

International Council for the Exploration of the Sea

REPORT OF ACTIVITIES
BIOLOGICAL OCEANOGRAPHY COMMITTEE

K. SHERMAN

1984

Belgium(R. De Clerck and Ph. Polk)Laboratory of Ecology, V.U.B., BrusselsZooplankton Research (Daro, M. H.)

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 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 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 analyses).

Copepod Population Dynamics (Bergmans, M.)

Monitoring of the population dynamics of a guild of epibenthic copepods (Tisbe) has been carried out in the field and is being related to

laboratory studies of the life cycle. Special attention is given to the following aspects: (i) knowledge of the reproductive performance in an "ecological vacuum" (yielding null hypotheses on growth rates and age distribution in the field by excluding competition and predation effects); (ii) the possibility of adaptive fine-tuning of the life cycle (including effects on "r" and the "net reproductive rate") as a function of demographic conditions, i.e. in expanding, stable and declining populations.

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 (time, space).
- 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.

The Influence of Temperature on the Biological Compartments in Sea (Bossicart, M.)

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.)

Ecotoxicological Marine Research (Joiris, C., K. Delbeke and W. Overloop; dienst Ecotoxilogie)

- 1) Estimation of transfer and biomagnification mechanisms of organochlorine residues and mercury in marine ecosystems (TPM, zooplankton, fish, birds, sediments) and integrating the results on contamination to biological activities (C. cycius).
- 2) Comparison of the contamination level of coastal ecosystem with the Atlantic ecosystem.
- 3) Estimation of the evolution of the mercury contamination by analyses of seabird feathers.

Canada

(A. R. Longhurst)

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

The Marine Ecology Laboratory was involved in several major oceanographic cruises this year, including the Scotian Shelf (2), the Grand Banks (2), the Labrador Sea (2), Eastern Arctic (1) and Caribbean Seas (1). These cruises have continued to add to the Laboratory's archives of comparative data on primary and secondary production processes in diverse marine habitats and provide the kind of data necessary for a clearer understanding of how environmental factors regulate these processes. Emphasis in these cruises, as in the past, has been specifically on the influence of light, temperature, nutrients and turbulence on primary and secondary production.

Studies have expanded in the area of microplankton ecology. On the Grand Banks, for example, studies were designed to assess the importance of microheterotrophs (protozoans and bacteria) on the primary production and nutrient cycling in that region; this trophic group of organisms has been largely ignored in past work and may be extremely important in the energetics of plankton communities. Studies have continued on the picoplankton and their role in marine primary productivity; cruises to the Arctic and Caribbean focused on these organisms with a view at understanding their geographical extent. The Laboratory's recent procurement of a laser-based flow-cytometer will for the first time provide the capabilities of enumerating and isolating these microorganisms from field samples for culturing and controlled laboratory study.

Several studies on the epontic and pelagic plankton communities were carried out at stations on the ice in Barrow Strait near Resolute Bay. These studies were designed to investigate plankton dynamics during the winter/spring non-navigable season, and have highlighted the role of physical processes in the system. For example, it seems as if tidal currents are important in supplying nutrients to the epontic algal community, and turbulent interactions at the ice-water interface cause algae to slough off, providing food for pelagic zooplankton consumers. Gear has been developed to measure both these physical interactions (in co-operation with Dalhousie University) and also to facilitate biological measurements (in co-operation with the Atlantic Oceanographic Laboratory here at Bedford Institute of Oceanography) under the ice.

BIO MASS sampling combined with the observations by the multiple frequency acoustic system were carried out during April and October 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.

On the Scotian Shelf, a second year of field work was carried out as part of the Southwest Nova Scotia Fisheries Ecology Program, a joint effort with the Marine Fish Division (also at Bedford Institute of Oceanography) and with Dalhousie University. Further sampling was undertaken with the ECOLOG dual beam acoustic fish detection device, and comparisons were made with net hauls in the same area. Fine-scale process-oriented studies of gadid egg and larval survival focused on predation, particularly by ctenophores, and on the ecological importance of aggregation of larvae close to the thermocline. Studies of the depth distribution of larvae in relation to mesoscale circulation patterns at different depths suggest that the larvae are advected towards the shore and that coastal waters are probably the most important nursery grounds for gadids from the Brown's Bank area.

Field observations and experiments undertaken within the Deep Ocean Ecology Project during 1984 have focused on determining how the presence of organisms of various size can alter the behaviour and fate of radionuclide and other elements in abyssal environments. A cruise on CSS HUDSON to the South Nares Abyssal Plain allowed redeployment of a baited multiple trap array. The trap was recovered after a 12-day deployment and the amphipods captured confirmed the presence of E. gryllus photographed near the site in 1982. Weight of gut contents was used to calculate feeding rates which were similar to those derived by analysis of time-lapse photographs.

The cruise also provided an opportunity to directly examine the response of meiofauna to organic enrichment. Two box cores were used to incubate sterile dye-labelled sardines in cores pushed into the undisturbed sediment surface. The boxes were placed on the bottom and retrieved after six days. Abundant nematodes and foraminifera in the sediment caused dye to penetrate up to 2 cm into burrows. These observations show that it may be misleading to consider abyssal environments as biological deserts. Work has also continued to develop methods which allow the quantification and manipulation of various size categories of benthic biomass. Floatation in a silica sole is used to separate micro- and meiofauna from sediment and an image analyzer is used to quantify the volume of biomass in different logarithmically-graded size categories. Preliminary work to assess the effect of adding or removing various size classes of organisms on wholecore respiration rate measurements has begun. The method holds potential for analyzing the distribution of radioactive or other toxic substances amongst organisms of different size within a complete benthic community.

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(Dr. Jean Piuze, Directeur)

La division d'océanographie biologique a continué ses recherches visant à étudier les processus de production primaire et secondaire dans l'estuaire du Saint-Laurent. Différentes études ont porté sur le contrôle de la répartition temporelle et spatiale de la production planctonique, l'influence des variations du mélange vertical sur la production et sur les facteurs contrôlant la distribution spatiale et temporelle de l'activité bactérienne (potentiel hétérotrophique) et la distribution de *Protogonyaulax tamarens* (principale algue responsable de la toxicité chez les mollusques) dans l'estuaire du Saint-Laurent.

D'autres travaux ont porté sur l'écophysiologie du phytoplancton. Ces études ont nécessité l'utilisation d'enceintes fermées où les conditions environnementales sont contrôlées afin de détecter les cycles endogènes des paramètres photosynthétiques et de déterminer les facteurs qui sont responsables de ces variations physiologiques. Une méthode simple pour étudier la photoadaptation en continu du phytoplancton en utilisant deux fluorimètres et une source de lumière brillante a également été développée.

Le rôle biologique du phytoplancton et de ses produits d'excrétion dans la synchronisation du déclenchement de la ponte d'invertébrés dans l'écosystème marin a fait l'objet d'un projet particulier. Enfin, un projet d'étude sur la productivité de la flore épontique a été développé.

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

The second field season of the Southwest Nova Scotia Fisheries Ecology Program was completed. The program focuses on all life history stages of haddock in the area in order to develop a comprehensive understanding of this important commercial stock. Five ichthyoplankton cruises were conducted to determine the distribution and survival of haddock eggs and larvae in relation to the hydrographic regime. In addition to usual sorting procedures, ageing of larvae was initiated in order to determine drift patterns from distribution maps. Results from the first two field seasons suggest that 1983 and 1984 were relatively poor year classes for haddock. A good year class in a subsequent field season should further help identify the factors involved in determining year class strength. Electrophoretic, morphometric, and meristic analyses on haddock were completed. This study, together with results obtained from two tagging cruises also conducted during the year on Georges and Browns Bank should elucidate relationships between localized haddock stocks in the area. Another midwater trawling cruise for juvenile haddock was conducted. Analysis of stomach contents collected during last year's cruise produced information on feeding

habits prior to and after transition to the bottom. Collection and laboratory analysis of post-juvenile haddock stomachs were also completed and these will be analyzed to determine the relationships between feeding habits, distribution of fish and bottom types.

An extensive analysis of groundtrawl survey data using clustering and discriminant methods defined groundfish species assemblages and described their distribution in relation to environmental factors (temperature, salinity, depth, bottom type) on the Scotian Shelf. A preliminary analysis on broad scale (east coast of North America) distribution of species groups was also completed.

A special cruise was conducted which sampled the continental slope epibenthic and mesopelagic fish faunas from LaHave to St. Pierre Banks, and measured environmental parameters. The project aims to define inter-relationships between the neritic and oceanic systems in addition to determining the commercial potential of underutilized species. Environmental parameters continued to be collected routinely on standard groundfish inventory surveys covering the entire Scotian Shelf and Bay of Fundy.

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(Dr. J. E. Stewart, Director)

Geographic synopsis for macrofaunal production in Minas Basin, Chignecto Bay and the lower Bay of Fundy has been completed. An interesting feature of the data is the linear logarithmic relationship between suspension-feeder production, mainly horse mussels, and tidal current speed in the lower Bay. Unfortunately, this relationship is not present in the upper Bay data, presumably because of the more extreme physical conditions there, particularly tidal currents and suspended sediment load. A contributing factor was the large grid scale sampling pattern employed which probably missed the rapid changes in tidal currents along short gradients which exist there, but not in the lower Bay.

Changes in average tidal current speeds and bed-stress values predicted by the Greenberg Model of the Bay with the B9 (Economy Point-Cape Tenney) barrage in place are used to suggest qualitative changes of macrobenthos which might occur if the barrage were built. A net sedimenting regime behind the barrage is likely to result in a change to a deposit-feeder dominated community. The relatively small increases in tidal current speed and bed-stress values which would occur at the mouth of the lower Bay and in Chignecto Bay, with decreases elsewhere, cannot be used to predict macrofaunal changes.

Northwest Atlantic Fisheries Centre, Fisheries Research Branch,
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(Mr. M. C. Mercer, Director)

Evaluation of the present status of the Flemish Cap Project led to the proposal for and acceptance of a NAFO Special Session to examine research results from the Flemish Cap (and Georges Bank) projects during September 1986. A compendium of Flemish Cap research vessel cruises was completed and published. Comparison to the MEDS data base revealed that only about one-half of the data collected was available through MEDS. While several primary manuscripts were produced in 1984, a significant amount of data has yet to be analyzed. A paper published on the early life history of redfish on Flemish Cap is important in that it provides a background for more specific papers on larval redfish.

The Vertical Plankton Sampler (VPS) was extensively tested during the winter months and a number of changes made. The complicated nature of the system necessitates a high degree of maintenance and support. The sampler is now functional. The sampler was used in an examination of larval yellowtail flounder (*Limanda ferruginea*) on the Southeast Shoal Grand Bank and in the region of the shelf-break. The lack of success in sampling yellowtail larvae in 1983 and 1984 has led the principal investigator to conclude that the original objectives of the project (i.e., specific aspects of growth, feeding, distribution and abundance related to biological and physical oceanographic conditions) are probably unattainable.

The quality of data collected on annual oceanographic cruises mounted by the Branch continues to improve with better CTD support. In addition to improvements in data acquisition and quality, it is noteworthy that we have now moved to digital XBTs on the larger research vessels (analogue XBTs are used as backup). Implementation of digital XBT systems removes the dependence on MEDS for data processing. All data are now available within three weeks of the completion of the cruise.

A review of environmental effects on distributions, migrations and movements of marine species was undertaken, a manuscript prepared and results presented during the Environmental Subcommittee Meeting of NAFO during June 1984. Documentation of larval fish ecology work being carried out in the Newfoundland Region was assembled for a meeting of the ICES Larval Fish Ecology Working Group in June 1984. In addition, a manuscript was prepared outlining recommendations for future research.

Considerable time was devoted in 1984 to considerations of standardizing plankton sorting contracts and a set of procedures has been put in place to standardize subsampling and quality control procedures for use in contracting services.

Environmental effects were obvious in 1984. It was a year of extreme polar outflow and Station 27 was abnormally cold (only 1 year in 20 is as cold) and of unprecedented low salinity.

Conditions are similar to 1972-74. High surface temperatures were due to a "skin" of relatively fresh water floating over cold saltier water. Unusually cold water conditions in 1984 contributed to delayed maturation in capelin, poor catches in the crab fishery and alterations in inshore cod migrations.

Field studies were conducted at Bryant's Cove, Conception Bay to investigate growth in larval capelin and preservation effects. Eggs and pre-emergent larvae were collected from beach sediments during June and July. Pelagic larvae were collected in Conception Bay during July and in Trinity Bay on five cruises during June-October. Enclosure experiments studying larval capelin growth under varying food concentrations were completed.

Studies of the reproductive ecology of herring and capelin in Trinity Bay continued in 1984. There is a considerable body of literature that suggests that recruitment in fish is determined in the larval phase and the project is primarily concerned with investigations at this stage. Five larval surveys were carried out in 1984 from the time of larvae emergence until larvae were no longer present in significant numbers in the Bay (i.e., June to October). The BONGOS were used during all cruises and the RMT net for the September and October cruises. A contract was let for a study of the circulation of Trinity Bay and oceanographic instruments were deployed for five months and all moorings successfully recovered. A report is in preparation. Additional meteorological data are being incorporated into the study. These studies will provide a key input to the appropriate interpretation of larval data and, in particular, whether or not we should continue with broad-scale synoptic sampling in favour of more specific hypotheses which can be accommodated by site-specific sampling.

Major progress was made in 1984 concerning models of food web stability. One primary manuscript on the effect of life history structure was completed and details for future developments of models were finalized.

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(Dr. A. W. Mansfield, Director)

Summer and winter work on phytoplankton and sea ice algae in Hudson Bay and Frobisher Bay, NWT, included studies on vertical distribution and standing stocks. Measurements of in situ production rates and of major photosynthetic products were related to environmental features of Frobisher Bay. Identifications were carried out on microalgal food species of herbivorous zooplankton in the water column and, in winter, within the lower levels of the sea ice. Energy reaches the zoobenthos largely as fall-out of detrital material originating in the water column, and the study of this activity was continued with the objective of showing seasonal variations, total annual input and the uses to which the material is put by members of the benthic community.

Work continued on the sea ice fauna, with special attention being paid to seasonally varying environmental factors and their effects, and to feeding by the predominantly herbivorous members of this community. A new genus of ice-dwelling cyclopoid copepod was found and described. Food studies on carnivorous zooplankton were continued. Work was continued also on seasonal changes in abundance and population structure of the dominant macrozooplankton species in Frobisher Bay (*Parathemisto*, *Mertensia*, *Sagitta*, *Thysanoessa*). This included measurements of oxygen consumption and ammonia production rates in winter, spring and summer, both in situ and in the laboratory, as part of an examination of year-round variations in metabolic activity.

In the study of the role of bacteria in the cycling of carbon, emphasis was placed on multiplication rates of bacteria in the water column and in the sediment. Combining these rates with measurements of bacterial standing stocks permits estimation of the quantity of carbon entering the bacterial biomass.

In the region of Killinig, northeastern Ungava Bay, a brief survey of inshore decapods, with emphasis on shrimp, was undertaken as part of the Northern Québec marine fauna study. These crustaceans are important food items of Atlantic cod.

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Les chercheurs du Centre tentent d'améliorer notre compréhension de certains liens primordiaux à l'intérieur des écosystèmes marins qui sont responsables de la production des ressources biologiques renouvelables. La plupart de ces travaux ne font que débiter concurremment à la mise en place des labos pour les nouveaux chercheurs.

