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FUNCTIONAL TRAIT ANALYSIS OF MEIOBENTHIC NEMATODES IN THE ARCTIC KONGSFJORD

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Abstract: We studied functional character of meiobenthic nematodes in relation to environmental parameters along the stations of Arctic Kongsfjord to determine the functional diversity and to detect the relationship between taxonomic and biological trait scheme in relation to the abiotic factors. The samples were collected as a part of Indian Arctic expedition from 27th June to 28th July, 2015, that forms the basis of this study. Along the Kongsfjord, meiofauna samples were collected from eight stations by van Veen grab (at depths 40 -303m). The meiofauna in Kongsfjord was mainly constituted by Nematoda, Foraminifera, Tintinnida, Ostracoda, Copepoda, Kinorhyncha and Oligochaeta, of which nematodes (41%) were the dominant organisms. A total of 25 nematode species representing ten families were found along the stations. Across the entire study area, the dominant species were *Dorylaimopsis* sp. (62%) followed by *Sabatieria* sp. (14%) and *Terschellingia longicaudata* (5%). The functional trait combination revealed that the most common feeding groups were non selective deposit feeders and epistrate feeders and most of the feeding groups were significantly linked to the organic carbon, depending on the sediment composition and nematode tail type has been shown to respond to variation in sediment composition and depth profile. Clavate, conical, long filiform were the most prevalent tail shapes in outer fjord and comparatively very low variations were observed in inner fjord. Majority of the nematodes were having slender and stout, body shape dominating the outer fjord whereas in the inner fjord they were long and thin in structure. Organic carbon and sediment texture significantly influenced nematode functional characters and functional diversity.

Keywords: Benthos; Meiofauna; Nematoda; Feeding groups; *Dorylaimopsis, Sabatieria, Terschellingia*

INTRODUCTION

Kongsfjord is a glacial fjord in Svalbard that harbours a mixture of Arctic flora and fauna. The glacial outflow of the fresh melt-waters containing mineral material influence salinity, water transparency, primary production and sedimentation rates. The meiobenthic group in the Kongsfjord was constituted by Nematoda, Foraminifera, Bivalvia, Polychaeta, Copepoda, Gastrotricha and Kinoryncha. Nematodes were the dominant group of metazoans in the sediment of Kongsfjord. Nematode functional trait groups share several morphological traits (Chalcraft and Resetarits Jr., 2003) and the use of these traits may provide additional information on changes in the biodiversity and also facilitate better comparison with other geographical regions (Bremner, 2008). Feeding, body shape and tail shape traits have each been shown response individually to variation in the environment (Soetaert *et al.*, 2002; 2009; Vanaverbeke *et al.*, 2004; 2007; Fleeger *et al.*, 2006; 2010). Wieser (1953) classified nematodes according to their morphology such as selective deposit feeders (1A), non-selective deposit feeders (1B), epistrate feeders (2B) and predators or omnivores (2B), had applications in a variety of marine habitats. Tail shapes are considered important in locomotion, reproduction and retention in the sediment (Thistle and Sherman, 1985; Thistle *et al.*, 1995; Fleeger *et* *al.,* 2006). The use of multiple traits provided more information relative to function than was gained from individual traits. The trait analysis have previously proven to be equal or even better than species composition in identifying community changes along environmental gradients (Schratzberger *et al.,* 2007; Wan Hussin *et al.,* 2012; Alves *et al.,* 2014; Ristau *et al.,* 2015).

Body shape provides information on adaptations to the sedimentary environment and locomotion (Vanaverbeke *et al.,* 2003, 2004; Alves *et al.,* 2013). The functional characters of nematodes and their trophic positions as well as the functional role in marine sediments are still poorly understood in spite of their abundance. There is no major scientific information available on the functional aspects of nematodes in relation to environmental variables of the glacial fjords of Arctic. In this study, we examined the functional characters of the meiobenthic nematode communities by biological traits analysis in the Arctic Kongsfjord. Studies on functional groups of nematodes may provide additional information on changes in biodiversity and also facilitate better comparison with other geographical regions. This study will be helpful in our understanding on the functional diversity of the meiobenthic nematodes and the influencing environmental parameters.

