Helgol Mar Res (2002) 56:1–2
DOI 10.1007/s10152-002-0102-6

EDITORIAL

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ECSA workshop: Community ecology of soft bottom mussel beds

Published online: 26 March 2002

An international workshop on the ecology of mussel beds with 42 participants from six nations was held at the Wadden Sea Station Sylt of the Alfred Wegener Institute for Polar and Marine Research on 2–6 August 2000.

This workshop focused on the ecology of soft bottom mussel bed communities, which are typical elements of the Wadden Sea ecosystem and the intertidal sandy and muddy shores of the North Sea coasts and their estuaries. The objectives were to update the state of current research by pooling the experience of various different "mussel bed ecologists" and to identify the needs of future research issues. We aimed to focus mainly on basic research and discussed advanced aspects or conflicts between mussel bed ecology and fishery only marginally.

To introduce the workshop guests to the local situation, K. Reise and H. Asmus gave an overview on the ecology of mussel beds near the island of Sylt. They showed that mussel beds provide a unique habitat on sedimentary coasts, which far surpass their surroundings in terms of species richness, biomass, productivity, trophic transfer and material cycling. Even at the comparatively small spatial scale of the Wadden Sea around Sylt, mussels are highly variable and complex in biogenic structure, species composition and species interactions.

This was also confirmed by M. Tsuchiya, who presented the ecological characteristics of the mussel beds of Japan and East Asia (this volume), showing that mussel beds are also able to accumulate biodeposits on exposed rocky shores and create a special environment. He further drew attention to the associated fauna causing a higher biodiversity in mussel beds compared with the ambient areas.

The habitat requirements of blue mussels in the Dutch Wadden Sea were described by B. Brinkman (this volume). Mussel beds in the 1990s showed a high preference for regions with low wave action and moderate flow velocities as well as immersion times of less than 50%. Mussel beds are very susceptible to wave disturbance, and thus increasing storminess will limit mussel bed distribution in sedimentary environments.

On the other hand, mussels also affect their ambient physical environment. This was demonstrated by studies with a laboratory flume by L. van Duren and co-workers. The filtration activity of mussels has modifying effects on the benthic boundary layer structure. Mussel beds create a microturbulent layer beneficial for food retention. This can also be shown using flume studies, as demonstrated by J. Widdows who found that mussel beds accumulate and stabilise sediments at high densities, while low densities and disrupted mussel layers may enhance erosion (this volume).

Most of the presentations elucidated the development of the population of blue mussels and the state of the stocks in different regions. Although larval supply is variable, it is rarely a limiting factor in mussel recruitment. However, larval supply seems to be dependent on parental stocks, as a study by C.P. Günther on larval abundance of mytilid larvae at different places in the boreal east Atlantic (Wadden Sea to the White Sea) showed. Recent phases of mussel bed declines in the North Sea may have been caused by a combination of overexploitation and natural disturbances.

In the Dutch Wadden Sea, A.C. Smaal explained that the large dynamics are due to variability in recruitment success, climate-induced mortality, predation and fishery. Subtidal stocks of wild mussels show great annual variability, and have decreased since 1990. Subtidal stocks of culture plots are more stable. Especially on the Lower Saxony coast, the development of mussel stocks declined to critical values, as presented by H. Michaelis, and G. Nehls, who reported that in the Wadden Sea of Schleswig-Holstein, mussel beds covered an area of 1,000 ha in 1999, which is about one-third of the value found 10 years ago. They discussed the development of the mussel stock in relation to recent history, the impact of storms, ice and fishery.

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Different types of mussel beds exist on sedimentary shores. In some regions, natural mussel beds are able to persist continuously over several decades, while in others bare flats and mussel beds may alternate over the course of time. Mussel beds reveal cycles of disappearance and recurrence, preferring distinct locations on intertidal flats. Mussel bed layers could be found buried in the sediment. G. Hertweck and G. Liebezeit (this volume) suggested a period of 35–40 years for forming those mussel bed layers. The occurrence of mussel bed layers buried in sediments provides an insight into the historic development of tidal flat environments.

