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Report of Activities

OID

Biological Oceanography Committee

by

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1990

Introductory Remarks:

At the 1990 Statutory Meeting, the function of the Activities Report was discussed and the overwhelming conclusion was that with such a broad and rapidly developing discipline as Biological Oceanography, a report such as that which has been traditionally produced within ICES is of extremely limited value.

It was, therefore, decided to limit the report to items directly relating to ICES activities but which are not dealt with in Working Group Reports. Nevertheless, a number of members of the Committee still submitted country reports similar to those of earlier years. In this connection, it should be noted that many of the members were not present at the discussions at the last Statutory Meeting. In addition, the Report from the Annual Meeting with the minutes from the BOC meeting where these discussions took place was not circulated until March and the Chairman did not inform Committee members of these discussions until after a number of country reports had been submitted. Thus, many members may not have been aware of the discussions which had taken place at the last Statutory Meeting.

Therefore, this year's BOC Activities Report contains a mixture of types of country reports. In cases where no country report appears, it is assumed that all BOC activity relevant to ongoing ICES activities is presented or referred to in Working Group Reports.

Belgium

C. Heip & R. De Clerck

Marine Biology Section, Zoology Institute, University of Gent,

I. Fish and hyperbenthos research

Abundance of fish and hyperbenthos in the shallow coastal area of the Voordelta, Southern Bight were studied.

The production and consumption estimates for 0-group gadoids, Merlangius merlangus and Trisopterus luscus were linked to production estimates of their main prey: shrimp and gobies. From these calculations it seems that the net efficiencies estimated for gobies by Doornbos & Twisk 1987 are most probably too high, i.e. numbers are underestimated. Especially the efficiencies of over 50 % for the larger size classes do not seem to apply for the Voordelta. Production estimates for mysids, the main food for the gobies, in the same area are hampered by the near total absence of the juveniles in the summer samples. Most probably the juveniles migrate to areas with a depth of less than 5 metres and are thus out of reach our sampling gear.

Food resource partitioning between two gobies, Pomatoschistus minutus and Pomatoschistus lozanoi seems not to be driven by competition for food: in localities with a lower food supply niche overlap is higher than in food rich areas.

Research on hyperbenthos is continuing in the Westerschelde estuary, where the mysids seem to be a major component in the system.

Doornbos, G. & Twisk, F. 1987. Density, growth and food consumption of goblid fish in the saline Lake Grevelingen, The Netherlands. Neth. J. Sea Res. 21:45-74.

II. Benthic communities in the Southern Bight of the North Sea and adjacent estuaries

The investigation of the structural characteristics of the benthic communities in the Southern Bight of the North Sea is still going on (1971 -). The meiobenthic communities in the Southern Bight of the North Sea are clearly defined by the sediment composition. The habitat preferences of the dominant nematode species have been determined from these data. These base-line studies are very important for biomonitoring, because they allow predictions when the evolution of the sediments is known.

The study of the energy fluxes in meiobenthic systems and the consumption of bacteria were continued.

Effects of eutrophication on meiobenthic commmunities in estuaries and the temporal evolution of nematode communities in the Western Scheldt were investigated (1976 - 1991).

The recruitment of meroplanktonic larvae of macrobenthic animals along the French, Belgian and Dutch coast in relation to hydrodynamical aspects of the area was studied.

Ecology and Systematics Laboratory - Vrije Universiteit Brussel

Research on interactions between particulate matter and zooplankton was carried out in the North Sea and the Western Scheldt. Distinct gradients in a number of particulate matter characteristics are found going from the Scheldt to the open sea: increasing chlorophyll concentration and Median Spheric Equivalent diameter of particles: decreasing particle volume concentration and POC concentration. Cluster analysis based on chemical parameters on one hand and coulter size distribution data on the other result in a comparable distinction between the "open sea" zone and the Scheldt and coastal stations. Relationships between these particulate matter patterns and zooplankton distribution will be evaluated in the future. In the Western Scheldt, the zooplankton research further focuses on population dynamics and grazing activity measurements of the dominant copepod populations: Eurytemora affinis and Acartia spp.

Groupe de Microbiologie des Milieux Aquatiques - Université Libre de Bruxelles

The main activity of the group was research in the CEC Joint Project on Phaeocystis dominated ecosystems in nutrient enriched coastal zones of which the group is the coordinator.

Massive blooms of Phaeocystis gelatinous colonies are observed each year during spring in the area extending from the Strait of Dover to the German Bight. Even if no toxicity has been reported until now, the damages caused by these blooms are serious enough to have prompted the CEC to start a joint European research project. This 4 year project started in January 1988 and involves nine research institutes from the UK, France, Belgium, the Netherlands and Germany. The final goal is to establish a predictive model of Phaeocystis development in response to terrigenous inputs to be used as a tool for the management fo the quality of these coastal waters.

Finland

J. Kuparinen

Finnish Institute of Marine Research

Studies on long-term fluctuations and population dynamics of phyto- and zooplankton as well as macrozoobenthos, started in 1961, were continued in the entire Baltic Sea including the Baltic Monitoring Programme of the Helsinki Commission. For the purposes of extensive surface water (5 m depth) monitoring and for the study of algal blooms, R/V Aranda was equipped with flow through instruments for continuous particle sizing, and recording of a-chlorophyll as well as temperature and salinity. The measurements may be carried out at 10 m/s cruising speed. Also continuous fluorescence and plankton recording was set to the ferry boat Georg Ots sailing from Helsinki to Tallin in order to study algal blooms in the Gulf of Finland.

Studies on the cycling of organic matter in the food web of the open Baltic were continued. The study plans were prepared for the extensive Finnish - Swedish cooperation for the Gulf of Bothnia. The field studies started in January 1991 and will continue till 1993 allthough 1991 is the most intensive year..

Studies on the dynamics of the cyanobacterial blooms and on the toxicity of the species were carried out in the open areas of the Baltic Sea. The expedition to Antarktis closed in spring 1990 and results were prepared throughout 1990 for publication in early 1991.

