
Dissertations

Zoobenthos biodiversity in Arctic fjords

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Post-doctoral (habilitation) thesis in earth sciences.

The post-doctoral (habilitation) dissertation of Dr Maria Włodarska-Kowalczyk of the Institute of Oceanology PAS, Sopot, entitled ‘Zoobenthos biodiversity in Arctic fjords’, is a monothematic cycle of five papers published in journals with an international readership in 2007–08. Two appeared in the *Marine Ecology Progress Series* (Włodarska-Kowalczyk & Kędra 2007, Włodarska-Kowalczyk & Węśławski 2008) and one each in *Estuarine, Coastal and Shelf Science* (Włodarska-Kowalczyk et al. 2007), *Marine Biology* (Włodarska-Kowalczyk et al. 2007) and *Polar Research* (Włodarska-Kowalczyk 2007). Not only is Dr Włodarska-Kowalczyk the first-named author of all these publications (in *Polar Research* the only author); she is also the unquestioned leader, taking full responsibility for the conception of the work, sampling of research materials, taxonomic identification, statistical analyses and preparation of texts for publication. Both the choice of papers and their arrangement are entirely logical.

Like most of Dr M. Włodarska-Kowalczyk’s scientific output to date, her post-doctoral dissertation addresses the problems of polar regions, in particular their biodiversity, not only in the context of their species richness, but also, and perhaps above all, with a view to finding new methods of defining and measuring species diversity, the mechanisms responsible for the changes it undergoes, and the relationship existing between biodiversity and the functioning of polar ecosystems. Since polar marine ecosystems are highly sensitive to environmental change, their biodiversity (and especially the changes in it) are a potentially crucial indicator of human activities on both a local scale (e.g. anthropogenic pollution, habitat destruction,

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accidental or intentional introduction of non-native species) and a global scale (e.g. greenhouse effect, climate change). The consequences of human activities on observed or predicted changes in the functioning of polar ecosystems are still insufficiently understood; even our knowledge of their biodiversity is rather sparse. In the context of the threat to biodiversity from anthropogenic transformations of the environment and climate change, Dr Włodarska-Kowalczyk's post-doctoral thesis addresses a highly relevant problem.

The subject of the dissertation is the evaluation of the biological diversity of Arctic fjords, the possibilities of describing it objectively, and the practical application of this knowledge in order to gain a better understanding of how polar marine ecosystems work. Three fundamental research questions emerge from the author's five publications: 1) How can the methods for evaluating the biodiversity of the benthic fauna be optimised? 2) What is the role and influence of environmental factors on biodiversity? and 3) How do the biodiversities of the marine ecosystems of both polar regions compare? To begin with, the author attempted to provide the most objective possible assessment of the biodiversity of Arctic fjords using different methodological approaches, from basic ones like drawing up species diversity lists to using surrogate methods/measures that take into account environmental factors and the spatial structures of benthic faunal associations. The first problem she tackled was the possibility and means of achieving an objective assessment (evaluation) of bottom fauna species diversity using molluscs as an example. Using a meticulously prepared methodology and benthos sampling strategy, taking into consideration the diversity of ecological groups and niches, and applying appropriate methods of statistical analysis, she made a successful attempt at assessing the 'true species richness' of molluscs in Kongsfjorden, Svalbard, (Włodarska-Kowalczyk 2007). The same research theme, this time investigating the changes in biodiversity along natural environmental gradients, was addressed in the paper on the surrogacy of complete data sets on the macrofaunal species composition of an Arctic fjord using data on higher taxonomic units (genus, family, order etc.). This method was found to be applicable for evaluating biodiversity with respect to generic and family level identification data as well as polychaete species data (Włodarska-Kowalczyk & Kędra 2007).

The role and influence of environmental factors on biodiversity are evaluated in two papers. In the first one (Włodarska-Kowalczyk et al. 2007) the measurement of macrofaunal biodiversity was used to assess the ecological state of habitats along a gradient of sediments disturbed by the inflow of fresh waters and the mineral material load carried by the rivers

entering Adventfjorden, Svalbard. In three zones delineated by the author, significant differences were found in the numbers, biomass, taxonomic composition and biodiversity of the benthic associations. The species richness was least in the waters over the most dynamic and changeable tidal slope zone and greatest in the stable sediments in the central part of the fjord, where conditions in general were the most stable. The relationship between the biodiversity of the benthic association and the spatial structure of species distribution was covered in the paper published in MEPS (Włodarska-Kowalczyk & Węśławski 2008). On the basis of studies carried out in Hornsund fjord, Svalbard, the author demonstrated that the associations there exhibited little biodiversity: in areas where the activity of environmental factors was strong, the spatial structure of associations was less differentiated than that of associations with a high biodiversity, which have a mosaic-like distribution.

The thesis ends with an article in which the author compares the species diversity of the polychaetes inhabiting Arctic and Antarctic fjords in the context of the hypothesis that the species diversity of the Antarctic fauna is greater (Włodarska-Kowalczyk et al. 2007). The author concludes that the biodiversities of the polychaete fauna of the Arctic and Antarctic at the level of both species and higher taxonomic units do not exhibit any significant differences. In her opinion, this is evidence that the biodiversity in these regions is shaped more by the similarity of ecological niches than by historical processes.

Presented in the form of a post-doctoral dissertation, this set of publications has much to recommend it in the way of practical observations, comments and methodological suggestions, which may serve other researchers interested in applying the biodiversity concept as a universal index of the state/quality of marine ecosystems in polar regions. This is what should be regarded as the added value of this dissertation.

In summary, the broad scope and degree of differentiation of the research presented, the innovative methodological approach to the problem of the biodiversity of polar fjords, and the methodological recommendations, are an indisputable quality of this thesis. The greatest achievements of this work are the comprehensive approach to the problem of assessing the biological diversity of polar fjords and the attempt to apply this as an indicator of the current state of that ecosystem. At the same time, this work shows that the author is looking for the best possible methods of describing and analysing this diversity. The problem tackled is an ambitious and highly relevant one in the context of global changes; it is the focus of interest of many teams of scientists.

List of publications comprising this post-doctoral thesis:

1. Włodarska-Kowalczyk M., 2007, *Molluscs in Kongsfiorden (Spitsbergen, Svalbard): a species list and patterns of distribution and diversity*, Polar Res., 26 (1), 48–63.
2. Włodarska-Kowalczyk M., Szymelfenig M., Zajączkowski M., 2007, *Dynamic sedimentary environment of an Arctic glacier-fed river estuary (Adventfiorden, Svalbard). II. Meio- and macrobenthic fauna*, Estuar. Coast. Shelf Sci., 74 (1–2), 274–284.
3. Włodarska-Kowalczyk M., Kędra M., 2007, *Surrogacy in natural patterns of benthic distribution and diversity: selected taxa versus lower taxonomic resolution*, Mar. Ecol. Prog. Ser., 351, 53–63.
4. Włodarska-Kowalczyk M., Węsławski J. M., 2008, *Mesoscale spatial structures in soft-bottom macrozoobenthic communities: effects of physical control and impoverishment*, Mar. Ecol. Prog. Ser., 356, 215–224.
5. Włodarska-Kowalczyk M., Sicinski J., Gromisz S., Kendall M. A., Dahle S., 2007, *Similar soft-bottom polychaete diversity in Arctic and Antarctic marine inlets*, Mar. Biol., 151 (2), 607–616.

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