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Low diversity of spongicolous Amphipoda (Crustacea) observed in the Antarctic autumn

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Abstract

Sponges represent a major component of the Antarctic zoobenthos. They are known to act as hosts for several invertebrates. In the present investigation a total of 1193 specimens of Amphipoda living in the sponge tissue of three species of Demospongiae were observed. The sponges were collected in the Weddell Sea and at the Antarctic Peninsula in April, during the Antarctic autumn 2000. The population density, species richness, composition, and reproductive biology of the spongicolous Amphipoda was studied. More than 40 individuals were collected per 1000 cm^3 sponge tissue. Females of all species had eggs or embryos in their marsupia. Interestingly, their young will be released – even though most of the studied species are filter feeders – in the Antarctic autumn and winter. Spongicolous inquiline Amphipoda may therefore not be influenced by the seasons as much as their free living relatives.

Key words: Amphipoda, Antarctica, Demospongiae, reproduction, seasonality, symbiosis

Introduction

Sponges are the major component of many Antarctic benthic communities (Barthel & Gutt, 1992; McClintock, 1987; Cattaneo-Vietti et al., 1999). Several Antarctic species of Demospongiae are used by other organisms as hosts. Amphipoda (Crustacea) are known to be an important component of the fauna associated with sponges. Several studies have focused on ecological or taxonomic aspects of amphipods associated with sponges (e.g. Biernbaum, 1981; Costello & Myers, 1987; Serejo, 1998), but little is known about amphipods associated with sponges from the Weddell Sea (Kunzmann, 1996). Until now nothing was known about the species composition of associated amphipods and their reproduction during the Antarctic autumn.

The main objectives of this paper are to analyse the abundance and composition of the amphipod fauna in sponges and outline their reproductive biology in the Antarctic autumn.

Material and methods

During the cruise ANT XVII-3 of RV "Polarstern" several sponges and sponge pieces were collected in April 2000 by means of a bottom trawl. Demospongiae with commensally living amphipods were sampled close to the German station Neumayer (station 119-1, 266 m, 70°50.40′S, 10°35.20′W & station 124-1, 269 m, 70°50.20′S, 10°34.89′W) and at the Antarctic Peninsula (station 166-1, 673 m, 63°01.20′, 59°09.20′W).

The volume of the sponges was measured by the multiplication of length, height and width. The tissue was afterwards dissected with a pair of tweezers and rinsed with seawater to collect the amphipod infauna. The small sponge pieces were examined under a stereoscope for further remaining animals. The samples were sieved through a mesh size of 300 µm. Most animals were fixed in buffered formalin (4%) and later transferred into ethanol (70%).

For comparison of abundance on different sponge species the numbers of inhabiting individuals were calculated for 1000 cm^3 (= 1 l). Only amphipods living within the sponge tissue, not outside on the surface, were considered. For calcula-

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tion of the length-frequency distribution the body length of the Amphipoda was measured from the tip of the rostrum to the base of the telson. Additionally the length of the oostegite at pereiopod four was measured. Win STAT Version 3.1 was used for statistical analyses.

Of all spongicolous amphipod species the eggs / embryos were counted and measured. They were considered as brood size if the oostegites forming the brood pouch were not damaged. The specimens are deposited in the Zoological Museum of Hamburg (ZMH K39818–39829) and at the Zoological Museum of Tromsø (TM 11024–11028).

Results

Population density

Different numbers of amphipods living within the sponge tissue were observed for the three species of Demospongiae (see table 1). Up to 25 pieces of sponge tissue were observed for each sponge species at each station. The richest amphipod density was found in *Jophon spatulatus* (Kirkpatrick, 1907) at a depth of 269 m (more than 40 individuals per 1000 cm^3 tissue).

