The Role of Zooplankton in Global Ecosystem Dynamics: Comparative Studies from the World Oceans

Introduction

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The Third International Zooplankton Production Symposium was convened to consider the theme of “The Role of Zooplankton in Global Ecosystem Dynamics: Comparative Studies from the World Oceans”. It was co-sponsored by the International Council for the Exploration of the Sea (ICES), the North Pacific Marine Science Organization (PICES), and the Global Ocean Ecosystem Dynamics Project (GLOBEC). The Symposium was held from 20 to 23 May 2003, at the Congress Center in Gijón, Spain, and was attended by 333 participants from 38 countries.

It is more than 40 years since ICES convened the first Symposium on Zooplankton Production” at Charlottenlund, Denmark, in 1961. At that time the traditional approach to the study of plankton was based on individual scientists working in relative isolation (Reeve et al., 1995). ICES also had a lead role in the organization of the Second Symposium on Zooplankton Production, Plymouth, UK, in 1994, which attracted 200 people from 22 countries. By then, the integration of physics and biology on large-scale cruises had led to more integrated approaches to the study of plankton (Reeve et al., 1995) and heralded the increasing importance of collaborative international programmes, i.e. GLOBEC, and the general concerns about global change. During the last decade (1990–2000), international and national research programmes contributing to GLOBEC have collected and accumulated an important amount of data and information, and this led the scientific community to demand a new international Symposium. Following the high standard set at the ICES Symposium held in Plymouth in 1994, an intensive three-year planning process for the Gijón meeting started with a concept for a global zooplankton Symposium, initially developed within PICES and proposed by Dr Tsutomu Ikeda to the ICES Working Group on Zooplankton Ecology at their annual meeting in April 2000, which was held that year conveniently (for ICES/PICES interaction) in Hawaii. With the addition of GLOBEC as a partner, it was subsequently submitted to the respective organizations for approval. It was approved by the GLOBEC Scientific Steering Committee at their meeting in June 2000, by the PICES Governing Council at the PICES Ninth Annual Meeting in October 2000, and by ICES at the 88th ICES Statutory Meeting in October 2000 as an ICES resolution (C.Res. 2CSY01).

Each organization nominated a convener for the Symposium: Dr Roger Harris (GLOBEC Scientific Steering Committee), Dr Tsutomu Ikeda (PICES Biological Oceanography Committee), and Dr Luis Valdés (ICES Working Group on Zooplankton Ecology). They, in turn, selected a Scientific Committee that included Dr Miquel Alcaraz (Spain), Dr Peter Wiebe (USA), Dr Tsutomu Ikeda (Japan), Dr William T. Peterson (USA), Dr Roger Harris (UK), and Dr Serge Poulet (France). The Local Organizing Committee (IEO-Centro Oceanográfico de Gijón) was made up of Dr Luis Valdés, Dr José María Rodríguez, and Dr Xosé Anxelu G. Morán. The Symposium was partially supported with funds from several international, national, and local institutions (PICES, GLOBEC, SCOR, the Spanish Science Foundation, Gijón Town Hall, and the Oficina Mixta de Turismo de Gijón), which provided partial travel support for 44 young scientists from countries with economies in transition.

Initially, nearly 450 contributions were received for the scientific sessions. The Symposium programme was organized as three half-day workshops, eight scientific
sessions, and a public exhibition on the world of plankton. A mix of full- and half-day sessions accommodated a total of 136 oral presentations and 16 invited talks (two per session). Parallel to the oral presentations, the poster session exhibited 243 posters during the Symposium.

Planning the Gijón Symposium required intense work and substantial coordination among ICES, PICES, GLOBEC, and IEO colleagues. Facilities at the Instituto Español de Oceanografía-Centro Oceanográfico de Gijón (IEO-CO Gijón) were used for workshops and for preparation and coordination of tasks before and after the Symposium. The staff of the IEO-CO Gijón made a tremendous effort to ensure that the Symposium would be a success. The PICES Secretariat provided professional assistance in the planning and development of the meeting by designing and producing the Symposium poster and brochure, providing facilities for online registration and abstract submission on the PICES Homepage, and corresponding with contributors. The GLOBEC International Project Office at Plymouth (UK) also shared the organizational work before and during the Symposium, and they oversaw the manuscript processing for this Special Issue.