National Board of Waters and the Environment, Water and Environment Research Office, Helsinki

Primary production, chlorophyll *a*, and phytoplankton species composition and nutrient chemistry were monitored at ca. 100 sampling stations (with high sampling frequency at twelve stations) along the Finnish coast in both polluted and unpolluted areas in order to study anthropogenic influences on the Baltic Sea ecosystem. Special investigations were performed off several residential areas. In the eastern Gulf of Finland a project was established to study the relation of heavy loading, water movements and algal production. Also monitoring studies on the influence of industrial and municipal pollution on the composition of benthic macrofauna were continued at long term reference localities. The changes of littoral ecosystems were followed in the Baltic Sea.

Tvärminne Zoological Station, University of Helsinki

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

The most extensive projects deal with the pelagic system: phytoplankton/bacterial relationships, coupling of autotrophy and heterotrophy, and diurnal dynamics of biological interactions. The studies on the different processes are carried out with long-term measurements in the Baltic Sea as a background. Nutrient cycling is being analyzed and coupled with the dynamics of the metabolism of the microbiota. Enclosure experiments are used to evaluate the effects of variations in biotic and abiotic factors on the community metabolism.

Husö Biological Station, Åbo Akademi University

Monitoring of long term fluctuations or changes in hydrography, sediment quality, zoobenthos and fish, at fixed stations in the Åland archipelago (reference areas for the northern Baltic Sea) and pollution control programmes (municipal effluents, aquaculture in archipelago waters, etc.) were continued. Studies on phytobenthos (*Fucus vesiculosus* community) as indicators of environmental stress were continued.

Ecological field- and laboratory studies on biotic interactions, structuring mechanisms and long term population- and community dynamics of zoobenthos and fish in shallow archipelago areas were continued. These studies also covered colonization strategies and recovery potential of the biota of disturbed habitats.

Archipelago Research Institute, University of Turku

The main work included continued monitoring of population dynamics and migration of phyto- and zooplankton in the vicinity of the institute and participation in a larger project on the biology of the Baltic herring, e.g. reproduction, food, migration and distribution of young and adult Baltic herrings in open sea. The *Cordylophora*-project, dealing with brackish water colonial hydroid, which has revealed strong physiological integration within colonies, also in conditions of nutrient deficiency, was continued. Examples of applied research were the repelling effect of industrial wastewaters on shoals of Baltic herring, maninduced changes in biocenoses by fishfarming and determining the effects of waves and currents caused by ferry traffic. Studies on the aquaculture and the effect of some nutrients on the growth of certain green algae species were continued.

Perämeri Research Station, University of Oulu

Studies on the population density of nearbottom fish and acoustic measurements on the movements and biomass of Baltic herring have been done. An ecosystem research project in the Bay of Liminganlahti was continued. It includes investigations on nutrients, phyto- and zooplankton, benthic flora and fauna as well as waterfowl and input of water and organic matter from rivers.

Studies of the fate of heavy metals (Hg, Cr, Pb, Cd, and Zn) in aquatic ecosystem, including sediment, bottom fauna, fish, macrophytes and phytoplankton were continued.

Iceland

T. Thordardóttor & O.S. Astthorsson

As in previous years the monitoring og primary production (P_{max}) and chl-a was conducted in a hydrobiological survey of Icelandic waters during May-June. At selected stations within different watermasses data on Pvs.I relationships were obtained and the depth distribution of AN's in turbulent as well as stratified waters was studied. A special emphasis was placed upon observations in the frontal zone of Polar and Atlantic water northwest of Iceland.

During an 0-group survey in August continuous recordings of fluorescence were made in the Atlantic and Polar waters of the northern Irminger Sea.

Continuous recordings of light (PAR) in Grímsey and Vestmannaeyjar were carried out for the second year. In addition to information on the light regime off north and south of Iceland, the data will be used to improve our model for evaluating daily illumination in offshore waters based on information on cloud cover at meteorological land stations.

Long term studies on the densities and composition of zooplankton in the Icelandic shelf area during spring were continued.

Work continued on the zooplankton material which was sampled during 1987-1988 in Isafjord-deep, northwest Iceland. The aim of the study is to quantify seasonal variations in distribution and abundance of the major species of the zooplankton in relation to the physical environment.

Ecological investigations were initiated southwest of Iceland on the spawning grounds of the most important commercial fish species. Three surveys were undertaken in spring to this area to investigate hydrography, phytoplankton, zooplankton and fish larvae. The study is aimed to understand the spring development of zooplankton spawning and the spawning of fish in relation to the onset of spring growth of phytoplankton and oceanographic features.

In March initial experiments were carried out to study the distribution and biomass of zooplankton in Ísafjord-deep, northwest Iceland, using 38 and 120 kHz acoustic sounders connected to integrators and multiple opening/closing nets.

Analysis of zooplankton material collected by sediment traps deployed at 1450 m northeast of Iceland and at 570 m south of Iceland was continued. The traps (which are of the WHOI type Mark 6) collect 13 separate samples throughout the year. The aim is to obtain initial information on the species composition and life cycles of the most numerous species from areas were very limited seasonal studies on zooplankton have previously been conducted.

As in previous years the Plymouth Marine Laboratory was assisted in the running of the Continuous Plankton Recorders between Iceland and Scotland. Further, scientists from PML were assisted during preparatory runs with an UOR between Iceland and Portugal. A preliminary run was undertaken on the route in July and it is hoped that further surveys covering the whole year will begin in 1991.

Netherlands

P. de Wilde & A. Rijnsdorp

A summary of the BOC-related studies are as follows:

- NIOZ participated in an international programme on the role of the coccolithophore, *Emiliania huxleyi* in the global carbon flow;

- NIOZ, as the lead institute participated in the ERSEM project (EC science and technology programme) aiming at the ecological modelling of the North Sea

- Detailed insight into the effects of organic matter deposition in the North Sea, in terms of sediment chemistry and benthic community structure and metabolic activity, was obtained from eutrophication experiments in mesocosms at NIOZ. Deep-frozen *Pheaocystis* matter was used as the carbon source.

- NIOZ participated in the IOC/ICES sea-going North Sea workshop aiming at the intercalibration of techniques for monitoring biological effects of contaminants.

- Long-term data series of the coastal fish fauna in the Netherlands and the changes in the occurrence of rare fish species in the Southern Bight were elaborated and documented by NIOZ.