Species richness and composition

The 1193 spongicolous amphipods consisted of six species, belonging to five different families: *Colomastix fissilingua* (Schellenberg, 1926) (Colomastigidae), *Andaniotes linearis* (K.H. Barnard, 1932) (Stegocephalidae), *Stegosoladidus ingens* (Chevreux, 1906) (Stegocephalidae), *Pseudokoroga* n. sp. (Lysianassidae), *Leucothoe spinicarpa* (Abildgaard, 1789) (Leucothoidae) and *Polycheria antarctica* (Stebbing, 1875) (Dexaminidae).

Species percentages of amphipod presence varied for the three sponge species (Fig. 1). At Kapp Norvegia, Colomastigidae and Lysianassidae were the clearly dominant taxa living in the sponges *Jophon spatulatus* (Kirkpatrick, 1907) and *Clathria pauper* (Broenstedt, 1926). At the Antarctic Peninsula, Stegocephalidae constituted 98% of the amphipod fauna inhabiting *Microxina simplex* (Topsent, 1916).

Table 1. Number of commensal amphipods per volume sponge .

Demospongiae	Station	Depth	Mean (Max.) number of Amphipoda per 1000 cm^3 tissue
Jophon spatulatus	119-1	266 m	23 (39)
Jophon spatulatus	124-1	269 m	34 (43)
Clathria pauper	124-1	269 m	35 (35)
Microxina simplex	166-1	666 m	10 (13)

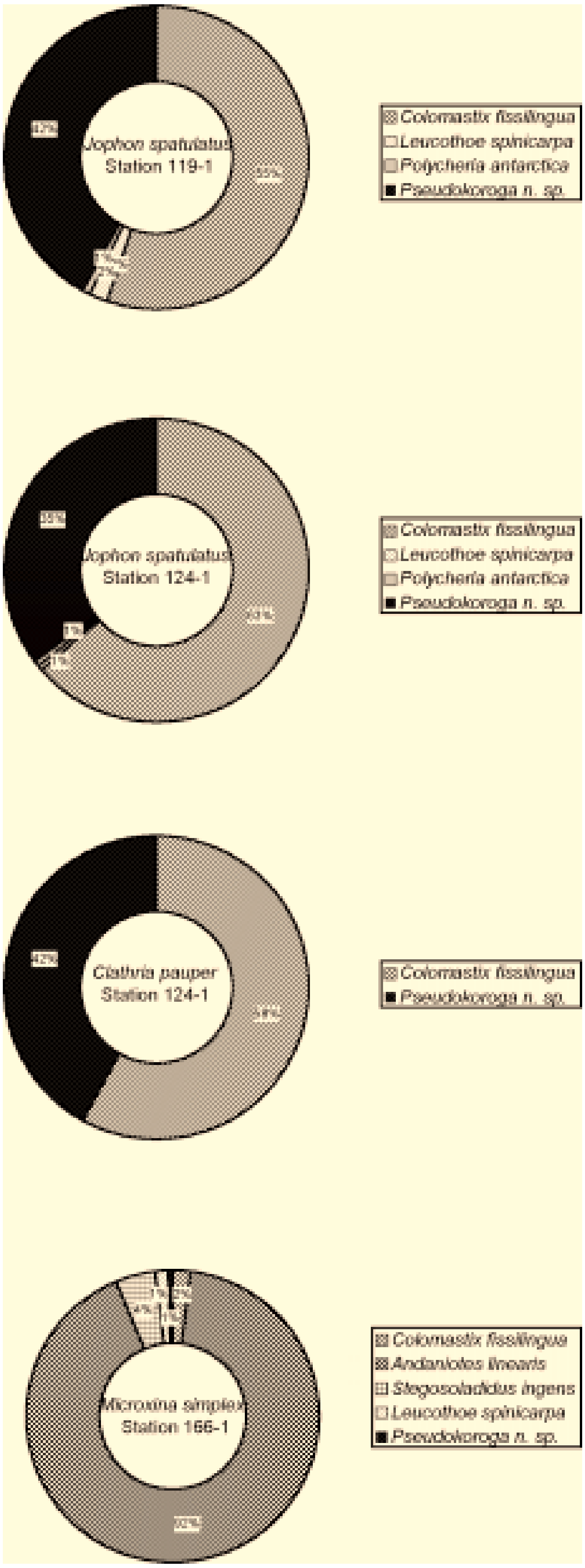

Fig. 1. The inquiline amphipods of different Demospongiae.

