperatures along the western edge of Sable Island and Western Banks in 1975-1979. In 1980-1984, when temperatures in this area were warmer and similar to shallower depths, cod densities decreased. It was concluded that the particularly dense aggregations of the late 1970's were due to restriction of range caused by availability of preferred temperatures. In addition, a preliminary analysis of bottom temperatures during 1984 in the southwestern Nova Scotia and Browns Bank areas was completed. This was compared with the location and depth of haddock catches from 1984 spring and summer groundfish surveys. Haddock generally occurred in cooler, deeper water in spring than summer, consistent with knowledge of seasonal depth movements. The analysis was inconclusive in indicating if spawning or migration times of 4X haddock have changed recently due to temperature.

A first draft of a technical report of current drifter patterns has been prepared and is undergoing revisions. Statistics and plots are presented of drifter releases and recoveries, rates of drift, direction, etc., for Scotian Shelf waters since 1923. Detailed analyses of derived residual current patterns are continuing and will be compared with sampled larval distributions.

Data from the Scotian Shelf Ichthyoplankton Program (SSIP) as well as from recent directed cruises were used to develop a theory linking Gulf Stream gyre activity to pollock recruitment. Good year classes appear to result from pollock spawning in the middle of the Scotian Shelf, while spawning locations for poor year classes were along the outer part of the Shelf. It is suggested that the presence of gyres influences the Shelf waters, acting to retain water near the Shelf break, while the absence of gyres allows the normal circulation to transport water (and eggs and larvae) off the Shelf. For the year classes identified during the 1980's, good recruitment appears positively related to the presence of numerous gyres off the Shelf.

Fisheries and Environmental Sciences Division, Fisheries Research Branch,  
P. O. Box 550, Halifax, Nova Scotia, B3J 2S7  
(J. E. Stewart, Director)

The toxic dinoflagellate, *Gonyaulax excavata*, blooms annually in the Bay of Fundy. Plankton studies since 1980 indicate that during the blooms this organism is most abundant in the south-central portion of the Bay. Preliminary work suggests that the toxic dinoflagellates accumulate in frontal zones in this region, as has been described for dinoflagellates in other locations. The periodic impingement of dinoflagellate-rich frontal zones on near-shore areas may explain the periodic occurrence of much higher than normal levels of "paralytic shellfish toxins" in coastal shellfish.

Since 1980, offshore blooms of *Gonyaulax* have diminished in intensity (although intense, localized, inshore blooms have occurred). Since 1982, another dinoflagellate, *Gyrodinium aureolum*, has formed moderate blooms in the Bay of Fundy. These blooms have not so far been associated with

mortalities of marine organisms. In the past few years, G. aureolum has caused tremendous damage to finfish resources in northwestern Europe.

Field benthic sampling on the southwestern Scotian Shelf, as part of the Fisheries Ecology Program, was completed (1983-1985). The following material is being analyzed:

- 135 0.5 m<sup>2</sup> Van Veen grab stations;
- 138 epibenthic sled stations inclusive of a top (1.0 m) and bottom (0.3 m) net sample for suprabenthic animals; and
- 100 stereo-camera stations with up to ten replicate pairs of slides at each station.

Because of the large amount of material involved, the analysis is proceeding on a priority basis. Haddock gut-content analyses indicate that suprabenthic animals are of importance in haddock diets.

Northwest Atlantic Fisheries Centre, Fisheries Research Branch, P. O. Box 5667, St. John's, Newfoundland, A1C 5X1  
(M. C. Mercer, Director)

The Flemish Cap Project began in the mid-1970's as an international study of mechanisms affecting fluctuations in recruitment of cod and redfish. This study has been carried out cooperatively by Canada and the USSR, with project results and programs being reported annually through the Scientific Council of NAFO. In 1985, zooplankton data collected during the project were stored in a standard format on magnetic tape. The data coding format was completely revised, and a new marine plankton species computer code was developed. A data report summarizing this information is in preparation. A computer-compatible tape of all primary production, chlorophyll, and nutrient data collected during the project, has also been prepared. A compartment model of the top 100 m of the Flemish Cap water column was presented and accepted for publication in the "NAFO Advanced Research" series. Fifty percent of Flemish Cap water is exchanged each month. The results of diurnal sampling variability of ichthyoplankton survey designs are being prepared for publication. It is of interest that diurnal variability was dependent on tidal cycles. Analyses of daily otolith rings gave insight into the variability of growth history of individual redfish larvae.

Analyses of plankton and oceanographic data collected from the Southeast Shoal (Grand Bank) larval yellowtail study in 1981 have been completed and submitted for primary publication. Ichthyoplankton, chlorophyll, and nutrient data collected in 1983 have been edited. The dominance of yellowtail flounder eggs and small larvae (5-7 mm) will severely constrain the study objectives as the absence of larger larvae precludes any comparison of growth, feeding, and condition across a range of larval sizes. The review year was largely devoted to collating, editing, and analyzing existing data from the project area (1981, 1983, and 1984). Project researchers have continued work as well on a multiple opening and closing sampling device, and the development of an important sampling

instrument is a step closer to completion.

Oceanographic data are reported by all the marine expeditions of the Fisheries Research Branch. The Branch increasingly utilizes more sophisticated instruments, including CTD's, moorings, and continuous monitors. An inshore RYAN thermograph network is maintained. Those instruments that we are unable to maintain are distributed from equipment pools at the Bedford Institute of Oceanography, Dartmouth, N.S. All oceanographic data collected are forwarded to the Marine Environmental Data Service and retrieved there for specific problems. Work proceeds on computer enhancement of local sea surface temperature and color patterns from NIMBUS 7 which is being related to known oceanographic features and developed into atlases.

A short benthic sampling cruise was mounted in April 1985 in cooperation with the Bedford Institute of Oceanography. The first benthic nitrogen flux and oxygen utilization measurements were made and information on benthic community assemblages expanded. Research staff also participated in a three-week study of the biological oceanography of the Labrador Current, again in cooperation with the Bedford Institute of Oceanography.

Approximately 240 samples of ichthyoplankton from 30 sea-days were collected May 21 to August 31, 1985, in Conception Bay. The data have been analyzed to reveal annual succession and temporal activity in the ichthyoplankton community. Further analyses will relate morphology to food and concentrate on niche separation. The study is a pilot project for a more penetrating investigation of ichthyoplankton ecology.

Techniques were developed to reliably detect differences in copepod development rate among enclosed ecosystems. Interannual effects on annual plankton cycles, such as changes in ice cover in the Labrador Sea, were examined but not addressed in detail due to conceptual differences in framing a physically controlled temporary cyclic model. The influence of mixing models on coexisting models was also investigated. It turns out to be difficult to formulate different mixing models in a way that allows fair comparison between them. A paper on one aspect of the difficulty is in preparation.

A project dealing with the growth of larval capelin was completed in 1985. Knowledge of mean growth rates and their variance will increase the value of ongoing larval surveys by making length-frequency distributions more meaningful and provide clues about oceanographic conditions which promote larval growth and survival. Determinations have been made of the rate of shrinkage of larvae in different preservatives. Collaborative arrangements will continue, with emphasis on the time of first otolith ring formation in larvae and validation of subsequent daily ring formation.

Research continues on the reproductive ecology of herring and capelin to describe larval biological parameters and to incorporate this information in the prediction of the strength of future year classes. Five inshore larval surveys were completed in 1985. Detailed oceanographic descriptions of the study area (Trinity Bay) were completed and meteorological indices developed. General emphasis in 1986 will be given to the analysis and publication of accrued survey data.

Analyses of food web models have indicated that model stability depends in part on the particular assumption that larval stage duration is invariable. Research to date has demonstrated that some better understanding of early life-history stages of species in the food webs is necessary before further progress is possible.

The inshore cod fishery of Labrador and eastern Newfoundland (NAFO Div. 2J, 3K, and 3L) has a long history of variability in terms of annual landings and local abundance. These problems have been particularly evident in recent years; and again, in 1985, the inshore fishery was late starting. An ad hoc working group was formed in September 1985 to examine factors affecting catch in the inshore fishery. An interim report was completed in December which examines existing biological and oceanographic information pertaining to cod abundance and availability inshore.

Gulf Region, Fisheries Research Branch, P. O. Box 5030, Moncton, New Brunswick, E1C 9B6  
(J. S. Loch, Director)

1. A program to obtain long-term measurement of bottom temperature was continued in 1985 in collaboration with the Bedford Institute of Oceanography. The objective of the program is to study the effect of temperature on the distribution of commercially important fish species. RYAN thermographs were deployed at 45 sites in the Gulf of St. Lawrence (NAFO Div. 4RST). These sites were chosen for their importance to inshore fisheries, particularly herring, cod, lobsters, and shellfish. A data report including plots of temperature distribution, daily mean temperatures, and accumulated degree-days is being prepared.
2. A herring spawning bed survey by SCUBA diving on Fishermans Bank east of Prince Edward Island (NAFO Div. 4T) was initiated in 1985. One of the objectives of this project was to study the effect of environmental factors on herring spawning success and larval survival. Divers observed spawning beds with thick carpets of eggs, frequently reaching a thickness of 20 to 30 egg layers and extending over an area of 500-m long and 200-m wide. The eggs were solidly packed in a continuous carpet with very few cavities between egg layer.

Mass mortalities of herring eggs before hatching occurred. Microbiological examination of cultured samples of dead eggs including tests for bacteria, fungi, and viruses showed negative results and indicated that eggs most likely died from some causes other than a known disease agent. Microscopic observations along a cross-section of the egg cluster revealed that almost all eggs were fertilized and had reached various stages of development. The rate of development was related to the position within the egg mass. The retarded development of embryos in the lower layers seemed to be caused by lack of oxygen due to densely packed layers with little water and gas exchange. Bottom temperature during spawning was unusually high (16.1°C). It is believed that unusual environmental conditions prevailed before and during spawning, which resulted in spontaneous massive spawning. Further analysis of data is required to elucidate the role of oceanographic factors in spawning success and herring recruitment.

3. All available temperature data collected during research vessel cruises in the Gulf of St. Lawrence (NAFO Div. 4RST) from 1965 to date were analyzed. Monthly vertical distributions of temperature showed the three-layer system characteristic of the Gulf. Comparison of water stratification in April and May showed the process of decay of the intermediate cold layer ( $0^{\circ}\text{C}$  or less) at the onset of spring. In May this cold layer shrinks in size, forming a cold core only along the center of the Laurentian Channel. The rate of shrinkage of the cold layer probably depends on the degree of spring warm-up which is influenced by the rate of freshwater run-off and wind direction (according to Ekman's theory of wind-driven currents). Herring spawning migration was investigated in relation to this oceanographic regime. Results led to the hypothesis that overwintering herring stay in the deep warm-water layer until such time when the intermediate cold layer has shrunk in size that allows the herring to move to the surface water on the Magdalen Shallows without swimming through the cold-water barrier. Ecological implications of this hypothesis on herring recruitment and year-class strength are being investigated.
4. The E. E. PRINCE survey in NAFO Div. 4T collected 80 temperature profiles using retrievable bathythermographs. The LADY HAMMOND survey in the northern part of Div. 4T and Div. 4RS collected 180 temperature profiles using expendable bathythermographs (XBT's). Preliminary analysis from the LADY HAMMOND survey indicates that bottom water temperatures were greater than  $5^{\circ}\text{C}$ . This appears to have had a marked effect on the distribution of redfish. Redfish were less prevalent in the 125-150 fm range sampled by bottom trawls and were more prevalent from 150-200 fm, in comparison to 1984. Redfish were noted 9-10 m off the bottom, which may indicate that redfish were avoiding warmer water by moving off bottom. Warm-water species such as spiny dogfish were taken as far north as the Strait of Belle Isle and as far west as the Gaspé Peninsula. This species is normally not taken in the northern Gulf of St. Lawrence.
5. During the LADY HAMMOND survey a multichannel data logger (ECOBUG) was attached to the ship's trawl and tested. Temperature data were collected for comparison with the XBT system. The ECOBUG was part of the Shipboard Data System which electronically collected all data during the LADY HAMMOND survey. The data of the 1984 and 1985 surveys are being analyzed in order to determine the effect of water temperatures on fish distributions in the northern Gulf of St. Lawrence.

Arctic Biological Station, Fisheries Research Branch, 555 St. Pierre Blvd.,  
Ste-Anne-de-Bellevue, Province of Québec, H9X 3R4  
(A. W. Mansfield, Director)

Studies on the sea ice biota were conducted during the winter in Frobisher Bay, Northwest Territories. Work on the microalgae showed late-winter and spring reproduction rates and the identity of major components of food of ice-dwelling herbivores. A dozen of the most abundant ice meiofauna species were shown to feed in the ice on ice-inhabiting diatoms and dinoflagellates. The annual cycle of bacteria occupying the lower levels of the sea ice showed activity rates ranging from lowest in January to highest

in June, in response to carbon fixed and lost by plants.

Primary production, tidal influences on populations, and spatial and seasonal variations in relative composition of low molecular weight metabolites, lipids, polysaccharides, and protein in sub-ice and open-water phytoplankton were determined. Grazing on bacteria in the water column by as yet unidentified predators between 1 and 3  $\mu$ m in size was observed. Specific feeding habits of most of the major zooplankton species found under the ice and in open waters of summer were described. Relative utilization as food of some 100 taxa of plants and 10 of animal prey was shown. A study was begun on sensitivity to crude oil of near-shore pelagic fish larvae. Metabolic rate measurements on some of the principal macrozooplankton species compared summer and winter levels. Amphipods from the sub-ice habitat were studied and seasonal variability in physiological rates were compared with those of amphipods from deeper pelagic and benthic habitats.

Benthic studies were concerned mainly with detrital fall-out, especially the assessment of contribution to bottom sediments of ice algae and phytoplankton.

In the second year of a study on the shrimp at Killiniq, northeastern Ingvav Bay, the main effort was put on the reproductive energetics of three species which contribute to the food of fishes.

Division des sciences halieutiques, Direction de la Recherche sur les pêches, 901 Cap Diamant, C. P. 15500, Québec, Province de Québec, G1K 7Y7 (J. J. Maguire, Chief de division)

Certaines des activités de recherche menées par la division en 1985 avaient un volet océanographique. On a lancé une étude de la répartition spatiale des oeufs de poissons et des larves de crevettes nordiques (Pandalus borealis) dans la partie nord du golfe du Saint-Laurent (zone 4S de l'OPANO), qui tiendra compte de la circulation des masses d'eau dans ce secteur. Dans le cadre de travaux de recherche sur le pétoncle géant (Placopecten magellanicus) et le homard d'Amérique (Homarus americanus), des données sur la circulation de l'eau recueillies autour des Îles-de-la-Madeleine ont permis de mettre en évidence l'existence d'un courant anti-cyclonique autour de cet archipel. Enfin, des études ont été menées sur les conditions hydrodynamiques au voisinage du fond et leur effet sur la croissance de la moule bleue (Mytilus edulis) et du pétoncle géant.

Division de l'habitat du poisson, Direction de la Recherche sur les pêches, 901 Cap Diamant, C. P. 15500, Québec, Province de Québec, G1K 7Y7 (Y. Vigneault, Chef de division)

Cette division a poursuivi ses recherches visant à connaître l'état actuel de contamination des milieux côtiers de l'estuaire du Saint-Laurent. Plusieurs études ont permis d'établir quelles sont les concentrations de polluants dans les sédiments de surface et dans les organismes marins. Une surveillance particulière a été effectuée dans la région de Baie Comeau. Les biphenyles polychlorés (BPC) et les métaux (Cd, Cr, Pb, Zn, Hg, As) sont les principaux contaminants dont les concentrations ont été mesurées dans les

sédiments. Les organismes qui ont fait l'objet de détermination de leur contamination sont le buccin (*Buccinum undatum*), le hareng (*Clupea harengus*), la moule bleue (*Mytilus edulis*), et l'anguille d'Amérique (*Anguilla rostrata*). La relation sédiment-organisme a été examinée surtout pour la contamination par les hétérocycles polychlorés. Ces travaux devraient permettre de développer une approche scientifique au problème de la contamination des ressources halieutiques et des habitats de l'estuaire et du golfe Saint-Laurent.

Division de l'écologie des pêches, Direction de la Recherche sur les pêches,  
310 avenue des Ursulines, Rimouski, Province de Québec, G5L 3A1  
(P. Béland, Chef de division)

Quelques uns des projets de cette division touchent le domaine de l'océanographie. Les résultats obtenus dans le cadre d'un programme d'étude des échouages de bélugas dans l'estuaire du Saint-Laurent ont permis d'avancer l'hypothèse que les contaminants organochlorés présents dans le milieu réduiraient le potentiel de renouvellement de cette population. Une étude de l'écologie de *Protogonyaulax tamarens*, sur la rive sud de l'estuaire, a intégré la prise de données océanographiques courantes dans le but de préciser quelles sont les conditions qui prévalent lors des blooms. On a décrit dans une publication primaire les effets des débits d'eau douce sur les communautés benthiques du littoral de la Minganie (Côte Nord du Saint-Laurent). Enfin, on a mis en place, pour la troisième année consécutive, onze thermographes qui permettront de décrire les changements saisonniers de température, par 10 mètres de fond, le long de la rive sud de l'estuaire.