Le programme d'étude des carcasses de bélugas échoués le long du Saint-Laurent a débouché sur l'identification d'un problème de contamination par les organochlorés, qui pourrait avoir des répercussions considérables sur l'état de santé autant du milieu lui-même que des humains qui l'utilisent. A cause de leur position dans la chaîne trophique, et de leur statut protégé, ces animaux sont d'une importance primordiale. Nous évaluons certaines composantes biologiques spécifiques et certains facteurs écologiques qui influencent l'accession des larves aux classes d'âge supérieures qui sont responsables du recrutement aux stocks. Nous étudions d'une part des facteurs physiques, et d'autre part des aspects physiologiques (taux d'alimentation, de digestion, d'activité métabolique) et comportementaux (migration et cryptisme) qui influencent la survie et la croissance des larves. Nous croyons que la façon dont les espèces exploitent la présence de structure thermique dans le milieu marin, et en particulier la migration verticale, représente la clé de leur recrutement. C'est dans

l'étude des facteurs physiologiques et éthologiques que l'approche du CREP se démarque de celle d'autres groupes du Ministère.

Nous avons réussi avec succès l'élevage de larve de maquereau et de hareng. Chez les premières, des mesures de taux instantanés de digestion ouvrent la porte à l'évaluation de leur budget énergétique. Chez le hareng, le montage des otolithes a débuté, afin de mesurer leur taux de croissance hebdomadaire. La condition des larves en milieu naturel a été mesurée et les résultats seront discutés en relation avec les hypothèses du match-mismatch et de la rétention larvaire. Des études de génétique viseront à préciser la nature de la population cible, celle de l'estuaire du Saint-Laurent. D'autres projets porteront sur les lieux et périodes de frai de même que sur l'écologie et la dynamique des stades juvéniles et adultes.

DALHOUSIE UNIVERSITY

Department of Oceanography, Dalhousie University, 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. A major new development in the past year has been the construction of an instrumented flume system for experimental analysis of 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). The extent of physical control of phytoplankton photosynthesis and primary production was investigated at a number of different scales. Vertical mixing estimated from determinations of microscale velocity shear was shown to control the vertical distribution of phytoplankton photosynthesis in the nutrient-rich waters containing the spring phytoplankton bloom (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 the Grand Banks of Newfoundland; these are the first measurements of their kind (Lewis). On a larger spatial scale, the influence of physical processes, including upwelling and horizontal dispersion, on the phytoplankton, zooplankton and ichthyoplankton populations off southwest Nova Scotia and northern Georges Bank was examined in a series of cruises associated with the Southwest Nova Scotia Fisheries Ecology Program (Koslow, Fournier). Application of an automated method for measurement of zooplankton grazing and growth rates over synoptic scales was accomplished by an instrumented "ferry of opportunity" which ran weekly between the southwestern tip of Nova Scotia and Portland, Maine (Boyd). On a still larger scale, coherences between climatic fluctuations and fish catch variations in the North Atlantic over the past thirty 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 behaviour 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.

UNIVERSITE DU QUEBEC A RIMOUSKI

Département d'Océanographie, Université du Québec à Rimouski, 310,
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(Jean Lebel, Chef)

Les professeurs du département d'océanographie de l'Université du Québec à Rimouski effectuent des recherches qui touchent plusieurs aspects de ce domaine. Les chercheurs suivants poursuivent des travaux se rattachant à l'océanographie biologique.

Ecologie et dynamique des communautés et des espèces benthiques du système phytal (Jean-Claude Brethes, Gaston Desrosiers et Bruno Vincent)--Les projets de recherche poursuivis par cette équipe visent à une meilleure compréhension de l'écologie des peuplements benthiques du substrat meuble des étages médio- et infralittoraux.

Ces projets s'inscrivent dans trois grands types d'activité: description générale des peuplements en relation avec certaines caractéristiques environnementales (sédiment, hydrodynamisme), suivant en cela les principes généraux de la biocoenotique benthique; évolution spatio-temporelle des peuplements, fondée sur l'examen de la structure du peuplement, et divers indices tels l'indice de diversité et la constante du milieu de Matomma; écologie et dynamique de certaines espèces particulières, soit à cause de leur importance au sein de leur peuplement, soit à cause d'un intérêt économique.

Après des études consacrées à la communauté boréo-atlantique à Macoma balthica de la région de Rimouski, dans l'estuaire maritime du Saint-Laurent, nos activités ont essentiellement portées sur les peuplements de sables fins terrigènes des régions des rivières Saint-Jean et Romaine; sur la Moyenne Côte-Nord du golfe du Saint-Laurent. Ce dernier secteur présente l'avantage de ne pas subir d'emprise humaine et de limiter les causes de variation à des causes naturelles identifiables: crues de rivières, hydrodynamisme, structures sédimentaires.

Un projet parallèle concerne l'écologie et la dynamique du crabe-des-Neiges (*Chionoecetes opilio*), en relation avec son exploitation dans le sud-ouest du golfe du Saint-Laurent.

Etudes de contamination et d'identification des unités du stock de harengs du golfe Saint-Laurent (Michel Arnac, Alcide C. Horth et Michel F. Khalil)--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 composantes sont bien connues. Dans le golfe Saint-Laurent, il y a apparemment plusieurs unités de stock de harengs. 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 trentes dernières années par des méthodes biométriques classiques. Nous croyons que l'analyse des protéines de certains tissus du hareng ainsi qu'une meilleure connaissance de la structure génétique de ces populations vont nous permettre de mieux caractériser les unités de ce stock et de le faire à meilleur compte. De plus, nous déterminons le degré de contamination du hareng par les organohalogènes, les hydrocarbures aromatiques polycondensés et les métaux lourds. Nous espérons ainsi en apprendre davantage concernant le comportement et les migrations du hareng.

Les méthodes biochimiques pour identifier les unités génétiques d'un stock ont connu un grand développement depuis 20 ans. Ces méthodes sont complémentaires aux méthodes classiques de mesure des caractères morphométriques et méristiques et ont même tendance à supplanter ces dernières. Un groupe de biologistes marins de grande expérience va même jusqu'à affirmer: "Electrophoretic data have, therefore, shifted from an optional to a primary position among methods used in studies of discreteness and relationships among stocks" (Inssen, P. E., H. E. Bookey, J. M. Casselman, J. M. McGlade, N. R. Payne and F. M. Utter. 1981. Stock identification: materials and methods. Can. J. Fish. Aquat. Sci., 38: 1838-1855).

Notre deuxième approche qui consiste à mesurer des contaminations pour identifier les unités d'un stock de poissons et à connaître les migrations n'a pas été employée souvent à notre connaissance. Nous croyons, cependant, que c'est une idée prometteuse. Nous nous intéressons à l'heure actuelle à l'estuaire du Saint-Laurent et à la Baie des Chaleurs. Pour affirmer que nos déterminations ne nous apprendront rien, il faudrait faire l'hypothèse que les eaux de l'Estuaire et de la Baie des Chaleurs contiennent des concentrations égales des mêmes matières polluantes et que le milieu physicochimique soit identique. Une hypothèse semblable nous semble très peu probable.

Relations entre le recrutement larvaire et les processus physiques et biologiques dans le sud-ouest du golfe Saint-Laurent (Mohammed I. El-Sabih)--En octobre 1983, une nouvelle équipe de recherche a été formée par madame Brenda Côté de l'INRS-Océanologie et monsieur Mohammed I. El-Sabih de l'UQAR sous la responsabilité administrative de madame Côté. Notre 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-elle 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? Nous étudierons 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, 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

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(John B. Lewis, Director)

Dr. Lewis continued his work on production processes on coral reefs. Coral reef zooplankton was sampled by means of inverted, in situ nets. Preliminary analysis indicates that plankton biomass is closely linked to microhabitat, that turnover rates are high because of abbreviated life histories and zooplankton community composition is influenced by the differing predation strategies of coral species. Production in a coral reef anemone was investigated and it was found that relative dependence on autotrophic and heterotrophic sources of nutrition depend upon the animal's previous nutritional history. Two populations of a reef dwelling echinoid were sampled monthly from widely differing habitats. Differences in morphology and life history traits were observed. Production, in terms of size and reproductive potential was higher in a low wave energy habitat than in a habitat exposed to heavy wave action. Estimates of secondary production of corals from a theoretical growth model were tested against field measurements of growth and respiration.

Browman and Marcotte studied larval Atlantic Salmon and demonstrated: (1) diurnal rhythms in activity and successful (feeding) performance which resembled rhythms in sleep observed for other fish species, (2) the non-linear effects of prey abundance on the fishes activity and performance including dysfunctional behaviours above 400 prey per litre, and (3) that natural zooplankton prey background colour affect food choice; red prey are preferred on blue backgrounds, blue prey on green backgrounds and uncoloured prey on red backgrounds. Rainville and Marcotte demonstrated that seasonal variations in zooplankton community structure and energy content are related to water column stability in the estuary of the St. Lawrence River. High energy content is

related to cold water habitats. Maximum abundance and diversity of short-lived species occurred in mixed water layers. Zooplankton energy content and diversity were negatively correlated.

Shea, Fife and Neuhof began studies on sea-ice associated crustacea. Sisak completed work on the distribution and physiology of an echinoderm in Barbados. Marcotte demonstrated seasonal, tidal and diel rhythms in abundances of primary and secondary producers in planktonic and benthic habitats.

Dunbar reports that research on the status of the Atlantic Salmon population over the whole of its range, with special reference to environmental changes and cycles, including climatic change, has been done under the auspices of, and funded by, the Institute of Marine and Terrestrial Ecology (IMTEC). This study began in August 1983 and is continuing. A large bibliography has been built up and is kept up to date, computerized. Interesting developments include the probable importance of the proportion of Irminger Sea water in the West Greenland current, in determining the migration of the salmon and the position of the area of sea life; and the possibility of an ecological oscillation of some 50-plus years which may be associated with changes in salmon abundance.

He is also preparing papers on Arctic Marine Ecosystems and the Arctic Oceans as a biological environment, for a book to be published in due course, and for the May 1985 Workshop of the Comité Artique to be held at Fairbanks, Alaska.

Reiswig reports that investigations of the organization and taxonomy of Porifera continued on two fronts: the investigation of fine structure of hexactinellids (glass sponges) and the analysis of several new forms of "slime sponges" (without sclerified skeletons). Hexactinellid specimens collected during excursions of the submersible PISCES IV in the inlet systems of British Columbia during 1982-83 were processed for electron microscopy. Two species, *Aphrocallistes vastus* and *Farrea occa*, were found to share all of the basic attributes previously described in *Rhabdocalypus dawsoni*. Details of the syncytial organization of the trabecular and choanodermal networks and the "pore plug" units joining cytoplasmic regions of specialized areas appear to be the same in all three species. This new information strengthens the basic distinction drawn between this group and other members of the phylum in recently proposed subphylum divisions. More tissue samples of other members of the glass sponges are in various stages of investigation.

The "slime sponges" include three main genera: *Oscarella*, *Chondrosta* and *Halisarca*, plus associated minor genera. These are included within the large and diverse class Demospongiae, and are considered to represent either primitive members of the class (and phylum), possibly containing clues to the relationship between Porifera and other invertebrate lineages OR to represent specialized members of sclerified demosponges that have undergone secondary loss of support systems. We are presently investigating the fine

structure of four recently collected species of this heterogeneous assemblage, some of which are undoubtedly new species or new higher taxa. It is expected that these specimens, from the tropics (Curacao, Jamaica) and high temperate (British Columbia, Canada) may provide new information to reinterpret the positions of the main "slime sponge" groups and offer new insights into the relationships between the classes and subphyla of Porifera and between the Porifera and other lower eukaryote organisms.

GIROQ (Groupe Interuniversitaire de Recherches Océanographiques du Québec)

Secrétariat, Pavillon Vachon, Université Laval, Ste-Foy, Québec
G1K 7P4
(Dr. 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.

- A. Les processus d'interface (hydrodynamique et production planctonique) en milieux côtiers et estuariens:
 - 1) Les échanges énergétiques air/mer et le mélange vertical dans la partie supérieure de la colonne d'eau;
 - 2) le contrôle hydrodynamique de la photosynthèse phytoplanctonique;
 - 3) modélisation de la croissance du phytoplancton en fonction de l'hydrodynamisme de la colonne d'eau;
 - 4) le contrôle hydrodynamique des microalgues et de la matière particulaire sous la glace de mer;
 - 5) l'impact des mouvements verticaux associés aux marées internes sur la dynamique des agrégats de zooplancton.
- B. L'écologie reproductrice des poissons--six projets se situent dans ce cadre:
 - 1) le contrôle environnemental de l'effort reproducteur chez les corégones anadromes de la Baie de James;
 - 2) le réglage de la dérive larvaire de l'éperlan (Osmerus mordax) dans l'estuaire moyen du Saint-Laurent);
 - 3) la mortalité chez les stades larvaires du capelan (Mallotus villosus): les processus dépendants de la densité et le rôle des prédateurs planctoniques;

- 4) la description des mécanismes d'apprentissage olfactif responsables de l'identification des rivières natales par le saumon (Salmo salar);
 - 5) description du patron de mortalité durant tout le cycle vital de trois espèces d'épinoches, et évaluation de l'influence de cette mortalité sur la fécondité des géniteurs;
 - 6) la description de la migration vers l'amont des civelles d'anguille (Anguilla rostrata) dans les rivières de la côte nord du golfe du Saint-Laurent.
- C. Le milieu benthique littoral de l'estuaire et du golfe du Saint-Laurent: aspects dynamiques et fonctionnels--cinq projets s'insèrent dans cette programmation:
- 1) l'hétérogénéité du milieu et la répartition des organismes benthiques intertidaux;
 - 2) influence des écoulements d'eau douce sur la production benthique dans l'estuaire et le golfe du Saint-Laurent;
 - 3) écophysiologie, variations intraspécifiques et utilisation par les herbivores des diatomées marines benthiques de substrats durs;
 - 4) structure des communautés infralittorales du golfe du Saint-Laurent;
 - 5) effets du stress trophique sur les communautés suprabenthiques subpolaires.

Denmark

(M. Back)

Greenland Fisheries and Environment Research Institute (E. Smidt)

Zooplankton Research

The standard sampling programme was continued using stramin net (2 m diameter ring, mesh aperture 1 mm) and bongo sampler (60 cm diameter ring, mesh apertures 0.5 and 1.0 mm) in July at the Standard Oceanographic Sections in Davis Strait from Fylla Bank to Egedesminde, in the area west of Disko, and in Disko Bugt. Half hour oblique hauls were made from about 50 m depth. The samples are analysed by volume. Fish eggs and larvae, shrimp larvae, and dominant zooplankters are sorted and counted.

Institute of Genetics and Ecology, Aarhus University, Aarhus (T. Fenchel)

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

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

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

Department for Experimental Ecology (E),
Danish Institute for Fisheries and Marine Research (J. E. Beyer)

The department's research activities are directed towards the understanding of recruitment to commercially important fish stocks.

The North Sea Herring has been chosen as target stock, and a series of research projects on the ecology of the early life stages of herring are performed on laboratory, basin, and field scale.