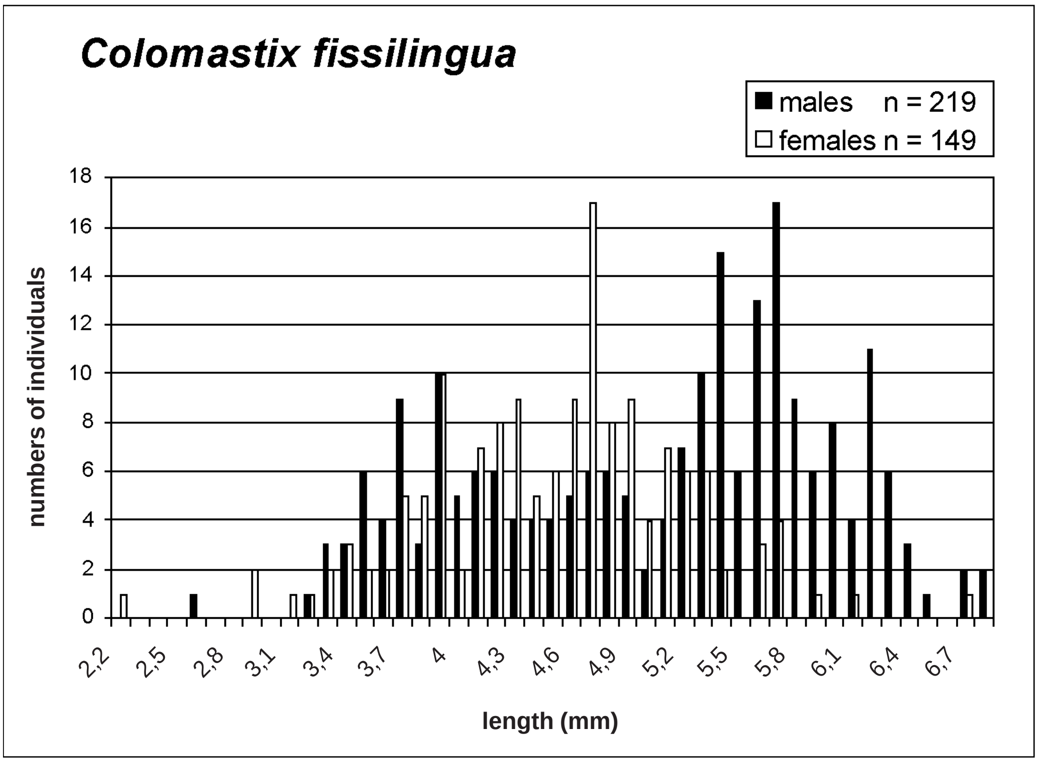

Fig. 2. Length-frequency distribution of *Colomastix fissilingua*.