#### DALHOUSIE UNIVERSITY

Department of Oceanography, Halifax, Nova Scotia, B3H 4J1  
(A. J. Bowen, Chairman)

Interactions between biological and physical oceanographic processes continue to be the major focus of research conducted by the biological oceanography group, both in the pelagic and benthic environments. Extensive experimental analysis has been carried out on the influence of benthic organisms on fluid flow in the benthic boundary layer, as well as for examination of the influence of different flow regimes on benthic biological processes (Mills, Grant). These experiments made use of a new instrumental flume system; with appropriate scaling, they are directly applicable to benthic processes in nature where it is much more difficult to perform controlled experiments. The extent of physical control of phytoplankton photosynthesis and primary production was investigated at a number of different scales. Rates of vertical mixing estimated from determinations of microscale velocity shear were used to determine the vertical fluxes of nitrate in the eastern Atlantic which control rates of productivity (Lewis). Horizontal fluxes of nutrient onto Georges Bank were also determined from turbulence measurements coupled with highly resolved nitrate and ammonium profiles (Lewis). Algal adaptation to variation in the spectral distribution of underwater irradiance was examined by measurement of photosynthetic action and absorption spectra of natural phytoplankton

populations during cruises to Georges Bank and the Canadian High Arctic (Lewis). On a larger spatial scale the influence of physical processes, including upwelling and horizontal dispersion, on the phytoplankton, zooplankton, and ichthyoplankton populations off southwestern Nova Scotia and northern Georges Bank was examined in a series of cruises associated with the Southwest Nova Scotia Fisheries Ecology Program (Koslow, Fournier). A new Antarctic program to examine krill feeding behavior was started (Boyd). On a still larger scale, coherences between climatic fluctuations and fish catch variations in the northern Atlantic over the past 30 years were examined (Koslow).

Experimental laboratory research in support of field programs included analysis of variability in algal physiology and chemical composition as functions of light, nutrient, and temperature fluctuations. Experiments with microzooplankton culture and behavior have yielded new insight into this delicate but important component of oceanic food webs. Feeding rates of larger zooplankton on various algal species such as toxic dinoflagellates have been determined. Quantitative studies of feeding of mackerel on hydromedusae have been carried out in the laboratory for the first time; it appears that this abundant prey item may be more important for economically important fish species than was previously thought. Finally, theoretical work into the nature of marine ecosystems, particularly the size structure of marine organisms and predator-prey relationships, has provided an important underpinning to both experimental and field research.

#### UNIVERSITÉ DU QUÉBEC À RIMOUSKI

Institut national de la recherche scientifique (INRS), 310 avenue des Ursulines, Rimouski, Province de Québec, G5L 3A1  
(J. Lebel, Chef)

Les professeurs-chercheurs de l'INRS effectuent des recherches dans trois grands domaines thématiques correspondant aux priorités du centre et qui se poursuivront au cours des prochaines années.

1. Les processus biologiques et biochimiques côtiers (mécanismes biologiques responsables de la production et de la transformation de la matière organique en milieu marin):
  - a) étude des diverses formes physiques, chimiques, et biochimiques de la matière organique et des mécanismes biologiques de contrôle;
  - b) étude des processus enzymatiques responsables de la stratégie adaptative des organismes zooplanctoniques aux variations naturelles et anthropogéniques;
  - c) études des mécanismes de contrôle de la répartition des larves de poissons: processus physiques à petite et moyenne échelle, facteurs trophiques; et



- d) étude des processus de contamination du milieu marin et des conséquences sur l'écosystème. Ce point comporte plusieurs aspects tels que: l'étude du transfert du méthyl-mercure dans les maillons supérieurs du réseau alimentaire; l'étude de l'antagonisme sélénium-mercure chez plusieurs espèces marines (moule, toile de mer, crabe, crevette); l'étude de modèle enzymatique permettant d'évaluer l'effet des polluants; la description des mécanismes de vieillissement du pétrole brut en milieu très froid et en particulier sous la glace.
2. Le milieu physique côtier est un thème visant à étudier les lois qui régissent le cycle sédimentaire et la circulation en milieu littoral, côtier et estuarien. Il s'articule en deux parties, l'une fondamentale étudiant les processus de transport sédimentaire et la circulation (dynamique) côtière et l'autre appliquée tournée vers les études d'impacts. Dans ce cadre s'inscrivent différentes études sur:
- a) la formation et l'évolution des barres d'avant-côte de littoraux en régime micro-tidal;
  - b) l'établissement des variations spatio-temporelles du littoral à partir du cycle érosion-sédimentation dans le but d'établir un bilan sédimentaire;
  - c) la création de rides sableuses sur la plateau continental;
  - d) la modélisation du transport sédimentaire en établissant un lien entre approches empirique et théorique dans des systèmes côtiers simples;
  - e) la formation et l'évolution d'un cône deltaïque sous-marin en utilisant des approches sédimentologiques, minéralogiques, et de modélisation;
  - f) l'évolution des estuaires en climat sub-boréal dans le but de modéliser le devenir de ce type d'estuaire; et
  - g) l'hydrodynamique côtière dont l'objectif reste la compréhension de la réponse des eaux côtières de l'estuaire et du golfe du Saint-Laurent aux diverses forces qui agissent sur elles. En dehors de campagnes sur le terrain, deux types de modèles sont en cours de développement: l'un à deux dimensions horizontales (barotropique) et l'autre à trois dimensions (barotropique et baroclinique) linéaire et à diffusions finies.
3. Le thème halieutique et aquiculture s'attache à valoriser la biomasse marine et à trouver de nouvelles avenues pour un secteur en difficulté. Les activités poursuivies concernent:
- a) l'installagion à grande échelle d'un système de culture en dialyse de phytoplancton afin de produire les microorganismes nécessaires aux développements des espèces phytophages;

- b) le développement d'une enclosure expérimentale du pétoncle géant de l'oeuf à la post-larve;
- c) l'adaptation physiologique des salmonidés au milieu marin avec l'étude des capacités osmorégulatrices de l'omble de fontaine lors de transferts de l'eau douce vers l'eau de mer et l'étude des transformations physiologiques du saumon de l'Atlantique avant sa migration océanique; et
- d) l'estimation in situ des besoins métaboliques de la moule bleue et de la capacité de support du milieu lagunaire des Iles-de-la-Madeleine.

Département d'Océanographie, Université du Québec à Rimouski, 310, ave des Ursulines, Rimouski (Québec) G5L 3A1  
(Jean-Claude Brêthes, directeur)

Les professeurs du Département d'Océanographie de l'Université du Québec à Rimouski effectuent des travaux qui touchent plusieurs aspects de ce domaine de recherche. Trois équipes poursuivent leurs activités reliées à la biologie marine et l'océanographie biologique.

Un premier ensemble de travaux (Bruno Vincent, Gaston Desrosiers, Jean-Claude Brêthes) s'attache à la dynamique des populations benthiques des substrats meubles intertidaux en climat froid. Le projet s'inscrit dans l'étude des mécanismes d'application des espèces à leur environnement. La question est de savoir quel est le rôle des facteurs de contrôle dans les variations d'abondance d'une population par rapport aux problèmes de l'hétérogénéité du milieu. Il serait vraisemblable qu'une stratégie d'étalement des risques existe dans le milieu benthique intertidal que nous nous proposons d'étudier. Dans cette adaptation à l'environnement interviennent les stratégies démographiques que l'on peut étudier selon deux modèles: le modèle déterministe ("r-K selection") et le modèle stochastique qui paraît le mieux adapté dans le cas où prédominent les facteurs abiotiques, comme cela paraît être le cas dans le milieu étudié. La communauté choisie, celle à *Macoma balthica* de l'estuaire du Saint-Laurent, de structure simple, semble bien appropriée à cette approche. En plus de considérations fondamentales, une meilleure connaissance du fonctionnement des écosystèmes littoraux paraît importante compte tenu de la place que ces écosystèmes prennent dans la productivité biologique marine. L'objectif est de mettre en évidence les facteurs et les mécanismes qui interviennent dans la dynamique des populations benthiques de substrats meubles intertidaux et d'analyser la valeur adaptative des stratégies démographiques en fonction des différentes pressions sélectives. La communauté à l'étude est la communauté à *Macoma balthica* et l'estuaire maritime du Saint-Laurent. Il s'agit donc de connaître le cycle de développement de l'espèce, de mettre en évidence les variations inter- et intra-population, de vérifier la correspondance tactique/facteurs extrinsèques avec les modèles démographiques, et de juger de l'importance des facteurs abiotiques. On vise donc à mieux comprendre le fonctionnement des communautés benthiques: compréhension qui peut s'avérer très utile dans l'étude des mécanismes plus vastes de productivité marine. Un projet parallèle de l'équipe se poursuit sur l'écologie et la dynamique du crabe

des neiges (Chionoecetes opilio) en relation avec son exploitation dans le golfe du Saint-Laurent.

Une deuxième équipe (Michel Arnac, Alcide Horth, Michel Khalil) s'intéresse à l'identification des unités de stock de hareng et à leur contamination dans le golfe du Saint-Laurent. Les modèles de gestion des stocks de poissons donnent ordinairement des résultats satisfaisants lorsque la structure d'un stock donné et les migrations de ses unités composites sont bien connues. Dans le golfe Saint-Laurent, il y a plusieurs unités du stock de hareng. Un certain nombre de ces unités de stock frayent au printemps (avril et mai) et les autres en automne (août et septembre). Ces unités ont été plus ou moins bien identifiées de façon très laborieuse au cours des trente dernières années par des méthodes biométriques classiques. Il existe des hypothèses concernant les migrations de ces unités de stock. Le hareng cependant a été supêché tant sur la côte ouest du Canada. Des données fondamentales nécessaires à une gestion efficace de cette ressource semblent manquer. L'hypothèse de base est que l'analyse des protéines de certains tissus du hareng ainsi qu'une meilleure connaissance de son bagage génétique vont permettre de mieux caractériser les unités de ce stock et de le faire à meilleur compte. De plus, on cherche à déterminer le degré de contamination du hareng par les organohalogénés et les métaux lourds. On espère ainsi en apprendre davantage concernant le comportement et les migrations du hareng. Les études de contamination sont d'abord faites pour vérifier les migrations du hareng, mais nous renseigneront aussi sur la qualité de ce poisson comme aliment. Le problème est abordé de deux façons. Par électrophorèse de protéines, on cherche une "empreinte" pouvant caractériser les unités du stock de hareng et on fait une étude de la structure génétique de plusieurs populations. Le degré de contamination de tissus du hareng par les organohalogénés et les métaux lourds est déterminé par chromatographie en phase liquide sous pression, chromatographie en phase gazeuse, absorption atomique sans flamme et avec flamme et polarographie avec tension surimposée.

Un troisième projet (J. I. El-Sabh) s'attache aux relations entre le recrutement larvaire et les processus physiques dans le sud-ouest du golfe du Saint-Laurent. Il est réalisé en collaboration avec madame Brenda Côté (INRS-Océanologie). L'objectif est d'étudier les relations entre la présence de certaines caractéristiques du milieu dans le sud-ouest du golfe Saint-Laurent (tourbillons, courants ...) et la ponte et le développement des larves de poissons. Ainsi, des zones contenant certaines structures physiques font-elles l'objet d'un choix préférentiel de la part des géniteurs? Certaines caractéristiques physiques jouent-elles un rôle de rétention des oeufs, des larves et de leur proie, ayant ainsi un effet sur la nutrition et sur le développement grégaire? On étudie en détail les conditions physiologiques des oeufs et des larves ainsi que les conditions de vie (abondance de proies, température ...) que l'on retrouve à l'intérieur et à l'extérieur des zones ayant des caractéristiques physiques d'intérêt. Parallèlement, on étudie ces zones de ponte en ce qui a trait par exemple aux patrons de courants, à la présence de tourbillons, etc. Une meilleure connaissance des facteurs qui affectent l'abondance et la survie des larves et par le fait même le recrutement, aura un impact sur notre capacité à bien gérer nos pêches commerciales.

McGILL UNIVERSITY

Institute of Oceanography, 3620 University Street, Montreal, Province of  
Québec, H3A 2B2  
(J. B. Lewis, Director)

M. J. Dunbar, with C. Rymes and M. de Sève, investigated the ice biota in northern Baffin Island waters and in the Magdalen Island region. Work on the biology of Arctic charr with D. Bouillon in northern Labrador was completed. Work is continuing on considerations of climate and abundance cycles in the sea, mechanisms of evolution at the ecosystem level, and the general status of Atlantic salmon throughout its range.

J. B. Lewis continued his work on resident coral reef demersal plankton in Barbados with J. Boers and P. Snelgrove. Investigations of nutrient loading by ground water onto coral reefs in Barbados was initiated. Spatial and temporal variations in ground-water discharge have been observed, and significant discharge of nitrates and phosphates is occurring onto the reefs.

B. M. Marcotte and his students have been involved in studies on population dynamics of meiobenthic harpacticoid copepods in respect to effects of fuel oil, diel vertical migrations, food resources, and sedimentary grain size. Dr. Marcotte completed his work on feeding behavior, learning, and memory in Atlantic salmon and has documented evolutionary patterns in copepod diversity from ancestral benthic forms to planktonic and parasitic taxa.

H. M. Reiswig continued his investigations of the organization, taxonomy, and ecology of Porifera on three fronts: 1) the fine structure of hexactinellid sponges; 2) new species of skeleton-less "slime sponges"; and 3) the distribution of sponge and symbiotic bacteria biomass with depth on the west coast of Barbados.

R. G. Ingram reported that over the past three years our oceanographic studies have centered on three distinct problems. In northern waters, entrainment and mixing processes in an under-ice plume (Hudson Bay) and its influence on the production of microalgae (with d'Anglejan of McGill and Legendre of Laval University) have been the main focus. Most of this research was conducted within the framework of two NSERC Strategic Grants, in collaboration with Department of Fisheries and Oceans scientists (Thériault, Demers, Larouche). In James Bay, the effect of river flow diversion on the circulation and salinity regime of the Eastman River was investigated. Further south, studies have centered on circulation, fronts, and mixing processes in the St. Lawrence Estuary.

Sedimentological studies in the Hudson Bay and in the St. Lawrence Estuary are being undertaken by B. d'Anglejan. A program is underway in the Hudson Bay, off Great Whale River, to study the vertical flux of settling particles in both under-ice and open-water conditions, bottom sediment rates of deposition, and geochemical transfers.

In the St. Lawrence Estuary, seasonal mass exchanges between marsh and tidal flats and the North Channel, believed to determine the fluctuations in position and intensity of the maximum turbidity zone, have been studied in detail.

GROUPE INTERUNIVERSITAIRE DE RECHERCHES OCÉANOGRAPHIQUES DU QUÉBEC (GIROQ)

Secretariat, Pavillon Vachon, Université Laval, Ste-Foy, Province de Québec,  
G1K 7P4  
(A. Cardinal, Secrétaire général)

Les travaux du GIROQ se sont articulés autour de trois axes principaux, et cette programmation se poursuivra au cours des prochaines années. Ces trois axes correspondent aux intérêts des trois équipes où sont regroupés les chercheurs du GIROQ.

1. Les processus d'interface (hydrodynamique et production planctonique) en milieux côtiers et estuariens:
  - a) les échanges énergétiques air/mer et le mélange vertical dans la partie supérieure de la colonne d'eau;
  - b) le contrôle hydrodynamique de la photosynthèse phytoplanctonique;
  - c) modélisation de la croissance du phytoplancton en fonction de l'hydrodynamisme de la colonne d'eau;
  - d) le contrôle hydrodynamique des microalgues et de la matière particulaire sous la glace de mer;
  - e) le broutage des microalgues des glaces par le zooplancton.
2. L'écologie reproductrice des poissons - cinq projets se situent dans ce cadre:
  - a) le contrôle environnemental de l'effort reproducteur chez les corégonines anadromes de la Baie James et de la Baie d'Hudson;
  - b) le réglage de la dérive larvaire de l'éperlan (Osmerus mordax) dans l'estuaire moyen du Saint-Laurent;
  - c) la mortalité chez les stades larvaires du capelan (Mallotus villosus): les processus dépendants de la densité et le rôle des prédateurs planctoniques;
  - d) la description des mécanismes d'apprentissage olfactif responsables de l'identification des rivières natales par le saumon (Salmo salar); et
  - e) description du patron de mortalité durant tout le cycle vital de trois espèces d'épinoches, et évaluation de l'influence de cette mortalité sur l'effort reproducteur.
3. Le Milieu benthique littoral de l'estuaire et du golfe du Saint-Laurent: aspects dynamiques et fonctionnels - cinq projets s'insèrent dans cette programmation:
  - a) l'hétérogénéité du milieu et la répartition des organismes benthiques intertidaux;

- b) influence des écoulements d'eau douce sur la production benthique dans l'estuaire et le golfe du Saint-Laurent;
- c) écophysiologie, variations intraspécifiques et utilisation par les herbivores des diatomées marines benthiques de substrats durs;
- d) structure des communautés infralittorales du golfe du Saint-Laurent; et
- e) effets du stress trophique sur les communautés suprabenthiques subpolaires.