MATERIALS AND METHODS

Study area

Kongsfjord is located on the west coast of Spitsbergen Island, which is part of the Svalbard archipelago, at 79 ^{0}N 12 ^{0}E. The fjord is 26 km long with an average width of 8 km and its entrance lacks a sill. The two fjord basins are separated by a 30-m-deep ridge. Three tidal glaciers terminate in the fjord waters. The length of the fjord coastline is 89.6 km, of which 15.9 km is covered by Kongsbreen; the most active glacier. The depth of the fjord gradually decreases towards the end, from 360 m in the outer basin to approximately 60 m in the inner basin. However, there are some deeper depressions, to about 400 m, in the middle of the fjord. The central basin of the fjord is up to 428 m deep (Elverhoi *et al.,* 1983). Kongsfjord is a high latitude glacial fjord (79^{0}N) influenced by both Atlantic and Arctic water masses. Atlantic water masses which influence Kongsfjord was comprised of the West Spitsbergen Current, a branch of the warm (4^{0}C) and the highly saline (35 PSU) Norwegian Current (Loeng, 1991). Due to the fact that Kongsfjord is an open fjord, both water masses make this fjord rather sub-Arctic rather than Arctic, in comparison with other fjords at the same latitude (Svendsen *et al.,* 2002).

Study stations

The samples were collected as a part of Summer Phase II Indian Arctic Expedition, 27 June to 28 July, 2015 at the Indian research base “Himadri Station” at Spitsbergen, Svalbard, Norway; which is a part of the International Arctic Research base, Ny-Alesund. The boat “*Teisten*” of Kings Bay was employed for collecting samples from the selected transects. The field location in the study area was Kongsfjord (79^0 N, 12^0 E) glacial fjord of Arctic (Svalbard) located northwards to Norway (Fig. 1). The samples for the present study were collected as an expedition part of the research programme. The sediment and benthic samples were collected from eight stations, of Kongsfjord. The depth of the area ranges from 45 m to 302 m. Based on depth profile, the fjord stations were divided into two subsets outer fjord (stations 1-5) and inner fjord (stations 6-8) (Table 1).

Collection and processing of sample

Sediment samples were collected in three replicates using van Veen grab with an area of 0.1 m^2 catching area. Immediately after grab hauling; ascertaining that the sediment was undisturbed, sub-samples were taken for meiofauna by a glass corer with cross-sectional area of 5 cm^2 to a depth of 5 cm from the middle of each grab sample. The core samples were immediately fixed in buffered formalin at a concentration of 4% and stained with Rose Bengal. The organisms were extracted from sediment by decantation technique (Pfannkuche and Thiel 1988). The replicate core samples were processed separately in the laboratory. Identification of nematodes was done to the highest taxonomic level possible by following the standard pictorial keys of Platt and Warwick (1983, 1988 and 1998) and Abebe *et al.* (2006). Measurements and photos of the specimens were taken using Leica DM 2000 LED Image Software.

Water and Sediment analysis

The pH of sediment was determined by Systronics

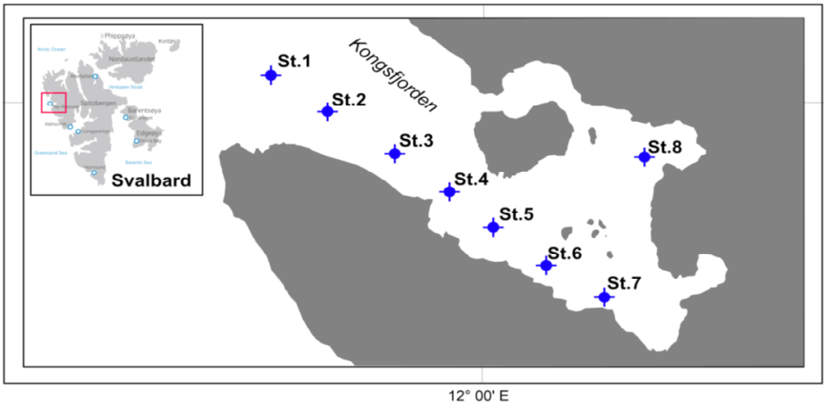

Fig. 1. Map of Kongsfjord with study stations

Table .1 Details of sampling stations in Arctic Kongsfjord, June 2015

Kongsfjord	Latitude	Longitude	Depth (m)
Stn.1	79°01’635"	11°39’149"	204
Stn.2	79°00’54"	11°47’695"	149
Stn.3	78°57’454"	11°49’088"	152
Stn.4	78°56’504'	11°57’224"	302
Stn.5	78°55’365"	12°05’642"	147
Stn.6	79°00’386"	11°47’874"	68
Stn.7	78°58’328"	12°20’255"	45
Stn.8	78°53’72"	12°19’244"	79