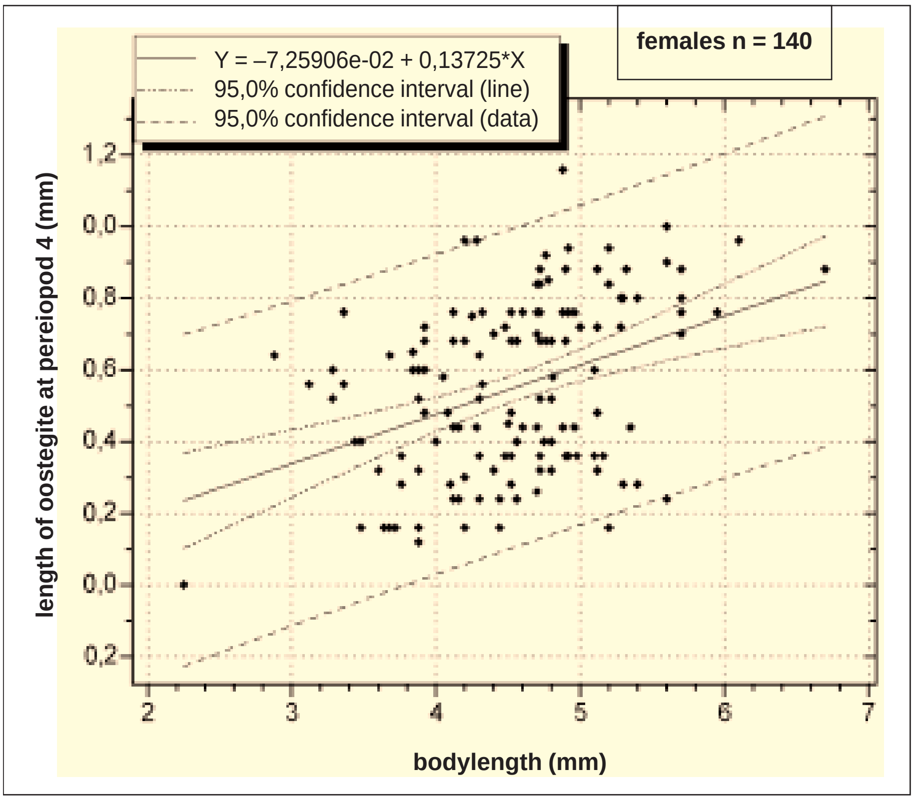

Fig. 3. Plot of oostegite length against body length of *Colomastix fissilingua*.

Reproductive biology

The length-frequency distribution was studied for the most common species *Colomastix fissilingua* (Fig. 2). This member of the family Colomastigidae shows a strong sexual dimorphism, the males have extremely enlarged second gnathopods. The males which in total were larger than the females show two size classes. No clearly separated size class can be seen among the females, their body length is distributed between 2.2 mm and 6.8 mm.

All except two females of *Colomastix fissilingua* had well-developed oostegites. The length of the oostegites measured at the fourth pereiopod showed a highly significant correlation to the body length, $p < 0.001$ (Fig. 3). Setae are grown when the oostegite reaches a size of 0.49 mm.

No juveniles of *Colomastix fissilingua* were found in the sponge tissue. All individuals showed characters which Holman & Watling (1983) classified as distinguishing for adults, for example the length of the outer branch of the third uropod; in juveniles it does not reach 80% of the length of the inner branch, in all studied species it does.

Some females of all four families Colomastigidae, Leucothoidae, Lysianassidae and Stegocephalidae carried eggs, embryos or young in their marsupia.

Discussion

Population density

Only very few quantitative studies of Amphipoda associated with sponges were completed in the past. Occasionally the number of amphipod species which inhabit a sponge were correlated to the weight of the sponge (Kamaltynov et al., 1993).

The spongicolous amphipod fauna which is associated with sponges is usually divided into two groups: species that are inquiline, and species that inhabit the outer surface of the sponge (Costello & Myers 1987). In the present study the latter are neglected because in samples taken with a bottom trawl it is impossible to distinguish benthic amphipods from those inhabiting the outer surface of the sponges.

Kunzmann (1996) worked with two species of Antarctic Demospongiae (*Mycale acerate* and *Tedania trirhaphis*) which were inhabited by even larger numbers of Amphipoda than *Jophon spatulatus*, but in that paper Amphipoda on the sponge surface were considered too, wherefore the estimated abundance might be unreliable.

Species richness and composition

While the abundance of spongicolous amphipods in Antarctic Demospongiae is very high, their diversity seems to be relatively low compared to species richness of spongicolous Amphipoda found in temperate climate. More than 15 species of amphipods were found in subtidal sponges in a shallow saltmarsh creek in South Carolina (Biernbaum, 1981), but here again also individuals inhabiting the sponge surface were taken into consideration. Kamaltynov et al. (1993) list 13 species of Amphipoda associated with the sponge *Lubomirska baicalensis* in Lake Baikal, East Siberia, but only one species of these is considered infaunal. Kunzmann (1996) found a maximum of 7 amphipod species in one species of Antarctic Demospongiae: *Tedania oxeata*, but among these some individuals were only identified to family level and – as mentioned above – surface associated amphipods were also considered.

