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ORIGINAL PAPER

Distribution and diversity of sipunculan fauna in high Arctic fjords (west Svalbard)

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Abstract Sipuncula is a relatively species poor and generally rarely investigated phylum; nonetheless, it may play a considerable role in the ecosystem. During this study sipunculan species distribution patterns in four fjords of west Spitsbergen (Kongsfjorden, Hornsund, Isfjorden and van Mijenfjorden) were examined. Material was collected during ten cruises undertaken from 1997 to 2006. A total of 381 samples were taken at 132 stations located in the four fjords and, a total number of 920 sipunculans specimens were found in 114 of those samples. The highest sipunculan species richness was observed in Hornsund (six species), followed by Kongsfjorden and Isfjorden (five species in each fjord). Sipunculan fauna in all fjords was strongly dominated by *Golfingia vulgaris* (80% of all sipunculan individuals in Kongsfjorden), and *Golfingia margaritacea* (84% in van Mijenfjorden and 40% in Hornsund) or *Nephasoma diaphanes* (54% in Isfjorden). Locally, sipunculans were found in high densities (max. 62 ind. 0.1 m^{-2} and up to 11% of macrobenthic densities) and biomass (max. 110.87 g 0.1 m^{-2} and up to 80% of total fauna biomass). At such sites, sipunculans may play an important role in bioturbation of sediments and as a food source for higher trophic levels. Sipunculans did not occur within close proximity of the glacier where they might be eliminated due to high sedimentation rate and low amounts of organic matter. Because of their importance in benthic systems, a need to include sipunculans in routine macrobenthic surveys is emphasized.

Keywords Sipuncula · West Svalbard · Arctic · Fjords · Diversity · Distribution

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Introduction

Sipuncula is a relatively species-poor phylum consisting of about 150 species and subspecies worldwide (Cutler 1994); nonetheless, it may play a considerable role in the ecosystem. Most sipunculan worms are deposit feeders that settle on various substrata, often on soft bottom. Sipunculans transform particulate food (microalgae, protista, meiofauna, detritus, fecal pellets) from the water column, sediment interface, or sediment itself (Murina 1984). Sipunculans are consumed by cephalopods, anemones, crabs (Fischer 1925), gastropods (Kohn 1975) and fish (Kohn 1975). They can transform their habitat through bioerosion of coral reefs (both recent and fossil) and soft rocks (Cutler 1968; Stearley and Ekdale 1989; Klein et al. 1991). Sipunculans of *Nephasoma* genus are producers of deep burrows in the deep-sea sediments (Romero-Wetzel 1987). Their role as bioturbators and active burrowers in the sediments was also described by Murina (1984). In some areas sipunculans occur in very high densities (Chapman 1955; Romero-Wetzel 1987; Kędra and Murina 2007).

In Arctic fjords, Sipuncula were found among the dominant taxa in several studies, but the worms are usually not identified to lower taxonomic levels (e.g. Węsławski et al. 1988; Włodarska-Kowalczuk and Pearson 2004). Identification of sipunculan species is not a trivial task, as usually the dissection of a specimen is required. The reason for neglecting the sipunculan species composition in the majority of ecological studies is also the general lack of Sipuncula taxonomists worldwide—there are less than ten specialists all over the world at present (Murina et al. 1999).

Previous reports of sipunculans from the Svalbard Archipelago were mostly published at the beginning of last century (Théel 1905; Fischer 1895, 1914, 1922, 1929) as were most of the studies on sipunculans from other Arctic areas (Wesenberg-Lund 1930, 1933, 1934, 1938, 1955; Murina 1977). The only recent report of the composition and distribution of the Sipuncula in the waters of the Svalbard Archipelago was just published (Kędra and Murina 2007). According to these studies nine sipunculan taxa (eight species and one subspecies) occur along the Svalbard coast. All mentioned articles were strictly taxonomomic or aimed at documenting the lists of species collected during scientific expeditions. A synopsis of the ecology of the group in Arctic waters has never been attempted. In the present study, we bring together extensive distributional data of sipunculans collected in several benthic surveys carried out in west Spitsbergen fjords by the Institute of Oceanology, Polish Academy of Sciences, from 1997 to 2006. The material comprises 381 samples taken at a depth range of 2.5–380 m in four west Spitsbergen fjords (Kongsfjorden, Hornsund, van Mijenfjorden, Isfjorden).

The aim of the present study is to (1) describe the patterns of sipunculan diversity, densities, biomass and distribution of species in four fjords off west Spitsbergen, (2) compare sipunculan fauna diversity of the studied fjords, (3) discuss the observed distribution patterns in relation to environmental factors, and (4) discuss the role of sipunculans in functioning of the fjordic soft bottom benthic systems.