-In November a well attended international flatfish symposium was organized at the NIOZ.

- A joint field study of NIOZ, RIVO and DGW was carried out on the effects of beam trawling in the southern North Sea showing severe short term effects on the structure of benthic communities. Therefore the NIOZ recommended that bottom trawling should be banned in some large representative parts of the North Sea.

- Population dynamics of dab and scaldfish were studied in cooperative research of NIOZ and RIVO.

- At the RIVO time trends in landing data were analysed for a number of demersal fish species. Between 1950 and 1980 the level of landings increased in species that exploit coastal nursery grounds coinciding with an increased level of eutrophication in coastal areas upto 1980. Concurrent with this increase an increase in growth of plaice and sole was observed, but since 1980 the growth rate showed a decreasing trend coinciding with a decrease in the level of nutrients, in particular that of phosphorus.

- A study was started at RIVO to recognise and sort eggs from plankton samples by using image analysis.

Portugal

M.E. Cunha

The following is a summary of some relevant activities performed during 1990 at the Instituto Nacional de Investigação das Pescas, Av. Brasília, 1400 Lisboa, Portugal.

Studies in Guiné-Bissau Coastal Waters

Plankton investigations in the framework of the Research Program "Guiné" was continued on a yearly basis in the Guiné-Bissau coastal waters in colaboration with the Guiné-Bissau Marine Biology Laboratory. Studies on phytoplankton, zooplankton and ichtyoplankton species evaluation and distribution in relation to the hydrographic conditions have been performed. In 1990, a cruise with hydrological, chemical and biological investigations has been carried out, for the characterization of the most productive areas.

Studies in Portuguese Coastal Waters

A new project has been established dealing with Norway lobster recruitment studies. The aim of this work is to develop and implement methodologies and survey techiques capable of real-time empirical prediction of Norway lobster recruitment and biomass levels. A Norway lobtser survey in Algarve was attempted in February to determine the density and distribution of the larvae.

Studies on the distribution and ecology of potentially toxic phytoplankton species in the Portuguese coast was started in 1990. During this year information on species composition and hydrology of the water colunm was obtained with two cruises (July and August) covering all the coast. Monitoring of the toxic phytoplankton in the inshore coastal waters were continued.

The studies on the distribution in space and time of the early life stages of the hake and horse-mackerel continued. This consisted of investigations on the area and intensity of spawning.

The project designed to answer questions relating to the survival of the pre-recruitment stages of Sardina pilchardus is under work with studies foccusing the age strutcture and growth of the larvae and juveniles by means of image analysis system.

The hydrological regime off the portuguese coast have been to be characterized by means of phytoplankton and zooplankton community analysis and distribution.

Studies on the characterization of coastal upwelling and its biological consequences are still going on. The dynamic of phytoplankton populations related with upwelling conditions is under study.

Spain

E. López-Jamar & M. Varela

A) PHYTOPLANKTON

1.- Instituto Español de Oceanografía. La Coruña Laboratory

The study on long-term variation of phytoplankton species composition, primary production and chlorophyll, which began in 1989, went on during 1990. Studies on phytoplankton size classes distribution (chlorophyll, and primary production) were carried out, as well as determination of particulate organic matter and phytoplankton abundance in relation to sardine larvae.

The study on phytoplankton of Ría de Huelva, a high polluted stuary in the SW of Spain, wich started in 1989, as well as the study on fossil diatoms and their role as paleoecological indicators in the Galician shelf, went on during 1990.

2.- AZTI-SIO Instituto de Investigación y Tecnología para la Oceanografía, Pesca y Alimentación. San Sebastian Laboratory.

Monthly studies on phytoplankton and primary production, which began in 1986, went on in 1990 in several stations near San Sebastian.

Studies on phytoplankton and primary production in the Cap-Ferret Fosse, during two cruises of 15 days, in cooperation with France, within the project ECOFER.

3.- Instituto de Investigaciones Marinas. Vigo Laboratory.

Since September 1990, a permanent station is sampled twice at week. Data on hidrology, nutrients, oxygen and chlorophyll are taken. Bacterioplankton, picoplankton, nanoplankton and microplankton are counted, being differenced, autotrophic and heterotrophic forms.

During september 1990, 5 cruises were carried out in the Ria de Vigo, to study spatial and temporal distribution of phytoplankton species in relation to environmental conditions. This study was carried out in cooperation with different european institutions, and is supported by MAST project 'The control of Phytoplankton Dominance'.

B) ZOOPLANKTON

1.- Instituto Español de Oceanografía. La Coruña Laboratory.

Mesozooplankton samples (> 250 µm) were collected once at month in two stations (neritic and estuarine) off Ría de La Coruña, to study abundance, biomass and size spectra in relation to trophic structure of the community. Species composition and abundance of the microzooplankton fraction (20-200 and 100-250 µm) has also been studied during an annual cycle.

Data on mesozooplankton (community composition, abundance and biomass) from the Galician shelf are being currently processed. Studies on spatial and temporal distribution of Necora puber larvae from Ría de La Coruña have been carried out. Laboratory experiments on this species have been undertaken in order to study the embryonic development as well as the effect of temperature and salinity.

2.- Instituto Español de Oceanografía. Vigo Laboratory.

Monthly samples of zooplankotn (> 250 µm) were collected once at moth in six stations in the Ría de Vigo and neighbouring shelf (NW Spain), to study spatial and temporal variation of zooplankton biomass, and its relation to sardine larvae.

3.- AZTI-SIO Instituto de Investigación y Tecnología para la Oceanografía, Pesca y Alimentación. San Sebastian Laboratory.

Monthly studies on zooplankton, which began in 1986, went on in 1990 in several stations off San Sebastian.

C) ICHTHYOPLANKTON

1.- Instituto Español de Oceanografía. La Coruña and Madrid Laboratories.

Monthly samples are being collected in three transects with different hydrographic regimes (Vigo, La Coruña, and Santander) to study the temporal variation of spawning intensity of commercial fish (mainly Sardina pilchardus) and its relation to oceanographic conditions.