The Chair of the Local Organizing Committee (Luis Valdés) opened the scientific sessions of the Third International Zooplankton Production Symposium on the morning of 20 May with a warm welcome address. This was followed by addresses by representatives of the Scientific Committee (Roger Harris) and Conveners of the Symposium (Tsutomu Ikeda), the Chair of GLOBEC (Francisco Werner), the Chair of the Science Board of PICES (Ian Perry), the Deputy Director of the IEO (Eduardo López-Jamar), and the President of ICES (Pentti Maikkilä). The Mayor of Gijón, Paz Fernandez Felgueroso, chaired the Opening Session.

The sessions and their conveners were:

- **Physical variability and zooplankton population dynamics** (Conveners: Miquel Alcaraz and Xabier Iriogoien);
- **Role of zooplankton in biogeochemical cycles** (Conveners: Hans Dam and Roger Harris);
- **Climate influences: What are long-term zooplankton data sets telling us?** (Conveners: Takashige Sugimoto and Hans Verheye);
- **New approaches to zooplankton modeling** (Conveners: Eileen Hofmann and Michio Kishi);
- **Progress in molecular biology** (Conveners: Ann Bucklin and Serge Poulet);
- **Application of new technologies** (Conveners: Gabriel Gorsky and Peter Wiebe);
- **Comparative life histories and life cycles of zooplankton populations within and between North Pacific and North Atlantic** (Conveners: Hans-Jürgen Hirche and Tsutomu Ikeda);
- **Microzooplankton in the marine pelagic: Recent advances from molecules to ecosystems** (Conveners: Dian Gifford and Suzanne Strom).

Three half-day workshops involving a total of 92 scientists were held on 19 May. Topics and conveners included:

- **Gelatinous zooplankton and fish: predators, prey or nuisance** (Patricia Kremer);
- **Meso- and bathy-pelagic zooplankton study: current status and future aspects** (Tsutomu Ikeda);
- **Climate variability, zooplankton abundance and distribution: comparative opportunities from the world’s oceans** (Ian Perry and Harold Batchelder).

At the closing ceremony, the students who gave the best talks and prepared the best posters were honoured. For best oral presentations, the winners were Jaime Gómez-Gutiérrez (Oregon State University) and Marina Marrari (University of South Florida). Jaime reported on his work on a ciliate that infects euphausiids. He showed that through rapid reproduction, the ciliates increase in volume to such a point that the euphausiid host explodes. Marina reported on studies of relationships between zooplankton distribution, community structure, and distribution of anchovies in shelf waters off Argentina. Best poster awards were presented to Ruthy Zahel (The Hebrew University, Eilat) and Soultana Zervoudaki (National Center for Marine Research, Athens). Ruthy’s poster discussed her work in the Red Sea on transport on/off coral reefs at night by predators and their prey. Soultana compared feeding and population dynamics of *Oithona* in three locations that differed along a eutrophication gradient. Each winner was presented with a beautiful large format photograph of zooplankton that was donated by photographer Per Flood (Norway).

Under the direction of Dr Luis Valdés, the Local Organizing Committee arranged a public exhibition on “Plankton: Life Adrift” from 20 to 25 May. The objective was to show examples of planktonic organisms to the public, in which the delicate coloured images produced by the pioneers could be compared with the perfection of modern microphotographs. The display, visited by a total of 512 visitors, included:

- **Exhibition of 12 rare books on marine biology and plankton, from 1554 to 1920**, from the Instituto Español de Oceanografía;
- **Exhibition of 100 large microphotographs of plankton with accompanying texts on plankton biology and ecology**, from Per R. Flood (Bathybiologica A/S, Norway);
- **Exhibition of 25 original paintings by Sir Alistair Hardy**, from the Sir Alistair Hardy Foundation for Ocean Science.

The Symposium revealed a number of long-term data sets with researchers interested in variability, trends, cycles, and comparative ecology of plankton systems. The required harmonization of procedures, results, and analyses were
discussed in the light of the Plankton Status Report produced annually by the ICES WGZE. It was also recognized that the collective value of data sets is greater than their dispersed value and that an accessible data bank for global time-series is strongly needed. The close relationship between variability and climate indicates that plankton time-series analyses are needed if we are to fully understand variability in fish stocks and fisheries.