Study area

Spitsbergen is the largest island of the Svalbard archipelago, situated on the western edge of the Barents Sea between 76 and 80°N. Despite its high northern location the western coast of Spitsbergen has a relatively warm, Atlantic character due to the influence of the West Spitsbergen Current, an extension of the North Atlantic Current (Svendsen et al. 2002). Cold Arctic waters are transported by the East Spitsbergen Current that flows around the southern tip of the island (Sorkapp) and than northward along the west Spitsbergen coast (Loeng 1991). The hydrological regimes of the west Spitsbergen fjords are shaped by warm and saline water masses of Atlantic origin flowing from a Spitsbergen shelf ($T > 3$°C, $S > 34.65$) and fresh and cold water masses ($T < 3$°C, $S < 34$) produced by large meltwater inflows provided by tidal glaciers or glacier-fed rivers located in the inner parts of the fjords (Svendsen et al. 2002; Cottier et al. 2005). The glacial or glaciofluvial inflows transport large amounts of mineral suspensions and produce steep gradients in water turbidity and mineral sedimentation along the fjords' axes (Svendsen et al. 2002). The fjordic sediments are composed of glacio-marine deposits; mostly silt and clay with some admixture of coarser fractions in the outer parts of the fjords influenced by the shelf currents (Plassen et al. 2004; Włodarska-Kowalczuk and Pearson 2004). The west Spitsbergen fjordic and shelf sediments are well oxygenated (Jørgensen et al. 2005). The fjords are generally ice-covered from November to June (Wiktor 1999). The late spring phytoplankton bloom generates a large flux of organic matter to the bottom sediments (Hop et al. 2002). Longer persistence of the fast ice cover and high water turbidity in the inner fjord basins result in lower flux of organic matter to the bottom (Görlich et al. 1987). The particulate organic carbon concentration in sediments increases as one gets closer to the fjords' mouths (Włodarska-Kowalczuk and Pearson 2004; Winkelmann and Knies 2005).

The present study is based on samples collected in four large west Spitsbergen fjords: Kongsfjorden, Isfjorden, van Mijenfjorden and Hornsund. The northernmost of the studied fjords, Kongsfjorden is one of the most thoroughly studied fjords (reviews of environmental and biological settings by Svendsen et al. (2002) and Hop et al. (2002)). It is a 20-km long open (no sill) fjord with Kongsbreen—the most active glacier in the Svalbard archipelago (Lefauconnier et al. 1994) and Blomstrandbreen on the northern bank. As one gets closer to the inner fjord Kongsfjorden glaciers, the mineral sedimentation in surface waters increase from 25 g m^{-2} day^{-1} (central basin) to 800 g m^{-2} day^{-1} (Svendsen et al. 2002), and particulate organic carbon content in sediments decrease from 2 to 0.2 mg g^{-1}, respectively (Włodarska-Kowalczuk and Pearson 2004). Isfjorden is the largest west Spitsbergen fjord (100 km long) with no sill at the entrance. The inner parts of the fjordic branches are influenced by large tidal glaciers or glacier-fed rivers. The entrance to van Mijenfjorden is almost closed by a sill (30 m) and a long and narrow island (Akseløya). Fresh water and mineral suspensions are transported to the 50-km long fjord by a river and a glacier. The coal dust produced by the Svea coal mine may also contribute to the high sedimentation in the inner part of the fjord. Hornsund is a wide open fjord with eight major tidal glaciers located in the central and inner parts. The banks of the inner basin, Brepollen, are almost entirely formed by the cliffs of tidal glaciers). The subtidal sediments in the fjord are composed mostly of silt and clay (Włodarska-Kowalczuk and Węsławski 2008). The sediment accumulation rate in Brepollen may reach 35 cm $year^{-1}$, while in the outer parts of Hornsund it is as low as 0.1 cm $year^{-1}$ (Görlich et al. 1987).

Advenfjorden is a small (8 km long) glaciofluvial estuary with two river mouths in the innermost part. A large tidal flat is formed at the mouths of the rivers. The very high concentration (around 800 mg l^{-1}) and vertical flux (over 1,000 g m^{-2} day^{-1}) of suspended solids are observed at the edge of the tidal flat and over the upper slope of the delta. The sediments of the delta slope are frequently resuspended and redeposited by the gravity-driven processes.

The concentration and sedimentation rate of mineral suspensions as well as frequency of turbidity currents decrease as distance from the river mouth increases (Zajączkowski and Włodarska-Kowalczuk 2007). Adventfjorden is located on the southern bank of Isfjorden, but due to its special environmental character (i.e. strong impacts of glaciofluvial inflows) and because a large sampling campaign was undertaken within its area it is treated separately from Isfjorden in data analyses and discussion.

Materials and methods

Material was collected during ten cruises of *r/v* 'Oceania', carried out in the Svalbard area, by the Institute of Oceanology, Polish Academy of Sciences, during every summer from 1997 to 2006. One hundred and thirty-two stations were sampled in all fjords; however, most of the stations were located in Hornsund and Kongsfjorden (Fig. 1). The Kongsfjorden material includes samples collected at two long-term monitoring stations (*INNER* and *OUTER*) located in the inner and outer part of the fjord, respectively. These samples were collected each summer in the last week of July during ten consecutive years (1997–2006). That material collected annually enables investigation of long-term (interannual) changes of benthos composition and here the differences of sipunculan diversity and densities in consecutive years are presented.