2.- AZTI-SIO Instituto de Investigación y Tecnología para la Oceanografía, Pesca y Alimentación. San Sebastian Laboratory.

Monthly studies on zooplankton, which began in 1986, went on in 1990 in several stations off San Sebastian.

D) BENTHOS

1) Instituto Español de Oceanografía. Laboratory of La Coruña.

Studies on the long-term variability of two subtidal macroinfaunal communities of Ría de La Coruña continued during 1990. Population dynamics, growth and production of the bivalves Abra alba and Abra nitida were investigated. Both species display a high growth rate, reaching 13 and 11 mm one year after recruitment, respectively. Annual production is higher in A. alba (1.6 to 3 g AFDW m-2) than in A. nitida (0.8 to 1 g AFDW m-2). Life span of most of the individuals of both species is less than two years.

2.- AZTI-SIO Instituto de Investigación y Tecnología para la Oceanografía, Pesca y Alimentación. San Sebastian Laboratory.

Monthly samples are being collected to study the production, exploitation and use of *Gelidium*, in several localities in the Basque Country.

Data on microbiolgy, heavy metals and organ-halogens, are being obtained from mollusca in several estuaries in the Basque Country (N Spain).

3.- Department of Zoologia. University of Oviedo.

Studies on sedimentation processes, as well as studies on Nemerteans, Hidrozoa, Braquiopoda and Misidacea from slope and continental shelf in Asturias (N Spain).

4.- Department of Animal Biology. University of Santiago de Compostela.

Population studies on intertidal Macrozoobenthos in Lourizán (Pontevedra, NW SPain), in an area influenced by wastewater from a paper mill plant.

Participation in the proyect "Biosedimentary Cartography: Sector Miño River-Ria de Pontevedra (NW Spain)", in Cooperation with Department of Geology, University of Vigo (NW Spain).

5.- Department of Animal Biology. University of Alcalá de Henares (Madrid).

During 1990 a study an Nemerteans in the Coast of Foz (NW Spain) was iniciated. The studies iniciated in previous years in the mouth of Rio Piedras and intertidal and subtidal zones in Punta Umbria Coast (both in Huelva, SW Spain), went on during 1990.

Sweden

L. Hernroth

University of Lund
Department of Marine Ecology

Since 1988 a project on the toxin production and nutritional value of different phytoplankton species to potential grazers have been investigated.
(Contact persons: Edna Granéli, Monika Puch).

Effects of biotic and abiotic factors on the accumulation of radionuclides in *Fucus vesiculosus* L. are being investigated.
(Contact person: Lena Carlson).

A study on the distribution and biomass of benthic algae in comparison with the situation in the 1970's has been conducted off the peninsula Kullen, southern Sweden.
(Contact persons: Lena Carlson, Berit S.-Gustavsson).

In 1990, phytoplankton monitoring in southeast Kattegat continued on a regular basis. The monitoring included measurements of primary productivity and nutrients. Phytoplankton were continously collected and analysed for mussel toxins. A similar phytoplankton monitoring programme was also carried out in Öresund.
(Contact person: Lars Edler).

Royal Swedish Academy of Sciences
Kristineberg Marine Biological Station

In the area of Lysekil a monitoring programme on hydrography, nutrients, chlorophyll and phytoplankton was continued for the second year at one offshore and five inshore stations. The measuring frequency was weekly to monthly. As in the previous five years, in situ primary production measurements were conducted on a regular basis in the Gullmar fjord. In addition to this, incubator measurements of potential primary production were initiated at two stations during 1990.
(Contact person: Odd Lindahl).

In 1990 a team of planktologists from the station participated in the Skagerrak Experiment (SKAGEX). The Kristineberg team was responsible for the B-transect (Gothenburg-Fredrikshavn) during both cruise periods (June and September). Special emphasis was put on measurements of primary- and secondary production in the area. The staff also participated in the "SKAGEX" intercalibration in Arendal, Norway.
(Contact persons: Odd Lindahl, Lars Hernroth).

To gain a better understanding of food uptake mechanisms of copepods, adetailed study of flow patterns around their feeding appendages has been carried out. The small size and fast movement of the appendages prevent studies on live animals and instead scale models of appendages have been studied. To keep Reynolds number constant, the models were observed in various dilutions of glycerol. Results show that even slight changes in morphology, size and movement of the appendages can functionally alter them from sieving rakes to solid paddles. This has important consequences for the understanding of prey selection among copepods.
(Contact person: Peter Tiselius).

An automatic CTD-station, lodged on a raft, powered by a petrol-driven generator and anchored in the central Gullmar fjord has been constructed at the station. The CTD-sond performes daily measurements down to 60 m depth and the data are transmitted (VHF) on line to the laboratory and stored in a computer.
(Contact person: Odd Lindahl).

Soft-sediment macrobenthos is monitored off the Swedish west coast in order to provide base line data for surveillance of the marine environment. This project is part of the Programme for Environmental Quality (PMK). The staion net comprises 53 stations evenly distributed along the coast. Detailed registration is performed concerning density and biomass of individual species and these are also chategorized with respect to biological properties such as means of feeding and/or reproduction. The redox potential and water content of the surface sediment is also examined, as well as the oxygen level in the bottom water. Some of the stations have been monitored for almost 20 years and large scale changes have been recorded during this period.
(Contact person: Björn G. Tunberg).

Hard-bottom epifauna is monitored at 10 stations along the northern part of the Swedish west coast. The main purpose of this programme (initiated in 1989) is to develop a streamlined and efficient technique for the purpose of monitoring shallow (max 20 m depth) hard bottom communities. Monophotography is used along three randomly selected vertical transects at each station. Photographs (slides) covering a surface of 0.25 m^2 are taken at every 2nd metres depth (down to at least 16 m depth), except closer to the surface where photographs are taken at 0, 0.5, 1, 2, 3, and 4 m depth. The slides are projected down on a digitizing tablet and the number of individuals and coverage (percent) of each species are calculated by means of an IBM-compatible computer and special software.
(Contact persons: Björn G. Tunberg, John Andersson).