In the laboratory the following projects have been run:

- Phytoplankton response to light and turbulence
- Copepod bioenergetics

- Larval feeding ability after yolk sac absorption
- Larval feeding behaviour and growth
- Larval digestion (digestion rate and production of pancreatic enzyme)
- Development of immunological methods for quantification of predator/prey relations

The biological basis of the laboratory work is:

- A culture of the copepod Acartia tonsa routinely maintained to produce feed material for the larvae, as well as material for the copepod studies
- A standardized technique for fertilisation and incubation of herring eggs, and routine methods of maintenance of larvae
- A stock of sandeel (Ammodytes marinus) held in the laboratory and used as predators on herring larvae

Studies have also been performed in large outdoor tanks:

In a 92 m³ tank, an experiment on the influence of artificially generated food-patches on larval herring growth and survival, was performed together with an experiment on density-dependent predation by juvenile fish on herring larvae. A 2200 m³ tank was used in 1984 and the first experiment performed with the aim of following development and spatial distribution of zooplankton and herring larvae.

The field studies concentrate on describing the physical and biological processes of importance to a patch of herring larvae. A patch stemming from a spawning ground at Aberdeen Bank off the Scottish coast has been chosen.

In a cruise September 1984 the following projects were conducted:

- Description of the hydrographic characteristics of the area and the connection hydrography and primary productivity
- Copepod abundance and productivity in the area
- Dispersal and drift of the larval patch
- Estimation of larval growth and survival
- Description of within-day variations in larval vertical distribution

The results of the projects conducted in 1984 will be published in international journals in 1985-86.

Finland

(J-M. Leppänen)

Institute of Marine Research, Helsinki

Monitoring of phytoplankton, chlorophyll a, and some related chemical parameters, as well as zooplankton and benthic macrofauna was continued in the entire Baltic Sea according to the Baltic Monitoring Programme of the Helsinki Commission. Studies on long-term fluctuations of the open sea macrozoobenthos, started in 1961, continued especially in the Gulf of Bothnia.

Phytoplankton, primary production and zooplankton were sampled at a fixed coastal station in the western Gulf of Finland as well as zooplankton in the Archipelago Sea and the Bothnian Bay.

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.

Effect of fish cultures on the marine environment have been studied in the Archipelago Sea, especially effects on periphyton production.

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

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.

Water Conservation Laboratory of Helsinki City

Monitoring of phytoplankton, primary production, chlorophyll a, and some related chemical parameters, as well as of fecal bacteria, benthic macrofauna, and littoral vegetation was continued in the sea area of Helsinki and Espoo.

Nitrogen fixation by blue green algae was studied in the Helsinki sea area.

Tvärminne Zoological Station, University of Helsinki

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

Husö Biological Station, Åbo Akademi

Studies on the ecology of phytoplankton, macroalgae and periphyton were continued in the Åland archipelago. The recovery potential of benthic macrofauna was studied experimentally in the field and in the lab. Macrobenthos samples were taken at several stations in the archipelago.

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.

France

(N. Lacroix and P. Lassus)

MINISTERE DE LA RECHERCHE ET DE LA TECHNOLOGIE--SECRETARIAT D'ETAT A LA MER

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.
- 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 : surveillance et étude des mécanismes de formation sur le littoral français (en collaboration avec Université Paris VII UBO (France), Tohoku University (Japon), Laboratoire de Vigo (Espagne)).
- Dystrophies : baie de Vilaine (en collaboration avec UBO (France) et CMMB (France)).
- Mise au point des techniques de cultures concernant les algues à vocation alimentaire ou industrielle (Laminaires).

UNIVERSITE DE NANTES

Laboratoire de Biologie marine Nantes

- Claires ostréicoles : mécanismes de transfert des nutriments (échelons Ier et IIème) (en collaboration avec le CNRS).
- 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.)).

UNIVERSITE DE PROVENCE--AIX MARSEILLE

Laboratoire de Biologie animale (plancton) Marseille

- Recherches cytophysiologiques sur la nutrition et la reproduction des copépodes calanéoïdes 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 Collège 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 les T.A.F. (France)).
- Etude des effets des polluants sur le phytoplancton (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

- Production et transferts pélagiques dans le Pas-de-Calais (GRECOMANCHE, France).

- Biologie des céphalopodes (Embryologie de la Seiche, mécanismes endocrines, Protéines sanguines) (en collaboration avec l'Université d'Anvers (Belgique) et d'Utrecht (Hollande)).
- Distribution générale et écologique de la faune benthique dans la Manche et les mers avoisinantes (GRECOMANCHE, France).
- 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

- Séquences alimentaires chez le poisson 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)

Biological and ecological investigations have been continued at the Institute for Marine Research, Academy of Sciences of the GDR during 1984 in the Baltic Sea. As a contribution of the GDR to the Baltic Sea Monitoring Programme (HELCOM) four expeditions (March/April, May, August, October/November) have been carried out and physical, chemical and biological parameters were measured according to the HELCOM Guidelines. The biological investigations were performed partly in cooperation with the Section of Biology, Wilhelm-Pieck-University of Rostock.

In autumn two polygons in the Southern Gothland Basin and in the Arkona Sea were investigated in preparation for the joint "Patchiness-Experiment" PEX '86. In these investigations physical, chemical and biological determinants were surveyed at a grid of 16 stations (distance 5 nm).

The Section of Biology, Wilhelm-Pieck-University of Rostock continued the qualitative and quantitative analysis of the phytoplankton, zooplankton and zoobenthos samples taken by the Institute for Marine Research in connection with the BMP of HELCOM. The investigations on phytoplankton and zooplankton dynamics in the Greifswalder Bodden in respect to food availability of herring larvae were continued. The survey programme of macrozoobenthos in the western part of the Baltic Sea was also continued.

Main attention was paid to the complex ecosystem analysis of the eu- and hypertrophicated estuary south of Darg/Zingst. Monitoring programmes as well as field and laboratory experiments have been carried out to get more insights, especially into the nitrogen cycle in the pelagic, the benthic community respiration rates, and the effects of heavy pollution upon benthic assemblages.

Investigations of the nitrogen fixation by autotrophic (phytoplankton, microphytobenthos) and heterotrophic microorganisms (sediment) were continued at the Biological Station Kloster/Hiddensee, Ernst-Moritz-Arndt University of Greifswald. Nitrogen input by blooms of blue-green algae in coastal waters amounts after dates from 1974-1983 665 (max. 1395, min. 220) $\text{mg N} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$. The vegetation period of blue-green algae varies between 18 and 71 days. During periods of upwelling water neither blue-green algae nor values of nitrogen fixation could be observed. In the offshore region missing upwelling waters, the average value of nitrogen input is about 780 (max. 1536, min. 243) $\text{mg N} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$. In backwaters near the coastal region, great amounts of nitrogen are fixed by benthic growing blue-green algae. N_2 -fixation by heterotrophic microorganisms is only present in sediments. Intensity varies depending on sedimentary formation.

Researches on primary production of phytoplankton are carried on. Measurements running from 1960 in coastal waters demonstrate an increasing primary production of phytoplankton mainly caused by an elongating of the spring vegetation period.

Germany, Federal Republic of

(J. Lenz)

Institut für Meereskunde an der Universität Kiel

The institute with its 5 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

The development and fate of the autumn phytoplankton bloom in western Kiel Bight was intensively studied in relation to environmental conditions. Special emphasis was laid on the response of herbivorous zooplankton and the benthic community to the food supply provided by the algae.

A new field of interest are life strategies of individual phyto- and zooplankton species and their significance in structuring the pelagic ecosystem. An example are diatom species forming resting spores which sediment to the bottom or deeper parts of the water column with a subsequent return into the euphotic zone. Under the above heading, a joint study on growth and sedimentation of natural plankton population was carried out in large experimental tanks (MERL) at the University of Rhode Island.

For comparison with similar investigations carried out recently in the shelf area of the Lofoten/Norway, growth conditions, grazing pressure and sedimentation losses of a phytoplankton spring bloom were studied in oceanic waters off the west coast of Ireland and Scotland.

In cooperation with Trömsø University, the input of organic matter to the sediment via sedimenting phytoplankton was assessed in the Balsfjord, Northern Norway.

Studies on the possible eutrophication of Kiel Fjord and Kiel Bight during the last decades and its causes were continued by a survey of the former and a re-evaluation of literature data for the latter.

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.

The use of satellite images for eutrophication studies and an identification of plankton blooms was demonstrated by a collection of images for the North Sea and Baltic Sea during the last 5 years.

A study on the ecological role of the jellyfish *Aurelia aurita* in the western Kiel Bight with special emphasis on its metabolic rates and contribution to the pelagic and benthic food web via the production of protein-rich planula larvae was continued for the third year.

The seasonal change of zooplankton size structure was studied in the western Kiel Bight by measuring biomass, respiration and excretion rates in 4 size classes both in the upper and lower part of the stratified water column. Additional measurements were carried out in the Baltic proper in close cooperation with the Askö Laboratory, Sweden for comparing both ecosystems

Within the framework of the international MIZEX '84 Expedition (Marginal Ice Zone Experiment) carried out in the Fram Strait between Greenland and Spitsbergen in June and July, phyto- and zooplankton abundance and composition was studied in the polar front region, at the ice edge, within the pack ice and in a large polynya off Greenland. Field observations were combined with grazing experiments for estimating energy transfer from primary to secondary producers.

Microbiological work concentrated on the abundance and physiological activity of pelagic bacteria in various regions of the North Atlantic and Baltic Sea. Special studies dealt with bacterial populations in the transgression zone between oxic and anoxic water masses. A new approach is the measurement of exoenzymatic activities in bacteria, by which they are able to break down high-molecular organic substances.

Within the framework of ICES, surveys for herring larvae were carried out in the Atlantic north of Scotland and in the English Channel. The distribution of sole larvae was surveyed in the eastern part of the North Sea. A special study was devoted to fish larvae and mackerel eggs in the offshore area west of the British Isles.

A detailed study on the interrelationship between fish fry and dominant zooplankton species is being carried out in the low-salinity Schlei Fjord in the western Kiel Bight.

Benthological investigations

For a better quantification of benthos abundance and community structure conversion factors for body length, weight and energy content were established for the Baltic Sea organisms by means of a literature survey and additional measurements.

The seasonal cycle in degradation of organic matter sedimenting to the bottom is being intensively studied by employing a great variety of methods, e.g. biochemical analyses, simulated in-situ community respiration and heat production measurements as well as the use of marker substances for measuring specific activities in bacterial

populations. Special emphasis is laid on the significance of short-term events such as a sudden sedimentation of a phytoplankton bloom for the energy supply to benthic communities.

An evaluation of the eutrophication status along the German coast line, in the North Sea and Western Baltic, cost much effort. The approach to this project which is supported by the Federal Government is multidisciplinary. It relies on an intensive literature study and on recent observations as well as on hydrographical and meteorological models in trying to understand cause-effect relationships and to differentiate between anthropogenic and climatological influences.

The contribution of sulfate reduction to oxygen consuming degradation processes was studied in anaerobic sediments in Kiel Fjord and in deep basins of the Baltic.

Another subject studied under various environmental conditions is the significance of bioturbation by burrowing organisms on sediment stratification and degradation processes. The study sites range from shallow sand flats of Kiel Bight to deep-sea areas in the Norwegian Sea.

The abundance, growth, population dynamics and physiological capacity of the sponge Halichondria panicea in relation to environmental factors is being studied in Kiel Bight with a comparative study at the North Sea coast.

Another project aims at the possibility of establishing a bioindicator for areas suffering from periodical oxygen deficiencies by an analysis of specific metabolites accumulated in the organisms during anoxic conditions.

A question still under debate is the nutrition of pogonophora. Symbiotic bacteria found in the newly described species Siboglinum poseidoni were successfully tested for their ability to oxidize methane which was also found in the sediment of the sampling site.

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 of organic enrichment and oxygen depletion on the benthos fauna is closely studied, especially by SCUBA diving. A macrobenthos monitoring programme over a 3 year-period in the inner part of the Fjord was finished, as well as a study on the distribution and ecology of Metridium senile and Mytilus edulis as well as on mussel banks and ascidians in general.

Current investigations deal with the situation of macrobenthos in the outer Fjord ("Breitgrund"), Fucus-communities along the gradient of organic enrichment, recolonization of the deeper parts with special reference to the opportunistic phase, and experimental recolonization in

shallow water under aerobic conditions. Another field and experimental study is focused on the response and resistance of selected macrobenthic species to low oxygen depletion.

Experimental work on the biology and behaviour of socially living Amphipoda as well as on the life cycle of Crangon with special emphasis on the larvae stages was continued.

In the German Wadden Sea, meiobenthic organisms are studied as indicator species for a classification of intertidal flats with differing sensitivity towards oil pollution.

Field experiments were carried out in order to demonstrate activity patterns of the two scavenging predators Carcinus maenas (Crustacea) and Anaitides maculata (Polychaeta) in an intertidal sand flat at Sylt/Germany. A further study on the effect of bioturbation on oxygen consumption and degradative processes in sandy sediments of the Wadden Sea is being started.

Investigations on the structure of littoral hard bottom communities are carried out on the Island of Helgoland.

Biologische Anstalt Helgoland

Routine measurements of hydrographical, chemical and biological parameters have been continued at Helgoland Roads (54°11,3'N 07°54,0'E). Five times a week, temperature, salinity, nutrients (PO_4 , NO_3 , NO_2 , NH_4 , SiO_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 micro-organisms were counted.

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

The long-term ecological studies on seasonal and spatial distribution of Noctiluca miliaris in the German Bight have been continued. Seasonal fluctuations and annual abundance of this dominant dinoflagellate have now continuously been recorded over a period of 16 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 at up to 5 depths on a grid of stations 12.5 nautical miles apart during three cruises with R.V. "Friedrich Heineke" from 14-18 May, 15-28 August and 23-28 October, 1984.

The ecological studies in the Northern Wadden Sea of Sylt (German Bight) were carried on. 73 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).

Forschungsinstitut Senckenberg, Institut für Meeresgeologie und Meeresbiologie, Wilhelmshaven

Biological research concentrates on benthic communities and their multiple relationships to naturally and anthropogenically influenced environmental conditions. A main subject is the fluctuations in occurrence and abundance and the dynamics in production and population structure. Special emphasis is laid on the close interrelationships between organisms and sediment structure.

Within this framework, standing stock analyses in various coastal zones were continued in 1984. Long-term analyses focus on periodical and aperiodical changes in species composition and abundance in relation to fluctuating environmental conditions.

Population dynamics were studied in selected species of the German coastal zone such as Cerastoderma edule, Pectinaria coreni and the newly immigrated Ensis directus. In connection with the holocene rise of the sea surface, subfossil stocks of molluscs were analyzed and interpreted as to their species composition.

Within the framework of environment-related research projects, a mapping of sensitivity of tidal flats towards oil pollution was initiated in a selected coastal section after having completed experimental studies on the effects of crude oil and crude oil/tensids mixtures. Studies on the effects of anthropogenic sewage on the ecosystem of the Jade Bay and bordering shallow water areas were continued.

Iceland

(T. Thórdardóttir and I. Hallgrímsson)

Phytoplankton (T. Thórdardóttir)

During a hydrobiological survey in May-June primary production and Chl a was monitored in coastal, as well as oceanic, waters around Iceland. In addition to the area traditionally monitored in previous May-June surveys (since 1958), investigations on phytoplankton and primary production were carried out in the boundary zone between Arctic and Atlantic waters north of the Faroes (between 5° and 10° E).

Zooplankton (I. Hallgrímsson)

As a part of a general environmental survey of Icelandic waters in spring, the long-term studies on the density and composition of zooplankton were continued. Similarly the distribution of zooplankton was investigated during an O-group survey in autumn.

Studies have been undertaken on the predation by cod on mysids in Icelandic subarctic waters, and a similar study on cod in the Atlantic water south and west of Iceland is in progress. Work also continues on the feeding of cod on euphausiids in Icelandic waters.