Altogether 381 samples were taken, with a total number of 920 sipunculans' specimens found in 114 samples (Fig. 1, Table 1). The samples were collected with a 0.1 m^2 van Veen grab or 0.045 m^2 Petit Ponar grab (samples collected at depths <20 m in Adventfjorden and van Mijenfjorden). Material was sieved over a 0.5-mm sieve (except for van Mijenfjorden samples which were sieved over 1 mm) and fixed in a 4% buffered formaldehyde and sea-water solution. All macrobenthic organisms were later sorted, counted and weighed after blotting. All sipunculans were identified, counted and weighed. The taxonomic nomenclature for sipunculan fauna was adopted from Cutler (1994). Species accumulation curves with 95% confidence intervals were computed using the formulae of Colwell et al. (2005).

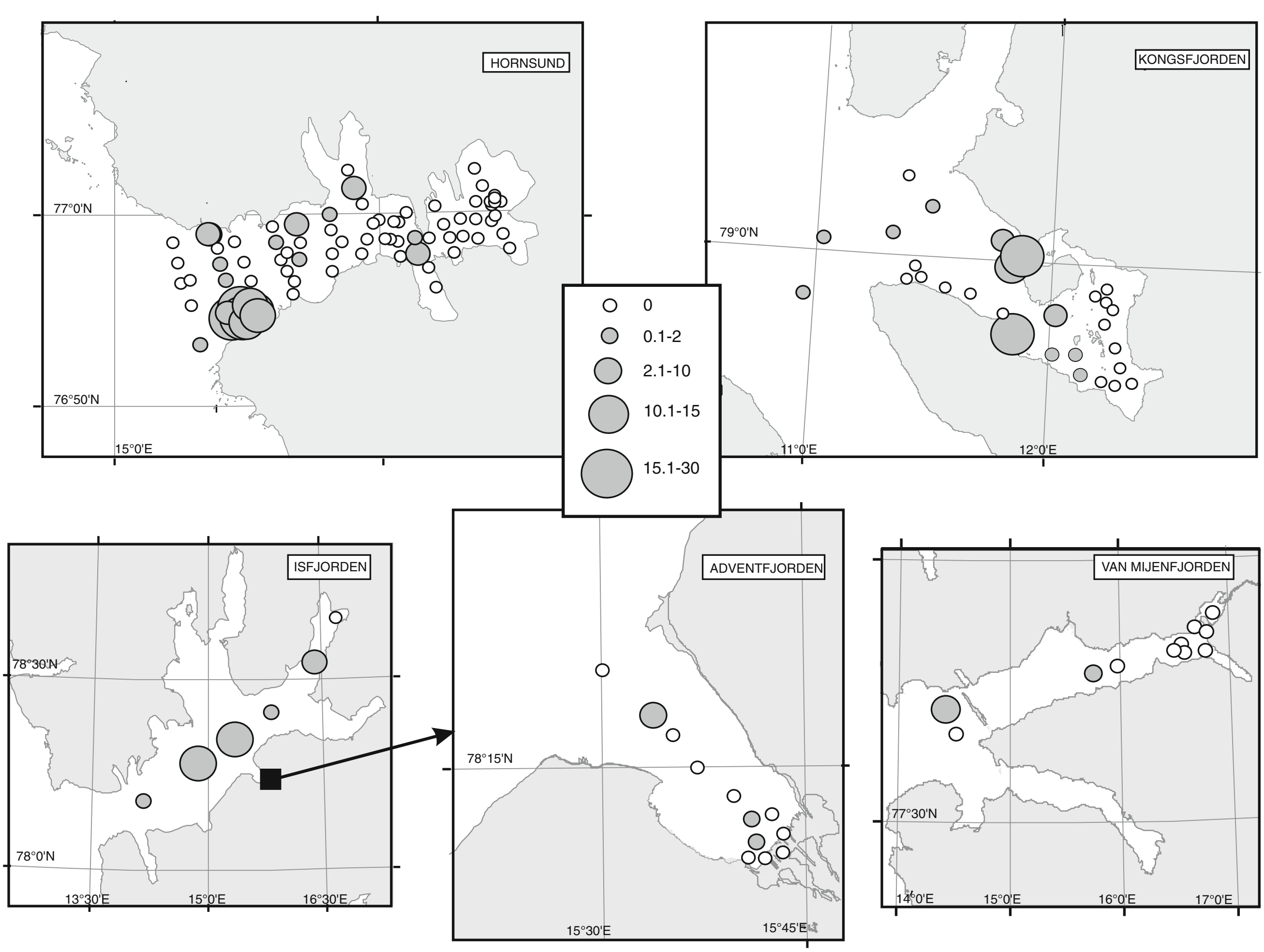

Fig. 1 Location of sampling stations and mean densities of sipunculan worms (ind. 0.1 m^{-2}) at stations in the studied fjords

To carry out tests of the relationship between sipunculan species distribution and environmental variables (temperature, salinity, POC, depth, sediment type) BIO-ENV analysis was conducted, using the PRIMER package.