#### NEWFOUNDLAND INSTITUTE FOR COLD OCEAN SCIENCE

Memorial University of Newfoundland, St. John's, Newfoundland, A1B 3X7

NICOS is responsible for the co-ordination and encouragement of basic oceanographic research within the Faculty of Science, Memorial University of Newfoundland. The staff engage in a variety of research projects, including physical oceanography, geophysics, biological oceanography, seabird ecology, biochemistry, chemistry of marine natural products and regional geographic studies. Interdisciplinary and cooperative fundamental research is stressed, and many of our scientists interact widely with each other, with oceanographers at the Bedford Institute of Oceanography, and with scientists across Canada and the United States.

#### Fishnet Fouling and Larvacean Biology:

Recent information on the ecology of the gelatinous organism Oikopleura emphasizes the value of a better understanding of its basic physiology. Precise information on diets was obtained in the field, and electron microscope observations have revealed the ultrastructure of the internal feeding filter in sufficient detail so that the energy required for feeding can be calculated. Using tritiated thymidine in the lab, the decay of abandoned mucus houses was determined to take as long as 3 weeks. One organism can produce 4-6 houses each day, so it is no wonder that mucus fouling of nets is a problem. The best tactic to avoid fouling may be to remove nets during periods of onshore movement of the very cold Labrador Current water which Oikopleura lives in.

#### Fjord Biology:

Our studies show that populations of deep-water pelagic animals, more typical of the outer continental slope, live in deep fjords along the south coast in relative isolation. Bay d'Espoir is rich in species that show a broad spectrum of sizes and are equitably distributed with respect to abundance; the Fortune Bay fauna is quite the opposite. These differences can be related to the differences in source waters and in the seasonal physical dynamics of the two areas. To help understand the differences

between these faunas in more detail, comparative studies of the pelagic food webs have begun using stable isotope tracer techniques.

#### Grand Banks Studies:

Work is being carried out on the Southeast Shoal of the Grand Banks in collaboration with the Department of Fisheries and Oceans. Movement of water onto and off the shelf in this area may affect the overall productivity and the recruitment of larval fishes. Studies of zooplankton exchange across the shelf/slope break there relate to questions of the general variability of zooplankton communities in response to physical oceanography. Physical dynamics also affect nearshore zooplankton community composition, which varies both temporally and spatially. The pattern of these variations, and their response to interaction with the adjacent slope areas, is another focus.

#### Whale Research:

The Whale Research Group's work on behavior of humpback whales emphasizes the identification and cataloguing of individuals on the basis of fluke patterns. A network is maintained for recording sightings and strandings, with a 24-hr telephone line for fishermen to report entrapments in inshore fishing gear and to request aid. At sea, workers investigated techniques for tracking, identifying, and studying the social behavior of sperm whales in various ocean areas, including the Indian Ocean. Nearer home, an analysis of the correspondence between baleen whale distributions and the abundance of capelin was carried out. Particular emphasis was placed on humpback whales inshore and on the Southeast Shoal of the Grand Bank.

#### Seabird Research:

One project utilizes an interdisciplinary approach directed at different levels of analysis of seabird/fisheries relationships. A major effort is being carried out in collaboration with the Department of Fisheries and Oceans and the Canadian Wildlife Service in the Witless Bay Seabird Sanctuary, where the breeding performance and feeding ecology of the dominant alcids (murres, puffins) are being studied in relation to the distribution and abundance of their primary prey, capelin. The research seeks to specify more clearly the impacts that the birds have on fish stocks, and the influences that fluctuating and patchy prey resources have on marine bird foraging, behavioral strategies, breeding success, and phenology. A project objective is to understand the patterns observed in relation to local physical oceanographic features. A coordinated approach allows simultaneous observations both at sea and at the breeding colonies.

A second project involves the design of lightweight and inexpensive depth meters and timers that can be attached to free-living seabirds. With these instruments, information on different components of foraging behavior (flight times, dive times and depths, resting times, etc.) can be obtained for the first time. The group has also carried out the first metabolic studies on free-living birds using radioisotopes ever conducted in Canada. Seabird diets and nutrition, and proximate analyses of seabird eggs are areas of focus. The major goal of the bio-energetics work is to model with precision the energy flow through a seabird colony.

Marine Microbiology:

A continuing study of cold-ocean bacterial strains indicates that only a few species are predominant in this environment. These are remarkably versatile in their production of exoenzymes and in their ability to mineralize different kinds of organic compounds.

Marine Biochemistry:

The properties of digestive enzymes from marine organisms are being studied in detail. The results are of direct interest with respect to the use of enzymes in industrial applications. The postmortem physiology and biochemistry of cod and squid muscle is being characterized so as to better understand the intrinsic factors which determine "quality" in these important seafoods. Investigations are continuing on the structure elucidation and synthesis of biologically active substances in cold-water invertebrates and plants.



-25-

Denmark

(V. Hansen)

Not received as of 10 June 1986.

Finland

(J.M. Leppänen)

Finnish Institute of Marine Research, Helsinki

Studies on long-term fluctuations and population dynamics of phyto- and zooplankton, as well as macrozoobenthos, started in 1961, were continued in the entire Baltic Sea including the Baltic Monitoring Programme of the Helsinki Commission.

The ecology of mysid shrimps was studied in the Gulf of Finland and in the Gulf of Bothnia in cooperation with the University of Helsinki and the Finnish Institute of Game and Fisheries. Special interests are the connections between mysid and herring distributions and the food selection of herring.

Studies on the cycling of organic matter, with the aim of quantification of the main energy and elemental fluxes in the food web of the open Baltic were continued. This involved investigations on primary and secondary production and on the decomposition at different trophic levels as well as on sinking of particulate matter. An essential purpose of the study was to elucidate the interaction between the benthic and pelagic systems.

National Board of Waters, Water Research Office, Helsinki

Phytoplankton primary production, chlorophyll a, and phytoplankton were measured at coastal monitoring stations in both polluted and unpolluted areas. At four stations the sampling frequency was high. Special investigations were performed off several residential areas.

Studies on the influence of industrial pollution on the composition of benthic macrofauna were continued at several localities along the coast of Finland.

Recent changes in the composition of littoral ecosystems, the decline and recolonization of Fucus vesiculosus have been studied in the Archipelago Sea.

The long-term monitoring of benthic fauna have been continued at Tvärminne Zoological station.

Finnish Centre for Radiation and Nuclear Safety, Helsinki

Environmental radioactivity monitoring and radioecological studies on selected species were carried out in the vicinities of two nuclear power plants, one situated on the coast of the Gulf of Finland, and the other one on the coast of the Bothnian Sea.

Studies on phytoplankton, primary production, and zoobenthos were continued in the sea areas around the two nuclear power plants.

Tvärminne Zoological Station, University of Helsinki

The research carried out at the station includes a broad spectrum of studies on brackish water ecology, basic physiology of brackish water animals, population genetics of Baltic molluscs, and effects of pollutants on selected coastal species.

The most extensive project deals with the factors regulating the pelagic carbon cycle in annual, diurnal, and immediate time scales. Of special interest are the responses of the pelagic community to nutrients, hydrography, and biological factors regulating the carbon and nutrient flows within the planktonic community. The biological interactions under detailed study are the connection between phytoplankton and bacterioplankton as well as grazing phenomena as structuring factors on different levels of the community. The basic approach to study these topics is to combine monitoring studies (annual/seasonal scale) of the key parameters describing carbon and nutrient flows, as well as parameters describing the basic state variables of these flows, with active manipulation of the system in experimental setups of variable scales of volume, duration, and parameters of interest.

Husö Biological Station, Åbo Akademi

Monitoring studies were continued at fixed stations in the Åland archipelago for long-term fluctuations (natural areas) and pollution control (municipal effluents, food industry, fish farming, oil pollution). Ecological studies were carried out on phytobenthos (Fucus vesiculosus community) in relation to seasonality and exposure to wave action in NW Åland archipelago. Interactions on shallow softbottoms in the archipelago were studied experimentally in the field and laboratory, including studies on biotic interrelationships and structuring mechanisms in zoobenthos and fish. Investigations on zoobenthos recovery potential and colonizing strategies were continued.

Archipelago Research Institute, University of Turku

The work at the station included basic research on the ecosystem of archipelago waters, e.g. production ecology of zooplankton and population dynamics of typical coastal species. Examples of applied research were studies on fouling, man-induced changes of biocenoses, and effects of waves caused by ferry traffic on fisheries. Studies on the effects of aquaculture on the environment were continued.

Perämeri Research Station, University of Oulu

Investigations in the population density of fingerlings (different species) were carried out in the vicinity of the research station and along the Finnish coast from Oulu to Kemi. Studies on the population density of near-bottom fish have been continued in three areas representing different types of exposition and pollution load.

Studies on the population dynamics of benthic macrofauna were continued.

An ecosystem research project in the Bay of Liminganlahti has been started again. It includes investigations on nutrients, phyto- and zooplankton, benthic flora and fauna, as well as waterfowl and input of water and organic matter from rivers.

France

(P. Nival and P. Lassus)

INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLORATION DE LA MER (IFREMER)

- Etude régionale intégrée du golfe Normano-Breton (écologie) (en collaboration avec divers laboratoires (France) et participation CEE).
- Automatisation des analyses de pêches zooplanctoniques par analyse d'image (en collaboration NMFS - Narragansett Laboratory (USA)).
- Etude de la production phytoplanctonique du bassin de Marennes-Oléron (zone estuarienne du golfe de Gascogne). Valeur nutritive du milieu pour les mollusques.
- Structure et fonctionnement des écosystèmes planctoniques de zones frontales (bassin Liguro-provençal) et résurgences côtières (Portugal) (en collaboration GRECO MEDIPROD./CNRS (France) Labo Pêches et Muséum de Lisbonne (Portugal) Université de Liège (Belgique)).
- Etude de l'écosystème hydrothermal à l'axe des dorsales océaniques (en collaboration avec le PIRO (France) et la Scripps Institution of Oceanography, California (USA), WHOI (USA) et l'Université de Victoria (Canada)).
- Etude de l'environnement profond de la plaine abyssale du NE Atlantique (en collaboration avec Brookhaven National Laboratory, NY (USA) et Université de Padova (Italie)).
- Travaux préliminaires sur le déterminisme du recrutement chez la sole. Distribution des oeufs et larves (en collaboration avec l'Université du MARYLAND (USA)).
- Normalisation d'un test de toxicité utilisant un microcrustacé planctonique marin (copépode).
- Impact des grands aménagements énergétiques littoraux sur les frayères et nurseries des poissons et crustacés en Manche et partie écologique de l'impact des grands aménagements énergétiques.
- Etude de l'impact sur l'environnement abyssal des activités humaines: rejet ou enfouissement de déchets radioactifs à faible et haute toxicité (en collaboration avec la CEA en France).
- Eaux colorées et organismes toxiques:
  - Essais de mise en culture de *Dinophysis acuminata* (en collaboration avec l'Université de Paris VII) et *Gyrodinium aureolum*.
  - Etude des mécanismes de formation des eaux colorées dans les bassins portuaires du Havre et en Baie de Vilaine. Ecologie des dinoflagellés toxiques, rôle des sédiments.
  - Etude des biotoxines de dinoflagellés (en collaboration avec l'Université de Tohoku - Japon).

UNIVERSITE DE NANTES

Laboratoire de Biologie marine Nantes

- Claires ostréicoles: mécanismes de transfert des nutriments (échelons Ier et IIème) (en collaboration avec le CNRS) et compétitions trophiques: microphytes/macrophytes, dans les bassins d'élevage.
- Cycles biologiques et flux énergétiques dans les écosystèmes productifs littoraux.
- Chaînes alimentaires dans les écosystèmes productifs littoraux.
- Production primaire et verdissement des claires à huîtres (agriculture).
- Inventaires faunistiques et floristiques, formations organogène, du benthos des claires à huîtres.
- Faunistique et aménagement littoraux.
- Ecologie des bioconstructions à annélides polychètes (en collaboration avec l'Université de MANCHESTER (U.K.)).
- Révision taxonomique du genre Sabellaria d'après l'observation des palées.

UNIVERSITE DE PROVENCE-AIX MARSEILLE

Laboratoire de Biologie animale (plancton) Marseille

- Recherches cytophysiologiques sur la nutrition et la reproduction des copépodes calanoïdes et harpacticoïdes.

UNIVERSITE PIERRE ET MARIE CURIE - PARIS VI

Laboratoire Arago, Banyuls sur mer

- Analyse de la composition spectrale des populations du mesozooplancton.
- Biologie de la reproduction des copépodes planctoniques (en collaboration avec Station Zoologique de Villefranche (France)).
- Biologie et écologie des céphalopodes (en collaboration avec la station de Roscoff, Université de Caen (France), les Universités de Cambridge (UK), d'Aberdeen (Ecosse) et de Dalhousie-Halifax (Canada)).
- Aspects énergétiques et biochimiques comparés chez les algues à fucoxanthine.
- Ecologie et physiologie du phytoplancton d'une zone néritique à forts apports terrigènes, le golfe du Lion (en collaboration avec l'IFREMER et la station marine d'Endoume).

- Ecologie et physiologie du phytoplancton des hautes latitudes (Antarctique et Arctique (en collaboration avec l'Université de Larval-Pêches et Océan (Québec))).
- Utilisation des ressources trophiques par le benthos. Ecophysiologie. Bilan énergétique.
- Recherches pluridisciplinaires sur l'écosystème des marges continentales (en collaboration avec les laboratoires de Sédimentologie et géochimie marine, CEA, de micropaléontologie, MNHN, UBO, Ecologie et Biochimie microbienne du milieu marin (France) et l'International Laboratory of Marine radioactivity).

#### Station zoologique de Villefranche sur mer

- Modélisation et simulation expérimentale du réseau trophique planctonique (en collaboration avec l'Institut de Zagreb (Yougoslavie) et le City College NY (U.S.A.))
- Cycle annuel du plancton et des paramètres du milieu en eau côtière et du large et analyse du métabolisme des peuplements (en collaboration avec l'Italie).
- Etude biochimique du processus de nutrition des organismes planctoniques (en collaboration avec Bedford Institut, Dartmouth (Canada)).
- Rôle des logettes d'appendiculaires dans le transfert de matière dans la mer (en collaboration avec le California State University (U.S.A.)).
- Surveillance de la composition du mesozooplancton en zone côtière. Etude de séries chronologiques pour différents groupes planctoniques.
- Analyse de la participation de différents groupes planctoniques au transfert de matière dans l'écosystème pélagique (bactérioplancton, microplancton, mésozooplancton, macroplancton, méroplancton) (en collaboration avec le Bedford Institut, Dartmouth (Canada)).
- Distribution spatiale des organismes du microzooplancton.
- Etude du rôle du macroplancton gélatineux dans l'écosystème pélagique de la mer de Ligurie (en collaboration avec le MNHN et l'ORSTOM (France) et le WHOI (U.S.A.)).
- Perturbations à long terme induites par la prolifération de certains groupes planctoniques (en collaboration avec le MNHN (France)).

#### UNIVERSITE DE PARIS VII

##### Laboratoire de Biologie cellulaire et végétale

- Etude de Dinoflagellés toxiques (cultures, toxines et leurs effets (en collaboration avec l'IFREMER, France)).

- Etude du plancton de l'Antarctique (cultures identification) (en collaboration avec le GIS Mer et Santé de Marseille (France)).
- Etude du mode d'action des biotoxines (en collaboration avec le CNRS de Montpellier, France).

#### UNIVERSITE DE BORDEAUX I

##### Laboratoire de biologie marine

- Macrofaune benthique et suprabenthique du plateau sud-Gascogne Meiofaune et macrofaune des sédiments lagunaires estuariens.
- Métabolisme (calorimétrie et respirométrie) des sédiments lagunaires.

#### UNIVERSITE DES SCIENCES ET TECHNIQUES DU LANGUEDOC

##### Station de Biologie marine et lagunaire de Sète

- Chaînes trophiques
- Métabolisme et comportement des larves et juvéniles de poissons.

