Foreword

What is the role of physical factors in controlling the biota of the Baltic Sea? It is well known that low salinity supports lower species diversity as compared to fresh- or marine waters. Besides, the marked salinity gradients and complex bottom topography make the sea hydrophysically more dynamic than many other systems. The alternating periods of stagnation and renewal of deep waters from the North Sea result in decade scale fluctuations in the Baltic Sea ecosystem. During the past 10 000 years the significant natural environmental alterations between more saline and fresher periods have shaped the characteristic mixture of marine, brackish water, and freshwater species of the Baltic Sea.

On the other hand, the Baltic Sea receives a strong load of human induced waste, and besides climate change eutrophication is considered to be a prime factor for the development of its biota. Eutrophication increases, for example, the production of pelagic and benthic algae, favours filter-feeders in the benthic system, and affects the dynamics of the fish stock. Since the 1960s cyano-bacterial blooms have become common in the whole Baltic Sea. However, the relationship between the nutrient load and the state of the biota is not straight-forward. Recently the mass development of benthic filamentous macroalgae and the formation of drift algal mats were recorded in some Estonian coastal areas after an improvement of the water quality.

Since the late 20th century global scale biological invasions have been levelling previously isolated biotas. Many natural barriers to dispersal have been weakened and consequently the rates of invasions have significantly increased in the past 50 years. To this date more than 100 species of non-native animals and plants have been recorded in the Baltic Sea. Of these species less than 70 have been able to establish reproducing populations. Biological invasions are believed to affect the diversity of the Baltic to the same extent as does chemical pollution.

Fish are the main product harvested by man in the Baltic Sea. Because of their socioeconomic importance, the fish stocks have been historically investigated more than other structures of the marine food web. Recent efforts to cope with the decline of the fish stock due to the overexploitation and increased pollution have produced good results. However, the possible negative effects of climate warming and the establishment of nonindigeneous species are stressed.

It has been often stated that the Baltic Sea is the most studied sea area in the world. To date, however, most evidence about various processes is circumstantial. This is due to the fact that the researchers have primarily concentrated on the issues of spatial distribution or temporal trends of the biota whereas experimental studies are in the minority. Therefore we know very little about the prevalence of different environmental factors in moulding the biodiversity of the sea, the

relationships between biodiversity and the magnitude of ecosystem processes, and how biodiversity contributes to the stability and maintenance of the ecosystem in the face of perturbations. In that respect the Estonian coastal sea is no exception as the bulk of the existing evidence about the processes taking place in it is circumstantial. However, the popularity of experimental studies as a tool to describe the processes in different subsystems of the sea has notably increased in the previous decade.

The present volume of the *Proceedings of the Estonian Academy of Sciences* contains scientific papers presented to the annual seminar of the Marine Biology Department of the Estonian Marine Institute held at Jäneda on 28–29 January 2002. During the seminar we discussed the importance of local conditions and global environmental changes to the structure and functioning of the Estonian coastal ecosystem. As a result of this discussion some papers were selected for this volume focussing on the state of the art of marine research carried out at our department.

Phytobenthic investigations in the Estonian coastal sea date back as far as the end of the 18th century. In this volume we summarize the current knowledge of the species composition and quantitative distribution of phytobenthos in the Gulf of Riga. Among phytobenthos charophytes are well known as a highly developed and diverse group of algae. They are widely distributed in freshwater, brackish, and marine habitats from tropical to polar regions. Recent species prefer freshwater environments while the majority of fossil species occurred in brackish waters; even marine species were quite common. In the Baltic Sea algae of this group inhabit sheltered coastal areas where their distribution pattern is primarily controlled by exposure, sediment type, and salinity regime. In recent decades the species number, distribution area, and biomass of charophytes have significantly declined virtually in the whole Baltic Sea. This decline has been attributed to increased nutrient loads resulting in higher productivity of phytoplankton, epiphytic algae, and angiosperms. The reduction in the available light intensity leads to an upward shift of the depth limit of charophytes and the replacement of the charophyte dominated community by phanerogams and filamentous algae. In this volume the variability of the spatial distribution of charophytes is related to various environmental variables in the West Estonian coastal sea.

In highly eutrophicated systems mass development of filamentous algal species is common in the coastal areas worldwide. When detached the algae form drifting mats and cover the sea bottom in extensive areas. Drift algae have been increasingly observed also in the Baltic Sea where they have become an ecological and economic problem. The algal mats modify the nutrient dynamics and significantly disturb benthic vegetation and invertebrates. The decomposition of the algae often results in widespread anoxic conditions, which destroy living organisms in the underlying sediments and destabilize the whole shallow-water ecosystem. Because of the ecological importance of the macroalgal mats it becomes essential to know which variables control the formation and decomposition of the drift algae. According to the literature the decomposition rate of the drift algae is highly variable and species specific. Algal mats may already disappear within a month but likewise persist for more than two years. In this volume we present the results

about the mapping studies of drift algae. Two locations were selected where the seasonal dynamics of macroalgal mats was followed.

Two papers of this volume focus on the invasive species. It has been shown that biological invasions in terrestrial and aquatic systems may render previously stable systems unbalanced and unpredictable and they may severely affect the biological diversity in the invaded area. Consequences of invasions are difficult to predict, in part because of the role environmental variability plays in determining the outcomes of invasions. Limitations of current models are related to the scarcity of experimental data concerning the mechanisms behind impacts. Currently, most evidence about the effects of invasions is circumstantial as impacts are based largely on observational correlations rather than experiments, and processes causing the patterns have not been identified. Only a limited number of species have been able to adapt to the conditions of the Baltic Sea. In part this is due to its isolation, short geological time of its existence, low salinity, and large fluctuations in temperature. Deposit feeders dominate in soft-bottom communities of the northern Baltic Sea. The competition for limited food and habitat appears to be the main mechanism regulating the population size of deposit feeders. Within the last few decades, a number of benthic animals have invaded the Baltic Sea. Since 1985 the North American detritus-feeding polychaete *Marenzelleria viridis* (Verrill) has become established in several areas of the Baltic Sea. As a deep sediment burrower, this species performs an entirely novel function in the northern Baltic Sea and, hence, has potential to cause the greatest ecological impacts. Furthermore, the addition of an efficient deposit feeder into the benthic system is likely to stress the native fauna through competitive interactions for food and/or for space. One paper experimentally evaluates the competitive interactions between *M. viridis* and the keystone species of the Baltic Sea *Macoma balthica* L. The other paper studies the effect of the recent planktonic newcomer, the cladoceran *Cercopagis pengoi* (Ostroumov), on the native mesozooplankton communities. The extensive dataset on 1997–2002 enables us to estimate whether bottom-up or top-down effects dominate in the pelagic food web and whether the external nutrient loads and/or the invasion of *C. pengoi* have a substantial effect on the dynamics of mesozooplankton.

The biomass distribution of macrozoobenthos within phytobenthic communities was studied in the Väinameri archipelago sea during the summers of 1993–2003. These data were compared with the historical observations from the 1960s. The results pointed to a major shift in the salinity regime and eutrophication.

For the first time a special volume of the annual seminar of the Marine Biology Department of the Estonian Marine Institute contains two papers on fish ecology and management. Eelpout is a relatively common viviparous fish in the Baltic Sea inhabiting both shallow and deep areas of the Gulf of Riga. In this volume the spatial variability in some important parameters of eelpout is discussed. Reallocation of the Baltic herring fishing possibilities is treated based on biological information of the fish stock identity. Possible theoretical solutions are presented.

The compilers of this volume are grateful to all contributors.

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