Results

Sipunculans were found at 45 of 132 (35%) stations sampled in all four fjords. In Isfjorden, sipunculans were found along the whole fjord except from the station at the head of the fjord. Similar distribution pattern was found in Kongsfjorden and Hornsund, where sipunculans were mainly found in the central part and near the mouth of the fjords (40 and 27% of stations within the fjord, respectively), but never in parts strongly influenced by the glaciers' activity. In Adventfjorden and van Mijenfjorden, sipunculans were present only at few stations (16% of stations within both fjords) (Fig. 1).

There were six species found in Hornsund. In Kongsfjorden and Isfjorden five species were found while the lowest number of species was recorded in van Mijenfjorden (three species) and Adventfjorden (two species). Sipunculan fauna in all fjords was strongly dominated by one (or two in case of Hornsund) species each—*Golfingia vulgaris* (80% of all individuals in Kongsfjorden, 71% in Adventfjorden and 55% in Hornsund) and *Golfingia margaritacea* (84% in van Mijenfjorden and 40% in Hornsund). In Isfjorden *Nephasoma diaphanes diaphanes* contributed 54% of all sipunculan specimens. *Golfingia elongata* and *Nephasoma diaphanes corrugatum* were found only occasionally in Kongsfjorden and Hornsund (the former) and in Hornsund and Isfjorden (the latter) (Fig. 2).

Overall sipunculan densities in all sampled fjords ranged from 1 ind. 0.1 m^{-2} to 59 ind. 0.1 m^{-2}. The mean density of sipunculans was similar in Isfjorden, Hornsund and Kongsfjorden (8.00 ind. 0.1 $m^{-2} \pm$ SD 8.48, 8.51 ind. 0.1 $m^{-2} \pm$ SD 7.75, 9.67 ind. 0.1 $m^{-2} \pm$ SD 11.33, respectively). The highest values were noted at the stations located in the central part of Kongsfjorden (62 ind. 0.1 m^{-2}), at the entrance of Hornsund fjord (36 ind. 0.1 m^{-2}) and in the central part of Isfjorden (28 ind. 0.1 m^{-2}). The lowest values of sipunculan densities were found in Adventfjorden and van Mijenfjorden (1.4 ind. 0.1 $m^{-2} \pm$ SD 0.89, 3 ind. 0.1 $m^{-2} \pm$ SD 2.45, respectively) (Figs. 1, 3).

In Isfjorden, Adventfjorden and van Mijenfjorden, the density of sipunculans constituted less than 2% of macrobenthic density. In the outer part of Hornsund and in the central part of Kongsfjorden. sipunculans constituted 10 and 11% of macrobenthic density, respectively (Fig. 4).

Sipunculan biomass at all stations ranged from 0.001 g 0.1 m^{-2} to 110.83 g 0.1 m^{-2}. The mean biomass of sipunculan fauna was the highest in Hornsund (43.78 g 0.1 $m^{-2} \pm$ SD 25.45) and was concentrated at the entrance of the fjord (max. 110.87 g 0.1 m^{-2}). In all other fjords the biomass was below 1 g 0.1 m^{-2} on average, except in the outer part of Kongsfjorden where the sipunculan biomass reached 6.75 g 0.1 m^{-2} (Fig. 3). In Isfjorden, Adventfjorden and van Mijenfjorden the biomass of sipunculans constituted on average less than 3% of total infaunal biomass. In contrast, in the outer part of Hornsund sipunculans dominated the total fauna biomass (from 35 to 82%), while in the central part of Kongsfjorden sipunculans constituted 43% of total benthic biomass (Fig. 4). In Hornsund *G. margaritacea* was the largest taxa strongly biasing the total fauna biomass. Its individual size ranged from 35 to 118 mm with mean of 72.97 mm $\pm$ SD 16.62 while individual biomass ranged from 0.42 to 35.88 g with mean of 7.9 g $\pm$ SD 39.83.

The Kongsfjorden species accumulation curve reached an asymptote after about 20 samples. The Hornsund species accumulation curve plotted for 37 samples did not level off. However, the 95% confidence intervals for the two curves overlap for all sample accumulation levels indicating that there are no significant differences between them at $P < 0.05$ (Fig. 5).

The density of all species found at the Kongsfjorden time series site is presented at Fig. 6. The inner basin station is not included in the figure as sipunculans were found neither at *INNER* station nor at the other stations close to the glacier. At the *OUTER* station, sipunculans were present in all years except for 1997, 1998 and 2001. There were

Table 1 Sampling effort and basic information on samples used in the present study

Fjord	Sampling years	Depths of sampling	Number of collected samples	Number of samples with sipunculans	Reference
Kongsfjorden	1997–2006	38–380	152	52	Włodarska-Kowalczuk and Pearson (2004)
Isfjorden	2006	160–254	18	15	–
Adventfjorden	2000–2001	0.5–100	48	5	Włodarska-Kowalczuk et al. (2007)
van Mijenfjorden	2001–2002	10–104	59	5	Renaud et al. (2007)
Hornsund	2002–2005	49–237	104	37	Włodarska-Kowalczuk and Węsławski (2008)