#### UNIVERSITE DES SCIENCES ET TECHNIQUES DE LILLE

##### Station marine de Wimereux

- Déterminisme du recrutement en Baie de Seine ATP (GRECO-MANCHE).
- Biologie des céphalopodes (Embryologie de la Seiche, mécanismes endocrines, Protéines sanguines) (en collaboration avec l'Université d'Anvers (Belgique) et d'Utrecht (Hollande)).
- Analyse des perturbations des écosystèmes planctoniques. Etudes d'impact d'une centrale nucléaire, des travaux de génie civil. Effets des polluants métalliques (en collaboration avec l'IFREMER et le programme GRECOMANCHE).
- Evaluation et optimisation de l'échantillonnage et écologie littorale (GRECOMANCHE, France).

#### COLLEGE DE FRANCE

##### Laboratoire de biologie marine de Concarneau

- Nurseries en estuaire et séquences alimentaires chez le poisson originaire de Mer Celtique.



- Biochimie et Physiologie de l'acclimatation et de l'adaptation en milieu marin (en collaboration avec le Zoologie Universität Nijmegen (Hollande) et le CNRS (France)).
- Ecotoxicologie et Bionomie littorale et estuarienne.
- Hormones peptidiques chez les crustacés (Réseau Crustacés du CNRS (France)).
- Rythmes biologiques des animaux de la zone des marées.

German Democratic Republic

(Prof. Dr. E. A. Arndt)

No report received.

Germany, Federal Republic of

(J. Lenz)

INSTITUT FÜR MEERESKUNDE AN DER UNIVERSITÄT KIEL

The institute with its five biological departments covering botany, zoology, microbiology, planktology and fisheries biology is engaged in a great number of activities falling into the scope of biological oceanography. The following enumeration of recent and current research activities is conventionally subdivided into planktological and benthological projects, though the interaction of biological processes between both ecological zones in shallow sea ecosystems forms the main topic of interest in a number of projects.

Planktological investigations

Studies on the trophic status of Kiel Fjord were finished after a 2 years sampling period of a close station grid for inorganic nutrients, phytoplankton biomass and species composition. The river Schwentine is a main source for nutrient input.

The potentially toxic dinoflagellate, *Prorocentrum minimum*, noticed in 1983 for the first time in Kiel Fjord, reappeared in 1984 and 1985. It seems now that this species has established itself as a regular member of the phytoplankton community in July and August.

In addition to monthly sampling of the monitoring stations for HELCOM in Kiel Bight, the water column at the Institute's pier was sampled three times a week in order to follow short-term changes in water chemistry and plankton composition.

Experiments on the natural fluorescence of phytoplankton algae carried out in the laboratory and under field conditions were continued in order to evaluate its significance as a signal for phytoplankton abundance in remote sensing.

A literature study on the factors governing the nutrient supply to Kiel Bight was finished. Since oxygen deficiency in the deeper parts apparently has increased during the last decade, an experimental study on oxygen consumption rates under in-situ conditions was started.

Field observations on phyto- and zooplankton biomass and community structure in relation to hydrographic conditions were carried out on the Scotia Shelf in late winter and spring in cooperation with the Marine Fish Division and the Bedford Institute of Oceanography in Halifax, Canada.

A new interdisciplinary programme was started within the framework of "Sonderforschungsbereich No. 313: Sedimentation in the Norwegian Sea". The main research area is the Vøring Plateau. Planktological research concentrates on particulate flux in dependence of season and community structure in the upper layers of the water column. A summer cruise met a phytoplankton population typical for the so-called regenerated period of

nutrients being dominated by small flagellates. In the future, planktological investigations will be accompanied with the deployment of anchored and drifting sediment traps.

The abundance and species composition of phytoplankton and microzooplankton in the high Arctic in the Fram Strait Region between East Greenland and Spitsbergen is investigated within the framework of the international MIZEX '84 Expedition. Grazing experiments carried out aboard PRV Polarstern indicate the energy flow from primary to secondary producers.

Under the heading "life strategies of individual species," a search for resting spores and resting stages of phyto- and zooplankton organisms on the surface of sediments in Kiel Bight was initiated.

Microbiological work was concerned with the abundance and physiological activity of pelagic bacteria in the Atlantic waters south of Portugal in relation to hydrographical and planktological factors.

Special studies dealt with bacterial populations in the transition zone between oxic and anoxic water masses which are typical for the deeper parts of the Baltic. Bacterial activity measured as uptake rate for organic substances decreased rapidly under anoxic conditions.

Measurements of exoenzymatic activities in bacteria, which enable them to break down high-molecular organic substances, were further improved and applied to various field studies.

The work on the occurrence, taxonomy and physiology of luminescent bacteria in Kiel Bight and other regions was continued.

A study on the ratio of free-floating bacteria to those being attached to suspended particles revealed a predominance of the former in Kiel Fjord. On the average, there were less than 10% attached bacteria. Their enzymatic activities, however, were considerably higher rendering them at least as important in destruction of organic matter as the free-living population.

Another study deals with denitrification processes in oxygen-poor deep water layers of the Central Baltic.

Within the framework of ICES, surveys for herring larvae were carried out in the Atlantic north of Scotland and in the English Channel.

A survey on the distribution of sole larvae in the North Sea was finished. It yielded also valuable information on sprat eggs and other fish fry.

A special study was devoted to mackerel eggs and the depth distribution of fish larvae and their planktonic food organisms in the offshore area west of the British Isles.

Plankton investigations in the Bornholm Basin showed that the spawning period of the cod extends up to August in this region.

### Benthological investigations

The standing stock of the seaweed *Fucus* was surveyed in Kiel Bight under the question whether it also may have been negatively affected by increased eutrophication as is observed in the eastern part of the Baltic. But no substantial decrease was found in spite of strong damages by the last winter ice.

The work on a possible eutrophication in Kiel Bight during the last decade and its effects on the benthos was continued. In 1985, again oxygen deficiency and subsequent damage of the bottom fauna was observed in deeper waters in late summer and autumn. Analyses of long-term observations indicate that bad years with poor oxygen conditions affect at least the following year, as strong oxygen deficiencies are already observed in spring after sedimentation of the phytoplankton spring bloom.

Within the framework of HELCOM macrozoobenthos populations are intensely monitored. The effect of installment of an underwater pipe line put underground on the benthos community and the process of recolonization of the pipe line track is studied. Another aspect under investigation is patchiness and mobility of freshly settled larvae and adult animals.

A study on the significance of sulfate reduction in anaerobic sediments in Kiel Fjord and deep basins of the Baltic was finished.

The significance and speed of bioturbation by burrowing organisms for sediment stratification and degradation processes within the sediment was investigated by means of luminophores in the form of fluorescent sand grains of different size classes.

Experiments on heat production by degradation processes in sediment samples showed that also anaerobic processes can be quantitatively measured by this sensitive method.

Benthos research also plays an important role in the newly founded "Sonderforschungsbereich: Sedimentation in the Norwegian Sea." The first cruise to the Vøring Plateau yielded quite a high population of macrobenthos organisms in a depth of 1000 - 1900 m. Dominant species were small, tube-forming sipunculids and comparatively large foraminifera. The estimated annual oxygen consumption in these deep-sea sediments corresponds to roughly  $6 \text{ g Cm}^{-2}$ .

Investigations on the nutrition of pogonophora were continued. It was demonstrated by several methods that the newly described species *Siboglinum poseidoni* depends on energy production by their methane oxidizing symbiotic bacteria.

The biochemical reaction of benthic bacteria to the seasonal food supply by sedimenting plankton and detritus was studied by a great variety of methods. Of special interest are short-term reactions to sudden sedimentation events.

### ZOOLOGISCHES INSTITUT DER UNIVERSITÄT KIEL

Marine research focuses mainly on the structure and response of benthic communities to varying environmental conditions. The main investigation site

is the highly polluted Flensburg Fjord, Western Baltic, where the influence on organic enrichment and oxygen depletion on the macrobenthic fauna is being studied. Long-term monitoring of hydrographical data including oxygen content of the near-bottom water came to an end, as well as recolonization experiments and recolonization studies of defaunated areas in the deeper parts. A detailed investigation of macrobenthos along three transects on the "Breitgrund" gave information about the benthos situation in the outermost part of the Fjord.

Experimental work on the biology and behavior of socially living Amphipoda was summarized by producing a film on Dulichia porrecta in collaboration with the IWS (Institut für den wissenschaftlichen Film) in Göttingen. Another experimental study on the life cycle of Crangon crangon with special emphasis on its larvae has been completed.

Investigations on the sensitivity of an intertidal flat to oil pollution were continued. In order to advise authorities what to do under different circumstances in the case of an oil accident, an intertidal flat was divided into different zones of sensitivity based on ecological features of meiofauna organisms.

Based on field experiments, another ecological study on an intertidal flat community ("Königshafenwatt", Island of Sylt) deals with the role of the macrobenthos within the nutrient cycles of the sediments.

Intertidal communities on sheltered rocky shores (Island of Helgoland), are studied, e.g. development, persistence, maintenance and organization. Furthermore the influence of predation, grazing and interspecific competition is observed. Using experimental field techniques, ecology of intertidal gastropoda (e.g., Littorina spp., Gibbula sp.) is studied, especially their preference for different algae of hard-bottom substrata.

In September 1985, long-term investigations on deep-sea Harpacticoida in the vicinity of Western Europe were started.

#### INSTITUT FÜR POLARÖKOLOGIE DER UNIVERSITÄT KIEL

An ecological investigation on the composition and structure of the arctic macrobenthic fauna was started in the Fram Strait between East Greenland and Spitsbergen during the expedition ARK III of PRV Polarstern. Sampling was carried out at about 30 stations by means of a large box corer, an Agassiz trawl and a photo sledge concentrated on the Belgica Bank of the East Greenland shelf and the adjacent continental slope.

#### INSTITUT FÜR HYDROBIOLOGIE UND FISCHEREIWISSENSCHAFT DER UNIVERSITÄT HAMBURG

##### Planktological investigations

In the highly eutrophic Schlei Fjord, Western Baltic, studies have been continued on the dynamics of two dominating copepod species, Eurytemora affinis and Acartia tonsa, in relation to variations of abiotic factors, phytoplankton supply and larval fish development.

Planktological studies are included in the project BIOTRANS which is described below.

#### Benthological investigations

In 1985 the benthos group studied the development of the benthic community in the Fladen Ground, northern North Sea, supplementing the Fladen Ground Experiment (FLEX) of the years 1975/76. From March to August, one station was sampled five times for meiofauna, chemical and biochemical parameters. Macrofauna was collected on two occasions. Data evaluation is finished and publication is in preparation.

A new deep-sea project was started: "Biologischer Vertikaltransport und Energiehaushalt in der bodennahen Wasserschicht der Tiefsee" (BIOTRANS). The area is given by 47.0°-47.30°N and 19.00°-20.00°W. Water depth is 3800-4500 m. Benthic studies cover all size classes of organisms and chemical sediment parameters. Benthopelagic organisms are trawled and caught with baited traps in chains up to 500 m above the bottom. Pelagic studies concentrate on the lower 500 m of the water column. The project aims at biological activities and transport in the deep ocean.

#### SONDERFORSCHUNGSBEREICH 94 "MEERESFORSCHUNG HAMBURG" DER UNIVERSITÄT HAMBURG

##### Research activities of the biological and chemical groups

The work of the Sonderforschungsbereich (SFB) 94 "Marine Research Hamburg" was concluded in 1985. This project was funded by the Deutsche Forschungsgemeinschaft for 15 years, and several biological and chemical programs running for many years could be brought to a successful conclusion.

During February, April and June, 1985, the last 3 SEAPLAD (Seasonal Plankton Dynamics) cruises were performed, a series of 12 investigations running since 1982. During the SEAPLAD cruises vertical profiles were investigated from the German Bight parallel to the North Friesian coast at 08°E to 55°10'N and from there northwest to the Fladen Ground (58°40'N 00°30'E). These sections were interrupted by two drift stations of a few days duration in the Fladen Ground area and at 56°N 06°E. In addition to CTD, oxygen, pH and nutrients were analyzed, chlorophyll a concentrations were measured by probes and fluorometric methods. Phytoplankton and zooplankton samples were collected, supplemented by an investigation of the standing crops of bacteria and bacteriovores. The field investigations were supplemented by laboratory experiments with isolated organisms.

In the Norwegian Trench, in connection with an intensive hydrographic investigation in March, samples for nutrient and zooplankton analysis were also collected.

In a 10 n.m. station grid in the German Bight, an intensive investigation was performed during early June. Within this grid, hydrographic parameters were measured, nutrients, dissolved organic substances, total N, P, amino acids, protein and carbohydrates were analyzed, uptake rates of amino acids were estimated, and samples were collected for phytoplankton analysis. The station grid was covered twice within 10 days. The main topic of this experiment was

the investigation of surface layers (slicks) which are formed by amphipatic substances released by the plankton. Slicks were observed and investigated for two days during this experiment.

During September/October another investigation was carried out in the German Bight. The station grid covered was that of the May/June experiment, extended to the north and west, reaching to 5°E and 55°30'N. The same parameters mentioned in connection with the previous experiment were analyzed for this station grid. The main aim of this cruise was the investigation of interactions in enclosed planktonic ecosystems at low nutrient concentrations using free-drifting enclosures. Due to high winds during this period, this experiment had to be concluded after 3 days.

All of these cruises were performed with the research vessel of the University of Hamburg, *Valdivia*, which will also be the platform for subsequent programs running in the Elbe estuary (Sonderforschungsbereich 327) and in the North Sea (Circulation and pollutant transfer in the North Sea).

#### BIOLOGISCHE ANSTALT HELGOLAND

Routine measurements of hydrographical, chemical and biological parameters have been continued at Helgoland Roads (54°11.3'N 7°54.0'E). Five times a week, temperature, salinity, nutrients ( $PO_4$ ,  $NO_3$ ,  $NO_2$ ,  $NH_4$ ,  $Si_4$ ), 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 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 temporal and spatial distribution of *Noctiluca millaris* 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 20 years at Helgoland Roads.

A new survey was started in the south-eastern North Sea (east of 6°20'E, south of 57°00'N). Seston, particulate organic carbon and nitrogen, and phytoplankton concentrations were measured along with dissolved oxygen, inorganic micronutrients, salinity and water temperature. Sampling was carried out in up to five depths on a grid of stations 12.5 nautical miles apart during five cruises with RV Friedrich Heincke.

The ecological studies in the Northern Wadden Sea of Sylt (German Bight) were carried on. Sixty-four times a year the following parameters were measured at four different stations (depending on the weather conditions): phytoplankton, mesozooplankton, seston components, temperature, salinity, pH, oxygen and phytoplankton nutrients ( $NH_4$ ,  $NO_2$ ,  $NO_3$ ,  $SiO_4$ ,  $PO_4$ ).

#### ALFRED-WEGENER-INSTITUT FÜR POLARFORSCHUNG BREMERHAVEN

Besides a wide range of activities in the Weddell Sea (Antarctica), the Institute of Polar Research also carried out some benthological and planktological investigations in the Fram Strait, North Polar Sea.

During the arctic summer, an investigation was made of the spatial and temporal development of physiological factors determining the secondary production of four zooplankton species, each of them rich in biomass. In a cooperative project with the R.U. Groningen (NL), experiments on egg production and somatic growth were complemented by studies on feeding activity, fecal pellet production, and the effect of periods of starvation, as well as by an inventory of vertical distribution of phyto- and zooplankton.

#### INSTITUT FÜR MEERESFORSCHUNG BREMERHAVEN

##### Planktological investigations

A study of composition and annual variation of zooplankton in the German Bight was finished, assessing the interrelation with the Central North Sea. Within this study, the importance of allochthonous mesoplanktonic larvae for the zoobenthos of the German Bight was of special interest.

Interchanges were also studied via tidal channels in the German part of the Wadden Sea. The balance between in- and outflow of nutrients, the transport of (meso)plankton, and active immigration/emigration of nekton were the focal points of this investigation.

The work on invertebrate zooplanktonic species in the Weser estuary and their larvae was continued.

##### Benthological investigations

The long-term studies on the variability of macrozoobenthos in the German Bight were continued. There are now some clear trends recognizable which are, however, contradictory, depending on the oxygenation of the respective stations. New work on the community structure of macrobenthos in the Central North Sea (mainly the Dogger Bank) was started.

Another study, combining planktological and benthological elements, was initiated at the North Sea Research Platform in the NE part of the German Bight. The aim of this experimental approach is to investigate initial colonization and early succession of macrozoobenthos on soft bottom substrates. The results could serve for a comparison with the "Benthosgarten" experiments in Kiel Bay during the seventies.