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)

NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ), TEXEL.

Studies in estuarine areas concentrated on the effect of heavy metals on the physiology of some benthic animals, notably the lugworm (*Arenicola marina*). In addition, studies on the population-dynamics and production of macro-benthic animals on the tidal flats continued. The observation was made that the total biomass of that fauna is gradually increasing in the area, possibly because of eutrofication. Studies on growth and mortality of o-group plaice were continued.

No work was carried out in the northern North Sea, but in the Southern Bight an attempt was made to analyse the factors responsible for the zooplankton-collapse occurring in that region in mid-summer. Indications were found that predation on nauplic of copepods by jelly-fishes and Nocticula may be mainly responsible.

Studies on the benthos in the area south and southeast of the Doggersbank continued. Biomass of the macrofauna appears to be high, in the order of 20 g ashfree dryweight m^{-2} . Special attention was paid to growth and mortality of the echinoderms Amphiura filiformis and Echinocardium cordatum.

Netherlands Institute for Fishery Investigations

Stomach Content Studies.

Intensive sampling of cod stomachs in a restricted area has been undertaken in 1984 in order to study diurnal variations in stomach contents. A total of 1200 individual stomachs have been collected and it is intended to use these data also to estimate the variance associated with individual differences in feeding.

A detailed analysis has been made of the predation on cod and plaice eggs by herring on the basis of all the stomachs collected during the February surveys 1980-1983. The revised estimates of egg predation mortalities exercised by the herring, which have been reported to the Council Meeting in 1984, indicate that in those years the herring stock has only had a marginal effect on the survival of cod and plaice eggs. Sampling of herring stomachs has been continued during the February survey in 1984 and ca. 1000 stomachs have been collected.

Phytoplankton studies

The phytoplankton monitoring in the Dutch coastal area has been continued in 1984 for the periode February-October.

The early spring bloom has been dominated by *Thalassiosira baltica* followed by *Chaetoceros* species. Dominance of *Phaeocystis ponchetii* has been observed principally in May. In this period development of some *Rhinosolenia* species were recorded as well. During July and August, the dinoflagellates *Prorocentrum minimum* and *Ceratium fusus* appeared to be the prominent species. The D.S.P. producing *Dinophysis acuminata* has only been scarcely observed during July.

Norway

(G. Berge)

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

1.1 Phytoplankton

1.1.1 The monitoring of primary production and standing stocks of phytoplankton of the coastal banks off western and northern Norway continued for the 9th and last year in a reduced form, covering the spring season two times at four sections across the Norwegian continental shelf. The results are being combined with the previous material in a study of the annual primary production and its fluctuations. The study constitutes a component of a biological baseline and monitoring study related to the oil exploitation programme on the shelf. The following parameters are included: primary production rates, chlorophyll a, hydrography, nutrients, and zooplankton. Chlorophyll a in vivo fluorescence was continuously recorded at the 5 m level (IMR).

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

1.1.3 The study of the phytoplankton and its primary production in the Barents Sea was in 1984 continued with two cruises, one in spring and another in late summer. In the phytoplankton field work, emphasis was put on determining light-photosynthesis relationships for natural phytoplankton populations and the vertical distribution of biomass. This study is a part of an interdisciplinary program designed to investigate the biological production processes in this important fishing area (IMR) and it is also integrated in the Norwegian Research Program for Marine Arctic Ecology (PROMARE).

1.1.4 Nitrate, orthophosphate, chlorophyll a and fixed samples of phytoplankton are analysed monthly from stations along the hydrographical section Torungen - Hirtshals in Skagerrak (BSF).

1.1.5 The distribution of the toxic algae Gyrodinium aureolum in the Skagerrak and along the Norwegian coast has been monitored.

1.1.6 The ecology of Gyrodinium aureolum has been studied, both in the field and in large plastic bag experiments.

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

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

1.2 Zooplankton

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

1.2.2 A programme designed to develop new instruments for acoustic estimation of zooplankton biomass and species continued in 1984. Acoustic observations of zooplankton organisms by means of multiple-frequency sonar systems were compared to observations with conventional gears (Juday nets, Gulf III, and Tucker nets (IMR).

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

1.2.4 An interdisciplinary programme designed to investigate the survival of and feeding in cod larvae was started in 1975 and continued in 1983, with special emphasis on the feeding of larvae in relation to the distribution of food organisms. An in situ particle counter Moccus 1 m² and a plankton pump were used in the study of small scale distribution of cod larvae and zooplankton organisms (IMR).

1.3 Ichthyoplankton

1.3.1 Investigations on the distribution of herring larvae in order to localize the main spawning grounds along the coast continued. Eggs and larvae of other species are also recorded. Two cruises were performed in 1983.

1.3.2 Postlarvae surveys which started off in 1977 were continued. The aim is to establish an index for the abundance of different species, with particular emphasis on cod, in 1983.

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 Arcto-Norwegian cod eggs and larvae continued in the Lofoten area, with emphasis on the spawning of cod, and the distribution and survival of eggs and larvae (see 1.2.4). In 1983 a few egg surveys were conducted during the spawning season covering the total spawning area in Lofoten 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 in 1983. The eggs and larvae investigations were also continued.

- 1.3.6 Investigations on the distribution and abundance of capelin larvae continued in 1983 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 in the western part of Norway (BSF).

2. University of Bergen

Department of Marine Biology

- 2.1 Feeding, growth and reproduction of benthic invertebrates (Vahl 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 ciliate (Dale).
- 2.6 Overwintering strategies of marine phytoplankton (Erga, Syvertsen).
- 2.7 Ecosystem studies in the land locked fjord system Lindåspollene have continued, including studies on vertical distribution of zooplankton and experiments on effects of artificial upwelling (Lie, Aksnes, and Magnesen).
- 2.8 A project on the advection of plankton between coastal and fjord waters has been terminated (Matthews, Heimdal, and collaborators).
- 2.9 Studies on sedimentation of organic material in west-Norwegian fjords have been terminated (Wassmann).

3. Norwegian Institute for Water Research NIVA, Oslo.

3.1 Phytoplankton

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

3.2 Benthic communities

Registration of shore and shallow water communities by diving is routinely applied in recipient studies. The lower limit of benthic algal growth was used to characterize the mean light conditions. Structure of soft bottom fauna was studied at several localities under the State Pollution Monitoring Programme. Stereophotography at fixed sites down to 30 m has also been applied.

A model for pollution impact on soft bottom fauna has been developed on the basis of diversity curves from about 150 fjord stations.

4. University of Oslo

Department of Marine Biology and Limnology

4.1 Phytoplankton

- 4.1.1 Ultraplankton flagellates (J. Throndsen).
- 4.1.2 Carotenoids in marine plankton algae (T. Bjørnland).
- 4.1.3 Nitrogen turnover in coastal waters: ^{15}N investigations (E. Paasche, S. Kristiansen).
- 4.1.4 Nitrogen turnover in arctic waters (PROMARE F. Kristiansen).

4.2 Zooplankton

- 4.2.1 Behaviour of Meganictiphanes norvegica (Y. Attramadal).
- 4.2.2 Filter feeding of the mysid Praunus flexuosus (Y. Attramadal).

4.3 Phytobenthos

Investigations were continued in the following areas:

- 4.3.1 Experimental studies on taxonomy, life histories, and environmental control of growth and reproduction in red algae (J. Rueness).
- 4.3.2 Autecological studies of algae in the Oslofjord (J. Rueness).

4.4 Zoobenthos

- 4.4.1 Work was continued on classification and dynamics of benthic animal communities in Oslofjord (Gray, Valderhaug, and students).

- 4.4.2 Studies on reproduction biology, population strategy, energy budget, and production of various polychaetes were continued (Gray and collaborators).
- 4.4.3 C, N, and P budgets were investigated for selected sediment-living species (Valderhaug, Gray).
- 4.4.4 At a coastal experimental station, belonging to the Norwegian Institute for Water Research, large indoor tanks were arranged to contain subtidal soft bottom communities under semi-natural conditions. The aim is to study biological and chemical responses to arrival of organic particles at the sediment/water interface (Gray, Berge Schaanning).
- 4.4.5 Experimental studies of population genetic variation in Mytilus edulis in oil contaminated water (S. Fevolden).

5. University of Tromsø.

Tromsø Museum

5.1 Zoobenthos

- 5.1.1 Monitoring of hard-bottom fauna, Northern Norway (B. Gulliksen)
- 5.1.2 Mapping of hard-bottom communities around the coasts of Spitsbergen and Bjørnøya (B. Gulliksen).
- 5.1.3 Under ice fauna studies near Spitsbergen (B. Gulliksen).

5.2 Fish

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

5.3 Birds

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

Institute of Biology and Geology.

5.4 Phytoplankton

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

5.5 Zooplankton

5.5.1 Ecological Investigations of the Zooplankton Community of Balsfjorden have concentrated on finding a biostatistical model for quantifying condition (based on changes in proximate biochemical content) of copepods and krill with respect to overwintering and reproductive demands (Hopkins, Grønvik, Tande and collaborators).

Work has continued on developing a physiological model describing food assimilation, respiration, and production in the species complex Calanus finmarchicus, C. glacialis and C. hyperboreus in the Barents Sea (Tande and collaborators).

Research has been initiated to compare and contrast phytoplankton and zooplankton community structure in the fjords along West Spitsbergen. The species assemblages in the East Greenland current, Atlantic flow water, South Cape Spitsbergen current (polar water) and west Spitsbergen fjords are being classified using principal component analysis (Hopkins and collaborators).

5.6 Phycobenthos

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

5.7 Zoobenthos

5.7.1 Studies of the population dynamics, ecological energetics and production of the deep-water prawn (Pandalus borealis) in Balsfjorden, selected north Norwegian fjords, the Barents Sea, and West Spitsbergen (Hopkins, Nielsen and collaborators).

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

5.7.3 Population dynamics of Macoma calcaria (E. Oug, 1 student).

5.7.4 Intertidal distribution and zonation (E. Oug).

5.7.5 Systematics and zoogeography of the Terebellomorpha (Polychaeta) (T. Holthe).

5.7.6 Investigations on the deep sea fauna of the Norwegian Sea (T. Holthe).

5.7.7 Zoogeography of the echinoderms of North Norway (T. Holthe, 1 student).

5.7.8 Growth of Modiolus modiolus (T. Holthe, 1 student).

5.7.9 Systematics of Oweniidae (T. Holthe, 1 student).

- 5.7.10 Reproduction and larval development of echinoderms, particularly star-fishes (I.-B. Falk-Petersen).
- 5.7.11 Ecology of Strongylocentrotus droebachiensis and S. pallidus in the Troms and Svalbard region (S. Lønning Vader, I.-B. Falk-Petersen, W. Vader).
- 5.7.12 Effects of aromatic hydrocarbons on sea urchin embryos (S. Lønning Vader, I.-B. Falk-Petersen).

5.8-----Fish

- 5.8.1 Fertilization and early development of marine fishes (cod, flatfishes, lumpsucker) are studied by morphological, physiological and genetical methods (S. Lønning Vader, E. Kjørsvik, A. Stene).
- 5.8.2 Effects of hydrocarbons on fish embryos and larvae (S. Lønning Vader, I.-B. Falk-Petersen, E. Kjørsvik, A. Stene).
- 5.8.3 Interactive segregation between small pelagic fishes in a fjord system (S. Grønvik, A. Klemetsen).
- 5.8.4 Studies involving quantification of somatic and gonad growth on the capelin (Mallotus villosus) in Balsfjorden. Seasonal deposition of otolith zones is being analyzed within the framework of an energetics model (Hopkins and collaborators).
- 5.8.5 Some aspects of the biology of polar cod (Boreogadus saida) (E. Oug, 1 student).

6 University of Trondheim

6.1-----Phytoplankton

- 6.1.1 Photoadaptation in arctic phytoplankton (E. Sakshaug, E. Nøst Hegseth).
- 6.1.2 Metabolism of 3-1,3 glucans in diatoms (S. Myklestad, K. Waarum).
- 6.1.3 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).
- 6.1.4 Effects on growth rates and chemical composition of dinoflagellates when adapting to different light intensities and photoperiods (K. Tangen).

6.1.5 Taxonomy and morphology of two species in the "Gonyaulax tamarensis complex" (K. Tangen).

6.1.6 Occurrence of potentially toxic algae in relation to fish diseases and mussel poisoning (K. Tangen).

6.1.7 Endogenous rhythms in marine diatoms (K. Østgaard).

6.2-----Zooplankton

6.2.1 Routine sampling of zooplankton once a month by Nansen 75/180 μ m net continued at three oceanographic stations in Trondheimsfjorden (J.-A. Snelli).

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 deepwater molluscs (J.-A. Snelli).

6.4.2 Taxonomy and zoogeography of archaeogastropods in Scandinavian and arctic waters (J.-A. Snelli).

6.4.3 Investigation on the bottom fauna of Vistenfjorden in Nordland county (J.-A. Snelli, T. Strømngren).

6.4.4 Investigations on the bottom fauna assumed to be affected by the activity of a paper pulp factory in the inner Trondheimsfjord (J.-A. Snelli, Ø. Stokland).

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 Carbon and nitrogen expenditure in eggs and larvae of plaice (Pleuronectes platessa) (L. Jørgensen).

6.5.3 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).

6.5.4 Population genetic studies in a wide range of fish species with special emphasis on gadoids (J. Mork, G. Sundnes).

POLAND

(K. Siudzinski)

Sea Fisheries Institute, Gdynia

Baltic

In the frames of long-term monitoring programme in Polish Fisheries Management Zone 8 cruises at permanent stations were conducted. Phytoplankton, primary production, Chlorophyll a, mesozooplankton biomass, ichthyoplankton and macrobenthos were sampled. During the cruises of soviet RV Akademik Kurczatov in July, primary production was measured in the Baltic Proper. Round-the-year investigation of microzooplankton in the Gdansk Bay was conducted. Incubation and hatching of herring larvae were studied experimentally. Determination of mercury, zinc, copper, lead and cadmium in plankton, fish, sediments and sea water have been performed.

Atlantic

Composition and abundance of macroplankton and ichthyoplankton in the north-western Atlantic /between Portugal and Azores/ were studied onboard RV Profesor Siedlecki in July-October.

Antarctic

In the frames of BIOMASS-SIBEX programme krill, macroplankton, euphausiid larvae and plankton size structure were investigated in southern Drake Passage, and Bransfield Strait in December 83-January 84.

Gdansk University

Department of Plant Physiology

Gibberellin-like substances in the cultivation medium of *Chlorella vulgaris*.

In some previous works gibberellin-like substances, being well known growth regulators in higher plants, were found in the green alga *Chlorella vulgaris*.

The presence of gibberellin-like activities was also observed in the cultivation medium of this alga. On the basis of further experiments it became evident that these activities were the result of exudation of some endogenous gibberellins into the surrounding medium by the algal cells.

In the year 1984 some experiments concerning isolation and some physiological characteristic of the active substances present in the cultivation medium of *Chlorella* were performed. Adsorption of gibberellin-like substances on Amberlite XAD-4, iron exchange and thin layer chromatographic methods were used. Simultaneously typical bioassays were also applied for gibberellins estimation.