Mussel beds provide suitable substrates for sessile epibionts and a rich associated fauna. C. Buschbaum suggested that the recruitment of the barnacle *B. crenatus* to subtidal mussel beds is strongly affected by adult shore crabs and juvenile starfish, whereas in the intertidal zone recruits of *Semibalanus balanoides* are mainly influenced by grazing periwinkle *Littorina littorea*.

A comparison between hard bottom mussel beds and soft bottom mussel beds was presented by M. Thiel and N. Ullrich (this volume). Based on their investigations they formulated the hypothesis that mussels on hard bottoms primarily provide substrate for the accompanying fauna, while mussels on soft bottoms provide both substrate and food resources.

B. Saier showed that the low tide line separates mussel beds into two distinct zones (this volume). In the subtidal zone, species richness and diversity of non-attached epifauna was much higher than in the intertidal zone. Abundances dropped with increasing submergence. This was due to higher densities of periwinkles and crabs, *Carcinus maenas*, in the intertidal mussel beds.

Some presentations focused on the fishery aspects of mussel ecology. Mussel fishery changes the physical structure and complexity of the seabed and has a strong impact on coastal ecosystems, where mussels are the dominant component. This was demonstrated by P. Dolmer and R. Frandsen at Limfjorden (this volume).

U. Walter showed that the seeding density of mussels on culture plots is one important factor determining somatic growth of *M. edulis* and controlling the yield of subtidal mussel cultures. Intertidal mussel beds have been decimated since 1988 with incidental large-scale spatfall in 1994 and 1999. In the poster session, the technique of long-line mussel culturing was demonstrated by D. Bryant (King's Lynn Fishing Industry Co-operative, Norfolk, UK). This could be an important step towards a sustainable mussel fishery, in that exploiting seed mussels from wild beds and the use of large areas of sea bottoms for culture plots could be reduced, especially if this technique is approached offshore.

Ecological models are increasingly being used as a tool to improve management of shellfish cultivation strategies, and therefore the existing approaches to modelling mussels have been reviewed. In future, dynamic energy budget (DEB) models will need to include the ability to parameterise population level processes (H. Beadman, this volume).

Poster presentations revealed topics from the community ecology of mussel beds and species diversity (B. Aspden), and sediment deposition (M. Browne) to methods of stock assessment (D. den Os), from settlement of bivalve larvae in relation to flow (I. Hendricks) to investigations into the valve movement behaviour of mussels in a special laboratory device (J. Wolf and H. Leuchs).

A. Wehrmann emphasised in the last oral presentation of the workshop that no common definition exists as what constitutes a mussel bed. He showed that soft bottom mussel beds often consist of an aggregation of two species, *Mytilus edulis* and *Cerastoderma edule*, and that this should be considered in the future.

Additional aspects of mussel bed ecology were touched on in discussions. One point was substrate availability: Suitable substrates for attachment are rare outside established mussel beds at sedimentary coasts. The sustainable use of mussel resources should attempt to maintain, restore or provide suitable substrates for juvenile attachment. Another point was the present mussel fishery, which should be open to some modifications due to the ecological characteristics of the mussels and the expected climatic changes. The provision of an off-bottom refuge for juvenile mussels from benthic predators will increase the efficient use of mussel resources and will help in avoiding destructive fishery on natural beds of seed mussels. Expected climate changes with more mild winters and increasing storminess may require the mussel fishery to turn more to off-bottom spat collection. On coasts with mussel beds on intertidal flats, the role of the subtidal populations and drifting mussel aggregates needs further research. The importance of introduced species for the development of the mussel beds should also be a future research issue. At North Sea shores, the introduced Japanese oyster *Crassostrea gigas* is advancing and capable of displacing mussel beds.

Mussel beds are biotic structures with a high potential to modify and control ecological relevant processes in the ambient ecosystem. Changing these structures by man will have consequences on the total ecosystem, especially on the material cycling, energy flow, species diversity, species interactions, trophic interactions as well as sediment stability and hydrodynamics.