

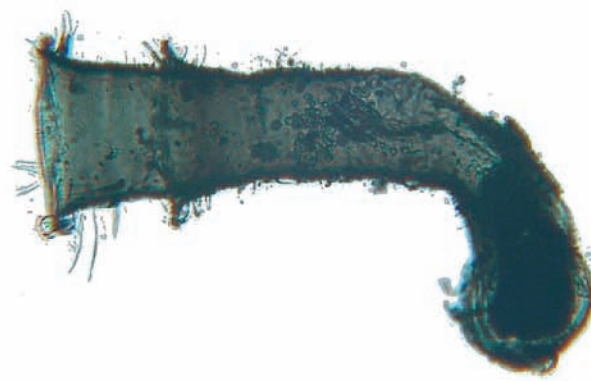
Hydrothermal vent meiofauna

Meiofauna, small animals and protists, which pass through a net with 1 mm mesh size and are retained on a net with 63 μm (or smaller) mesh size (GIERE 1993), is part of the hydrothermal vent community. In general, very little is known about the diversity of vent meiofauna. So far, only a few phyla such as the Arthropoda (Acariformes, Copepoda, Cumacea, Isopoda, Ostracoda, Tanaidacea), the foraminiferan *Granuloreticulosa*, and the Nematoda have been described from vents. In addition, Plathelminthes and three protist phyla including amoebae, colonial chrysophytes and ciliates are known but have yet to be described (SMALL & GROSS 1985; M. B., pers. obs.). In contrast, other marine habitats, such as sediments from shallow waters to the deep sea harbor far more diverse meiofauna. For example gnathostomulids, gastrotriches, loriciferans, tardigrades, and small-sized representatives of hydroids, bryozoans, nemertines, rotifers, or gastropods have not yet been discovered (HIGGINS & THIEL 1988; GIERE 1993).

All together, two foraminiferan, seven nematode, nine ostracod, two acari, two cumacean, six tanaidacean, two isopod, and 78 copepod species are included in this edition. Only the Copepoda are known to a greater extent (IVANENKO & DEFAYE, this volume). Currently, meiofauna species contribute to about 20% of the total diversity at vents. However, at large, the diversity of meiofauna is unknown. There are entire mid-ocean ridges or back-arc basins known for a relatively long time, in which not a single species of ostracod, tanaidacean, mite, or nematode is described. Most known species are reported from a single site. The biogeographic range of meiofauna species is virtually un-

known. The few ostracod species described exclusively come from the eastern Pacific (DEEVEY 1969; KORNICKER 1969, 1991, KORNICKER & HARRISON-NELSON 2005; MADDOCKS 2006). The few tanaidaceans and the two isopod species were collected at the site Lucky Strike at the Mid-Atlantic Ridge (CUNHA & WILSON, in press; LARSEN et al., in press); tanaidaceans were also observed at the site Rainbow (M. Segonzac, pers. comm.) Only one mite is described from Lau and North Fiji Back-Arc Basins (KRANTZ 1982) and the second species comes from the Mid-Atlantic Ridge (BARTSCH 1990). Similarly, one cumacean and one foraminiferan species each are described from the East Pacific Rise (BRÖNNIMANN et al. 1998; CORBERA this volume), the second species each come from the Mid-Atlantic Ridge (KAMENSKAYA et al. 2002; CORBERA this volume). The few described free-living nematode species exclusively were collected at sedimented vent sites from the East Pacific Rise, the Guaymas Basin, and the Lau and the North Fiji Back-Arc Basins (DE-CRAEMER & GOURBAULT 1998; VERSCHELDE et al. 1998).

To date there is not a single site for which the entire meiofauna community structure is known. The picture emerging from the few meiofauna studies points to a vent meiofauna, which is low in abundance and diversity (DINET et al. 1988; SHIRAYAMA 1992; VANREUSEL et al. 1997; TSURUMI et al. 2003). Comprehensive studies are urgently needed not only to understand the community structure of meiofauna but also to provide insight in the biodiversity of the entire vent community and their trophic interactions.



1, 2: Folliculinid ciliates from the East Pacific Rise: 9°N; by M. Bright.

To our knowledge, vent meiofauna can be found in virtually all vent habitats, from inactive bare basalt or sediments to diffuse flow areas up to *Alvinella pompejana* DESBRUYÈRES & LAUBIER, 1980 aggregations located on black smokers. Many vent meiofauna animals such as copepods, nematodes, and ostracods survive the transit from the vent environment at depths of more than 2500 m to the water surface and can be maintained without pressure at 4°C for at least a few days (M. B., pers. obs.).

Quantitative sampling of meiofauna is usually carried out in soft sediments with various types of corers. Hard substrate sampling and as well as sampling of megafauna aggregations such as tubeworm clumps or mussel beds requires some sort of special designed devices such as the “mussel pot” (VAN DOVER 2002) or the “Bushmaster Jr” (GOVENAR et al. 2005). Abundance and biomass are standardized to 10 cm² surface area.

As there is no single technique available for extracting and fixing the entire meiofauna community quantitatively, the usually applied compromise is either to sort through the entire sample including the sediment or to use various centrifugation techniques in order to separate organic from inorganic material. Fixation then is done by using 4% buffered formalin. However, it has to be kept in mind that mostly the more robust so-called “hard” meiofauna such as copepods and nematodes is extracted and fixed and “soft” meiofauna such as plathelminthes or gastrotrichs, which is often not separated from the sediment grains and/or is more delicate and sometimes requires other fixation media, is lost. For storage, 70-80% ethanol is recommended (see HIGGINS & THIEL 1988).

