Macrozoobenthic communities as an indicator of the ecological state of benthic habitats along the Bulgarian Black Sea coast (Burgas Bay)

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Summary of PhD Thesis

The aim of the present study was to investigate the current biodiversity of soft-bottom macrozoobenthic communities in the shallow coastal zone of Burgas Bay, evaluate the changes in their structure and composition under the influence of anthropogenic and natural environmental factors, and analyze the performance and sensitivity of zoobenthic biotic indices in ecological state assessments of coastal habitats. Two types of coastal habitats - unvegetated sandy bottoms and seagrass meadows - were studied, over the course of an initial pilot experiment (Sozopol Bay, 2012), and another, larger-scale experiment in a stable gradient of anthropogenic pressure (Burgas Bay, 2013-2014).

The pilot study in Sozopol Bay revealed significant differences in the biodiversity, abundance, biomass and structure of the macrozoobenthic communities in the seagrass meadows and the adjacent unvegetated sediments. The communities were influenced by the local point source of untreated sewage waters, with a slight increase of the proportion of tolerant and opportunistic taxa at the site closest to it, but the observed effects were not severe and were concordant with the intermediate disturbance hypothesis. Due to the nature of the experiment, these results must be considered preliminary and the study should be replicated to allow more definite conclusions.

In 2013-2014, 147 taxa in total were identified in the soft unvegetated sediments of the shallow coastal Burgas Bay. The diversity, abundance and biomass were high during the study period, and similar to the typical values for the Bulgarian Black Sea. The taxonomic structure of the communities did not deviate significantly from expectations, suggesting relatively low amounts of ecological stress. The multivariate analyses revealed the presence of 4 infralittoral biotopes according to the Bulgarian national classification: Infralittoral fine and medium sands with *Chamelea gallina*, *Lentidium mediterraneum*, *Tellina tenuis*; Infralittoral shelly sand and gravel with varied fauna; Infralittoral coarse and medium sand with *Upogebia pusilla*, Infralittoral muddy sand with *Melinna palmata* and *Anadara kagoshimensis*. The initial experimental hypothesis stating that the structure and composition of the macrozoobenthos change under the influence of the anthropogenic gradient in Burgas Bay was confirmed by both the classical (PERMANOVA) and the modeling (manyGLM) statistical methods; the most significant environmental parameters were eutrophication indicators (nutrient and suspended matter concentrations in the water column) and the

pressure index LUSI. However, both analyses also singled out the contribution of natural factors, specifically, the grain size composition of the sediments, in structuring the communities.

In the seagrass meadows in Burgas Bay, 93 taxa in total were identified in 2013-2014. The macrozoobenthic communities exhibited very high biodiversity, abundance and biomass, underlining the significance of these habitats for the functioning of coastal ecosystems in the Black Sea. The taxonomic structure of the communities also did not deviate significantly from expectations, suggesting relatively low amounts of ecological stress. The community composition and structure were similar to the associated fauna of seagrass meadows from other parts of the Black Sea and other seas in the temperate zone: herbivores and detritivores (*Rissoa membranacea*, *Bittium reticulatum*, oligochaetes, capitellid and spionid polychaetes) dominated; there was also a significant proportion of lucinid bivalves and crustaceans (*Monocorophium acherusicum*, *Ampelisca diadema, Chondrochelia savignyi,* etc.). There were no sharp delimitations between stations allowing the definition of separate subtypes of seagrass-associated zoobenthic communities in the study area; rather, the observed differences probably reflected the pressure gradient in the area, with an increase of the proportion of tolerant taxa in the inner, more impacted parts of the bay, as well as at the Ropotamo river mouth due to natural enrichment. Both types of multivariate analyses determined that anthropogenic eutrophication (nutrients in the water column, LUSI), and also sediment grain size composition and seagrass biometric parameters, were the most important factors for the observed community composition and structure. The modeling method seems to be more sensitive in this case, giving a higher weight to factors with more ecological significance to the infauna such as the below-ground biomass of the seagrasses.

The tested biotic indices - the Bulgarian national monitoring indices H', AMBI, M-AMBI, M-AMBI*n, and the Mediterranean index BENTIX - exhibited a variable performance and sensitivity in both types of habitats in the study area, and did not always adequately reflect the anthropogenic gradient. On the other hand, the changes in community structure and composition were accurately captured by the changes in ecological group proportions. This is likely due to design peculiarities of the indices, as well as the lack of specific reference values for some of the shallow coastal biotopes. This is especially true in the seagrass habitats, where the naturally higher proportion of tolerant organisms particularly influenced the assessments. The indices demonstrated a reaction to the environmental gradients in the area, but it was also influenced by their particularities, and was not always in the expected direction (negative to pollution and pressure indicators, and positive to indicators of non-impacted conditions). The correlation of the index assessments with environmental parameters was surprisingly good in the seagrass habitats, which gives reason to suppose that they will perform well if the classification system and reference values are adapted accordingly. The level of agreement between indices was low in both types of coastal habitats, suggesting low comparability of the assessments. The discrepancies also often cross the good/ moderate ecological state boundary - a serious disadvantage with potentially considerable negative consequences for the conservation and management of coastal ecosystems.

Until these shortcomings are addressed, it is recommended to use several or multimetric indices with documented high performance and sensitivity, and additionally examine the ecological group composition of the communities. The addition of functional diversity indices to the monitoring programmes will allow more comprehensive assessments consistent with the MSFD philosophy of maintaining functioning marine ecosystems.