Taking into account the obtained results, the possibility of gibberellins isolation from a large volume of a liquid medium using XAD-4 resin can be recommended. With the described chromatographic methods it was possible to detect the presence of gibberellic acid /GA₃/ and also some other non-identified gibberellin-like substances in the cultivation medium of *Chlorella*. It was also stated, that the gibberellin-like substances isolated from the cultivation medium of *Chlorella* showed a significant growth promoting effect when applied to the same species of alga. So it can be assumed that gibberellin-like substances exuded by the algal cells into the cultivation medium may exert a secondary effect on the growth of these algae, whereby the influence on other species of algae can also be not excluded.

The effect of fuel oil pollution on *Scenedesmus quadricauda* /Turp./Breb.

The experiment in the year 1984 attempts to assess the effect of one of the anthropogenic factors which pollute the marine environment, namely, L-2 type fuel oil, on the growth and morphology of the cells of the green alga *Scenedesmus quadricauda*.

It was found that in the presence of a water extract of the fuel oil, the growth intensity of the population of *Scenedesmus quadricauda* was markedly retarded. This was expressed in a considerable decrease in the cell number of algae. The extent of growth inhibition depended on the concentration of oil and was the strongest in the presence of a non-diluted, 100% extract obtained from 50 cm³ of oil in 1 cm³ of the cultivation medium. Besides modifying growth the oil pollution induced some changes in the morphology of the cell population. The oil extract favoured the formation of unicellular organisms, whereas two-celled cenobia prevailed in the control. Increase in size or an alteration of the cell shape was also observed. Modification in configuration of the four-celled cenobia from linear form to tetrahedral and the formation of giant cells was noted.

The presented results, supported by some literature data, indicate that certain oil pollutants can act as morphogenetic agents.

Department of Vertebrate Ecology and Zoology

Our department prosecuted several years studies of the number, dynamics, migration, and wintering of waterfowl in the Gulf of Gdansk. Observed changes may be related to the pollution of the gulf. The Anseriformes observations from ship are in progress. Our scientists have engaged in gull's catching and ringing for ten years. We carried out an analysis of diving ducks food wintering on the Gulf of Gdansk.

Besides we continue observations concerning the possible effects of a new Gdansk port /North Port/ built on the open seas in the wintering area of waterfowl.

Other investigations dealt with polar studies in Spitsbergen on the role of some sea birds in relation to energy flow between marine and land environments.

Institute of Oceanography

Changes in sea shore biocenosis zone in the Gulf of Gdansk.

Biological Station at Górkı Wschodnie

Ecophysiological processes /respiration, production, assimilation, filtration/ of some Baltic Crustacea and Mollusca.

Academy of Agriculture, Szczecin

Institute of Fisheries Oceanography and Protection of Sea

The scope of research carried out at the Institute in 1984 covered marine biology and ichthyology. Marine biology projects concerned mainly studies of meiofauna and mesozooplankton of the Baltic Sea and the Szczecin Lagoon.

Ichthyological research concerned problems of biology of some fish species belonging to the families Chaenichthyidae and Nototheniidae and to the genera Trachurus and Scomber, all from the Atlantic Ocean. Also Baltic Sea flatfish were studied.

Institute of Ichthyology, Fish Biology Department

In 1984, the long-term project started in 1977 on feeding of cod, herring, and sprat in the Southern Baltic was continued. The study is aimed at determining the amount and composition of food consumed annually by populations of the species listed, and at detecting trophic relationships among them. A particular attention is paid to cod predation effects on sprat and herring populations. Samples collected in 1984 are being examined.

In 1984, three papers based on the long-term studies were submitted for publication. Two of them concern methodology of fish feeding studies; the third one deals with trophic relationships between sprat and herring.

Department of Sanitary Hydrobiology of Agriculture Academy in Olsztyn

Studies were conducted on bottom fauna and zooplankton biomass of the Vistula Lagoon.

Research Institute on Environment Development, Gdansk Branch

The Institute was engaged, as in previous years, in the organization and coordination of the Baltic Sea monitoring programme. Joint investigations were carried out for this branch by the Sea Fisheries Institute /heavy metals and primary production/, the Institute of Meteorology and Water Management in Gdynia /chemistry of water/, and the Agricultural Academy in Szczecin /Baltic zooplankton/.

Institute of Ecology of Polish Academy of Science, Warszawa

In cooperation with Sea Fisheries Institute in Gdynia onboard of RV Profesor Siedlecki 20 scientists have taken part in international SIBEX-BIOMASS Programme 10 December 1983 to 8 January 1984. Research was carried out in Bransfield Strait east of Anvers Island to 54° /Sector A/ and in Drake Passage along the northern side of South Shetland Island /Sector B/. Work began on 21 December 1983 west of Elephant Island /station 51/. On 26 December, work was continued in Sector A east of Anvers Island and ended on 3 January 1984 with a transect along 54°S. From 4-7 January 1984 investigations were done on the only krill swarm found during the cruise in the area of Elephant Island.

In addition to completing all obligatory transects, two nonobligatory transects were done, as well as a number of stations not included in the BIOMASS-SIBEX program /such as stations 147, 148, 149, 164/. During the fisheries survey performed in the first part of the cruise, additional investigations were carried out on 23 biology and oceanographic stations. The most interesting locations were on the shelf around the South Orkney Islands. Altogether, 218 stations were completed during the entire cruise.

Studies were conducted on temperature and salinity distribution, chlorophyll content, composition and distribution of bacteria, phytoplankton, zooplankton, fish and birds in the Antarctic /Atlantic sector/.

Portugal

(T. 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 new proteins (SCP) for food and feed in 2000-6000 litre raceway pounds (M.A.M. Sampaio and M.F.G. Martins).

Studies on some physiological aspects of microalgae, a biotechnological approach (M.A.M. Sampaio and M.T. Meneses).

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

Experimental studies on the encystment and excystment of the dinoflagellate Amphidinium carterae (M.A.M. Sampaio).

Study of pigments in material caught by the N.E. "Noruega" in the Portuguese coast during 1981 (M.G. Vilarinho).

Studies on the temporal distribution of zooplankton at Cascais Bay (March to August 1983, 1984) (M.E. Cunha and C. Massapina).

Studies on respiration, excretion and grazing by zooplankton at Cascais Bay (March to August 1984) (M.E. Cunha and C. Massapina).

Upkeep of the zooplankton culture stocks (copepods, cladocerans, branchiopods, and rotifers) (M.H. Vilela et al.).

Development of 5- and 12-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.).

Production of Brachionus plicatilis in 500-litre cylindric tanks in the open air, with Nannochloris sp. and Saccharomyces cerevisiae for aquaculture support and animal protein production (M.H. Vilela; A. F. Lupi).

Production experiments with the harpacticoid Tigriopus brevicornis using various feeding regimes (M.H. Vilela).

Growing experiments in laboratory conditions with a Portuguese Artemia strain fed on dried microalgae (Chlorella sp. and Scenedesmus sp.) produced in INIP (M.H. Vilela and M.A. Castelo Branco).

Portuguese *Artemia* cysts harvest and all the inherent processing for the purpose of their characterization (M.H. Vilela and M.A. Castelo Branco).

Production experiments with the cladoceran *Daphnia magna* fed on freshwater microalgae and rice-bran (M.H. Vilela and M.C. Silva).

Phytoplankton and zooplankton studies on Cascais Bay, an area favorable to red water events (M.A.M. Sampayo and M.T. Moita, M.E. Cunha, C. Massapina, A. Morais, A. Carreira, and R. Fernandes).

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

Training program on the role of the zooplankton in the upwelling ecosystem at Point Conception-Point Arguello area, California (M.E. Cunha).

Study of phyto- and ichthyoplankton related with spawning and breeding areas between Cape Espichel and Vila Real de Santo António of the most important commercial fishes (P. Lopes, M.H. Afonso, A. Farinha, I. Meneses, A.M. Costa, M.F. Quintela, M.T. Rodrigues, F. Varela, and F. Sousa).

LABORATORIO NACIONAL DE ENGENHARIA E TECNOLOGIA INDUSTRIAL (LNETI) -
SACAVEM

- Prediction and estimation of ecological impacts due to human activities on coastal systems (coordinated by M.C. Peneda).

INSTITUTO HIDROGRÁFICO - LISBOA

- Quantitative and qualitative analysis of the plankton in the area Figueira de Foz - Peniche, integrated in upwelling studies (M.C. Noronha).
- Studies of plankton seasonal fluctuation in Rias de Aveiro, Formosa e Tajus River (M.L. Shirley).

Spain

(E. López-Jamar)

A) PHYTOPLANKTON

1) Instituto Español de Oceanografía, La Coruña and Vigo Laboratories:

In June and September 1984, two oceanographic cruises were carried out in the Galician Continental Shelf, within the new Spain-USA five-year cooperative program "Oceanography of the Galicia Coast (NW Spain) in relation to demersal and pelagic fisheries. Research on phytoplankton was addressed to the following points:

- Estimation of production of the area and comparison with other upwelling areas.
- To establish differences of production between upwelling and non-upwelling conditions.
- To determine relative contribution to biomass and production of nanoplankton and netplankton fractions.
- Study of excretion rates of phytoplankton.

Production is high in areas affected by upwelling, and the netplankton fraction largely dominates. However, in non-affected upwelling areas, production is low and nanoplankton dominates. Excretion accounts for a high percentage of total primary production.

2) Instituto de Investigaciones Pesqueras de Vigo:

The effect of industrial wastes on phytoplankton communities of Ria de Pontevedra is being studied.

B) ZOOPLANKTON

1) Instituto Español de Oceanografía, La Coruña Laboratory:

Zooplankton communities and production in the Galician shelf are being investigated. At the present, two oceanographic cruises, within the new USA-Spain five-year cooperative program were carried out. Biomass, community composition, and ingestion rates of macrozooplankton, and composition and biomass of microzooplankton were studied.

C) ICHTHYOPLANKTON

1) Instituto de Investigaciones Pesqueras de Vigo:

Study of ichthyoplankton in the Ria de Vigo, started in 1983, was continued during 1984. Data obtained are being processed.

D) BENTHOS

1) Instituto Español de Oceanografía, La Coruña Laboratory:

- Population dynamics of the bivalves Thyasira flexuosa, Tellina fabula and the polychaete Paradoneis armata are being studied in La Coruña Bay.

- Long term variations of a Tellina fabula community and a Thyasira flexuosa facies are being investigated in La Coruña Bay.

- The spatial distribution of the macroinfauna of the northern Galician continental shelf has been completed. A reduced Amphipura filiformis community is the major assemblage in this area.

- Macroinfauna studies are being undertaken in the Galician shelf in relation to upwelling processes and to organic enrichment coming from the Rías Bajas of Galicia.

- Species composition, abundance, and diversity of the megabenthos of the Galician continental shelf in relation to demersal fisheries are being studied. The distribution of the decapod Polydora henslowii and the factors causing the swarms occurrence are also being investigated.

2) Instituto de Investigaciones Pesqueras, Vigo Laboratory:

- The effect of industrial wastes on intertidal sedimentary areas has been studied. The factors investigated were: meiobenthic composition, abundance, biomass, and diversity; environmental factors: T, S ‰, pH, Eh, organic matter, and grain-size; and liposoluble photosynthetic pigments. These variables have been controlled every month during 1984.

- The effect of commercial extraction of bivalves in the stratigraphy of vertical gradients of sediments.

3) Sociedad Cultural de Investigación Submarina, San Sebastián:

- Quantitative studies on intertidal and subtidal macrophytobenthos of several embayments along the Bask Coast (East Cantabric Sea) are being carried out.

- Infauna studies of the Oria, Urola, and Urumea estuaries are being continued.

- Ecology and systematics of amphipods, mollusca, coelenterates, polychaetes, harpacticoid copepods in the Bask Coast, as well as the ecology and systematics of the genus Patella are being studied.

- Investigations on heavy metal pollution and benthic organisms are being carried out.

- Investigations and systematics of sponges, bryozoans, echinoderms, are being studied as well as pigment in macrophytobenthos.

4) Centro Experimental de Villajuan, Villagarcía de Arosa, La Coruña:

The three-year program "Management of Marine Resources," was elaborated in order to get a rational exploitation of bivalve natural banks. In a first step, production of different areas of the Rías Bajas will be studied. Cerastoderma edule and Venerupis pullastra were the species selected for study since they represent the major contributors to total catching of bivalve molluscs.

Sweden

(R. Rosenberg)

INSTITUTE OF MARINE RESEARCH, LYSEKIL (R. Rosenberg)

In cooperation with other research projects financed by Swedish Environment Protection Board concerning Eutrophication in the Marine Environment the following are conducted at the Institute of Marine Research, (Contact person: Rutger Rosenberg).

1. The effects of organic enrichment and periodic oxygen deficiency on benthic infaunal production and recruitment success.
2. The role of benthic suspension feeders in reducing phytoplankton biomass and regenerating nutrients.
3. Large scale eutrophication effects are investigated by resampling the benthic stations studied and carefully reported by Petersen in 1911/12 in the Kattegat and Skagerrak.
4. Effects by eutrophication on the function of an area as a traditionally important nursery area for especially flat fish, mainly plaice.
5. Effects by eutrophication on *Nephrops norvegicus*: Population structure, physiological parameters and catch per unit effort.

The research group is also in the process of finalizing reports from a previous project "Benthic faunal energy flow and biological interaction in some shallow soft bottom habitats." Some of the results from that project are oriented towards coastal zone management.

DEPARTMENT OF MARINE BOTANY, UNIVERSITY OF GOTHENBURG (I. Wallentinus)

The ecological investigations carried out can be characterized as belonging to three main research areas:

- A) The rôle of the benthic algae in the marine ecosystem
 - B) Life strategies of marine macroalgae
 - C) Geographical distribution of benthic algae (incl. algal taxonomy)
- A) These projects aim at estimating: a) Productivity and nutrient uptake rates, as well as nutrient storages in marine macroalgae, with special emphasis on nutrient availability (both from benthic fauna and in pollution gradients). b) The rôle of recolonization and successional patterns on rocky benthic communities for the total productivity and respiration of the community. c) Competition and predation as biologically regulating mechanisms for macroalgae.

- 1) Variations in macroalgal occurrences in marine rocky benthic communities on the Swedish west coast - A causal analysis. This project is sponsored by the National Swedish Environment Protection Board, and carried out in cooperation between L. Axelsson, Kristineberg's Marine Biological Station and a Ph.D. student in marine botany (C. Larsson). It started in 1984 and includes laboratory investigations on competition for nutrients and carbon between filamentous macroalgae and fucooids under various stress conditions, as well as field experiments analyzing recolonization patterns and transplanted experiments for the seaweed Halidrys siliquosa.
- 2) Most limiting nutrients for macroalgae in the eutrophicated bay of Himmerfjärden, northern Baltic proper (I. Wallentinus) is a project within the National Swedish Environment Protection Board's larger project "Eutrophication in the marine environment." The four-year study, carried out at the Askö Laboratory, started in 1984. It is run in cooperation with the other projects in Himmerfjärden, studying the effects of a full scale experiment with different loads of phosphorus and nitrogen in an eutrophication gradient. The impact on macroalgae, both as chemical constituents, metabolic activities, species composition and macroalgal distribution is followed.
- 3) The project The rôle of the phytal system for the total Baltic ecosystem, in which I. Wallentinus is also engaged, has been run at the Askö Laboratory, Univ. of Stockholm for the past five years sponsored by the Swedish Natural Science Research Council. The field experiments, analyzing ecological properties such as ratios of productivity and respiration in rocky benthic communities and their nutrient turnover during development of succession, are now finished. Manuscripts are under preparation, and one paper will be presented at the 9th Baltic Marine Biologists Symposium in 1985.
- B) These studies aim at testing different theories of life strategies among marine macroalgae and the applicability of form-functional group models.
- 1) A study of Life history tactics of marine macroalgae with special emphasis on the natural selection and evolution of the reproductive effort is carried out as a Ph.D programme (P. Åberg). It started with a pilot study in 1984 and will continue for four years.
- 2) The project The rôle of the phytal system for the total Baltic ecosystem mentioned in A 3, has also included studies of the significance of annual versus perennial strategies among Baltic macroalgae (I. Wallentinus). Two papers on this issue have been published in 1984, and an abstract is submitted to the 20th EMBS in 1985.
- 3) The planned and accepted project Competition and coexistence among macroalgae in the Baltic Sea (I. Wallentinus) could not be materialized because of the contract holder's new position at the Univ. of Gothenburg. A similar project, including instead

macroalgae from the Swedish west coast, which belong to the same form-functional groups but have different survival strategies, has now been proposed to the Swedish Natural Science Research Council.