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Hydrothermal vent parasites

Currently, very few macroparasites are known from hydrothermal deep-sea vents. Only four copepods, *Genesis vulcanotopusi* (East Pacific Rise, LOPEZ-GONZALEZ et al. 2000), *Cholidia polypi* (Endeavour Segment, HUMES & VOIGHT 1997), *Ceuthoecetes aliger* and *Rimitantulus hirsutus* (Galapagos Spreading Center, HUMES & DOJIRI 1980), one leech *Bathybdella sawyeri* (East Pacific Rise, BURRESON 1981; BURRESON & SEGONZAC, in press), one acanthocephalan *Hypoechinorhynchus thermaceri* (East Pacific Rise, BURON 1988), and one nematode, *Moravec-nema segonzaci* (Mid-Atlantic Ridge, JUSTINE et al. 2002) have been reported from these sites. Significantly, each of these species was new to science. At least one monogenean and two digeneans are currently being described by various specialists from material collected on crabs and fishes collected from southern East Pacific Rise sites and each of these also appear to be previously unreported species.

Because the concentration of potential hosts in a vent ecosystem could possibly increase parasite transmission and diversity, BURON & MORAND (2004) hypothesized that the low diversity of macroparasites presently reported from these sites is likely a reflection of these organisms having been overlooked by vent biologists due to their inconspicuous nature. In support of this idea, the use of molecular tools has shown the presence of a high diversity of parasitic protists genetically linked to apicomplexans, perkinsozoans, syndiniales, and kinetoplastids (MOREIRA & LOPEZ-GARCIA 2003). Additionally, *Rickettsia*-like inclusions have also been found in numerous limpets from various vents (TERLIZZI et al. 2004), and in mussels from Snake Pit and Logatchev sites (WARD et al. 2004) are further indications that parasite diversity is vastly underreported from these important sites.

In brief, most often parasites must carefully looked for in order to be noticed. Hosts are various and diverse and range from the smallest of copepods to the largest of fish.

Since numerous parasites have a complex life cycle involving more than one host, a better knowledge of the parasite vent fauna would help researchers to understand the trophic structure present at each vent. Because trophically transmitted parasites are in many cases known to alter intermediate host behavior to increase capture by definitive hosts (LAFFERTY & MORRIS 1996) these organisms may play significant roles in increasing or directing the flow of energy into higher trophic levels at the vents. For example, acanthocephalans at the East Pacific Rise use fish as definitive hosts and appear to be transmitted via amphipod ingestion (I. B., pers. obs.): evidence from other systems indicates that such infected amphipods exhibit altered behavior (BAUER et al. 2005). Significantly, at the Atlantic sites these crustaceans were found to contain nematode larvae of the ascarid genus *Hysterothylacium* although the adults were not found (A. Petter, unpublished data).

Furthermore, non-trophically transmitted parasites present at vents may also pose interesting problems for researchers. For instance, the leech *Bathybdella sawyeri*, living among *Riftia pachyptila* and mussel *Bathymodiolus thermophilus* at the Galapagos Spreading Center, raises an interesting specificity problem: although a parasite of fish, it has never been found on such hosts but was observed on vent crabs and bivalves from the southern East Pacific Rise (BURRESON & SEGONZAC, in press). Because of the well known specificity of many parasite-host relationships the recognition and identification of vent parasites may play an important role in deciphering vent colonization. In this regard it is impor-



1: Hirudinea *Bathybdella sawyeri* from East Pacific Rise: 17°S; cruise Biospeedo (Ifremer, CNRS).



2: Nemertea *Carcinonemertes* sp., semi-parasite on bythograeid crabs from Lau Basin; cruise TUIMO6MV (MBARI); by G. Rouse.

tant to note the presence of carcinonemertids (nemertean worms) at vents. These worms are known to feed on the eggs of shallow water decapods and were discovered on several vent crab species (SHIELDS 2001). Given the depth (1800-2400 m) and isolated nature of vent communities, the origin of vent colonization by carcinonemertids has been raised and it has been speculated that infections were acquired from a more shallow-water host (see SHIELDS 2001 for review). Such egg predators were recently collected on several bythograeid crab species from western back-arc basins, and northern and southern East Pacific Rise (J. Shields & M. Segonzac, unpublished data). Moreover, because of the isolated nature of the vent ecosystems these sites will likely provide excellent sources of material for the study of the processes of co-evolution in a relatively simple trophic system.

In summary, the study of parasitism in isolated vent communities should be emphasized not just because it would further increase our understanding of the unique parasite fauna present at these sites, but also because it would allow us to address and answer important questions regarding the colonization of vents and vent community structure as well as allow us to identify and recognize new strategies for parasite survival.

Parasites may be located almost anywhere on or in a host. Ideally, parasites should be isolated from their host while still fresh and then prepared in a specific manner dependent on the taxon collected (see, for example, PRITCHARD & KRUIZE 1982 for macroparasite fixation techniques). Importantly, parasites collected from formaldehyde fixed hosts, such as museum specimens, are most often of no use to taxonomic study.

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