University of Gothenburg
Marine Research Station at Kristineberg

The Skagerrak-Kattegat project

The objective is to intensify marine research in the Skagerrak and northern Kattegat and to use the results to implement measures based on scientific results. The research is interdisciplinary comprising physical oceanography, circulation of nutrients and persistent organic compounds and ecological effects.
(Contact person: Rutger Rosenberg).

United Kingdom

M. Heath

FISH LARVAE DISTRIBUTION PATTERNS AND PELAGIC ECOSYSTEM NUTRIENT DYNAMICS - M HEATH

In January 1990, a cruise was carried out in the northern North Sea to investigate the role of eddies in the boundary of the Norwegian Coastal Current in the advective loss of larval herring from the North Sea. An eddy was identified from satellite images, surface hydrographic mapping, and with an acoustic doppler current profiler, and tracked for approximately seven days. The distribution of herring larvae within the eddy was studied, together with variations in the rates of primary and secondary production and the growth and condition of the larvae. The eddy entrained larvae from the North Sea plateau and carried them rapidly northwards out of the area. However, the productivity of the entrained water and the growth of the entrained larvae may have been enhanced.

In May 1990, the last of a series of three pilot studies was carried out in Loch Linnhe on the west coast of Scotland, in preparation for a major programme which started in January 1991. During the May cruise, investigations were carried out with an *in situ* plankton camera, designed to measure nearest-neighbour distances of plankton organisms *in situ* in the sea. The main programme which started in January 1991, is a seasonal study of the nitrogen cycling in the loch, involving a number of moored instruments, and a series of 12 cruises at monthly intervals over the whole of 1991. As part of the design phase of the programme, an ecosystem model was developed in conjunction with the University of Strathclyde, and sensitivity analysis of the model used to direct the sampling effort. A key aspect of the programme is the use of moored instrumentation, and to this end, development of nitrate autoanalyser systems for long-term moored deployment was carried out at the Marine Laboratory throughout 1991, together with moored fluorometers, transmissometers, current meters, thermistor chains, and tide gauges.

HERRING SPAWNING GROUND STUDIES - J GAMBLE, J MORRISON

An additional spawning site was located in the Firth of Clyde in April 1990 about 20 km away from the well known site on Ballantrae Bank. Spawn censuses were carried out on both sites and estimates of spawn mortality were made. As in the previous year, the site on Ballantrae Bank was badly affected by a storm which dislodged over 50% of the attached eggs. In contrast, the newly located site to the south of the Isle of Arran was in more sheltered water. It was not affected by the storm which caused damage at Ballantrae but a bloom of the diatom *Skeletonema costatum* sedimented onto the surface of the spawn was correlated with almost 100% mortality of the eggs. Oxygen measurements suggested that the developing eggs were suffocated by the sedimented diatoms.

BENTHIC COMMUNITY RESEARCH - S HALL

Studies in the last year have focused on the effects of physical disturbance on the structure of marine benthic soft-sediment communities. Attention has been paid to the effects of natural disturbance by foraging predators such as crabs and of disturbances caused by fishing practices such as suction dredging and trawling. Field experiments were conducted to examine recolonisation processes in disturbed sediments and conclusions to date suggest that much more attention should be paid to the role of sediment transport, particularly during storms, in controlling community structure. An understanding of these natural larger-scale processes is necessary in order to judge the likely effects of either biological disturbance or disturbance by man. In February 1991 field work was also undertaken to examine gradients in benthic community structure in areas protected from fishing by the presence of a wreck. Samples from this work await analysis.

Studies were also undertaken on the importance of small scale disturbance for foraging by young fish. Preliminary results suggest that fish and invertebrate epibenthic predators are vigilant for such disturbances and that considerable energetic benefits may obtain for those individuals which are able to exploit them.

DUNSTAFFNAGE MARINE LABORATORY, OBAN - PROFESSOR J B L MATTHEWS

Studies on water column and sediment processes in sea lochs and the coupling between such processes reached an intensive stage of close observations in Loch Linnhe in 1990. Exceptionally heavy rainfall in the early months of the year drastically affected the hydrography of the loch and appears to have delayed the development of the spring phytoplankton. When this did develop a measured proportion sedimented to the sea bed. Sediment processes have been measured throughout the period to detect and attempt to quantify the effect of this impact and the flux of nutrients from the sea bed.

Studies have continued on the effects of fish farming activities on the local marine environment, particularly in the water column. A final report on this work is due to be completed in spring 1991. Other work on environmental effects of fish farming are continuing and developing.

USA

K. Sherman

Fisheries Ecosystem Investigations

National Marine Fisheries Service (NMFS), Northeast Fisheries Center (NEFC) Laboratory, Narragansett, R.I.:

The Plankton Ecology Investigation continued its cooperative research on automated plankton analysis. The flow-through system was tested in cooperation with the University of Rhode Island and the results were reported to ICES. The Investigation is also collaborating on a research project being led by C. Davis at Woods Hole Oceanographic Institution to build an in-situ video plankton recorder for near real-time, small-scale analysis of zooplankton distributions.

1990 marks the 30th year of monitoring plankton and environmental conditions across the Gulf of Maine and the 15th year of monitoring in the New York Bight. The survey uses the Hardy Continuous Plankton Recorder, XBTs and surface water samples.

Comparisons between abundance of zooplankton in the Northeast and Northwest Atlantic based on the data from Continuous Plankton Recorder surveys show differing trends, possibly related to different climatic regimes over the past three decades. Zooplankton abundance declined in the Northeast Atlantic with no observable upward or downward trend in the Northwest Atlantic, except for an apparent increase in one copepod species, *Calanus finmarchicus*. Collection of Continuous Plankton Recorder data and the analysis of the plankton time-series in relation to oceanographic and climatic conditions within the U.S. Northeast Continental Shelf ecosystem is continuing.

Field studies on the impact of sludge dumping to the marine ecosystem were conducted during 1990 to: (1) collect samples of midwater fish (principally Myctophidae and Sternoptychidae) and their prey; (2) measure broad-scale water mass identification parameters, (3) conduct a synoptic oceanographic survey and deploy eight satellite-tracked drifters in the area around the ocean dumping site for the Greater New York City, Deepwater Dumpsite 106. Over 1,300 fish and invertebrate samples for chemical analysis from 35 IKMT and 32 Bongo tows were collected, and 46 CTD/Transmissometer profiles were made. The cruise was a joint effort of personnel from the Physical Oceanography Branch, the Chemical Processes Branch, and the Ecosystems Dynamics Branch, as well as the National Ocean Survey. Staff scientists are investigating the potential transfer of contaminants through the food web from plankton and midwater fish to higher trophic levels.