- C) The biogeographical investigations analyze the marine vegetation in several areas within and outside Sweden. Many of them also include taxonomic studies of benthic micro- and macroalgae.
- 1) Results from the investigation Long-term variations of macroalgae in the southern part of the Laholms Bay, Swedish west coast (I. Wennberg) are now being compiled within the National Swedish Environment Protection Board's larger project "Eutrophication in the marine environment". Species composition and semiquantitative data on macroalgal distribution in the study area are summarized for a 30-year period, which will be presented during 1985.
- 2) Benthic micro- and macroalgae in the estuary of the River Nordre Älv, province of Bohuslän, Sweden, carried out as a Ph.D programme (M. Kuylenstierna), will be concluded next year and presented as a monograph. It includes algal distribution patterns, accomplished by diving, and detailed taxonomic studies of both macro- and microalgae (the latter mainly benthic diatoms).
- 3) A regional survey of the marine vegetation in the Göteborg archipelago area, Swedish west coast. Results from the 3-year field study (L-H. Jenneborg & M. Kuylenstierna), using diving and underwater video recording, are now being compiled (in Swedish).
- 4) A survey of the marine macroalgal distribution outside the town of Varberg, Swedish west coast. Descriptions and analysis of the results from a diving investigation in summer 1983 (J. Karlsson) has now been presented (in Swedish).
- 5) Results from a study of The marine macroalgal flora of Spitsbergen, Norway (L-H. Jenneborg) are in preparation and will be presented as a monograph within two years.
- 6) Marine vegetation in the North Aegean Sea, Greece is a Ph.D programme which started in 1981. It combines results from regional diving surveys with taxonomic studies of especially the red algal group Antithamnioidae. Several macroalgae new to the area and to Greece have been recorded, two papers are now accepted for publication (in addition to an earlier published one) and a major manuscript will be concluded next year.

Research projects at the department, dealing only with algal taxonomy are not included in this summary.

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Head of department: Prof. Inger Wallentinus

DEPARTMENT OF MARINE MICROBIOLOGY, UNIVERSITY OF GOTHENBURG

The research in the department falls largely, but not exclusively, into four research areas.

A) Studies on the survival and adhesion mechanisms of bacteria:

Starvation survival mechanisms of bacteria.
Mechanisms for bacterial adhesion at inanimate surfaces.
Bacterial activity at inanimate surfaces.
Specific bacterial adhesion in the gastrointestinal tract.
Microbial corrosion.

B) Molecular biology of osmoregulation in microorganisms: (yeasts):

Physiology of osmotolerant yeasts.
Enzyme regulation in osmoregulatory pathways.
Gene regulation in osmoregulatory pathways.

C) Studies on the fluxes of nitrogen, oxygen, and carbon in marine systems:

Denitrification and nitrification in sediments and the water column.
Nitrogen metabolism in relation to eutrophication of Laholm Bay.
Assimilation of the various forms of nitrogen by marine phytoplankton.
Photosynthesis and respiration of oceanic plankton.
Structure of planktonic microbial communities.
Flux of the biogenous gases oxygen and carbon dioxide in oceanic water.

D) Studies of Biofilms:

Impact of iron bacteria with ground water heat pumps.
Test system for the study of bacterial biofilms in drinking water systems.
Development of thermal and optic sensors for detection and analysis of biofilms.
Studies of bacteria in industrial cutting fluids with emphasis on wall developing organisms.
Mechanisms for build-up of biofilms from adhered bacteria.

DEPARTMENT OF ZOOECOLOGY, UNIVERSITY OF LUND

During 1984 we have terminated and reported a project concerning productivity in shallow coastal areas in southern Sweden.

The main line in our research deals with structure and dynamics of zoobenthic communities. In one project, started in 1984, we are studying effects of predatory fishes on macrozoobenthos. Our intention is to use large exclusion and inclusion cages to test a hypothesis on causes of long-term changes in zoobenthic abundance and biomass in the Baltic. The project will continue, hopefully, for three years.

We have studied effects of predation of waders during the breeding season on shallow zoobenthic species by exclusion cages. The only effect measured was a decrease in abundance of the amphipod Corophium volutator inside the cages. The possible influence of cage artifacts will be studied in 1985.

One dissertation project deals with life-history tactics in two populations of the lamellibranch Macoma baltica. It will probably be going on for another two years. It has been shown that growth is density dependent in muddy but not in sandy bottoms. This is thought to be due to the possibility of using both suspension and deposit feeding in Macoma baltica.

DEPARTMENT OF MARINE BOTANY, UNIVERSITY OF LUND (Lars Hälsén)

The following activities are taking place:

PROJECT	AIM	PERIOD
Phytoplankton dynamics in Laholm Bay (Edler)	Study phytoplankton influence on eutrophication and anoxia in Laholm Bay	84-87
Phytoplankton stimulating compounds in Laholm Bay and adjacent areas (Granélic)	Study what nutrients or other substances stimulate or limit production in Laholm Bay	84-87
Function and structure of benthic microalgae along a eutrophication gradient on the Swedish west coast (Sundbäck)	Study size of microbenthic algal biomass and production. Investigate nutrients and light as limiting factors	84-87

UNITED KINGDOM

1. England and Wales
(J. D. Riley)

A. Ministry of Agriculture, Fisheries and Food, Lowestoft

1. Sampling plaice eggs in the southern North Sea continued to be a major input to a study of the distribution and behaviour of plaice on their spawning grounds. Using a high speed sampler, a spawning area was localised and the progression of spawning monitored over a fifteen day period. A twenty-four hour series of plankton samples was taken in the centre of an egg patch which, together with more precise data on rate of development, demonstrated a diurnal periodicity of spawning.

2. A total of approximately forty days was spent participating in the ICES co-ordinated sole egg surveys of the North Sea from April to June. The production of eggs by stage for the whole data set has been calculated at Lowestoft and seasonal production curves will be produced before the sole egg working group meets.

3. One twenty-eight day cruise was made in collaboration with IMER, to the western Irish Sea in May/June to begin a study of the ecology of the frontal system in that area, and its relevance to fish recruitment. The horizontal and vertical distribution of Nephrops larvae and fish larvae were examined in relation to the front, with particular emphasis on its effect on larvae movements. Nutrient and particle profiles were also taken over the area and a 38 kHz transducer was used to examine plankton layering.

4. The ICES co-ordinated herring larvae surveys south of 62°N were completed in areas IVC and VIID in January and in IVB during October. As part of the October surveys additional samples were taken to study larval drift, mortality, growth and feeding in this area. An 'Argos satellite' tracked buoy was successfully launched in a patch of 10 mm herring larvae off Whitby and tracked for ten days before it eventually grounded 35 nm SSE of its launching position. The device proved useful in helping to maintain contact with the larval patch, and was not noticeably influenced by wind-induced surface movement. Preliminary results from the larval patch tracked indicate a mortality of approximately 3.5% per day and a growth rate of approximately 0.2 mm per day during the twelve days of tracing.

Selected samples of herring larvae were taken on all the larval surveys and on the ICES Young Fish Survey in February. These are being used in an intensive field study of otolith ring deposition and its relationship to daily age from hatching.

B. Institute for Marine Environmental Research, Plymouth

1. Continuous Plankton Recorder Survey

Continuous Plankton Recorders were towed at monthly intervals when possible on the routes shown in Figure 1. Recorders were towed

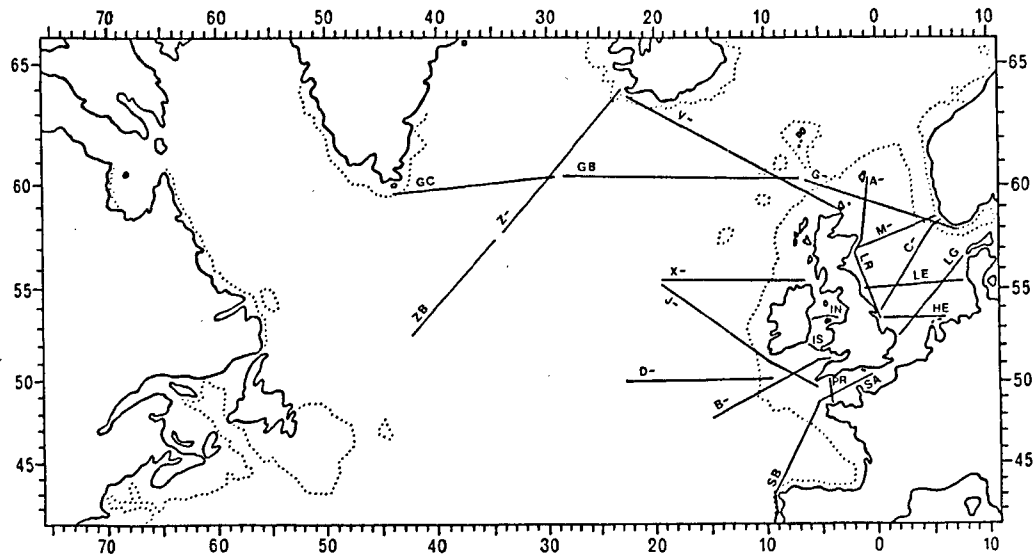


Figure 1

The Continuous Plankton Recorder Survey 1984

70,000 miles in 1984. Further details of the survey are given in Edinburgh Oceanographic Laboratory 1973 Bulletins of Marine Ecology, 7, 1-174 and Colebrook J. M 1975, Bulletins of Marine Ecology, 8, 123-142

Temperature records were obtained on the PR, M, LR and IN routes.

2. Research Cruise

RRS Frederick Russel, 19 May to 12 June 1984

- (a) to study the feeding characteristics of mackerel larvae and to relate their vertical distribution to food availability in the Celtic Sea
- (b) to determine rates of primary and secondary production and relate them to the production and flux of organic matter by various components of the pelagic ecosystem.

3. Undulating Oceanographic Recorder (UOR)

- 3.1 During the spring of 1984 a UOR Mark 2 (Aiken, J., 1981 Journal of Plankton Research, 3, 551-560) was equipped with two chlorophyll sensors, 8/9 light sensors for the measurement of ocean colour, chlorophyll concentration and the estimation of primary production. The UOR tows on 11 June and 18 June were covered by the NERC aircraft carrying the Daedalus airborne Thermatic Mapper. All tows were in the western English Channel.
- 3.2 The UOR was deployed twice in the Bristol Channel (in association with Swansea University) to provide sea-truth measurements of remote sensed measurements of upwelling light from the ocean in terms of the suspended material, chlorophyll and inorganic solids.

4. Ecotoxicology

A component of IMER's research programme is concerned with determining the biological results of environmental stress and pollution. Biological stress responses are measured at the cellular, individual and population levels of organisation. These responses play an important role in understanding the mechanisms of toxicity and potential pollutants, in assessing and monitoring environmental quality, and providing a biological end point in integrated environmental quality models.

C. Marine Biological Association, Plymouth

1. Phytoplankton and chemistry

Investigations on the tidal and shelf break frontal systems to the southwest of the UK in June included (a) Studies on upwelling and

downwelling irradiance to evaluate remote sensing methods for the detection of phytoplankton (an overflight of the Daedalus scanner was also made during the cruise), (b) Measurements of volatile organic sulphur compounds in the water column in relation to the total biomass and species composition of the phytoplankton, (c) Primary production experiments with the radioisotopes ^{14}C and ^{45}CA , and (d) Gravity coring on the continental slope between 500 and 2500 m for analysis of particulate organic C, N and P, and inorganic C (calcite) in recent sediments.

Nutrient enrichment experiments were carried out during the July cruise to investigate the separate and combined effects of ammonium and phosphate on rates of photosynthesis. In surface stratified waters selective filtration techniques were used to study the relationship between phytoplankton growth and nutrient regeneration by the microzooplankton, and the relative importance of the picoplankton (<1 μm diameter) in primary production.

Further data on the distribution and abundance of the dinoflagellate, Gyrodinium aureolum, were obtained in July and August.

2. Zooplankton and larval fish

Analysis of larval fish data from 1983 cruises has been extended to include studies of the gut contents of the more robust larvae, particularly the Soleidae. This information is being used in conjunction with data on densities of potential prey items in the water column to develop conclusions initially based on a consideration of the Clupeidae.

In March comparative trials were conducted to compare the 6" pump system with conventional vertically-hauled nets. This work has confirmed that the pump is an effective and efficient sampling system for the smaller fish larvae.

Analysis of the vertical distribution of zooplankton in mixed and stratified water are included in a paper published in *Oceanologica Acta*. This contribution also reviews long and short term fluctuations in two species of macroplankton predators in the vicinity of the coastal front off Plymouth, as shown by the continued routine sampling at stations L5 and E1.

D. Marine Science Laboratories, Menai Bridge Angelsey

During 1984 the statistical evaluation of observations made on the microbiology and zooplankton at the front lying approximately along the line $54^{\circ}00'\text{N}$ $5^{\circ}00'\text{W}$ to $53^{\circ}25'\text{N}$ $6^{\circ}00'\text{W}$ in the Irish Sea has been completed. The results are now in the press and will appear in seven papers in the *Philosophical Transactions of the Royal Society London Series B*. Experiments conducted in dialysis bags in the stratified waters near this front have indicated that heterotrophic production near the surface is about equal to that of the photosynthetic

phytoplankton. Echo-sounder records have shown that the distribution of scattering layers shows characteristic relations to the front and confirms information on the distribution of zooplankton obtained by sampling techniques. The distribution of sea birds also shows characteristic relationships with the front.

E. Biology Department IOS, Wormley

The research programmes of the Department fall within three main subject areas. Each of these is reported on separately, but the overall pattern of work is tending to converge towards trying to understand the vertical distribution of biomass and communities and how fluxes of material and energy determine these distributions.

1. Pelagic studies

Two cruises involving the midwater programme were held during the year. Discovery cruise 146 was a joint physical/biological investigation carried out between 46°N 14°W and 40°N 15°W. This region is a transition between a northerly area having deep winter mixing and seasonal thermal stratification, and a southerly area having permanent thermal stratification. Biological work was aimed at describing the changes in structure and distributions of the pelagic communities in association with the physical changes. Horizontal and vertical profiles of chlorophyll a were obtained from Seasoar, from continuously pumped surface water and from vertical dips associated with CTD measurements. The fluorometer observations were related to particulate concentrations, light attenuation, nutrients, temperature and salinity. Primary productivity was measured with C^{14} both for total phytoplankton and for two different size categories. Plankton and micronekton was sampled at the 2 main stations at either end of the transect and at intervals between these. North/South differences in distributions and numbers of both plankton and micronekton were apparent; these differences are consistent with previous IOS observations that this area is a region of faunal discontinuity.

