A community of meiofauna relying on chemoautotrophic bacterial symbioses in a permeable subtidal sand (Islands of Elba and Pianosa, Italy, Mediterranean Sea)

Observations
In the study region in medium to coarse grained sand in a few metres water depth several metazoa species from different taxa are found to live far below the sediment surface layer where oxygen can be measured (1-5 cm sediment depth) in a transition zone (5-20 cm) where only low to moderate sulphide concentrations (≤ 1-2 μM) prevail. Many of the organisms found here have a bright white appearance indicating the possible association with sulphur bacteria as ecto- and/or endosymbionts that themselves carry elemental sulphur as a metabolic intermediate.

Hypothesis
The microxic-microsulphidic layer of (some) permeable sands harbour a rich community of chemoautotrophic symbioses as diverse as e.g. deep-sea chemoautotrophic faunal assemblages.

Examples of known and assumed symbioses, some highly speculative

Protista
Ciliophora

At least one ciliate of the *Tracheloraphis/Kentrophoros*-type *Karyorelictida* can be found regularly in the sediment samples. Preliminary light microscopic investigation shows two rod-shaped bacterial morphotypes attached externally to the cell wall interspersed between the ciliary bands. Most likely there are more than one species of ciliate to be found showing a whitish appearance. Remarkably *Kentrophoros* sp. is described as having no oral apparatus (sic!)

Plathyhelminthes
Turbellaria
cf. *Paracatenula* sp.

At least one „flatworm“ of the *Paracatenula*-type Retronectidae can be regularly found in the sediment samples. Mouthless *Paracatenula* species have been found in the wider Carribean (Belize? Bermuda?) and in the Red Sea (Dahab?) carrying symbiotic bacteria within bacteriocytes in the intestine transformed into a trophosome (pers. comm. Ott). Gruber and Ott, unpubl. determined the symbionts as members of the α-subgroup of the Proteobacteria. Most likely there are more than one species of *Paracatenula* to be found showing a whitish-rosé appearance. This is the first record of *Paracatenula*-like species with symbionts in the Mediterranean and thus of special biogeographical interest given its occurrence in the western Atlantic and the Red Sea.
Annelida
Oligochaeta

*Olavius algarvensis*

*Olavius ilvae*

*(Olavius n.sp.)*

Two species of these gutless oligochaetes have been intensely studied, *O. algarvensis* becoming a model organism for a multiple bacterial endosymbiosis in a metazoan host (Dubilier et al. 2001; Woyke et al. 2006). Both known worm species harbour a γ-proteobacterial main symbiont and up to 5 bacterial phylotypes of the γ- and δ-subgroup of Proteobacteria presumably living in syntrophy upon different sulphur species as redox sources/sinks. Both worm’s body is of a bright white colouring when freshly retrieved from deeper sand layers indicating their bacteria being loaded with sulphur granules and presumably PHB as storage. Abundances of *Olavius* spp. in the studied sediments are calculated for up to 25 000 ind./m².

Ecdysozoa
Nematoda

*(Stilbonematidae, z.B. Eubostrichus sp., X sp.)*

At least 4 different nematode species are regularly found in the sand samples that are completely or partially white indicating the presence of ectosymbiotic sulphur bacteria as described and studied by Ott and group, and others. Nematoda is the most abundant group of meiofauna with more than 1 000 000 ind./m² reported.

Further taxa of potential interest:

Copepoda
Harpacticoidea

Polychaeta

*“Small crustacean groups“* as Ostracoda and Tanaisacea

Gastropoda
Opisthobranchia
Acochilidae

Ongoing studies on meiofauna (Werner, 2006; Nemecky & Sevilgen, in prep.) in both sediments from the Island of Elba and the neighbouring Island of Pianosa show the regular occurrence of certain copepod (Harpacticoidea) and polychaete species in the sediment depths of interest i.e. microxic-microsulphidic. No relationship with a bacterial association was investigated so far in any one group. Interestingly the occurrence of live copepods as far down as 15 cm under the sediment surface surprised renowned experts in this field. Meiofauna, i.e. non-tube or borrow forming, polychaetes have been found in 18 cm depth.

Few small crustaceans can be found in depths around 10-15 cm. No investigations regarding possible bacterial associations have been made so far.

This small group of meiofauna „nudibranchs“ occurs with a few species within the studied sands. Some species are white, bearing internal skeletal elements (sclerites). No investigations addressing bacterial associations have been made.