The table includes references to original studies

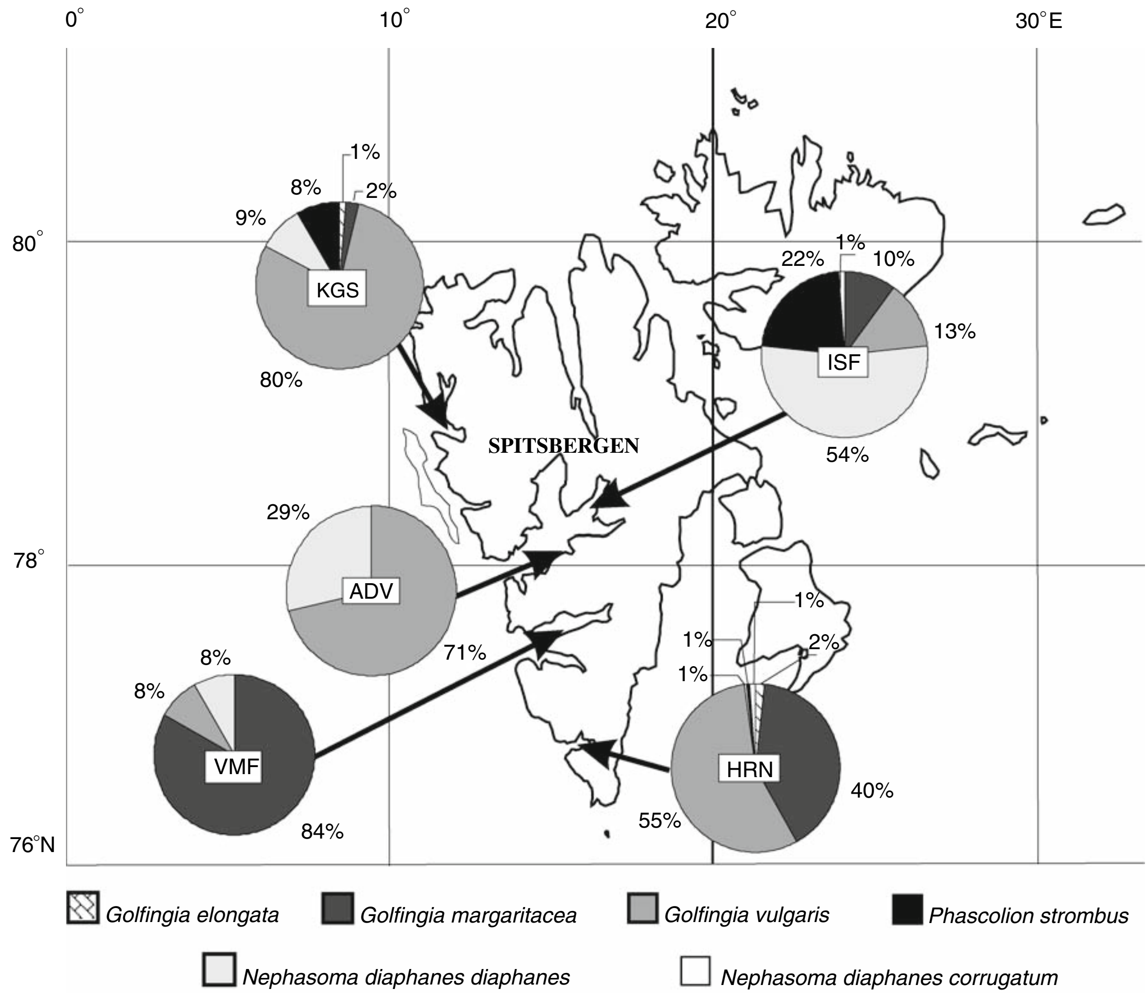

Fig. 2 Species occurrence and percentages in the total numbers of sipunculans in: *ISF* Isfjorden, *ADV* Adventfjorden, *HRN* Hornsund, *KGS* Kongsfjorden, *VMF* van Mijenfjorden

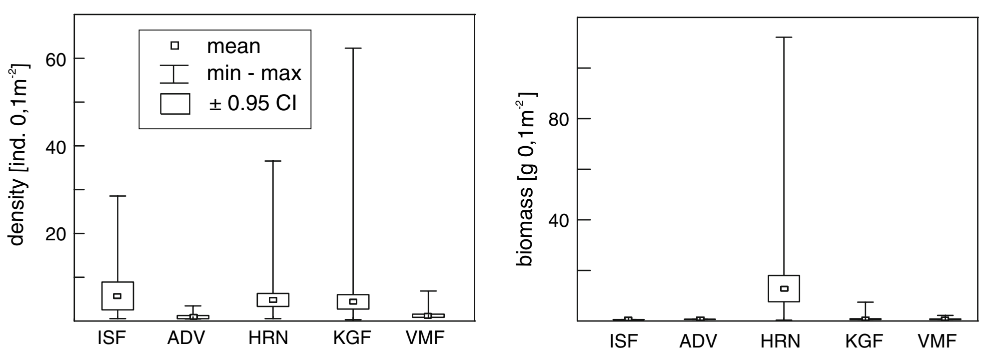

Fig. 3 Basic statistics (minimum, maximum, mean with 0.95 confidence intervals) for density and biomass of sipunculan fauna in: *ISF* Isfjorden, *ADV* Adventfjorden, *HRN* Hornsund, *KGS* Kongsfjorden, *VMF* van Mijenfjorden

significant differences found in density and species richness at this station in different years (Kruskal–Wallis test, $P < 0.05$). *G. vulgaris* dominated sipunculan fauna in 1999, 2002 and 2006, *Phascolion strombus* in 2000, 2003, 2004 and 2005. *N. diaphanes* occurred in higher numbers in 2002. All of those species were consistent part of benthic fauna while *G. margaritacea* occurred only in 2000, 2004 and 2006 (Fig. 6).