Cruise 148 concentrated upon deep water sampling in the Kings Trough Area (42°N 21°30'W). A series of repeated tows were made at 3500 m to assess variability and repeatability in deep-sea sampling. Preliminary analyses suggest that variability between samples is not high. A modified near bottom echo-sounder was successfully tested on the RMT-1+8M; this is an essential component of future deep-water sampling programmes. A transect was made between 43-36°N to extend the observations on latitudinal fauna changes made on Cr. 146. Generally the results were consistent with those found earlier.

Dr. P. R. Pugh made a series of observations and collections from the Harbor Branch Foundation's submersible, Johnson Sealink. He participated in dives down to ca. 700 m.

During the year, work on near-bottom populations of decapods, mysids, siphonophores and ostracods was completed, and analyses of data obtained on previous joint physical/biological cruises to the frontal system SW

of the Azores have continued. On the Azores cruises and Cruises 146/148 collaborative work with the International Atomic Energy Agency at Monaco was continued. Extremely high levels of Po^{210} have been found in the detritivorous penaeids.

2. Benthic studies

The sampling programmes in the Porcupine Seabight have continued. Further epibenthic sledge samples were collected in order to further develop the sampling coverage on a multiple-year seasonal basis over an extended depth range. Particular attention was given to the zone at 1000-1300 m depth dominated by filter-feeding organisms to provide information on the sponge *Pheronema* and the decapod *Dorynchus*. Analysis of the samples previously taken in this zone has continued. Photography has been used to a greater extent than in the past and a series of transects across the filter-feeder zone has shown remarkably sharp bathymetric limits.

Data on allometric growth and distribution, both vertical and horizontal, of the decapod *Paromola cuvieri* has been assembled from other sources as well as IOS material and are being prepared for publication. An investigation into the variations of shell morphology of the large buccinid gastropod *Troschelia berniciensis* has been initiated, and is being extended to include the continental margin immediately south of the Seabight and the Bay of Biscay. Studies on holothurians have resulted in papers on the biology and distribution of the pelagic forms, and the data on the distributions and feeding of the benthic species are being written up. The continuing analysis of the amphipods throughout the Seabight indicates that there is a very high species richness over most of the continental slope.

Samples collected with the SMBA multicorer have been used for meiofaunal studies particularly on the vertical distribution of the foraminiferans and komokiaceans within the sediment. Some preliminary determinations of sediment community oxygen demand made using the multiple corer, have led to a start being made to develop the system into a more effective benthic respirometer.

Finally data on the bathymetric distribution of megafaunal biomass as measured in a number of ways have been assembled for publication.

3. Flux of organic material through the deep water column

During 1984 the phytodetritus phenomenon was further investigated during three cruises to the Porcupine Seabight, in April, May and August. A series of fairly distinct aims pursued on these cruises met with limited and very variable success.

As in 1983, the Bathysnap deployments were made at 2000 m and 4000+ m, respectively. This year the shallow one was recovered and the deep one lost - the reverse of the 1983 situation. The results indicated the arrival of phytodetritus at 2000 m in mid-May, that is consistent with a

sinking rate of about 100 m day^{-1} from a peak phytoplankton bloom about a week or two earlier indicated by IMER data.

Phytodetritus samples obtained at the 2000 m station shortly after its presumed arrival were examined by IOS chemists. The fatty acid composition indicated that the material was derived mainly from diatoms, but possibly also from dinoflagellates and coccolithophorids, that the bacterial contribution to the total biomass of the samples was small, and that the organic matter in the samples had been very recently derived from living phytoplankton - thus nicely supporting the previous results.

Microbiological examination of the phytodetritus samples at UWIST indicates a much higher bacterial productivity than would be expected from community metabolism data, from the estimated input from primary productivity in the area, or from the fatty acid analyses. These discrepancies may have resulted from the application of shallow-water techniques to the deep sea. This possibility is being investigated.

An attempt to measure the impact of the arrival of phytodetritus on the benthic community metabolism indicated by oxygen uptake rates was only partially successful. Spatial and temporal hydrographic variability at the depth chosen for metabolism measurements shortly after the arrival of the phytodetritus invalidated the results. At the 2000 m station, where these hydrographic problems do not occur, "post-fluff" incubation were not obtained until August, by which time the uptake rates measured were not significantly different from those measured in April before the arrival of the phytodetritus. Thus, the response of the fauna to the phytodetritus is either very short-lived, or the material takes so long to be metabolised that it is still supporting the community metabolism at the end of the winter.

An attempt to measure the vertical flux of material in mid-water using sediment traps failed partly because of a winch malfunction during deployment and partly as a result of a failure to recover the gear.

Further analyses of phytodetritus and FIDO samples are still being made.

2. Scotland

(R. Jones)

1. Marine Laboratory Aberdeen

Loch Ewe tank and enclosure experiments

In 1984 the Loch Ewe large enclosures were used to investigate the role soluble organic material may play in providing food for higher trophic levels such as zooplankton, fish, and jelly fish. There were 2 objectives. These were firstly to measure the overall efficiency with which soluble organics may be incorporated into the food chain and transferred to the higher trophic levels, and secondly to try to identify any animals capable of either taking up soluble organics directly or, by feeding directly upon bacteria, to accumulate soluble organics with enhanced efficiency. These problems were investigated by dosing a 300 m³ bag containing a natural plankton population with C¹⁴ labelled glucose and making a time series of measurements of the amount of label in the size fractions 0.2-1 μ ; 1-3 μ ; 3-12 μ ; 12-40 μ ; 40-250 μ ; 250-400 μ and > 400 μ over a period of 30 days. The results suggest that soluble organic materials are not taken up directly by any of the animals but that some species (eg. Appendicularians) do accumulate label at a higher specific rate than other zooplankton suggesting that they feed directly at the bacterial/flagellate level. The overall efficiency with which label appeared in the zooplankton fraction was about 2-5% of the label originally added to the bag.

The Loch Ewe enclosures were also used to study the growth and survival of cod and herring larvae. The growth, survival and feeding of simultaneously reared populations of these larvae were examined in relation to different zooplankton levels in 300 m³ enclosures. Initial results indicate that although cod grew faster than herring, the herring had a much greater survival capacity. This seemed to include ability to withstand starvation as well as a better avoidance of predators.

Lipid and fatty acid metabolism of the herring larvae was compared with differing food regimes while the genetic make-up of the herring larvae populations were compared with the rates of survival.

Theoretical studies of energy flow through food webs

Further work has been done on the simulation of factors affecting primary production and nutrient recycling in simple food webs.

2. Dunstaffnage Marine Research Laboratory, Oban (SMBA)

Deep sea studies to the west of the British Isles

The seasonal sampling of the demersal fish populations of the Rockall Trough and Porcupine Sea Bight continued in 1984. A major study of the food and feeding of both the pelagic and demersal fish of the Rockall

Trough was completed and published. This dietary information, in conjunction with the pelagic and benthic sampling, is evolving with a major study of the trophic ecology of an oceanic and slope-region. The theme of the SMBA investigations in the pelagic, benthic and fish populations is to examine the population recruitment, breeding and growth rates of animals in the Rockall Trough. In 1984 the emphasis was on the euphausiids, molluscs and gadiform fishes.

Carbon and nitrogen flux through the microplankton

A study of the flux of carbon and nitrogen through the microplankton of a sea-flooded quarry, which had limited exchange with the open coastal water was carried out in 1984. The quarry stratified during summer isolating bottom water which became increasingly deoxygenated until the early winter overturn. The structure and dynamics of the microplankton community were investigated by determination of size fractionated biomass and productivity whilst nitrogen regeneration in the stagnant deep water was measured. The rates of production and regenerative processes determined during the study will be used to test a mathematical model of microplankton dynamics being developed for shelf seas.

Relationship between hydrography and coastal phytoplankton ecology

Studies have continued in 1984 on the effect of vertical turbulence on phytoplankton productivity and community structure in coastal and shelf seas with particular reference to the Sound of Jura and Firth of Lorne areas.

U.S.A.

(K. Sherman and G. D. Grice)

Fisheries Ecosystem Investigations (K. Sherman)

National Marine Fisheries Service (NMFS) Laboratory, Sandy Hook, NJ: Personnel at the NMFS Sandy Hook Laboratory completed nine broad-scale MARMAP surveys of fish eggs and larvae in 1984, the eighth consecutive year of surveys in the 260,000 km² 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 with coastal ecosystems, support research on recruitment processes, and derive fishery-independent assessments of adult spawning biomass. In 1984 we occupied more than 1,100 stations, collected in excess of 2,500 plankton and 480 neuston samples, and made nearly 20,000 ancillary observations and measurements in support of our marine ecosystems research. Survey efforts were intensified during the spring/summer period to establish an appropriate data base for estimating the adult spawning biomass of bluefish, a popular recreational species thought to be at an all-time high level of abundance. Abundance estimates of sand lance larvae in 1984 were nearly double the highest level recorded during the past seven years, a period when we observed a 50-fold increase in adult spawning biomass. The once productive spawning Atlantic herring on Georges Bank remains at a very low level.

Analyses of spatial and temporal distribution patterns of larval fishes in relation to circulation, phytoplankton production, and seasonal pulses in zooplankton showed that spawning strategies are related to topographic features and circulation which, in turn, play a role in the maintenance of adult stocks. Peak spawning for important species such as cod, haddock, and redfish was shown to be in synchrony with increasing abundance levels of their seasonally dominant copepod prey. Others, such as silver hake and sand eel, have developed a ubiquitous spawning strategy whereby larvae are produced over a protracted time period along most of the northeastern shelf area. These populations are more likely to rapidly increase in abundance in response to favorable conditions than the cod, haddock, and redfish stocks that spawn for the most part within gyres.

The first MARMAP Atlas was issued (Sibunka, J. D. and M. J. Silverman, 1984. MARMAP Surveys of the Continental Shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia (1977-1983). Atlas No. 1. Summary of Operations. NOAA TM NMFS-F/NEC-33). It summarizes sampling activities for 47 surveys. Survey data analyses, which will occur in subsequent volumes, indicate that the shelf is among the most productive in the world. Primary productivity and zooplankton production values are similar to those reported in the mid 1950s, indicating that productivity at the lower end of the food chain is relatively stable. Based on these observations, NEFC scientists have concluded that the major source of interannual variability in the abundance of fish stocks results from heavy fishing mortality and predation on post larval and juvenile stages.

NMFS Laboratory, Narragansett, RI:

An initial comparison of micronekton sampling gear took place in June and August with juvenile gadoids as target species. A 10 m² MOCNESS, the IGYPT and a Boothbay Depressor Trawl were used in June to sample pelagic stages of cod and haddock at which time the Boothbay trawl and the MOCNESS appeared to catch equal numbers. The IGYPT was unsuccessful at catching the less than 20 mm post larvae predominant within the water column at that time. In August, numbers of cod and haddock were low but substantial catches of other gadoids and flatfishes were taken with the Boothbay trawl.

A cooperative effort to develop means of otolith ageing (yellowtail flounder and dover sole) with Centre de Recherche en Ecologie Marine et Aquaculture de l'Houmeau was initiated in summer of 1984.

Development of a multicomputer image analysis system for fisheries research was completed at the Narragansett Laboratory. The image analyzer was used to study the community structure of the zooplankton along a transect from Narragansett Bay to the edge of the continental shelf. This same system was used for otolith ageing of adult cod and silver hake. The results of this study were presented at the 1984 ICES meetings.

Program emphasis in recruitment studies was continued. Some of the facility has been modified to accommodate studies on juvenile stages of fish. Initial studies of juveniles are focusing on growth and conversion efficiency at maximum ration of juvenile bluefish and mackerel. Adult bluefish are being maintained for spawning in the spring. A study of protein and nucleic acid composition of cod larvae and pelagic juveniles collected on Georges Bank indicate that biochemical composition changes rapidly up to about 10-mg dry weight, or 18-mm standard length, and stabilizes at about this size. Laboratory exposure of sea scallops to copper was found to inhibit accumulation of protein and DNA in male gonads during maturation.

A joint study with the Marine Ecosystem Research Laboratory (MERL), University of Rhode Island, to determine the effects of thermal stratification on the growth and survival of larval haddock in controlled environmental systems was conducted. Trophically related zooplankton and phytoplankton were also monitored to gain an understanding of larval fish responses observed. The effort began with the simulation of water column structure on Georges Bank in April-May when newly hatched haddock larvae are present and stratification has begun. This involved producing a thermal gradient of 4°C in a 5-m water column with surface temperature at 9°C ± 0.5°C and bottom temperature at 5°C ± 0.5°C. Salinity was raised to 32.7 ‰. The investigation included a comparison of larval responses in the stratified system to a more dynamic, well-mixed system. Each tank was stocked with 500 larvae.

Preliminary results from two haddock experiments conducted over a 4-wk period produced growth rates in dry weight of 11.6%·day⁻¹ and 8.9%·day⁻¹, and survivorship of 2.0% and 8.8%, respectively, in the stratified tanks. No larvae survived in the well-mixed tanks. This increased growth and survival of haddock larvae in a stratified

environment is supported by field evidence from Georges Bank. Results support the hypothesis that thermal stratification serves to concentrate prey organisms and larvae in the thermocline.

NMFS Laboratory, Woods Hole, MA:

Two juvenile fish surveys were initiated this year in June and August to assess mortality and growth rates of Georges Bank cod and haddock for a life table of their first year of life. Using both pelagic and demersal sampling gear, in June the young gadids were found mostly on the shoaler part of Georges Bank (<60-m isobath), but in August they were only found concentrated on the Northeast Peak in deeper water (70-100 m). Site studies were made to investigate their diurnal vertical distribution, food habits, and predation by larger fish. Some additional sampling was made on the Northeast Peak population from September through November during the standard bottom trawl survey. The modal length of the young cod in June was 2.2 cm, and increased to 6 cm by August, and 10 cm in September. The more abundant haddock were 1.5 cm in June, 10 cm in August, and 15-16 cm in November. Otolith ageing studies are in progress. Predators observed feeding on juvenile fish included spiny dogfish, silver hake, fourspot flounder, windowpane, bluefish, and winter skates. Larger windowpane were observed to be feeding extensively on their own juveniles, which underscores the potential impact of cannibalism on pre-recruit mortality.

Major emphasis was given to synthesis of information on the biological productivity of Georges Bank in a series of chapters for a book on Georges Bank. Fish production per unit area on Georges Bank appears to be significantly higher than other comparable shelf regions in the North Atlantic and Northeast Pacific, despite the fact that secondary production (macrozooplankton and macrobenthos) is about the same as in other areas--an enigma that has yet to be explained satisfactorily. Food web studies continued with completion of reports on diet and consumption of squid, mackerel, sand eel, spiny dogfish, bluefish, and 17 other species, and a description of a generalized model for estimating consumption of fish based on observations of stomach contents collected in the field was published (Pennington, M. 1985. Estimating the average food consumption by fish in the field from stomach contents data. Dana 5:81-86). Finally, a new series of studies was begun on recruitment of spring-spawning gadids on Georges Bank involving new field, laboratory, and analytical studies in an attempt to pinpoint timing and causes of mortality controlling year-class visibility.

NMFS Laboratory, Beaufort, NC:

Since 1979 the Beaufort Laboratory has conducted research aimed at defining the food web that supports the survival and growth of larval fish in the northern Gulf of Mexico. This research, conducted cooperatively with NOAA's Atlantic Oceanographic and Meteorological Laboratories, Miami, Florida, has focused on food web interactions about the Mississippi River Plume.