Investigation staff are currently developing methods for analysis of a large data base derived from ecosystem monitoring. One approach utilizing stochastic surfaces devised from gridding techniques provides for statistical modelling to study large marine ecosystems. Options for residual analysis and discriminant function analysis of independent data sets can be selected using map modelling techniques.

NMFS, NEFC Laboratory, Woods Hole, Mass.:

Greg Lough (NEFC) and Page Valentine (U.S. Geological Survey) were able to use the Navy's nuclear submarine *NR-1* (137 ft.) for a study of herring egg bed ecology on Georges Bank, 24 August-5 September 1990. The objective was to presurvey historic sea herring spawning beds on northern Georges Bank to map the sedimentary environments of the sites and surrounding areas and gather associated faunal and environmental data. The submarine *NR-1* visited four spawning areas previously identified by bottom grab surveys (1960s and 1970s) and submersible observations (1970). The *NR-1* began survey bottom time at 0100 EDT, 31 August 1990 and ended at 0730, 1 September 1990, for a total of 30.5 hours. The dive began on northern Georges Bank at 42°4.4', 67° 13.9' (161 ft. bottom depth) and worked in shoaler waters covering 28.0 nautical miles. Transect documentation included continuous side-scan sonar and 8-mm black and white video, and occasional benthos 35-mm photos and visual observations. The survey confirmed that in all four areas, pebble gravel is present as preferred substrate for spawning herring; however, one of the spawning areas has been mostly covered by sand. We observed that there generally is a rapid transition between the two major sedimentary environments which are rippled sand and sand dunes, and pebble gravel. Sand waves are formed by strong tidal currents (ca. 1 knot) which are in the same direction as the surface currents and aligned NW-SE, the same as the dominant sand ridges. The gravel bottom observed was covered with bottom trawl door marks, except in the sand areas where presumably they are rapidly obliterated by the mobile sand. Scallops were observed in all the environments; however, there was no evidence of epifauna on the gravel substrate such a byozoa, ectoprocts, and tubiculous polychaetes found on previous submersible surveys on the extensive gravel area to the east. We interpret that their absence here may be due to the extensive trawling activity observed. Other species common to the area included adult cod, sculpins, dogfish, skate, ocean pout, silversides, and squid.

The sedimentary data obtained on this dive will be published as an interpretive map (digital data base) for eastern Georges Bank, U.S. Geological Survey Miscellaneous Series Atlas. The data also will be used for future investigations, specifically proposed submersible work beginning in 1991 on Georges Bank herring egg beds. We can now select the most important areas to sample from surface ships and submersibles in the initial year of our proposed study.

Dr. Grosslein reports that examination of gut contents at sea continued on the demersal trawl surveys in 1990. More than

15,000 stomachs were examined with a focus on major fish predators including spiny dogfish, cod silver hake, and other hake. Principal prey fish observed were small silver hake (0-group and some 1-year olds) in stomachs of cod, larger silver hake, and red and white hake. Also, herring (25 cm) were found in stomachs of spiny dogfish, larger cod, and white hake. Sand lance appeared to be in low abundance (in both catches and predator stomachs) compared with the early 1980s.

Two cruises were conducted on southern Georges Bank during the period 23 April-18 May to investigate predation on pelagic 0-group fish. A 50-station grid was replicated four times, with a trawl haul and Bongo tow at each station to document the density distribution of both predators and prey. A total of 6,000 stomachs were examined at sea and principal predators of 0-group fish included mackerel, herring, silver hake, spiny dogfish, and sand lance. The most common 0-group fish observed in predator stomachs included sand lance, Atlantic herring, and cod. A pattern of relatively little overlap between predators and prey was observed in 1990, similar to that observed in 1986. Analysis of the joint density distribution of predators and 0-group fish, in relation to consumption estimates based on stomach analysis, will be used to test the hypothesis that the discontinuities in distribution are a direct result of predation. This is particularly important during the April/May period when mackerel are migrating across Georges Bank during vernal warming. This warming and the associated stratification are processes affecting the growth and vulnerability of their prey (0-group gadids and sand lance) as well as the distribution of the predators; thus the predator-prey interactions could be profoundly affected by any significant climatic change.

Data were summarized from observations on 3,500 mackerel stomachs examined on commercial vessels by Foreign Fisheries Observers during the winter and spring of 1990. Total food consumption by mackerel was low during January-March while mackerel were in the Middle Atlantic Bight region, and then increased significantly during April and May as the fish migrated northward into southern New England and onto Georges Bank. The bulk of the mackerel diet consisted of invertebrate zooplankton throughout the study. Predation on age-0 fish, primarily sand lance, occurred chiefly during April and May.

A computerized simulation model was used to evaluate the method of determining number of fish eggs hatched given larval length frequencies from a series of cruises. The model showed that temporal and spatial sampling variability can produce large variability in the results. However, high frequency variability was shown to have less effect than low frequency variability. The interval of time between cruises should not exceed twice the standard deviation of the spawning curve. The assumption of constant mortality rate is important; a length dependent mortality rate can reduce the results to one-third of the true value. Accurate knowledge of the length of time for larval growth is also important. The variability of the results was most sensitive to random variability of the growth rate followed

in order by mortality rate, cruise date, and spawning. The results of this study will be published in *Journal du Conseil* in a paper entitled "Quantitative evaluation of larval hatching estimates derived from larval abundance" by J. Hauser and M. Sissenwine.