During the discussions on zooplankton time-series and monitoring in environmental programmes, the role of zooplankton monitoring in the European Water Quality Directive of December 2000 was highlighted. This EU Directive was welcomed as an initiative to oblige EU coastal nations to undertake continuous and standardized monitoring and reporting of the state of life in coastal and transitional waters, but it was noted that zooplankton do not appear as a target community. Zooplankton monitoring was considered important in revealing the quality status of the ecosystem, natural large-scale variability, and regime shifts, and it was thought that zooplankton monitoring should be included at the same level as phytoplankton and benthic monitoring.

New approaches to zooplankton modelling were discussed. Innovative applications of models that advance our understanding of zooplankton population dynamics and the role of zooplankton in biogeochemical cycles were presented. Models cover the full range of processes and scales: coupled biophysical models, models of the population dynamics of zooplankton species or taxa, biogeochemical models, individual-based models, and predator–prey models. It was demonstrated that modelling is an especially powerful tool because it allows novel experiments to be conducted and the testing of hypotheses that are otherwise too expensive or too difficult to explore in situ.

Presentations showed that small-scale turbulence affects a range of zooplankters and processes. There are bottom-up effects that should increase the net production of the system as well as top-down effects that should move biomass into the heterotrophic compartments. Small-scale turbulence also affects sedimentation to some degree. All these effects on biological activities and community structure modify the quantity and/or quality of particulate matter and therefore have consequences for biogeochemical fluxes.

Good examples of the importance of zooplankton in mediating the transport and balance of particulate and dissolved matter in the system were presented. They showed that the degree of coupling between zooplankton and producers gives rise to regional and seasonal variations in the abundance of producer stocks, nutrient utilization and recycling efficiencies, and elemental export ratios. Hence, there is a growing recognition of the essential role that zooplankton play in regional and global biogeochemical cycles.

Technical innovations to study zooplankton were highlighted in two sessions. Recent technical developments in automatic methods to count and measure zooplankton in real time are now able to provide 3-D data from not only physical environments but also biota with high temporal resolution. However, the trade-off between gaining spatial and temporal resolution and losing detailed species and life-stage information has hampered a breakthrough in new methods. Progress in molecular biology can help to resolve...
this, as genetic systems promise to become more popular, cheaper, and easier to apply for the identification of species. Molecular biology is also developing as a powerful tool in understanding zooplankton diversity, dynamics, and production. Field studies presented at the Symposium demonstrated practical applications that have yielded new insights into the role of zooplankton in ocean ecosystems.

Papers presented showed that diverse groups of zooplankton have the potential for several life history traits within one species and among congeners. Regional variations in temperature and production cycles of habitats may play an important role, but the cues controlling the choice of a particular trait are largely unknown. Many species undergo extensive ontogenetic migrations, but the triggers for initiation and termination of the resting phase and for the depth of overwintering stages are still obscure. Since the evaluation of the underlying mechanisms of the life of each species is a key to modelling material cycling and energy flux in pelagic systems via zooplankton, there is an urgent need to resolve these problems through international collaboration.

Improving the scientific culture of society is a prime objective of modern science. This is particularly important in environmental sciences. The Third International Zooplankton Production Symposium was an ideal platform to show the general public basic concepts of the biology, ecology, and dynamics of zooplankton and to attract them to the world of oceanography. The exhibition of paintings, rare books, and microphotographs was a success attended by an impressive number of visitors. Symposium participants were enthusiastic about this initiative, and the conveners recommend the incorporation of similar public outreach exhibitions at future symposia.

Everyone agreed that this was the largest and most exciting zooplankton Symposium that has ever been held. In particular, it was a rare occasion that zooplanktologists living in North Pacific and North Atlantic regions and elsewhere could meet to discuss common issues. The major objectives of the Symposium were fulfilled and the exchange of views, ideas, and data by zooplanktologists from around the world facilitated development of new research directions and ideas. The importance of this Symposium as a firm step towards closer cooperation between ICES, PICES, and GLOBEC must be reiterated. All Symposium participants agreed that we should endeavour to expand such links to other research areas in the future. At the end of the Symposium, colleagues from Japan announced that they were interested in initiating preliminary negotiations to host the next International Zooplankton Production Symposium in Japan.

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References