The "Bremerhaven Caissons" were used once again for a number of experiments on the effect of crude oil, dispersants and heavy metals on the benthic fauna of the Wadden Sea. These mesocosms will now primarily be used for a series of experiments on predator-prey-interactions on the mudflats, with special reference to the small food web.



Iceland

(T. Thórdardóttir and O. S. Astthórsson)

Phytoplankton (T. Thórdardóttir)

During the routine hydrobiological survey in coastal, as well as oceanic waters, around Iceland in May-June, monitoring of primary production and Chl a was carried out as in previous years.

In a cruise in Faxaflói in late April, primary production was measured simultaneously in situ and by the routine incubator technique at several stations.

Zooplankton (O. S. Astthórsson)

Long-term studies on the densities and composition of zooplankton in Icelandic waters during spring were continued. Similarly, the distribution and composition of zooplankton was investigated during an O-group survey in the autumn.

A study of the mysids occurring in the stomachs of cod at depths from 50-500 m in the shelf area around Iceland has been completed. A similar work on the predation of euphausiids by cod is being continued. On the south west coast of Iceland, population studies on shallow water mysids are in progress.

The Institute for Marine Environmental Research in Plymouth has been assisted in running their Continuous Plankton Recorders between Iceland and Scotland, and Iceland and the U.S.A.

Ireland

(R. Grainger)

The Fisheries Research Centre has conducted surveys for herring larvae in the Celtic Sea during the spawning season (October-February) since 1978/79. Herring larval surveys have also been carried out in Divisions VIa and VIIb since 1981 (October-November).

The University College, Galway, is involved in ichthyoplankton research off the west coast of Ireland and, in particular, Galway Bay. This work is mainly descriptive but vertical and horizontal distributions are examined in relation to physical and chemical oceanographic data collected concurrently. This University is also involved in community mapping and population studies of benthos in Irish coastal waters and in the Celtic Sea.

Trinity College, Dublin, conducts research on the benthos of Dublin Bay.

Netherlands

(J. J. Zijlstra and N. Daan)

NETHERLANDS INSTITUTE FOR SEA RESEARCH, TEXEL (J. J. Zijlstra)

In estuarine waters of the Wadden Sea effects of eutrophication on the biological system are becoming evident. Phytoplankton, measured as chlorophyll *a* and as cell-counts, is increasing between 1973-1985, and the increase seems to concern mainly flagellates (*Phaeocystis*). Diatoms varied over the period without a clear trend. As reported last year, an increasing trend was also observed in the benthic macrofauna of the tidal area. In this case a short-lived species, *Heteromastus*, showed the largest increase. Fluctuations in the benthic macrofauna, observed in the Dutch tidal area, were found to be similar to those in other regions of the North Sea. A study was started on the factors governing settlement success of benthic macrofauna.

Attempts were made to model phytoplankton dynamics in the Southern Bight in relation to nutrient-supply from the rivers, but the timing of production in the model did not agree properly with reality. Research is now concentrating on the limiting factors of phytoplankton production during summer. In addition, more work was carried out on zooplankton dynamics in the summer period, when usually the population collapses. The collapse seems to be related to a declining egg-production of copepods, an increased cannibalism and predation on eggs by the zooflagellate *Noctiluca*. Some preliminary studies by echo-recorder indicated the large importance of frontal zones for the distribution of zooplankters.

During an intercalibration experiment of the ICES Benthos Methodics Working Group on Texel, large differences were found in species composition and benthic biomass between the collecting methods used, in particular on a sandy station. Studies on meio- and macrobenthos across a boundary zone (benthic front) in the area south and southeast of the Doggerbanks were continuing. Attention was paid to the larval distribution of two echinoderms, *Echinocardium cordatum* and *Amphiura filiformis*, in relation to the hydrographic situation.

A study was started on the factors responsible for year-class fluctuations in North Sea plaice. This study, which will concentrate on the egg and larval stages, is a follow-up to previous work carried out in the late larval and postlarval stages in the coastal estuary.

NETHERLANDS INSTITUTE FOR FISHERY INVESTIGATIONS, IJMUIDEN (N. Daan)

Stomach Sampling Studies

Within the framework of a new stomach sampling project, initiated by ICES in 1985 and planned to be continued for at least three years, a large effort has been put in sampling cod and whiting from the North Sea throughout the year.

Phytoplankton Studies

During the first half of 1985 phytoplankton monitoring has been interrupted.

From the period August onwards, a very limited bloom of dinoflagellates has been recorded, most probably due to the unsteady weather circumstances.

Only in October was a bloom observed of the potential toxic dinoflagellate Dinophysis acuminata of up to 850 cells per litre. This bloom did not lead to D.S.P. effects upon shellfish in the Dutch Waddensea.

Norway

(G. Berge)

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

1.1 Phytoplankton

1.1.1 Studies on the phytoplankton ecology in the Barents Sea continued. Emphasis was put on the study of the vertical biological structure through a strong pycnocline and on the assessment of the contribution by nanoplankton to the total primary production. This study is part of an interdisciplinary program designed to investigate the biological production system in this important fishing area (IMR) and is integrated with the Norwegian Research Program for Marine Arctic Ecology (PRO MARE).

1.1.2 A long-term programme on the environmental conditions of the Norwegian fjords was continued. In November-December 30 fjords were surveyed and analysis of nutrients, oxygen, salinity, and temperature were made.

1.1.3 The spring phytoplankton development in the Lofoten area (Northern Norway) was studied. Once to twice a week during March and April nutrients, chlorophyll a and species composition were analyzed. (Integrated with 1.2.3).

1.1.4 The distribution and ecology of toxic phytoplankton in the Skagerrak and along the southern coast of Norway was studied, Biological Station, Flødevigen (BSF).

1.1.5 The ecology of *Gyrodinium aureolum* was studied, both in the field and in large plastic bag experiments. (BSF).

1.1.6 The occurrence of *Dinophysis* species along the southern coast of Norway was studied during a period with problems due to Diarrhetic Shellfish Poisoning (DSP). (BSF).

1.1.7 Plankton observations in simultaneous enclosures in Rossfjord Southern Norway. Joint investigations Universities of Hamburg/Bergen/Oslo/Trondheim and the Biological Station Flødevigen.

1.2 Zooplankton

1.2.1 A programme on acoustic estimation of zooplankton by means of multiplefrequency sonar systems continued. Results were compared with observations with conventional gears (Juday nets, Gulf III, and Tucker nets).

1.2.2 A study of the zooplankton at the ice edge in the Barents Sea continued. (Integrated with 1.1.1).

1.2.3 An interdisciplinary programme on the spawning success and the survival of cod larvae was continued in 1985 with emphasis on the feeding conditions for the larvae. Mocness 1 m<sup>2</sup> and a plankton pump were used to study the cod larvae and zooplankton distributions.

### 1.3 Ichthyoplankton

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

1.3.2 Post larvae surveys (since 1977) continued with the aim of establishing indices for the abundance of different species, with emphasis on cod.

1.3.3 Investigations on mackerel eggs in the North Sea continued. Based upon intensive egg surveys, one aims to establish the abundance of the North Sea mackerel spawning stock.

1.3.4 Investigations on cod eggs and larvae continued in the Lofoten area (see 1.2.3). In 1985 egg surveys were conducted during the spawning season covering the total spawning area in order to estimate the abundance of the spawning stock of Arcto-Norwegian cod.

1.3.5 A study of the coastal cod stock in the Møre region continued, including surveys on the distribution of eggs and larvae.

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

1.3.7 Investigations on eggs and larvae of sprat were carried out to determine the state of spawning in the Ryfylke and Nordfjord areas of the western Norway. (BSF).

## 2. University of Bergen

### Department of Marine Biology

2.1 Feeding, growth and reproduction of benthic invertebrates. (Vahl, Paulson, and students).

2.2 Effects of organic pollution on benthic communities. (Johannessen and students).

2.3 Investigations on the composition of the near-bottom fauna (suprafauna) in Norwegian fjords, on the continental shelf off Norway, and in the Norwegian Sea, with special emphasis on plankton benthos interactions and food-selection of demersal fish. (Brattegard and students).

2.4 Quantitative composition of littoral communities. (Lein).

2.5 Taxonomy and functional role of planktonic ciliates. Effects of oil pollution on planktonic ciliates. (Dale).

- 2.6 Ecosystem studies in the land locked fjord system Lindåspollene have continued. (Lie, Aksnes, and Magnesen).
- 2.7 Experiments on the effects of artificial upwelling have been started. (Lie, Magnesen, Aksnes, and collaborators).
- 2.8 A multidisciplinary investigation with the purpose of evaluating the potential for enhancing stock size of cod in Masfjorden (release of pond reared fry) has been initiated in collaboration with other institutes at the University and the Institute of Marine Research.

3. Norwegian Institute for Water Research NIVA, Oslo.

3.1 Phytoplankton

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

3.2 Benthic communities

Registration of shore and shallow water communities by diving is routinely performed in recent studies. Prime elements are community structure on fixed subtidal sites (T. Bakke, A. Pedersen), by use of stereophotography (N. Green, K. Kvalvågnaes), and the lower limit of algal growth (A. Pedersen). Structure of soft bottom fauna was studied at several selected localities under the National Pollution Monitoring Programme, and tied to the influence of eutrophication and metals (B. Rygg, T. Bakke). A large mesocosm experiment on the long term sublethal effects of diesel oil on rocky shores was finished at the Marine Research Station Solbergstrand (T. Bakke, T. Bokn, A. Pedersen), and experiments of effects of organic input and drill cuttings on soft bottom sections are running (T. Bakke) in close cooperation with the University of Oslo (J. S. Gray, J. A. Berg, M. Schaanning). A series of field experiments on the effects of oil based drill cuttings on soft bottom recolonization, community structure and function are about to be finished (T. Bakke, K. Naes, N. Green, A. Pedersen). Mapping of heavy metal and micropollutant transport mechanisms in Norwegian fjords has been done (J. Knutzen, A. Pedersen); and, as part of the Joint Monitoring Programme, levels of metals in cod, flounder and mussels in selected fjords have been monitored (N. Green, J. Knutzen). In cooperation with VERITEC a databank on offshore fouling organisms is generated (A. Pedersen). In addition, several projects on effects of discharges and levels of contaminants in water, sediments and tissues have been continued, partly under the National Pollution Monitoring Programme (J. Knutzen, B. Rygg, T. Bokn, J. Skei, A. Pedersen m.m.).

4. University of Oslo

4.1 Marine Botany

4.1.1 Pico- and nanoflagellates. (J. Thronsen).

- 4.1.2 Diatom taxonomy and distribution. (G. R. Hasle).
- 4.1.3 Nitrogen turnover in coastal and Arctic waters. <sup>15</sup>N investigations. Part of PRO MARE Project. (E. Paasche, S. Kristiansen).
- 4.1.4 Experimental studies on taxonomy, life histories and environmental control of growth and reproduction in red algae. (J. Ruess).
- 4.1.5 Autecological studies of benthic algae in the Oslofjord. (J. Ruess).
- 4.2 Marine Zoology and Chemistry
  - 4.2.1 Studies in population genetics of Antarctic krill (Euphausia superba). (S. Fevolden).
  - 4.2.2 Comparison of genetic structure in two populations of Atlantic halibut (Hippoglossus hippoglossus) off Northern Norway and one off Mid-Norway. (S. Fevolden).
  - 4.2.3 Population field studies of littoral fish in the Oslofjord. (K. I. Ugland).
  - 4.2.4 The Polar cod (Boreogadus saida) as part of the Arctic ecosystem. Experimental studies on growth in addition to field studies in the Barents Sea and Spitsbergen waters. Part of the PRO MARE Project. (M. Anstensrud).
  - 4.2.5 The ringed seal (Pusa hispida) as part of the Arctic ecosystem. Field studies. (Experimental studies planned.) Part of the PRO MARE Project. (K. I. Ugland).
  - 4.2.6 Studies of excretion rates in the mussel Nucula tenuis in experimental tanks. (O.-A. Follum).
  - 4.2.7 Aquaria studies of feeding behaviour in terebellid polychaetes. (J. A. Berge).
  - 4.2.8 Studies on recruitment, growth, sexual development and mortality of periwinkle (Littorina littorea) and the influence of long-time exposure to low concentrations of hydrocarbons. (E. Lystad, K. A. Moe).
  - 4.2.9 Studies on the influence of oil contamination on recruitment, growth and mortality of the mussel (Mytilus edulis). (P. Thome, M. Waldøy).
  - 4.2.10 Experimental tank studies of biological and chemical responses to the settling of plankton and suspended oil drill cuttings on soft bottom. (J. A. Berg, M. Schaanning).
  - 4.2.11 Studies on recolonization, particularly by endobenthos, of oil contaminated sublittoral sediment. (J. A. Berge).



- 4.2.12 Experimental studies on variation in genetic structure of populations of mussel (Mytilus edulis), periwinkle (Littorina littorea), and barnacle (Balanus balanoides) in oil contaminated water. (S. Fevolden).
- 4.2.13 Classification of soft bottom animal communities in inner Oslofjord and their relation to the state of pollution. (A. M. Skullerud, M. Aschan).
- 4.2.14 On the relation between a local concentration of the common seal (Phoca vitulina) in the Oslofjord and the occurrence of the nematode Pseudoterranova decipiens in various species of fish. (K. I. Ugland).

5. University of Tromsø

Tromsø Museum

5.1 Zoobenthos

- 5.1.1 Monitoring of hard-bottom communities along the northern coast of Norway (Troms, Finnmark) and Svalbard. (B. Gulliksen).
- 5.1.2 Succession of hard-bottom communities on volcanic rock after the volcanic outbreak at Jan Mayen in 1970. (B. Gulliksen).

5.2 Pelagic fauna

- 5.2.1 Ecology of sympagic fauna (under ice fauna) in the Arctic and Antarctica. (B. Gulliksen).

5.3 Fish

- 5.3.1 Biology and ecology of Arctic fish. (T. Haug, B. Gulliksen, I.-B. Falk-Petersen, V. Frivoll, W. Vader).
- 5.3.2 Migration and recruitment mechanisms of Greenland halibut, Reinhardtius hippoglossoides, in the Svalbard area. (T. Haug, D. R. Godø, B. Gulliksen).
- 5.3.3. Biology, ecology and the possible use of the Atlantic halibut, Hippoglossus hippoglossus, in aquaculture. (T. Haug, B. Gulliksen, E. Kjørsvik, P. Solemdal, S. E. Fevolden).

5.4 Birds

- 5.4.1 Mapping and population surveillance of seabirds in Northern Norway. (W. Vader, R. Barrett, K.-B. Strann).
- 5.4.2 The food and breeding ecology of breeding seabirds in Northern Norway and Svalbard. (W. Vader, R. Barrett, B. Gulliksen).

Institute of Biology and Geology

5.5 Phytoplankton

5.5.1 Marine ecological research in the arctic: Phytoplankton (a component project of PRO MARE, the Norwegian Research program for Marine Arctic Ecology) is focused upon the growth physiology of arctic diatoms and Phaeocystis pouchetii and interactions between phytoplankton and herbivorous zooplankton. (H. C. Eilertsen, J. P. Taasen).

5.5.2 Quantifications of seasonal variations in numerical abundance and production of phytoplankton in fjords and coastal waters of northern Norway. (J. P. Taasen, H. C. Eilertsen).

5.6 Zooplankton

5.6.1 Ecological Investigations of the zooplankton community of Balsfjorden have concentrated on quantifying condition, growth and production (based on proximate composition) in copepods and krill. (C. C. E. Hopkins, K. S. Tande, S. Grønvik).

5.6.2 Calanus finmarchicus, and C. glacialis in the Barents Sea: Growth strategy and ecological importance. The project (part of PRO MARE) analyzes the interaction between phytoplankton production and production ecology of these two dominant calanoid copepods in the Norwegian arctic. (K. S. Tande, C. C. E. Hopkins).

5.6.3 Research has been continued comparing phytoplankton and zooplankton ecology and community structure in the fjords of Spitsbergen. (C. C. E. Hopkins, K. S. Tande, H. C. Eilertsen, J. P. Taasen).

5.7 Phytobenthos

5.7.1 Quantitative studies of algal communities in the littoral zone. (J. R. Hansen).

5.8 Zoobenthos

5.8.1 Studies of the population dynamics, and production of the prawn (Pandalus borealis) in north Norwegian fjords, the Barents Sea, and west Spitsbergen. The importance of prawns in the diet of cod (Gadus morhua). (C. C. E. Hopkins, E. M. Nilssen and collaborators).