Reproductive biology

The fact that no juveniles of *Colomastix fissilingua* were found associated with any of the three sponge species and that nearly all females bear oostegites may lead to the assumption that this species inhabits sponges during its reproductive period only. At first glance a strong seasonality and a short individual life-span might explain the absence of juveniles, but many females had large oostegites with long setae, juveniles had been released from these marsupia shortly before and were not found in the sponge tissue. LeCroy (1995) proclaimed that there is no apparent reproductive season for the genus *Colomastix* as a whole, although not considering *Colomastix fissilingua*. There may be a constant level of reproduction throughout the year, at least in deeper waters. Here the seasonal fluctuations in water temperature are somewhat moderated, the increased protection and readily available food supply afforded by this habitat may facilitate the constant level of reproduction

Table 1. Mean female length, embryo diameter and number of well developed embryos in the marsupia of two spongicolous Amphipoda.

Species	Mean female length (mm)	Mean embryo diameter (mm)	Mean brood size (mm)
Colomastix fissilingua	5	0,9	21
Andaniotes linearis	10	1,2	12

(LeCroy, 1995). It has to be considered that LeCroy worked in the not very seasonal Gulf of Mexico. Focusing on Antarctica, ecological parameters such as ice covering in winter and phytoplankton spring bloom have to be thought of. Many Antarctic organisms are known to release their young during the Antarctic summer (e.g. White, 1977). Oligotrophic conditions in the water column in Antarctic winter (Matsuda et al., 1987) could represent a metabolic constraint for filter-feeding organisms. Many sponges adopted their trophic strategy; they take up and preserve dense concentrations of diatoms to overcome severe food fluctuations typical for the Antarctic environment (Cattaneo-Vietti et al., 1999). While providing similar conditions throughout the year for their symbionts the sponge hosts buffer the extreme seasonality of the Antarctic environment. Therefore spongicolous amphipods, especially inquilinous species, may not be influenced by the seasons as much as free living amphipods.

A correlation of body length and length of the right oostegite at pereiopod four was expected for *Colomastix fissilingua*, as previously shown for other Antarctic amphipod species such as *Eusirus perdentatus* (Klages, 1993). Surprisingly, some large females had very small oostegites without setae. Nevertheless the correlation of body length and length of the oostegite was highly significant. Sagar (1980) has observed that the oostegites of the Antarctic amphipod *Paramoera walkeri* (Stebbing, 1906) degenerate shortly after the release of young from the brood pouch. Maybe the oostegites of *Colomastix fissilingua* also degenerate and grow again after renewed fertilisation. However, it is also possible, and energetically logical, that females only grow their brood pouch once after being fertilised the first time.

Females of *Andaniotes linearis* are about twice as long as *Colomastix fissilingua* while they are carrying far less embryos of a similar size. While the shapes of the embryos are very similar, the shapes of the females differ. *Andaniotes linearis* is curled up as is typical for Stegocephalidae, whereas *Colomastix fissilingua* is stretched like a tanaidacean. Generally, amphipod lineages that are parasitic or obligate associates of other animals display consistently smaller body sizes than their closest free-living relatives (Poulin & Hamilton, 1995).

It is remarkable that very different stages of development were found in different marsupia of one species in the Antarctic autumn. Some females apparently had just released their young because big oostegites with long setae were still present. The development time is not known for either *Colomastix fissilingua* or *Andaniotes linearis*, but for two members of Lysianassidae, *Tryphosella kerkueleni* and *Cheirimedon femoratus*, the mean development time is about 3 months (Bregazzi, 1973). Assuming similar development times, it is most probable that the studied species release their young in the Antarctic winter.

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