NMFS, NEFC, Sandy Hook Laboratory, Highlands, N.J.:

The Ichthyoplankton Dynamics Investigation at the Sandy Hook Laboratory conducted a series of six monthly plankton surveys from October 1990 through March 1991 to measure the changing status of Atlantic herring and sand lance in the Nantucket Shoals/Massachusetts Bay/Georges Bank area. Cruises in autumn and early winter provided the third consecutive year of concentrated sampling activity to monitor the changing status of herring which continue to increase after more than a decade of extremely low biomass in the study area. During the autumn of 1990, larval herring were concentrated along the southern edge of Nantucket Shoals and over the western half of Georges Bank where spawning was centered on Cultivator and Georges Shoals. Moderate concentrations of recently hatched larvae on the Northeast Peak indicate that the spawning range continues to expand eastward as biomass increases.

Sand lance larvae occur in the study area in late autumn and winter. Distribution patterns differed significantly during the past two years. In January 1990, larval concentrations occurred only on Nantucket Shoals. In January 1991, the principal concentrations were restricted to isolated locations over the northern half of Georges Bank. Our larval information suggests that sand lance biomass is in decline, which agrees with predator-prey model simulations. As the biomass of Atlantic mackerel and herring continues to increase, it will continue to depress population levels of sand lance through predation.

NMFS, Southeast Fisheries Center (SEFC), Beaufort Laboratory, Beaufort, N.C.:

In 1990, the Beaufort Laboratory continued work on oceanographic features and processes that influence the survival of larval fishes in the northern Gulf of Mexico and the southeastern Atlantic Bight of the United States.

In the northern Gulf of Mexico, work continued on the spatial distribution, feeding, nutritional status, and growth of larval fishes about the Mississippi River plume. The hydrodynamic mechanisms responsible for the observed accumulation of fishes at the plume front have been resolved.

In the western North Atlantic, research continued to focus on the meteorological and hydrodynamic mechanisms that operate, during winter, in the cross-shelf transport of Atlantic menhaden, *Brevoortia tyrannus*, and other estuarine dependent species to estuarine areas. Work on the influence of the western Gulf Stream front on the spatial distribution of larval fishes and the exchange of larvae between water masses continued.

NMFS, SEFC, Miami Laboratory, Miami, Fla.:

The Southeast Fisheries Center is conducting research on the early life history of fish and invertebrates to determine recruitment mechanisms and population sizes of spawning adult stocks. Research is principally focused on the early life stages of bluefin tuna in the Gulf of Mexico around the Loop current which is the site of bluefin tuna spawning. Experiments were conducted in May 1990 using MOCNESS-1 nets in a sampling pattern across the Loop Current. The discrete depth sampling was done in Loop Current water, transition water, and Gulf Shelf water to test hypotheses on bluefin spawning and subsequent advection of eggs and larvae in the Loop Current. Sorting of the samples is nearly complete and analysis will begin in late 1991. Results of previcus experiments in this area made in 1987, 1988, and 1989 are now forthcoming as larval identifications for all the material are complete. As this is principally tropical fauna, there are a large number of taxa and few specimens of each taxa which requires a great deal of time just to identify the samples. A community analysis will be the focus for studies on this material. Other work in the Gulf includes studies on the early life history of tunas and mackerels along the Mississippi River plume.

A major study of recruitment mechanisms of early life stages is being conducted cooperatively by the Southeast Fisheries Center and the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. It is part of a multidisciplinary project termed SEFCAR (Southeast Florida and Caribbean Recruitment) involving oceanographic studies and biological sampling along the Florida Reef tract around areas of current gyres and eddies which may be used as retention areas by early life stages of fish and invertebrates. Two years of field sampling have been completed, and a third year is underway. The first two years involved transects across the Straits of Florida along the Florida Keys using CTD's, MOCNESS-1, current drifters, and fixed current meters. Preliminary results indicate that a gyre capable of retaining early life stages is seasonally present over the Portales Shelf and that this gyre is used by some fish and invertebrates. A larger and more permanent eddy exists off the Dry Tortugas, and it will be the focus of 1991 sampling. Data analysis for the first two years of study is still underway, but progress is slowed by the large number of fish taxa. Efforts are concentrated on reef fish taxa, principally snappers and groupers, plus spiny lobsters and slipper lobsters. Preliminary results indicate that the slipper lobsters with their shorter larval development time use the Portales gyre, but spiny lobsters are further offshore, which indicates a Caribbean source. Associated with these studies are mitcchondrial DNA studies of adult and larval lobsters to determine genetic origins of the populations. Also laboratory studies to rear snappers, groupers, and lobsters are underway.

NMFS, Alaska Fisheries Science Center (AFSC), Seattle Laboratory, Seattle, Wash.:

The Recruitment Processes Task at AFSC devoted most of its efforts to the Fisheries Oceanography Coordinated Investigations (FOCI), a cooperative research program with NOAA's Pacific Marine Environmental Laboratory. The goal of FOCI is to develop an understanding of causes of recruitment variability in commercially important fishes in Alaskan waters. Most of the efforts have focused on the concentrated and predictable spawning of walleye pollock (*Theragra chapcogramma*) in Shelikof Strait, Gulf of Alaska. A wide variety of physical and biological parameters measured at sea are supplemented by experimental laboratory studies on trophodynamics and behavior of young walleye pollock.

During 1990, a series of five cruises to the Gulf of Alaska supported this program. Specific objectives to these cruises were to estimate the magnitude of the spawning stock size from the abundance of eggs and larvae to oceanographic conditions, and trace the drift and assess the feeding condition of the larvae. An eddy was located in lower Shelikof Strait during the cruises, and this was sampled intensively to characterize it both biologically and physically, and study its dynamics. The last cruise of the year, in September, was designed to describe the distribution and relative abundance of young-of-the-year juvenile walleye pollock using a variety of sampling gears and echo integration techniques.

In February 1990, FOCI sponsored a Recruitment Modelling Workshop which was attended by about 40 scientists from the USA and Canada. Invited presentations on three types of recruitment models (correlative, life history, and ecosystem) were followed by discussion sessions. This workshop was intended to allow active researchers in the field to share current ideas and help FOCI formulate its modelling strategy.

USSR

A.A. Elizarov

1.1. Chemical hydrology of the offshore part of the sea

Studies on chemical hydrology were carried out in the Barents and Norwegian Seas and also in the Northeast Atlantic including the Irminger Sea in the spring/summer period. Earlier than usual increase of phosphate concentrations in the subsurface layer resulted in the faster regeneration of the element. Variations of biogeneous substance concentrations over shelf and continental slope indicated the longer and less intensive as compared with 1989. spring maximum of photosynthesis in the eastern Norwegian Sea. In spring there was observed a high oxygenation of photic layer and intensive destruction of newly formed organic matter in shelf areas west of the British Isles.