Sipunculans were never found in close distance from the tidal glacier front but in all depths sampled (Figs. 1, 7). No

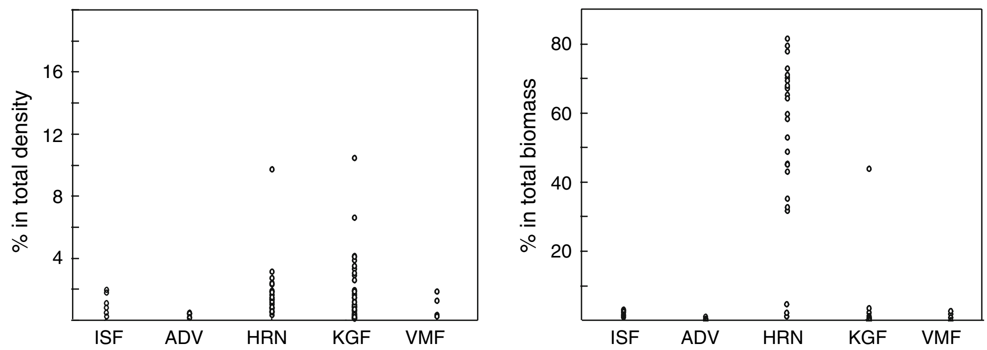

Fig. 4 Percentage of sipunculan fauna in total benthic density and biomass in samples collected in: *ISF* Isfjorden, *ADV* Adventfjorden, *HRN* Hornsund, *KGS* Kongsfjorden, *VMF* van Mijenfjorden

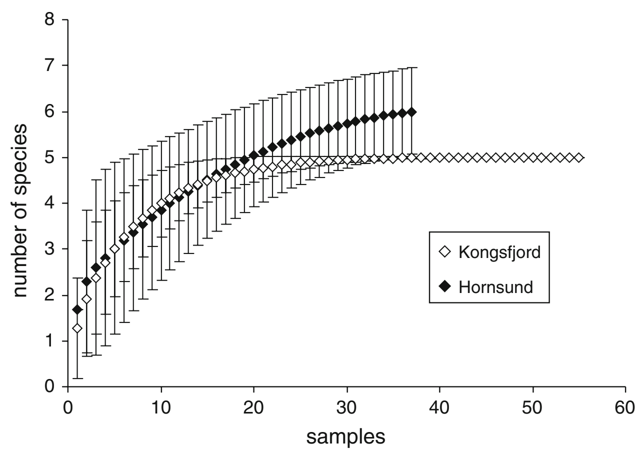

Fig. 5 Species accumulation curves for Hornsund and Kongsfjorden. Means of 50 estimates based on 50 randomizations of sample accumulation order (without replacement) are plotted with 0.95 confidence intervals

significant correlation was found between sipunculan species distribution and environmental variables including sediment type, temperature, salinity, POC and depth (BIO-ENV test).

Discussion

In this study, we have shown that sipunculans, although not diverse, may locally comprise over 10% of the total macrofauna density and may contribute to more than 80% of total biomass. The population density of sipunculans varies widely in the oceans, from quite-scattered (0.1–0.2 ind. m^{-2}, Cutler 1994, this study—vanMijenfjorden, Adventfjorden) to very-dense (392 ind. m^{-2}—deep sea, Vöring-Plateau, Norwegian continental slope, Romero-Wetzel 1987, 404 ind. m^{-2} Hausgarten, off Svalbard, Kędra and Murina 2007, almost 4,000 ind. m^{-2}, Rice et al. 1983 or 8,000 ind. m^{-2}—Azores, Chapman 1955). Cutler (1994) noticed that very often individual species of Sipuncula occur with very high densities. The highest density of sipunculan in this study (620 ind. m^{-2}) was recorded in Kongsfjorden. The mean sipunculan biomass in Hornsund (43 g m^{-2}) resulted mostly from the presence of large (length exceeding 110 mm) *G. margaritacea* specimens. Many sipunculan species are large, therefore, the presence of only few specimens may strongly bias the total sampled macrobenthic biomass. The genus *Nephasoma* is generally small to medium sized (<50 mm long) (Cutler 1994) and, although very abundant in deep-water communities (Cutler and Cutler 1987), is never dominant in terms of biomass (e.g. Romero-Wetzel (1987) reported mean density 224 ind. m^{-2}, while an average biomass was as low as 0.314 g m^{-2}).