Earlier work has indicated that the larvae of three ecologically-abundant and economically-important species, gulf menhaden (Brevoortia patronus), spot (Leiostomus xanthurus), and Atlantic croaker (Micropogonias undulatus), are more abundant in the vicinity than

elsewhere within their range in the northern Gulf. Moreover, this abundance may be affected by hydrodynamic mechanisms associated with the plume front. The biological relevance of this aggregation of larvae may be enhanced feeding success and possibly growth, the result of the high nutrient levels, and heterotrophic bacterial, phytoplankton, and zooplankton production that also characterizes this area.

Persuant with the objective of defining the larval fish food web, we have in 1984 defined the diets of gulf menhaden, spot, and Atlantic croaker, as well as the diets of their principal food, copepodites and adult copepods. Laboratory experiments with gulf menhaden and analysis of samples collected in the Gulf for spot and Atlantic croaker indicate that these larvae are selective feeders that select a limited array of food organisms from the available plankton. Young gulf menhaden, less than 5 mm in length, select tintinnids, but do not select copepod nauplii. Spot and croaker larvae of all sizes do not select either tintinnids or copepod nauplii, but select copepodites and adult copepods primarily of the genera Paracalanus and Oncaea. Laboratory experiments with older gulf menhaden larvae and various ages of spot and croaker larvae are underway to verify these inferences and to assess the rigidity of larval fish food selection. Highly rigorous food selection could make larval fish feeding success vulnerable to environmental perturbations of their food web. Other components of this food web vary in their food selection. Tintinnids are highly selective of dinoflagellates as food, whereas copepodites and adult copepods, including Paracalanus and Oncaea appear to be indiscriminant omnivores.

Indicators of the physiological response of larval fishes to feeding success are under development and will be applied to assess temporal and regional, as well as meso- and fine-scale spatial differences in larval fish trophodynamics. These indicators are morphometric indices and growth rates. Within-season comparisons of gulf menhaden growth for two winters indicated significantly greater growth rates early in the spawning season when water temperature and zooplankton biomass were higher. In addition, growth rates appear to be higher in regions of greater primary and secondary production, i.e., above the Mississippi River plume than in other less-productive regions.

NMFS Southeast Fisheries Center, Miami Laboratory, Miami, FL:
Large scale ecosystem survey work of the Gulf of Mexico continues. Under the title SEAMAP (Southeast Area Monitoring and Assessment Program). This cooperative effort between the National Marine Fisheries Service, Gulf States Fisheries Commission, States of Florida, Alabama, Mississippi, Louisiana and Texas, and the government of Mexico has been conducting plankton, environmental, shrimp and bottomfish, and satellite image surveys of the Gulf of Mexico. Two reports were published in 1984 summarizing the 1982 results--SEAMAP Environmental and Biological Atlas of the Gulf of Mexico, 1982 and SEAMAP 1982-Ichthyoplankton, Larval distribution and abundance of Engraulidae, Carangidae, Clupeidae, Lutjanidae, Serranidae, Coryphaenidae, Istiophoridae, Xiphiidae, and Scombridae in the Gulf of Mexico. Copies of these reports are available upon request. These cooperative surveys continued in 1983 and 1984 and are planned for future years. Data are currently being analyzed but the

long-term benefits of time series are looked to for providing an understanding of the Gulf of Mexico Ecosystem.

With our ichthyoplankton research, a major development in 1984 was the publication of a book entitled Ontogeny and Systematics of Fishes based on an International Symposium dedicated to the memory of Elbert Halvor Ahlstrom. This book forms a basis for the identification of fish larvae. The Southeast Fisheries Center, through a cooperative agreement with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies, is investigating recruitment mechanisms in tropical ecosystems. Emphasis is being placed on coral reef assemblages. Also the Miami Laboratory is continuing studies of tropical estuaries and the effects of channelized surface runoff on fish recruitment.

Plankton Ecology Investigations (G. D. Grice)

Woods Hole Oceanographic Institution:

Modelling studies in fisheries ecology have focused on zooplankton prey organisms and pre-recruit fish. Zooplankton population models have provided insights into the dynamics of the annual production cycle in the temperate ocean. The traditional view that zooplankton is highest during the spring and is tied to the phytoplankton cycle may hold for biomass but not for production. Production by small zooplankton, which are inconspicuous in terms of biomass, is more influenced by temperature than by phytoplankton concentration. Simple analytical models have been used to show that small ($\pm 20\%$) interannual variations in growth rate of pre-recruit fish can potentially lead to large variability in recruitment (\pm an order of magnitude). Growth rate and mortality rate carry equal weight in this regard. Variability in growth rates of larval haddock on Georges Bank appears sufficient to potentially account for all observed recruitment variability between 1961 and 1982. Models are being developed to examine the biological and physical mechanisms regulating prey availability to pre-recruit fish.

The reproductive strategies of epi- and mesopelagic ctenophores, the feeding behavior of thecosome pteropods, and the development and behavior of the salp-eating ctenophore, *Lampea pancerina* are being studied. Using the submersible, the JOHNSON SEA-LINK, 20 species of ctenophores (of which 15 were new), 30 species of siphonophores (of which 15 were new), and 37 species of medusae (of which 7 were new) were collected in one 3-week cruise. Observations were made on the field behavior of these animals, as well as on the field behavior of midwater fishes and crustaceans. Several new associations between arthropods and gelatinous organisms were discovered.

A number of problems that have arisen from previous work on the photoperiodic control of dormancy in marine copepods are being investigated. These include study of: the effects of bioturbation by benthic polychaetes on recruitment of planktonic copepod nauplii; endogenous controls of spawning behavior in marine copepods; the response of copepod populations to directional selection; heritable variation for diapause and other life history traits which influence population growth; and copepod population and developmental genetics using electrophoresis.

Lamont-Doherty Geological Observatory:

Phytoplankton distribution is being studied in the Middle Atlantic Bight; analysis of chlorophyll *a* data, physical parameters and nutrients from the shelf edge front are being used to establish the degree to which physical phenomena at fronts control the distribution of phytoplankton. Over the continental shelf the emphasis is on the fate of primary production and the impact that grazing, fecal pellet production and particle decomposition have on overall transport and transfer rates of particulate material. Zooplankton studies underway include projects on the metabolism and trophic interactions of tropical radiolaria, the distribution and ecology of subarctic estuarine radiolaria, the influence of environmental factors and algal symbionts on shell composition and morphology of tropical foraminifera, the distribution of Antarctic crustacean zooplankton, and the characterization of benthopelagic zooplankton communities in selected submarine canyons off the eastern seaboard and their comparison with those overlaying the adjacent continental shelf.

State University of New York, Stony Brook:

Current research on bacteria involves a study of the relationships between nutrients, bacteria and bacteriovores in Long Island coastal waters. This includes an ongoing seasonal study of biomass and activity of planktonic bacteria and heterotrophic flagellates. Similar work has just commenced in Chesapeake Bay. Other research on bacteria involves measurements of nitrification and denitrification using both $^{15}\text{-N}$ and $^{13}\text{-N}$. Also we are investigating the significance of marine bacteria as a source of dissolved hydrogen in seawater, measurement of the distribution and density of various strains of chroocoid cyanobacteria in the open ocean and coastal waters, as well as measurements of their growth rates.

Phytoplankton studies involve investigations on the ecology of the toxic dinoflagellate *Gonyaulax tamarensis* in Long Island waters. Other research concerns the resistance of phytoplankton to PCB's in the Hudson River, an investigation of the viability of diatoms found in surface sediments of the New York Bight, and a study of the hydrography, phytoplankton and zooplankton species composition of Jamaica Bay (Brooklyn), New York.

Zooplankton work includes a study of the sources of regenerated nitrogen in local waters, using the activity of glutamate dehydrogenase as an index of ammonium excretion. Results show that macrozooplankton ($>200\text{ }\mu\text{m}$) account for 24% of the ammonium excreted, microzooplankton ($200\text{-}200\text{ }\mu\text{m}$), 20% and nanozooplankton ($<20\text{ }\mu\text{m}$), 56%. The population dynamics of *Temora longicornis* and *Acartia hudsonica* are being investigated, in particular a study of the effects of phytoplankton food quality and species composition on fecundity.

Fisheries work includes an ongoing study of the effects of water temperature on sex determination in Menidia. A description of the offshore distribution and migration patterns of bluefish was completed this year and studies of the early life history of this fish are planned for 1986.

University of Maryland Center for Environmental and Estuarine Studies: 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 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 in 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 in the Gulf coast of Mexico.

Skidaway Institute of Oceanography:

Current programs are concerned with mechanisms of removal of nearshore water masses towards offshore during spring and plankton processes in these waters. Laboratory research includes studies on the population dynamics of the cladoceran *Penilia avirostris* on the feeding behavior of oceanic copepods on small and large cells, and of neritic copepods on particles of different composition.

Rosenstiel School of Marine and Atmospheric Science:

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 re-evaluate 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.

U.S.S.R.

(S. A. Studenetsky)

Polar Research Institute of Marine Fisheries and Oceanography (PINRO). In 1984 the euphausiid stock in the Barents Sea in winter was assessed to estimate the food conditions for commercial fishes. For a long period an increase of abundance of neritic arctoboreal species Thysanoëssa inermis was observed; the eastern areas turned out to be poorer than the western ones; the distribution of phyto- and zooplankton was investigated at the 24 hour station in the polar front zone; peculiarities of zooplankton growth and distribution in the spring/summer period were revealed and feeding areas for capelin, polar cod and blue whiting in the Norwegian and Barents Seas were determined; an intensive feeding of blue whiting on copepods in the areas with the most abundant young Calanus and a high content of oxygen was found; food supply of the Barents Sea polar cod during 1980-1983 period was investigated and 24 hour food diet, intensity of consumption, and predation of the main food organisms of polar cod were calculated; investigations on ecology and distribution of deepwater shrimp larvae in the Norwegian and Barents Seas were conducted and intensity, scope and main direction of larval drift from the areas of mother population species were determined, and the relative indices of larvae abundance in the branches of the Norwegian, North Cape and Murmansk Currents were calculated.

450 phytoplankton samples, 2780 zooplankton, and 300 euphausiids, taken with a trawl-attached net, were collected; 2000 deepwater shrimp larvae were measured and stages of development determined; and a quantitative-weight analysis of feeding was made for 450 capelin and 100 blue whiting.

In 1985 the research on plankton in the Barents and Norwegian Seas will be conducted according to the previously adopted programme.

Northern Department of PINRO. In 1984 investigations of habitat of pelagic fishes were continued in the White and south Barents Seas. Plankton samples were taken on 697 stations. 2000 fishes (herring and navaga) were examined for feeding analysis. Feeding conditions were good.

The White Sea biological station of Moscow State University. To study size and age structure of the abundant neritic copepod Acartia longiremis, data were collected. The duration of reproduction was defined. Preliminary data on fecundity were collected.

Distribution peculiarities of four abundant copepod species Metridia longa, Pseudocalanus elongatus, Temora longicornis and Centropages hamatus in relation to environmental conditions and different seasons were studied based on the data of plankton surveys in the Kandalakshsky Bay and adjacent waters. Data were collected on 24 hour stations. Age, diurnal and seasonal migrations were especially studied.

Investigations of larval plankton of Velikhaya Salma Strait (Kandalakshsky Bay) were continued. Seasonal variations of larvae abundance and sizes in relation to temperature and salinity were studied. Pictures of larvae at different stages and in different seasons were taken. In plankton there were larvae which were never registered before.

Samples of bottom fauna were taken in the north Onega Bay. Samples of bottom fauna were taken in the mouth of the White Sea.

The distribution of Hydrobia ulvae in three different areas of the littoral zone was studied. It was revealed that in the case of Hydrobia, sulphuretted hydrogen pollution did not interfere, the presence of filamentous algae as the accumulator of detritus in the coastal region was probably important.

Functional morphology of mouth apparatus of several detritivorous species was studied (species of the genus Littorina, Hydrobia ulvae). The content of food bolus was examined. The content of mineral particles was measured (method of food ranging was developed). Digestion of sulfurized bacteria in intestines of Jaera and Hydrobia collected in mud was observed with the help of phase-contrast microscopic analysis.

Investigations of the White Sea hydroids was continued. Food spectrum of 10 hydroid species was studied. It was revealed that species with small hydranths (below 0.5 mm) fed mainly on infusorians and fragellate; species with hydranths about 1 mm fed on infusorians, rotifers, nauplii of crustaceans, larvae of polychaetes and molluscs, and eggs of different crustaceans. Species of hydranths over 1 mm were represented by gymnoblastous hydroids only, and consumed copepods, chironimids, round worms, etc. It was the first time that the data obtained allowed us to take into account hydroids in trophic webs.

Studies of fish feeding in the littoral zone were continued. The presence of annual seasonal cycles of behaviour and feeding were revealed. It was shown that sculpin appeared to be the most active predator in the littoral zone. During polar nights fish were more active in dull weather and at dusk. In August navaga prevailed in catches. Navaga had the widest food range. Gammarus oceanicus, Fabricia sabellia, and Jaera albifrons were exposed to the highest pressure from predators in the littoral zone.

In 1984 Baltic Research Institute of Marine Fisheries conducted the following studies. Data on phosphorus, nitrogen, silicium, carbon, pigment content, abundance, biomass, and specific composition of phytoplankton in the Gulfs of Riga and Finland and the Baltic Sea proper were collected.

It was revealed that the seasonal cycle of nutrients and the concentration level in the upper layer of the Baltic Sea were nearly the same as in 1983. The contents of nitrogen decreased a bit in winter. During the first half of the year phosphorus content of the upper layer stabilized at the level of the last two years and then decreased.

Nitrogen content of the upper layer decreased. Maximum concentrations of phosphorus in the trophogenic layer were registered in the south-eastern Baltic Sea and the Gulf of Finland in summer. In summer primary productivity was limited by the shortage of nitrogen.

Statistical analysis of long-term investigations (1962-1984) allowed us to conclude that hydrochemical conditions in the Baltic Sea were subjected to long-term variability, which manifested itself in the growth of phosphorus and nitrogen content in the trophogenic layer in prevegetation period.

As per chlorophyll contents, the most productive zones in summer 1984 were areas of Piltenskaya Deep and eastern shallows near Kurshskaya shoal. Uneven vertical distribution of chlorophyll, with the second undersurface layer, was registered.

In 1983-1984 the total biomass of phytoplankton was continuing to increase in the Gulf of Riga.

The consumption of phytoplankton by Limnocalanus grimaldi was studied.

Zooplankton. Seasonal zooplankton surveys in area 25, 26, 28, and 29 of the Baltic Sea and the Gulf of Riga were conducted in February, May, August, and May-November. 240 samples were taken in the sea, 270 samples were taken in the gulf. Samples were taken by a Judday net 37/50 with mesh size 0.16 mm in the filtering cone.

Ichthyoplankton. Ichthyoplankton surveys were conducted monthly from February to August in areas 25, 26, 28, 29, and 32 of the Baltic Sea. 300 samples were taken. Samples were taken by a X-80 net.

Nektobenthos. Nektobenthos surveys were conducted in January, March, June, July and September in areas 26 and 28 of the Baltic Sea. 288 trawlings were done with an Isaacs Kidd trawl (10-foot model).

Fish feeding. Data on sprat feeding were collected in January, March, and May-July in areas 26 and 28 of the Baltic Sea. 1330 digestion tracts were collected.