1.2. Plankton

Plankton studies were carried out in the Barents and Norwegian Seas in the spring/summer period following the same program as in 1989. In all 2623 mesozooplankton and 261 macroplankton samples were collected during the 14 cruises of the PINRO research vessels using conventional fishing gears (Juday and Hensen nets, Isaaks-Kidd trawl).

The mass development of phyto- and zooplankton (Copepoda and Euphausiacea) is reported to occur 1.5-2 weeks earlier than in 1989 and continue during the whole period of observations which created good conditions for the fish larvae feeding in the Barents Sea. Mesozooplankton biomass increased from 50-100 mg/m^3 to 200-300 mg/m^3 in the reproduction period. The maximum plankton biomass (800-1000 mg/m^3) was observed in coastal areas of Murman

and off the north-western coast of Norway. The value of maximum plankton biomass exceeded the long-term mean one. The total numbers of Euphausiacea was 3 times lower the norm (112 and 332 spec./1000 m^3, respectively). Euphausiid concentrations were distributed westerly and found for a short time due to prevalence of arcto-boreal species Thysanoessa inermis. As a result, cod fed poorly on euphausiids.

Earlier than in 1989 development of phyto- and zooplankton in the south and south-east of the Norwegian Sea and close to the long-term mean dates in central and western parts of the Sea was characteristic of plankton state in 1990. Warmwater zooplankters were distributed more westerly than in 1989 while coldwater ones were mainly observed in the East Iceland Current waters and were spread in the form of a narrow strip from Iceland south-eastward. Representatives of neritic plankton were found nearly in the same areas as in 1989 but were distributed farther off-shore. Plankton biomass increased from 36 mg/m^3 (March) to 784 mg/m^3 (July) in the 0-50 m layer. In June plankton biomass (determined by weighing method) constituted 572 mg/m^3 which is higher than the last year's (461 mg/m^3) and the long-term mean (438 mg/m^3) biomass. During the whole spring/summer period the highest productivity was registered in the southern, south-eastern and eastern parts of the Sea. In June areas with high plankton biomass (500-1000 mg/m^3 and more) were located from the Faeroes and Shetland Islands north-eastward.

1.3. Early stages of life

1.3.1. Ichthyoplankton

Studies of ichthyoplankton distribution and numbers of the most important commercial spring-spawning fishes were proceeded. The studies included analysis of composition and numbers of zooplankton as well as measurements of physical and oceanographic characteristics and pollution.

In the north-eastern Norwegian Sea and adjacent areas of the south-western Barents Sea the emergence of abundant cod and capelin yearclasses was recorded as a result of water warming and due to rich nutritive base; numbers of redfish larvae turned to be higher than the long-term mean value and haddock and long rough dab yearclasses are estimated at larval stage as poor.

According to the results of the larvae abundance survey the blue whiting yearclass from the Northeast Atlantic is estimated as average though the larvae numbers were at a little lower level than the long-term mean one.

1.3.2. O-group fish

Studies of distribution and numbers of O-group of the main commercial fish species were proceeded in adjacent areas of the Barents and Norwegian Seas within the frames of joint cooperation between the PINRO and IMR (Bergen, Norway). O-group fish survey included measurements of physical and oceanographic characteristics. As a result of survey, boundaries of O-group fish distribution area are determined, estimates are obtained concerning the pattern of young fish distribution depending on environment, and also relative numbers of different commercial fish yearclasses are estimated.

Within statistical modelling of processes of commercial fish reproduction we continued constructing the regression models of year-to-year variability of yearclass survival and strength for Arcto-Norwegian cod, Barents Sea and Grand Bank capelin. A number of diagnostic and prognostic reproduction models is constructed which parametrize the effects of factors dependent and non-dependent on stock densities.

E. Rimsh

Mezozooplankton. In 1990, investigation areas were Subdivisions 26, 28, and 29 of the Baltic Sea and the Gulf of Riga. The zooplankton surveys were carried out in February, May, August, and in October-November at standardized oceanological stations(both, International and national). In the spawning areas of main commercial fishes, monthly samples were taken in March through to August. In 1990, a total of 448 zooplankton samples were taken. The fishing gear was Jeddy net of 37/50 with a mesh of 0.16 mm in the filtering cone. The species age and compositions, abundances and biomasses, their distribution over the areas, seasons and layers were studied in relation to concrete oceanographical situations. The food available for larval, young, and adult fishes was estimated.

Nectobenthos(macroplankton). Investigations carried out covered Subdivisions 26 and 28 of the Baltic Sea. The surveys were made in March, May-June, July, September, and in October at seven standardized(national) transects, each containing 4 and more stations above depths of 20-100 m. A total of 190 trawlings were made with a 10-foot model of Isaacs-Kidd trawl with a mesh of o.5 mm in a cod-end.

Investigations covered species, size, age, and sexual compositions, abundance, biomass and their distribution over areas and seasons. The food availability for commercial fishes was estimated.

Macrobethofauna. Investigations covered Subdivisions 26, 28, and 29 of the Baltic Sea and the Gulf of Riga. The surveys were made in February, May, July, and in October at standardized International and national stations. The fishing gear was the Van-Vin's grab of 0.1 m^2, the ground was washed through the sieve with a mesh of 0.5 mm. A total of 169 stations were made. The area of investigations was the same as in the afore-mentioned section.

Ichthtyolankton. Monthly samles were taken in Subdivisions 26,25, 28, and 29 of the Baltic Sea in March through to August. The fishing gears were the IKS-80 net for the eggs and small larvae samplings, and a 10-foot model of the Isaacs-Kidd trawl for larger larvae and fingerlings. A mesh size in the net and the cod-end was 0.5 mm. A total of 540 samples were taken. Investigations were carried out on the terms, scopes, success of commercial fish reproduction, eggs survival, ecology, distribution, larvae growth rate; the fish year-class strength was investigated.

Publications of Interest

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