Despite locally high densities, sipunculans are often neglected in ecological studies or faunal surveys, mainly because the species identification may be challenging for non-experts (Schultze 2005) and taxonomic expertise required to properly identify them is unavailable in most ecological laboratories. In community studies conducted on the whole macrofauna the sipunculans are usually identified to the phylum level only and there are very few publications dealing with their role in macrobenthic communities. Several authors (Węsławski et al. 1988; Włodarska-Kowalczuk et al. 2005; Włodarska-Kowalczuk and Pearson 2004) pointed out sipunculans (identified only to the phylum level) as dominant group in the macrobenthic communities of west Spitsbergen high Arctic fjords.

The distribution patterns showed that sipunculans did not occur in proximity to glaciers where high sedimentation rate and low amounts of organic matter are observed. There seem to be neither preferences towards sediment type nor any obvious relation between species diversity or density and POC. Most of the sipunculan species present in Spitsbergen area are burrowing, actively moving worms that indiscriminately ingest the substratum (Murina 1984) and extract organic particles from the ingested material (Stephen and Edmonds 1972). For *Golfingia* species Walter

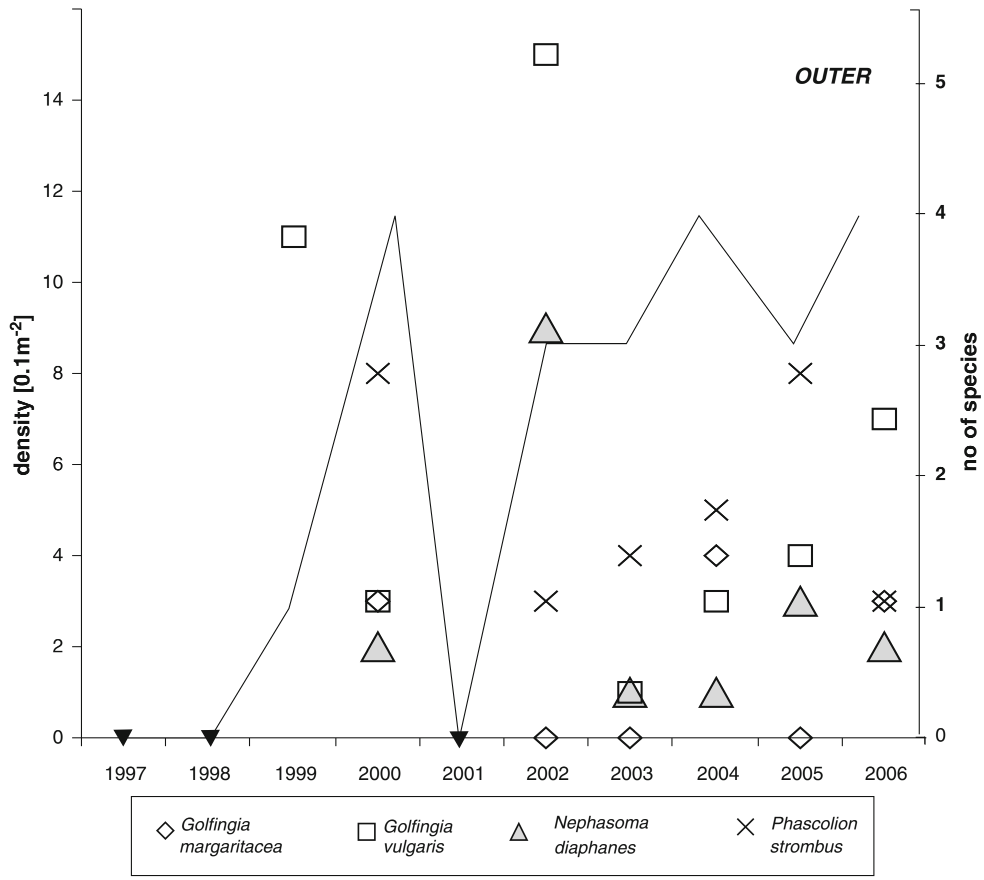

Fig. 6 The density of sipunculan species and sipunculan species richness at the *OUTER* station in Kongsfjorden in ten consecutive years. The *black triangles* mark those years when no sipunculan specimens were found

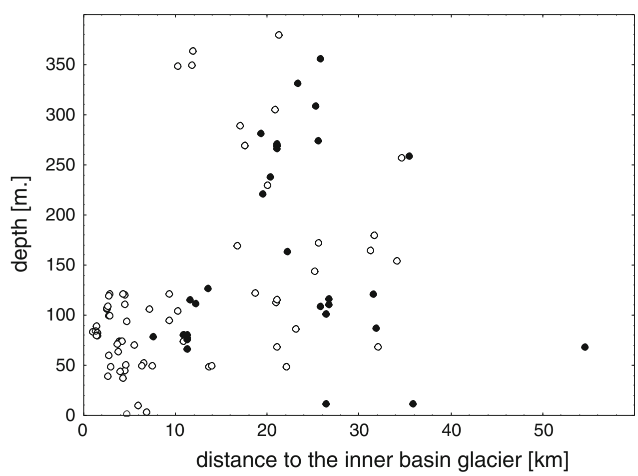

Fig. 7 The relationship between occurrence of sipunculans and depth (m) and distance to the inner basin glacier (km); *filled circle* stations where sipunculans were present, *open circle* stations where sipunculans were absent

