Human and climate forcing of zooplankton populations

Introduction

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Zooplankton play a key role in the pelagic foodweb by controlling phytoplankton production and shaping pelagic ecosystems. In addition, because of their critical role as a food source for larval and juvenile fish, the dynamics of zooplankton populations have a significant influence on recruitment to fish stocks. In 1961, ICES convened the First Zooplankton Production Symposium in Charlottenlund, Denmark. ICES also played a leading role in the Second Zooplankton Production Symposium on "Zooplankton Production: measurement and role in global ecosystem dynamics and biogeochemical cycles", held in Plymouth, UK, in 1994. The increasing importance of international programmes such as GLOBEC, the general concerns about global change, and the changing role of zooplankton in ocean ecosystems were reflected in the development of this Symposium. This trend was developed further in the Third Zooplankton Production Symposium on "The role of zooplankton in global ecosystem dynamics: comparative studies from the world oceans", held in Gijón, Spain, in 2003. It was the first time that the Symposium was co-sponsored by ICES, PICES, and GLOBEC.

The Fourth International Zooplankton Production Symposium was held in Hiroshima, Japan, from 28 May to 1 June 2007. This Symposium, co-sponsored by ICES, PICES, and GLOBEC, was the first of the series to be held outside Europe, and its focus was on "Human and climate forcing of zooplankton populations". This symposium not only provided a better knowledge of zooplankton production processes but also contributed to a deeper understanding of all marine ecosystems. Zooplanktologists from countries around the world met to address issues important to marine science and to society in this time of rapid and serious climate change. The week-long symposium involved 334 participants from 46 countries, who contributed 141 oral and 250 poster presentations. These demographics clearly indicated the international nature of zooplankton research.

The opening plenary session provided three excellent presentations on different aspects of the symposium theme:

(i) "Impacts of ocean acidification on marine zooplankton: knowns and unknowns", Victoria J. Fabry;

(ii) "In hot water: zooplankton communities now and in the future", Anthony J. Richardson;

(iii) "The role of microzooplankton in a changing ocean", Albert Calbet.

Papers based on these three plenary presentations are included in this symposium issue of the ICES Journal. Parallel oral sessions on a wide range of important zooplankton topics followed throughout the duration of the meeting, and served as the basis for the remaining papers in this special volume. These were:

(i) "Global comparisons of zooplankton time-series", David L. Mackas (Canada) and Luis Valdés (Spain), conveners;

(ii) "Importance of zooplankton in biogeochemical cycles", Hiroaki Saito (Japan) and Deborah K. Steinberg (USA), conveners;

(iii) "The role of zooplankton in foodwebs: changes related to impacts of climate variability and human perturbation", Hans G. Dam (USA) and Michael St John (Germany), conveners;

(iv) "Mortality impacts on the ontogeny and productivity of zooplankton", Mark Ohman (USA), Serge Poulet (France), and Anthony Verschoor (The Netherlands), conveners;

(v) "Zooplankton functional groups in ecosystems", Sanae Chiba (Japan) and Sun Song (People's Republic of China), conveners;

(vi) "Microbial loop vs. classical short food chains: implications for appraisal of foodweb efficiency and productivity", Ulf Bamstedt (Sweden), convener;

(vii) "Environmental and other constraints on zooplankton behaviour, life histories, and demography", Charles B. Miller (USA) and Atsushi Tsuda (Japan), conveners;

(viii) "Zooplankton biochemistry and physiology: practical and potential biotechnology applications", Ann Bucklin (USA), Adrianna Ianora (Italy), and Kurt Tande (Norway), conveners;

(ix) "Advances in image technologies and the application of image analysis to count and identify plankton", Cabell Davis (USA) and Xabier Irigoien (Spain), conveners;

(x) "Analysis and synthesis: modelling zooplankton in aquatic ecosystems", Daniel Grunbaum (USA) and Michio Kishi (Japan), conveners.

Before the main Symposium, three well-attended 1-day workshops were held. The topics were:

Workshop 1: "Temporal and regional responses of zooplankton to global warming: phenology and poleward displacement", Wulf Greve (Germany), convener;

Workshop 2: "Zooplankton research in Asian countries: current status and future prospects", Sun Song (People's Republic of China), Sanae Chiba (Japan), and Young Shil Kang (Korea), conveners.

Workshop 3: "Krill research: current status and its future", So Kawaguchi (Australia) and William T. Peterson (USA), conveners.

A collection of papers from the krill workshop will be published in a special issue of *Deep Sea Research*.

We anticipate significant advances before the next Zooplankton Symposium, such as automated/semi-automated characterization of zooplankton spatial and temporal distribution on a global scale, coupling foodweb models from phytoplankton to fish, coupling between physical and biological models, and assessments and prediction of climate change on marine resources and marine ecosystems. Society is beginning to demand a predictive capability regarding marine ecosystems, and it is likely that this will be a major challenge for the community. With developing new technologies, carefully posed new questions and hypotheses, and with new people entering the field, progress is assured. The quality of papers presented at this Fourth Zooplankton Symposium provides us all with real confidence for the future.

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