5.8.2 Investigations on the bottom fauna of the Barents Sea and the Spitsbergen area. (E. Oug).

5.8.3 Population dynamics and production of Macoma calcaria. (E. Oug, K. E. Langseth).

5.8.4 Intertidal distribution and zonation. (E. Oug).

5.8.5 Systematics and zoogeography of the Terebellomorpha. (T. Holthe).

5.8.6 Deep sea fauna of the Norwegian Sea. (T. Holthe).

- 5.8.7 Zoogeography of the echinoderms of northern Norway. (T. Holthe, H. P. Mannvik).
- 5.8.8 Systematics of Oweniidae. (T. Holthe, R. Nilsen).
- 5.8.9 Reproduction and larval development of echinoderms, particularly starfish. (I. B. Falk-Petersen).
- 5.8.10 Effects of hydrocarbons on sea urchin embryos. (S. Lønning Vader, I. B. Falk-Petersen).
- 5.9 Fish
- 5.9.1 Fertilization and development of marine fishes studied by morphological, physiological and genetic methods. (S. Lønning Vader, E. Kjørsvik, I. B. Falk-Petersen).
- 5.9.2 Effects of hydrocarbons on fish embryos and larvae. (S. Lønning Vader, I. B. Falk-Petersen, E. Kjørsvik).
- 5.9.3 Development and function of the digestive system as well as the influence of egg quality on the condition and survival of marine fish larvae (cod, and flatfish). (S. Lønning Vader, E. Kjørsvik, C. C. E. Hopkins).
- 5.9.4 Reproduction cycles and larval ecology in fish. (I. B. Falk-Petersen).
- 5.9.5 Interactive segregation between small pelagic fishes in a fjord system. (S. Grønbvujm A. Klemetsen).
- 5.9.6 Quantification of feeding, somatic and gonad growth as well as condition in relation to otolith zone deposition in capelin, (Mallotus villosus). (C. C. E. Hopkins, O. Nyholmen, K. Aase).
- 5.9.7 Selected aspects of the biology of polar cod (Boreogadus saida). (E. Oug, V. Frivoll).
- 6. University of Trondheim
- 6.1 Phytoplankton
- 6.1.1 Metabolism of 3-1,3 glucans in diatoms. (S. Myklestad, K. Waarum).
- 6.1.2 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).
- 6.1.3 Effects on growth rates and chemical composition of dinoflagellates when adapting to different light intensities and photoperiods. (K. Tangen, K. Hegge).

- 6.1.4 Taxonomy and morphology of species in the "Gonyaulax tamarensis complex". (K. Tangen).
- 6.1.5 Occurrence of potentially toxic algae in relation to fish diseases and mussel poisoning. (K. Tangen, Kristin Heidal).
- 6.1.6 Studies of arctic marine diatoms from ice and polynyas with special emphasis on photoadaptation, growth rate and respiration. (E. Sakshaug, E. Nøst Hegseth).
- 6.2 Zooplankton
  - 6.2.1 Routine sampling of zooplankton once a month by Nansen 75/180 µm net continued at three oceanographic stations in Trondheimsfjorden. (J.-A. Snell).
- 6.3 Phycobenthos
  - 6.3.1 Comparative studies of growth within species of Fucus. (T. Strømngren).
- 6.4 Zoobenthos
  - 6.4.1 Taxonomy and life history of deep water molluscs. (J.-A. Snell).
  - 6.4.2 Taxonomy and zoogeography of archaeogastropods in Scandinavian and arctic waters. (J.-A. Snell).
  - 6.4.3 Growth of Buccinum undatum. (J.-A. Snell, F. Sigurdsson).
- 6.5 Ichthyoplankton and fish
  - 6.5.1 NMR studies on changes in phospholipids during development of living embryos and yolk-sac larvae of plaice (Pleuronectes platessa). (H. Grasdalen, L. Jørgensen).
  - 6.5.2 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).
  - 6.5.3 Population genetic studies in marine fishes. (J. Mork).

POLAND

(K. Wiktor and Z. Witek)

Sea Fisheries Institute, Gdynia and Swinoujście

Baltic

Several times a year environmental studies in the Polish fishery zone were continued. They included measurements of primary production in situ and in an incubator, determination of chlorophyll a concentration, phytoplankton composition, mesozooplankton biomass, ichthyoplankton and macrozoobenthos composition, and the concentrations of heavy metals in plankton, fish, sediments and water.

Investigations were carried out to determine the composition and abundance of protozooplankton and microzooplankton depending on the distance from the shore. The biomass of protozooplankton in the open sea was not lower than that in the near-shore zone.

Seasonal changes in composition and biomass of zooplankton in the near-shore zone of the Gulf of Gdańsk in years 1983-1985 were compared; it was found that maximum biomasses of certain groups of animals differed several times.

Environmental investigations served to provide a basis for analyses of the impact of hydrological conditions on the spawning of commercial fish; the impact of temperature and oxygen content was the greatest. Optimum temperature range for the development of sprat eggs was determined. Experimental studies of incubation and hatching of herring larvae were continued. Spawning of autumn herring in the Pomeranian Bay in recent years (1982-1985) was analyzed. The share of soft-bottom fauna in the food of fish in the Szczecin Lagoon was investigated.

Long-term changes in mesozooplankton biomass and macrobenthic communities in the southern Baltic were analyzed. As a result, a large decline in mesozooplankton biomass and a decline in biomass and changes in composition of deep-water macrobenthos (below the halocline) in recent years were observed. Communities of shallow-water macrobenthos remained at a stable level.

Atlantic

In the spring cruise of RV Profesor Siedlecki to the North Atlantic (north-west of the British Isles) macro- and ichthyoplankton were sampled.

Taxonomic studies of chaetognaths from the North Atlantic were carried out on materials collected the previous year. Taxonomic investigations of ichthyoplankton from previous and present materials were conducted.

Investigations of the size structure of Antarctic plankton were conducted on materials from the previous year (BIOMASS-SIBEX). Processing of data on

distribution of macroplankton, euphausiid larvae and krill concentrations was finished.

Gdańsk University, Institute of Oceanography, Gdynia

Baltic (Gulf of Gdańsk)

Investigations of bioenergy of marine animals were continued; energetic value and lipid contents in common mussel and cockle in an annual cycle were determined. Observations of the diurnal activity rhythm in Mesidotea entomon were carried out.

Investigations of the impact of selected factors (salinity, nutrients) on the development of Baltic phytoplankton in experimental conditions were continued.

Atlantic

Composition and distribution of phytobenthos growing on skerries off the south-western coast of Spitsbergen (Hornsund Fjord area) were determined.

Materials collected during the RV Profesor Siedlecki BIOMASS-SIBEX expedition served to determine composition, abundance, and distribution of zooplankton, with special emphasis on copepods.

Gdańsk University, Department of Plant Physiology, Gdynia

Investigations of the impact of growth-promoting substances (gibberellins and auxins), isolated from Baltic water, on the growth of marine algae were continued.

Gdańsk University, Biological Station at Górkki Wschodnie

Investigations of the role and nature of selected enzymes in Baltic crustaceans were continued.

University of Łódź, Department of General Zoology

Benthos from the Admiralty Bay (King George Is., South Shetland Is., Antarctica) was studied.

Materials collected during the 1984 expedition of the RV Profesor Siedlecki to the Antarctic (BIOMASS-SIBEX) were processed. They covered phytoplankton and macrozooplankton (especially euphausiids).

In spring of 1985, samples of macroplankton were collected and subjected to preliminary processing during a cruise of the RV Profesor Siedlecki to the area north-west of the British Isles.

Agricultural Academy, Szczecin

Investigations of meiofauna and mesozooplankton of the southern Baltic and Szczecin Lagoon were carried out. Feeding of Baltic commercial fishes was studied.

Agricultural Academy, Olsztyn

Benthos and zooplankton of the Vistula Lagoon were investigated.

Polish Academy of Sciences, Institute of Oceanology, Sopot

In cooperation with the Shirshov Institute of Oceanology, Academy of Sciences of the USSR, a mathematical model of the photosynthesis process in the Baltic was worked out. It allows for the determination of the size of primary production on the basis of the knowledge of optical properties of the sea and chlorophyll concentrations.

Other investigations concerned geographical and seasonal differences in biochemical composition of the Baltic organisms, bioaccumulation and distribution of microelements in their bodies, as well as biological and physiological mechanisms of their adaptation to natural and anthropogenic changes in environmental conditions.

Polish Academy of Sciences, Institute of Ecology, Warsaw

Materials collected the previous year during the RV Profesor Siedlecki BIOMASS-SIBEX expedition to the Antarctic were being processed. They included the distribution of chlorophyll a, phytoplankton, bacteria, organic carbon, amino acids, krill concentrations, and marine birds. At the Arctowski Antarctic station, annual investigations of benthos in the Admiralty Bay (King George Is., South Shetland Is.) were carried out.

Bioenergetic investigations of plankton in the South Atlantic and Antarctic were conducted on the Soviet RV Akademik Kurchatov.

Research Institute on Environment Development, Gdańsk

Work was continued on the international monitoring programme in the Baltic.

Portugal

(I. Neto)

INSTITUTO NACIONAL DE INVESTIGAÇÃO DAS PESCAS (INIP): LISBOA

Upkeep of the phytoplankton stock cultures (phytoflagellates, diatoms, dinoflagellates, chlorophyceae) (M.A.M. Sampaio et al.).

Development of 10 to 100 litre laboratory cultures to feed zooplankton cultures and as a need to raceway pounds (M.A.M. Sampaio et al.).

Outside (open air) microalgae production as (SCP) for food and feed in 2000-6000 litre raceway pounds (M.A.M. Sampaio and M.F.G. Martins).

A biotechnological approach on physical aspects of microalgae (M.A.M. Sampaio and M.T. Menezes).

Studies on the nutritional value of microalgae (M.A.M. Sampaio et al.).

Study of redwater event at Algarve coast, May 1985 (M.A.M. Sampaio, M.G. Cabeçadas and M.J. Brogueira).

Upkeep of the zooplankton stock cultures (copepods, cladocerans, branchiopods, rotifers and ciliates) (M.H. Vilela et al.).

Development of 12 to 150 litre cultures of the rotifer *Brachionus plicatilis*, in laboratory conditions, to feed fish and crustacean larvae and to inoculate bigger tanks in the open air (M.H. Vilela et al.).

Massive production of *Brachionus plicatilis* with microalgae, in the open air, in 500 litre cylindric tanks and 3000 litre raceway tanks with paddle-wheels for bigger scale aquaculture support and animal protein production for feedstuff (M.H. Vilela and A.F. Lupi).

Production experiments with the harpacticoid *Tigriopus brevicornis* in 20 litre volumes in laboratory conditions using microalgae associated with different inert feed (M.H. Vilela).

Periodic harvest of cysts and/or adult *Artemia* from several salines along the Portuguese coast and respective cysts treatment and upkeep in durability conditions (M.H. Vilela and M.A. Castelo Branco).

Characterization of some Portuguese *Artemia* strains: type of reproduction, cysts eclosion rate, biometrical characteristics of cysts and instar nauplii and nutritive value evaluation (M.H. Vilela and M.A. Castelo Branco).

Outside (open air) *Daphnia magna* production in 500 litre tanks for feedstuff using *Selenastrum capricornutum* produced with pig effluent (M.H. Vilela and C. Gonçalves Silva).

One project "Planktonic production cycles in relation to pelagic fishes (mainly sardine)" including food availability, spawning areas and seasons and description and characterization of nutrients started in 1985.

INSTITUTO HIDROGRÁFICO - LISBOA

Quantitative and qualitative analysis of the zooplankton in Rias de Aveiro, Formosa and Tâmega river (M<sup>a</sup> L. Shirley).



Spain

(E. López-Jamar)

A) PHYTOPLANKTON

1) Instituto de Investigaciones Pesqueras de Vigo:

Ecology studies on the phytoplankton of the Galician Rías and the Galician shelf were carried out. The principal aim is to assess the fertilization mechanisms and their effect on the phytoplankton populations.

2) Instituto Español de Oceanografía, La Coruña Laboratories:

In July-August 1985, an oceanographic cruise was carried out in the Galician shelf to study temporal variability of phytoplankton in relation to upwelling. Chlorophyll, primary production, as well as species composition of nanoplankton and net plankton fractions were studied. Although the net plankton fraction is dominant when upwelling conditions are present, nanoplankton accounts for an important percentage of biomass and production, at least during the first stages of upwelling.

B) ZOOPLANKTON

1) Instituto Español de Oceanografía, La Coruña Laboratory:

The study of the zooplankton and secondary production of the Galician shelf was continued. During a cruise carried out in July 1985, biomass, secondary production, microzooplankton composition, and ingestion rates were estimated. In general, secondary production was higher in the shallower areas, and the zooplankton exhibits a greater homogeneity in the northern area of the shelf.

C) ICHTHYOPLANKTON

1) Instituto Español de Oceanografía, La Coruña Laboratory:

Ichthyoplankton surveys were carried out in the Galician shelf. The main objective is to relate the occurrence, abundance and growth of the sardine (Sardina pilchardus) larval stages to the upwelling conditions in the area.

D) BENTHOS

1) Instituto Español de Oceanografía, Laboratorio de La Coruña:

Long term variations of a Tellina fabula community and a Thyasira flexuosa facies are being investigated in La Coruña Bay. Population dynamics and production of the dominant species (T. fabula, T. flexuosa, and Paradoneis armata) are being estimated.

- The macroinfaunal communities of the Galician shelf were studied in relation to the organic enrichment and the upwelling processes in the area. Two main sources of organic matter could be detected: organic outwelling

coming from the Rías Bajas, mainly due to bedload transport, and organic sedimentation produced by the high primary production due to upwelling conditions.

-Spatial and temporal variation of the megabenthos of the Galician shelf are being investigated. Species composition, abundance, diversity, and the factors controlling distribution are being studied. Feeding, reproduction, and growth of the decapod Polydora henslowii, the dominant macroinvertebrate in the megabenthos, are also being investigated.

-Primary production of benthic microalgae was studied in an intertidal sand flat in the Ría de Arosa (Northwest Spain). Active and degraded pigments, organic matter and vertical migration of algae were also studied. Total annual production of sediment reached  $79 \text{ g C m}^{-2}$  while water column production in the same area was only  $6 \text{ g C m}^{-2}$ .

## 2) Instituto de Investigaciones Pesqueras de Vigo:

The study of spatial gradients of the sedimentary environment of the inner part of the Ría de Pontevedra (NW Spain) is being continued in relation to the organic pollution caused by an industrial effluent. The factors that are being measured are: temperature, salinity, pH, Eh, grain size, organic matter, and liposoluble photosynthetic pigments. The meiobenthic communities were also studied.

## 3) Sociedad Cultural de Investigación Submarina, San Sebastián:

- Quantitative studies on soft-bottom benthic fauna along the Bask Coast (East Cantabric Sea) are being carried out.

- Studies on spatial variability of the mussel (Mytilus edulis) were undertaken.

- Long term variation of 4 species of Patella is being followed, as well as their reproductive cycle.

- Qualitative studies of the intertidal rocky shores were continued.

- The effect of dock building on the red algae Gelidium sesquipedale was estimated.

Sweden

(R. Rosenberg)

KRISTINEBERG MARINE BIOLOGICAL STATION (L. Hernroth)

Phyto- and Zooplankton

During 1985 the long-term monitoring of the Gullmar Fjord continued. Special emphasis was put on the relationships between sedimentation of organic material, hydrography, and oxygen consumption in the deep basin of the fjord. A special project studied the short-term variations in the zooplankton community in connection with water exchanges. (Contact person: O. Lindahl.)

The previous studies on the biology of Aurelia aurita were in 1985 extended to include also Cyanea capillata and C. lamarcki. The main objective of the project is to describe the regulating mechanisms during the different phases in the life-cycle using both field and experimental techniques. (Contact person: L. Hernroth.)

Benthic Communities

Soft-sediment benthos was monitored off the Swedish west coast within the framework of the Swedish Environmental Monitoring Programme (PMK), supported by the Swedish Environment Protection Board. (Contact person: A. B. Josefsson.)

Large-scale temporal changes in the benthos were investigated by resampling stations visited by Petersen in 1919 in the Skagerrak. (Contact persons: A. B. Josefsson/R. Rosenberg.)

Recruitment, succession, and larva-adult interactions on marine subtidal hard-bottoms: The project includes in-situ experiments along horizontal and vertical gradients and laboratory experiments on interspecific ascidian larva biology in relation to the reproductive patterns. (Contact person: I. Svane.)

Adult-larva interactions: An in-situ experimental approach to test the influence of adult density on recruitment into soft bottom marine community. (Contact persons: W. A. Crowe, A. B. Josefsson, I. Svane.)

Please see C.M. 1985/L:1 for activities for 1984. No additional reports are available for 1985.

Recent Publication

Hernroth, L. (Editor). 1985. Recommendations on methods for marine biological studies in the Baltic Sea. Mesozooplankton biomass assessment: Individual volume technique. The Baltic Marine Biologists Working Group 14, Publication No. 10. The Library, Institute of Marine Research, Lysekil, Sweden. 32 pp.