(1973) reported 'passively selective' type of food uptake, i.e. the worms aimlessly draw in sediment searching for food, often leaving starlike traces. Hansen (1978) described the food uptake of *G. vulgaris* as selective with regards to small sediment grain sizes. Stable isotopes analysis revealed that sipunculan species belonging to genus *Golfingia* were deposit feeders (Grall et al. 2006; McMahon et al. 2006). Some mobile deposit feeding worms may become eliminated from near glacial areas where they are confronted with the low amount of available organic matter as the high turbidity reduces primary production in the water column, and organic matter sedimenting to the bottom is diluted by the high inorganic sediment load (as was shown, e.g. for annelids by Włodarska-Kowalczuk et al. 2005 or Kendall 1994).

G. margaritacea, found in very high numbers and significant biomass, may be an important food source for higher trophic levels fauna in Svalbard fjords. This species along with *P. strombus* (also found during this study) are an important part of the diet of the fish (Gadiformes, Scorpaeniformes, Pleuronectiformes) as well as of several sea stars and some gastropods in the Barents Sea, Greenland Sea and Alaska (Kohn 1975).

Members of the family Golfingiidae burrow actively in the sediment (Murina 1984). Romero-Wetzel (1987) reported *Nephasoma* species, even thought rather small sized (<50 mm long, Cutler 1994), produced burrows to depths exceeding 50 cm. They may build up to 11,000 burrows per m^2 (Romero-Wetzel 1987). Graf (1989) found that *Nephasoma* species may very effectively transport pelagic material, which settles on the sediment surface, more than 50 cm into the sediment itself. *N. diaphanes* dominating sipunculan fauna in Isfjorden and Adventfjorden may play similar role in the fjordic environment. Also other species, especially large ones as *G. margaritacea* dominating in outer Hornsund, occurring locally in such high numbers may play an important role in bioturbation of the sediments in fjords. Burrowing capacities of *P. strombus* which live in molluscs shells or polychaetes tubes is considerably lower and therefore its role as bioturbator is not that prominent.

Two species (*P. strombus* and *N. diaphanes*) use empty mollusc shells, polychaete tubes and foraminiferan tests as a shelter. *P. strombus* is know to be semimobile, mostly epibenthic worm holding empty shells and tubes, collecting sediments with tentacles. The density of this ecological group tends to be limited by a number of available empty shells and tubes and is determined by the sediment type (Hylleberg 1975). *P. strombus* avoids soft clay as the irrigation then is impossible due to clogging of the apertures (Hylleberg 1975). This may be the reason for keeping away from near glacial areas where sedimentation rate is high and sediments are soft and easily resuspended. In Kongsfjorden the sediments in the deeper sublittoral zone of the fjord (below 30–40 m) are composed of silt and muds with some sandy and clayey admixtures (Włodarska-Kowalczuk and Pearson 2004). That makes good conditions for both *P. strombus* and other sipunculans species (like *G. vulgaris* and *G. elongata*) that are known to prefer muddy sediments (Hylleberg 1975).

The temporal patchiness observed in sipunculan occurrence and diversity throughout one decade might be a result of reproduction success in different years. The long term biological observations in Kongsfjorden were accompanied by a survey of inter-annual differences in hydrological regimes (Węsławski and Adamski 1987; Beuchel et al. 2006). During 10 years of the study, the amounts of warm Atlantic waters inflowing to the fjord varied, and so changed the hydrological conditions within the fjord. The variation in the amount of relatively warm Atlantic waters transported into the Spitsbergen area may much influence both local hydrological conditions and the composition of local fauna (Berge et al. 2005). In 1997, 1998 and 2001 no sipunculans were found at the monitoring station in the outer part of the fjord. Those years followed the ones when large volume of Arctic waters were present at the surface and Atlantic water masses inflows were relatively small (Piechura and Walczowski 1996; Walczowski and Piechura 2006; 2007). Many sipunculans have planktonic larvae, enabling them to disperse over long distances (Rice 1981) and so the circulation of water masses is crucial for their distribution (Scheltema and Hall 1970; Scheltema and Rice 1990). Teleplanic larvae of sipunculans are abundant across the open ocean waters (Scheltema 1975; Scheltema and Rice 1990) and in the west Spitsbergen coastal areas may be transported with the Atlantic water masses penetrating into the fjord.

Conclusions

Sipunculans, although species poor, may locally occur in large standing stocks and hence play an important role in the Arctic fjords' marine benthic systems. Occurring locally in such high amounts they may play an important role in bioturbation of the sediments and as a food source for higher trophic levels. Therefore a need to include sipunculans in routine macrobenthic surveys must be emphasized. We also recommend that despite their bad reputation of the 'difficult group' every effort should be taken to increase the level of taxonomic expertise in this group in all marine ecological labs involved in benthic studies. We would also like to highlight the need for further studies on the ecological and potential geochemical importance of sipunculans as well as their role in sediment as bioturbators.

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