UNITED KINGDOM

1. England and Wales

(J. D. Riley)

A. Ministry of Agriculture, Fisheries and Food, Lowestoft

1. Herring Larvae Surveys

Regions IVC and VIID were surveyed during the two standard sampling periods in January. some comparative tows with the FRV Anton Dohrn were made in an area of high larvae density in the eastern Channel.

Region IVB was surveyed during three standard periods at the end of September and during October. The surveys in this region included an integrated programme of ecological studies related to herring larvae growth and mortality. These studies represent a continuation of the programme begun in 1984, the results from which were presented to the last statutory meeting (C.M. 1985/H:51). In 1985 two Argos satellite-tracked buoys were launched and used to follow the movement of herring larvae away from the spawning areas. Estimates of growth and mortality from a number of larval cohorts will be made. During early October, a submersible pump was used to study the vertical distribution of herring larvae in the vicinity of the spawning grounds. The pump delivered 7,500 litres per minute via a 14-cm diameter intake pipe, and successfully sampled herring larvae up to 15 mm long. There were two particular features worthy of note from this year's survey in this region. The first was the high larvae production off the Yorkshire coast with abundances up to 12,000 10-mm larvae  $m^{-2}$ . The second was the reappearance of larvae production from the western edge of the Dogger Bank after an absence of some 15 years.

2. Western Irish Sea Surveys

Surveys in this area were conducted between April and June directed at the main hatching area of Nephrops larvae. Their main aim was to obtain an estimate of stage I Nephrops larvae production from which a mature stock biomass could be calculated. The production estimate and estimates of stage to stage mortality will also be compared with those obtained from similar surveys in 1982 and presented at the 1986 statutory meeting.

Useful data is also collected concurrently on the distribution and abundance of other zooplankton including ichthyoplankton. These data which include physical data will be used together with the 1982 set in a study of planktonic processes in this region. The relevance of the Western Irish Sea front to fish production is of particular interest in these studies.

B. Institute for Marine Environmental Research, Plymouth

The Continuous Plankton Recorder Survey

The survey was maintained on the same basis as in previous years to give a time series of 38 years, collected at monthly intervals, in the seas around the British Isles, (see Figure 1). During 1985, Recorders were towed 78,500 miles by 16 ships of seven nations (Denmark, France, Iceland, Malta, Netherlands, Republic of Ireland, and the United Kingdom.) The LR route was reinstated during the year to monitor the occurrence of *Gonyaulax tamarensis* along the north-east coast of England. Further details of the survey are given in Oceanographic Laboratory, Edinburgh, Bull. Mar. Ecol., 7, 1-174.

Further information about the survey will be supplied on application to the Director, Institute for Marine Environmental Research, Prospect Place, The Hoe, Plymouth, PL1 3DH, England.

C. Marine Biological Association, Plymouth

1. Nutrients and phytoplankton growth:

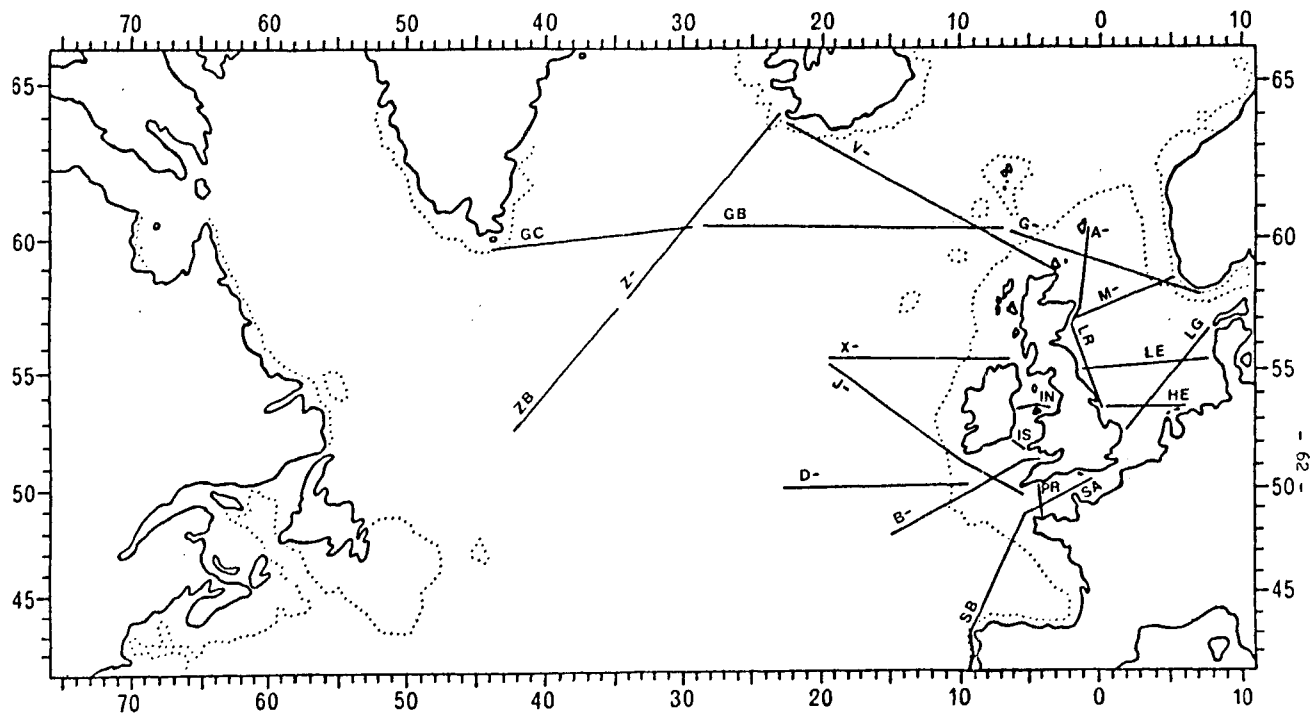
Nutrient enrichment experiments were carried out during two cruises in the western English Channel (June and July 1985) to extend existing data on the effects of ammonium and phosphate additions upon photosynthesis. Observations in the northern Bay of Biscay provided direct evidence for the upward mixing of nutrients across the thermocline by processes associated with internal wave energy dissipation. Large internal waves generated at the shelf break during spring tides also travel on to the shelf. These are considered to have a significant influence on vertical fluxes of nutrients in stratified shelf waters and the growth of phytoplankton within the seasonal thermocline.

2. Plankton blooms:

As a continuation of studies of phytoplankton blooms in shelf waters, experiments were successfully completed in July-August, 1985 on the relationships between carbon assimilation and calcification in coccolithophores, and between carbon and nitrogen assimilation in the dinoflagellate, *Gyrodinium aureolum*. The results will provide further information about the environmental conditions favoring the growth of these organisms. Related work on zooplankton included vertical pump sampling within dinoflagellate blooms in the western English Channel and northern North Sea, and a series of horizontal transects for microzooplankton through the Ushant Frontal System. Shipboard experimental work concentrated on estimation of rates of ingestion and egg production by *Calanus* within coccolithophore and dinoflagellate blooms.

3. Long-term changes:

Regular sampling at the routine stations off Plymouth (L4, L5 and E1) showed that the standing crop of macroplankton in 1985 was very low.



Continuous Plankton Recorder Survey 1985

Figure 1

The abundance of planktonic stages of the young of demersal fishes was much reduced. Eggs of pilchard were recorded in every month in 1984/5, an exceptional occurrence for recent years.

D. Marine Science Laboratories, University College of North Wales, Menai Bridge

The work on the biology of frontal systems continues with emphasis on the distribution of hydrocarbons in the surface layer. The chemistry and bacteriology of the carbon tetrachloride soluble material has been followed. Further attempts are being made to model the bacteriology and zooplanktology of frontal systems by devising new modelling techniques. The value of some methods of studying planktonic distributions has continued.

More recently, with the arrival of Professor Williams and Dr. Tett in the Department, there will be an expansion of work into the area of the overall metabolism of the plankton, in particular the microplankton. Very precise chemical techniques for the analysis of seawater for total carbon dioxide and oxygen have been developed for this work. It is planned to make the studies in both coastal and oceanic environments.

E. Institute of Oceanographic Sciences, Biology Department, Godalming, Surrey

1. The main sea-going activity this year was a Discovery cruise (156) to the Madeira Abyssal Plain to conduct a biological characterization of a deep (5450 m) oceanic site. Plankton and micronekton samples were collected systematically throughout the whole water column with opening-closing trawls. A new near-bottom echo-sounder enabled nets to be fished to within a few metres of the sea-bed. Special attention was paid to the benthopelagic zone within 100 m of the sea-bed which was subdivided into three sub-zones, each of which was sampled by three replicate tows, where the majority of the catches consisted of copepod carapaces and decomposing corpses. The benthic communities were sampled with otter trawls and benthic sledges, the latter fitted with a camera. One notable haul collected nearly a ton of manganese nodules, and a number of rare and novel fish were taken. In addition to the trawl sampling, primary productivity was estimated, particulate concentrations and chlorophyll profiles were measured, together with the standard physico-chemical measurements.
2. Studies on natural levels of trace metals in mesopelagic organisms are generating startling results. Collaborative work with IAEA Monaco on  $^{210}\text{Po}$  levels in penaeid decapods has revealed that marked variations in level occurred across an oceanic front. These data, together with taxonomic studies at another front of a myctophid Ceratoscopelus townsendi revealing two morphological forms occurring on either side of the hydrographic feature, begin to suggest that important differences occur in ecological processes across such fronts which may have far-reaching implications. Another surprising observation was that the polonium levels in some detritivores were so high that their exposure to alpha-radiation was estimated to exceed the lethal dose level for Man by a factor of four. Very high levels of cadmium have also been found in other decapods. These and other results begin to

indicate that "non-essential" trace elements may be useful as quantifiable tracers in oceanic food webs.

3. In June, further studies were made on phytodetritus on the sea-bed in the Porcupine Seabight (in spite of the Indian airliner disaster). At depths of 2000 m, a layer 0.5-4-mm thick covered the sediment. Total community oxygen consumption was estimated by measuring oxygen levels in the water overlying core samples in the SMBA multicorer after hanging it off for 18 hours. There was no indication that the arrival of the detritus stimulated greater benthic respiration. A new pop-up corer/respirometer is being developed in conjunction with UC Galway designed to economize on the use of shiptime, and improve the accuracy of the measurements.

Phytodetrital samples were analyzed for their lipid constituents and the indications were that degradation was occurring on the sea-bed. In addition, the gut contents of holothurians are being examined for evidence of the importance of the detritus in their diet.

## 2. Scotland

No report received.



U.S.A.

(K. Sherman and G. D. Grice)

Fisheries Ecosystem Investigations (K. Sherman)

National Marine Fisheries Service (NMFS)  
Northeast Fisheries Center (NEFC)  
Sandy Hook Laboratory, Highlands, NJ

Personnel at the NMFS Sandy Hook Laboratory completed the ninth year of ichthyoplankton surveys in the 260,000 km<sup>2</sup> shelf area between Cape Hatteras, North Carolina, and Cape Sable, Nova Scotia. Fish eggs and larvae collected on these surveys are used to investigate multispecies interactions within coastal ecosystems, support research on recruitment processes, and derive fishery independent assessments of adult spawning biomass. In 1985, we cooperated in 10 surveys, making this one of our most active years. Five of these, conducted in the March through September time period, were extended south of Cape Hatteras as far as Charleston, South Carolina, to study bluefish spawning in the South Atlantic Bight (SAB). Personnel from SEFC completed a 5th survey in the SAB in May, covering shelf and slope waters from Palm Beach to Virginia Beach. Overall, the 1985 survey effort produced 2880 60-cm bongo samples, 372 20-cm bongo samples, 1000 neuston samples, and more than 33,000 ancillary observations of temperature, salinity, dissolved O<sub>2</sub>, chlorophyll a, and primary productivity.

Autumn 1985 surveys revealed that the once-productive spawning beds of Atlantic herring on eastern Georges Bank remained dormant for the 7th consecutive year. No larvae were observed in samples taken over the eastern half of the Bank in October, and only two specimens were found in November/December samples taken east of the 68° meridian. These results contrast sharply with those of the 1960's and early 1970's when larval herring abundance estimates over the Georges Bank spawning beds routinely exceeded 1000/10 m<sup>2</sup> and occasionally topped 10,000/10 m<sup>2</sup>. NEFC biologists have been conducting ichthyoplankton surveys off the New England coast on an intermittent basis for the past 30 years. These surveys provided the first evidence of a downward turn in herring spawning on the Bank in the mid-1970's. By 1979, no larvae were collected east of 68°N. During the 1980's they have remained scarce to absent. Trawl surveys confirm the lack of spawning activity on Georges Bank during the autumn of 1985. Fewer than 10 adults were captured.

NMFS NEFC Narragansett Laboratory,  
Narragansett, RI

A juvenile fish survey aboard Delaware II 85-05 (8-25 July) succeeded in locating concentrations of juvenile cod and haddock along the southern flank and northeast peak of Georges Bank. Both pelagic and bottom gear were used to determine areas of maximum abundance and occurrence of major predators. Sampling with an international young gadid pelagic trawl (IYGPT) demonstrated that smaller cod juveniles (30-50 mm SL) were in the water column while relatively higher numbers of larger cod (40-70 mm SL) and haddock (50-110 mm

SL) were taken in bottom trawls. A maximum of 2,000 juveniles were taken in a single bottom trawl, while a maximum of approximately 700 were captured in the the IYGPT.

Few potential midwater predators were taken during pelagic trawling and no evidence of predation was observed in pelagic samples. From bottom trawling, it appeared that the dominant prey items of potential predators were Ammodytes sp. of 90-140 mm. Gadids were found in the stomachs of winter and little skates, spiny dogfish, silver hake, cod, and longhorned sculpin, in decreasing order of occurrence. However, the contribution of young gadids to the diets of these predators appeared to be small.

A subsequent cruise, Delaware II 85-06 (5-21 August), sampled with midwater and bottom trawl gear on Georges Bank to monitor changes in abundance and distribution of juvenile gadids since July. Over the intervening month, the size range of haddock had increased to 80-190 mm SL and cod had increased to 50-120 mm SL. By August, gadids were absent from the water column and catches were typically less than 100 per 1/2 hour tow for cod and haddock with the exception of five catches of 150-340 juveniles in the southeastern part. As observed in July, the incidence of feeding on juvenile gadids was low, with Ammodytes sp. the most common prey item in fish predator stomachs. Juvenile gadids occurred in greatest numbers on the eastern half of Georges Bank but were absent from the shoal (<60 m) portion of the Bank.

A 3-yr submersible program to study the physonect siphonophore Nanomia cara was concluded in the summer of 1985. Since these organisms can episodically occur in densities sufficient to foul commercial fishing gear, the study was initiated to evaluate its potential as a larval fish predator. Nanomia cara appears to be ubiquitous; however, it is patchy and densities vary greatly. It is often observed in the presence of other gelatinous organisms, particularly ctenophores. The co-occurrence of these groups is probably based on the presence of suitable prey, usually copepods. An examination of the guts of 48 colonies indicated that the most common prey item was copepods, although amphipods, euphausiids, and Sagitta sp., among others, were ingested. Fish larvae were not found. On-board feeding experiments failed to prove that the siphonophores prey upon fish larvae. Larvae which were introduced were killed, presumably by the organisms' nematocysts, but not ingested. It appears that although N. cara is capable of ingesting a prey item the size of larval fish, unless special conditions exist, such as very high densities of larval fish, it is unlikely that it is more than an occasional predator on fish, and therefore, is unlikely to impact larval fish populations under normal conditions.

Improvements in both hardware and software components of the image analysis system have increased its speed and accuracy. Although the system is still a prototype, it is now out of the research and development phase and is being used to analyze samples for a number of different projects. One major test of its capabilities was carried out in 1985. Its resolution was tested on six species of copepods that usually dominate MARMAP plankton samples. This study concluded that most trophodynamic fisheries research needs can be met with group level identifications and size frequency analysis. However, new techniques will be needed for species level identification.

A cooperative research program with the University of Tokyo continued. Mark Berman and Kenneth Sherman met with marine ecologists and fisheries scientists working with image analysis techniques in several laboratories in Japan. Future work with the Japanese will include analysis of plankton samples from the Kuroshio and Oyashio Current, separation of toxic and non-toxic dinoflagellates, and ageing of krill through morphometric analysis.

August 1985 marked the completion of the 24th year of monthly continuous plankton recorder (CPR) transects of the Gulf of Maine with concurrent XBT transects during the last 10 years. 148 taxa of zooplankton and phytoplankton are routinely identified and long- and short-term statistical analyses are typically completed within 30 days of collection. In 1985, a comparison of the CPR and bongo net monitoring data was initiated.

Sixteen manuscripts were prepared or contributed to by Apex Predators biologists. These included book chapters and scientific journal publications dealing with transatlantic migrations of the blue shark, age and growth of the sandbar shark, and feeding ecology of the sandbar shark and swordfish. Other publications provided estimates of shark catches by U.S. fishermen and abundance and prey consumption estimates of large pelagics off Georges Bank. Research cruises on the R/V Delaware II and R/V Wieczno resulted in the capture of 911 sharks and teleosts. Six hundred and thirty-eight were tagged for migration studies and the remainder were taken aboard for ongoing studies of age and growth, reproduction and food habits of large apex species. In 1985 vertebrae from 1,334 sharks of 27 species were histologically prepared for ongoing age and growth studies. Computer programs to process age information were developed and used on four of the 27 species. Histological and morphological studies of shark reproduction were continued with emphasis on four common species (mako, thresher, hammerhead, and dusky sharks). Under the Cooperative Shark Tagging Program over 6,000 sharks representing 30 species were tagged and released. Over 300 sharks (15 species) and swordfish were recaptured in 1985. This is the highest annual number of releases and recaptures since the program began 24 years ago.

The relation between RNA-DNA ratio and growth rate of larval fish has proven useful for estimation of recent growth rate and for evaluating the response of larval fishes to their environment. This work was extended to juvenile fishes by studying the relations between size (dry weight) and RNA, DNA, and protein composition of cod pelagic juveniles collected on Georges Bank.

The relation between RNA-DNA ratio and growth is not constant over the entire life history of fish. When attempting to estimate growth rate from RNA-DNA ratio measurements, the technique should be calibrated for the particular size range or life history period of interest. These data also suggest that cod reach a physiological balance at about 10 mg dry weight. Since periods of transition or discontinuity in development are sometimes associated with changes in behavior, growth or mortality rates, achieving a size of about 10 mg may represent a critical state in the history of cod.

Good progress has been made in formulating pelleted diets for juvenile fish. The pellets consisting of a mixture of fish flesh, roe, and fish meal (ground fish solid, vitamins, and minerals) can be prepared in a variety of sizes and textures. They are readily consumed by a variety of juvenile marine fishes supporting good growth and survival. Pellets <200  $\mu$ m, are currently being

tested on larval cod. Development of suitable formulated diets is an important step in conducting experimental studies of growth and survival of fish.

A Model for Estuarine Research (MER) describing a generic approach to studies of contaminant effects on fish was prepared and submitted for review.

A Program Development Plan of directed research in support of CCAMLR was prepared by the Antarctic Marine Living Resources Program Office in Narragansett. The program objectives include: 1) reviews of catch/effort and by-catch; 2) short-term surveys to validate commercial data; 3) assessment and monitoring of natural variability in populations of krill, fish, seals, whales, squid, and sea birds; and 4) participation in long-term coordinated multinational CCAMLR time series to test hypotheses relating to changes in the trophodynamics of the Antarctic ecosystem.

NMFS NEFC Woods Hole Laboratory,  
Woods Hole, MA

In 1985, significant effort was again directed to juvenile gadoid studies on Georges Bank. A cruise conducted in July compared results of the 10 m<sup>2</sup> MOCNESS, the IYGPT, and bottom trawls. Samples were taken to determine vertical and geographical distribution of juveniles, predators and prey of juveniles, condition (biochemical), incidence of parasites and disease, and for otolith ageing. Comparisons of the MOCNESS and IYGPT juvenile cod catches (30-60 mm) showed very similar size frequencies, suggesting that avoidance at this size was not serious for either underwater gear (ref. ICES doc. C.M. 1985/G:74).

In August, a bottom trawl survey showed that juvenile haddock (4-10 cm) were much more abundant and widespread than in 1984, and concentrated on the eastern half of Georges Bank. This appears to be a fairly consistent pattern with maximum densities of young gadids ending up on the eastern side of Georges Bank, where most of them were spawned. It is hypothesized that variation in the clockwise recirculation of water around the western end of Georges Bank may control dispersal, and also influence survival of young gadids. An array of current meters was deployed in spring 1985 specifically to measure the flow field at the western side of Georges Bank. In addition to the physical studies, more than 10,000 stomachs of various predator species caught on Georges Bank were examined between July and November 1985, but only a few 0-group cod or haddock were positively identified in the gut contents. The relatively scarcity of demersal stage 0-group gadids observed in predator stomachs over the past few years, suggests that if post larval predation is the major factor controlling recruitment success, then it may be occurring for a short period during the pelagic juvenile stage.

Analytical studies in 1985 focused on development of a numerical model of recruitment for Georges Bank haddock. Also, emphasis was placed on development of a statistical method for smoothing time series of trawl survey abundance indices in an attempt to adjust partially for environmentally induced changes in availability and catchability.

Scientists issued a prediction of a strong 1985 haddock year class on Georges Bank based on large numbers of 0-group haddock caught in July and October

bottom trawl surveys. The 1985 index appears comparable to that of 1975 which was a strong year class, and which supported the Georges Bank haddock fishery in the late 1970's and early 1980's.

A report was issued on the diet and food consumption of short-finned and long-finned squid, the two major species of squid of commercial importance in the northwest Atlantic. Both species prey heavily on juvenile fish, particularly during summer and autumn, and are believed to account for a significant fraction of the natural mortality on juvenile fish.

Celebration of the Woods Hole Fisheries Laboratory Centennial (1885-1985) was the occasion for a series of public lectures and forums on the history and future of fisheries research and management.

NMFS Southeast Fisheries Center (SEFC),  
Beaufort Laboratory, Beaufort, NC

During 1985, ichthyoplankton research at the Beaufort Laboratory continued to concentrate on factors affecting distribution, growth, and survival of selected commercial and recreational species. Field work was concentrated in areas around the Everglades National Park, Florida, and in North Carolina. In Florida, our research centered on determining the abundance and seasonality of the larvae of red drum (*Sciaenops ocellata*), snook (*Centropomus undecimalis*), gray snapper (*Lutjanus griseus*), and spotted seatrout (*Cynoscion nebulosus*). A primary objective of this research is to better define where larvae of these species are spawned and where they enter the Park. A report on this research will be completed in 1986.

A new project was initiated in North Carolina waters in October of 1985 to examine the relative estuarine recruitment and survival of age cohorts of late larval stages of Atlantic menhaden (*Brevoortia tyrannus*). We propose to conduct this research over a number of years in order to estimate year-to-year variation in recruitment success and survival of age cohorts (determined from otolith ageing procedures). We expect to obtain information on immigration period, spawning season, age, size and condition factor, relative contribution of spawning cohorts to numbers of immigrants, and the distribution of age cohorts in the estuary. We plan to coordinate this research with larval fish transport research to be conducted in 1986 in coastal North Carolina waters. We are continuing to work up data collected on ichthyoplankton cruises in the Caribbean Sea and the northern Gulf of Mexico. Our Caribbean research is examining the vertical distribution of fish larvae at two sites, one off of Puerto Rico and the other off of St. Croix. An initial report on this research will be completed in 1986.

We did not conduct any field work in the northern Gulf of Mexico in 1985, but continued to analyze data from previous cruises conducted between 1979 and 1984. This work is concentrating on defining the larval fish food web from field collections and laboratory experiments and has led to the publication of a number of papers on larval fish feeding. We have completed our work on ageing gulf menhaden (*Brevoortia patronus*) larvae and will publish this information in 1986.

Our current analysis of data from the Mississippi River delta area indicates that the larvae of gulf menhaden, Atlantic croaker (*Micropogonias undulatus*)

and spot (*Leiostomus xanthurus*) are more abundant and may have enhanced feeding and growth in this area. Therefore, proposed work in the Gulf of Mexico centers around larval fish transport mechanisms and the association of larvae with the Mississippi River plume front.

NMFS SEFC Miami Laboratory, Miami, FL:

Large-scale ecosystem survey work of the Gulf of Mexico continues for its fifth consecutive year of interstate, as well as international, cooperation. The program titled Southeast Area Monitoring and Assessment Program (SEAMAP) is a cooperative effort of the SEFC National Marine Fisheries Service and Texas, Louisiana, Mississippi, Alabama, Florida, and the government of Mexico, to survey the waters of the Gulf of Mexico for environmental data, plankton, shrimp, and bottomfish. The program commenced in 1982, and reports on ichthyoplankton and environmental data for 1982 and 1983 are available. In addition, real time reports on shrimp abundances off Texas and Louisiana are made available to fishermen and management agencies during June and July. Spring ichthyoplankton surveys have yielded impressive results for indexing the spawning stock size of bluefin tuna. An ichthyoplankton survey will be conducted in May, 1986, to continue this effort. Because of recent declines in king mackerel, ichthyoplankton surveys are being redirected to determine areas of spawning concentrations for this species.

Research is also conducted under a cooperative agreement with the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) of the University of Miami. Climate variability investigations include Subtropical Atlantic Climate Studies (STACS), Equatorial Pacific Ocean Climate Studies (EPOCS), and studies of atmospheric carbon dioxide loading. Ecosystem dynamics studies are directly in the realm of biological oceanography and include research on multispecies reef fish assemblages and coral reef fish recruitment. Research is also underway on understanding biological processes associated with larval fish survival within zooplankton communities.

The Early Life History section of the American Fisheries Society will hold its 10th Annual Larval Fish Conference in Miami on May 18-21, 1986. Symposia will be held on the theme "Key questions in the study of the early life history of fish and directions of future research" in four areas--ecosystems, ecology, behavior/physiology, and systematics, plus a workshop on "Techniques for estimating fisheries recruitment." Contact W. J. Richards, Southeast Fisheries Center, 75 Virginia Beach Dr., Miami, FL 33149, for additional information.

#### Plankton Ecology Investigations (G. D. Grice)

Woods Hole Oceanographic Institution  
Woods Hole, MA

Research continues on modelling and data analysis of zooplankton populations in warm-core Gulf Stream rings and on Georges Bank. Studies have also continued on recruitment processes in marine fishes. Analyses of temporal changes in zooplankton biomass, size distribution, and taxonomic composition in one ring revealed that the ring appears to be a quasi-enclosed system. Georges Bank modelling has focused on the biological/physical interactions

controlling mesoscale distributions and seasonal cycles of dominant species. Results of this work suggest that zooplankton production in temperate ocean areas peaks during autumn, not spring as traditionally thought, and zooplankton species having associations with the sea floor, either through bottom resting eggs or demersal migration, can greatly reduce population losses caused by physical advection and diffusion. Other modelling results have shown that: 1) small scale patchiness (1-100 m) of planktonic prey populations can greatly enhance planktonic predator growth rates, and 2) relatively small interannual variations ( $\pm 10\%$ ) in growth rate of pre-recruit fish can lead to order of magnitude variability in recruitment to the adult fishery.

The description of the new medusae, siphonophores, and ctenophores collected in October, 1984, with the submersible Johnson Sea-Link is continuing. Other research centered around studies on the reproductive behavior of the lobate ctenophore *Ocyropsis*, and studies on the feeding rates of salps on a cruise in March-April. A cruise in August-September to Greenland and adjacent Canadian waters documented an extensive ctenophore fauna in the Greenland and Labrador Currents. On this cruise, studies were made on the field behavior of ctenophores, medusae, and pteropods. In September the submersible Deep Rover was used to study and collect mesopelagic ctenophores in Monterey Bay.

Bigelow Laboratory for Ocean Sciences,  
West Boothbay Harbor, ME

Research goals have concentrated on the plankton biology of the eastern portion of the Gulf of Maine and the slope waters off Georges Bank. Attempts are being made to pin down the timing of the spring bloom in both areas and following the bloom, the sequential distribution of major species of zooplankton. Associated with this is an estimate of the amount of surface production that resides in the deep sediments. With the advent of satellites that measure ocean color temperature, slope to ocean interchanges which are called streamers are being examined. Streamers appear to be the result of a warm core ring moving into the slope water and deflecting the horizontal circulation  $90^\circ$  out into the open ocean. The streamers are very narrow filaments of high velocity water. They contain slope and shelf planktonic organisms which are transported considerable distances into the open sea. It is believed a unique ecosystem results from the rings that lie adjacent to the tidal fronts in the southern bank of Georges Bank. The rings provide a means for transporting deep nutrient rich water into the euphotic zone. This tends to support the high productivity and biomass of plankton in these regions. The close proximity of the ring to tidal fronts argue that there is continuity of frontal flow with the high velocity region of a warm core ring. These hydrodynamic features need close scrutiny and provide new insight into the mechanisms of distribution and regulation of growth of planktonic communities.

University of Maryland, Center for  
Environmental and Estuarine Studies,  
College Park, MD

Current research includes a study of the spatial and temporal coupling between nutrient input and the productivity of phytoplankton, bacteria, and zooplankton in the plume of the Chesapeake Bay estuary. In addition, research also focuses on the effects of nutrient input and plankton productivity on the

yearly development of anoxic bottom waters in Chesapeake Bay. Plankton physiology studies include research on the effects of light and nutrients on the partitioning of photosynthetic products in phytoplankton, carbohydrate metabolism in phytoplankton, the role of detritus in copepod nutrition, and protein synthesis as an index of zooplankton production. Larval fish energetic studies are being conducted on striped bass and striped bass hybrid larvae. Other programs include interdisciplinary projects in plankton ecology off the NW coast of Spain, in warm core Gulf Stream rings, and off the Gulf coast of Mexico.

Rosenstiel School of Marine  
and Atmospheric Science,  
Miami, FL

The optimum nutrient ratios and the relative importance of trace metal micronutrients compared to macronutrients are being examined in a large number of phytoplankton species to reevaluate ideas concerning the most important nutrients in marine ecosystems. The energetics and predator-prey dynamics of heterotrophic flagellate and ciliate grazing on picoplankton are also being examined. the seasonal cycle and spatial distribution of phytoplankton and zooplankton are being studied in Biscayne Bay.



U.S.S.R.

(S. A. Studenetsky)

In winter 1985 the assessment of stock abundance and distribution of euphausiids in the Barents Sea was made to determine food supply for commercial fishes by the Polar Research Institute of Marine Fisheries and Oceanography. Specified were features on the growth and distribution of zooplankton in the spring-summer period, and the most productive areas for feeding of capelin and blue whiting in the Barents and Norwegian Seas were located. It has been revealed that feeding of capelin is significantly affected by spring water temperatures and plankton biomass (the obtained regression equations will consequently allow to predict intensity and duration of capelin feeding in the summer-autumn period two months ahead). Found were areas where blue whiting fed upon copepods, matching the areas of the greatest biomass and abundance of Calanus of older copepodite stages. Determined were feeding grounds of blue whiting in the Norwegian Sea in summer. Analyzed were food relations of animals from various trophic levels in the pelagial of the Barents Sea, and the food chain scheme was arranged. Studies were conducted on conditions for development of phytocenosis in various waters, and it has been revealed that formation of a phytoplankton biotope in the Arctic waters is governed by the salinity gradient while in Atlantic waters--by the density gradient. It has been found that favorable conditions for phytoplankton growth are being formed earlier in the cold Arctic waters.

With the trawl-attached net collected were 352 phyto-, 2090 zooplankton, and 252 euphausiid samples; 200 capelin and 100 blue whiting were examined for quantitative weight analysis.

In 1986 the investigations of plankton in the Barents and Norwegian Seas will be continued according to the program previously adopted.

VNIRO and Northern department of PINRO carried out a plankton survey of the whole White Sea. 288 stations were made, 840 samples were taken. Regularities of the distribution of mass zooplankters in relation to temperature and salinity were revealed. Vertical distribution of zooplankton in stratified and mixed waters as well as on their boundaries (structural hydrological fronts) was investigated.

To study feeding habits, 9000 stomachs of herring, navaga and smelt and other species were examined.

Feeding data collected during previous years were generalized. The significance of prey fish was shown. Fish feeding potential was fully utilized, while feeding potential of pelagic and benthic zones was underutilized.

The Biological station of Zoological Institute of the Academy of Sciences of the USSR continued observations on ten-day stations. 180 plankton samples were taken. In the Dvina Bay 20 benthic stations were made.

In 1985 the Baltic Research Institute of Marine Fisheries conducted seasonal zooplankton surveys in areas 25, 26, 28, 29 and the Gulf of Riga in

February, May, August, October, and November. 500 samples were taken by a Juday net 37/50 with mesh size 0.16 mm in the filtering cone.

Ichthyoplankton samples were taken monthly from March to July in areas 25-29 and 32. 320 samples were taken by a X-80 net with mesh size 0.40 mm in the filtering cone.

Nekto-benthos surveys were conducted in January, March, June, July and September in areas 26 and 28 of the Baltic Sea. 170 samples were taken with an Isaaks Kidd trawl (10-foot model).

Data on fish feeding were collected in areas 26 and 28 of the Baltic Sea in January, March, May, July, and September. 1780 herring digestive tracts and 1190 sprat digestive tracts were taken and examined.