analyser (No.371, [accuracy ± 0.01]), and that of oxidation reduction potential (Eh) by Systronics digital Eh meter (No.318). For granulometric analysis International Pipette Method (Folk, 1974) was followed, that for Total Nitrogen (TN), Total Carbon (TC), Total Organic Carbon (TOC) and Inorganic Carbon (IC) concentrations were determined on dried samples by thermal combustion using a TOC -analyzer, Analytic Jena multi N/C 2100s. Samples for inorganic carbon were pre-treated with 2N HCl to remove carbonates.

Nematode functional trait analysis

Nematode species were classified according to their buccal morphology, tail shape, adult length and adult shape.

Feeding type

Wieser (1953) proposed buccal structure as a proxy for trophic relationships (Jensen 1987; Vanaverbeke et al. 2011). According to feeding type nematode species were assigned to four feeding categories: selective deposit feeders (1A), non-selective deposit feeders (1B), epistrate feeders (2A), and predators or omnivores (2B).

Tail shape

Thistle and Sherman (1985) developed a functional-trait scheme based on tail-shape groups, which are common in free-living marine nematodes: short or round, elongated or filiform, conical and clavate. Tail shapes are considered important in locomotion, reproduction, and retention in the sediment (Thistle and Sherman, 1985; Thistle et al. 1995; Fleeger *et al.*, 2006).

Total length and body shape

Total length and the maximum body width for nematodes were measured and the length: width ratio was calculated. From the measured length, each species was therefore assigned to one of four length groups (<1, 1– 2, 2–4, and >4mm) and three shape categories (stout, with a length: width ratio <18; slender, with a length: width ratio of 18–72; and long thin, with a length: width ratio>72) Soetaert et al. (2002). Body shape provides information on adaptations to the sedimentary environment and locomotion (Vanaverbeke *et al.*, 2003; 2004; Alves *et al.*, 2013).

Data analysis

The software PRIMER v6 (Plymouth Routines in Multivariate Ecological Research, version 6.1.8) was used for univariate and multivariate analysis of data (Clarke and Gorley, 2006). Environmental variables and functional traits were then subjected to principal-component analysis (PCA) for identification of the spatial patterns based on environmental data.

RESULTS

Environmental characteristics

Environmental characteristics of water and sediment of 8 stations were analysed (Table 2). Water temperature was found to increase towards the inner fjord and the values varied from-1.3°C (station 8) to -5.3°C (station 3). Salinity showed slight variations, station 3 had maximum salinity (35 ppt). Outer fjord had higher salinity when compared with the inner fjord. Sediment pH values were high in station 3 (6.49) and lower in station 8 (5.6). Outer fjord showed higher pH values when compare with the inner fjord. The Eh value was higher in station 7 (3.1 mV) and lower in station 8 (- 4 mV). The sediment in the Kongsfjord system consists of three fractions sand, silt, and clay. The mean silt fraction in the Kongsfjord during the study period was 66.75%, that of inner fjord was 62.6% and outer fjord was 69.19%. The mean clay fraction was 20.02%, outer fjord had higher value (20.46%) when compared to the inner fjord (19.3%).The mean sand fraction was 12.24% and the sand fraction was higher in inner fjord (17.18%) than the outer fjord (9.27%).The total carbon varied from a lowest value of 22.87g/kg to a highest value of 36.95g/kg. The mean value of total carbon was 30.88g/kg. The inorganic carbon varied from a lowest value of 6.37g/kg to a highest value of 27.08g/kg with a mean value of 17.82g/kg. Organic carbon varied from a lowest value of 8.69g/kg to a highest value of 16.49g/kg with a mean value of 13.28g/kg. PCA ordination constructed for the environmental factors (Fig. 2). The pH, OC, IC, sand, silt and water temperature contributed significantly to the PCA1. The pH, IC, and silt were negatively correlated and OC, temperature and sand were positively correlated with PCA1. In PCA2 Eh and clay were negatively correlated, whereas the TN and Eh was positively correlated. PC1 has 56.9% variation (eigen value 6.26) and PC2 has 19.7% variation (eigen value 2.17). PC1 and PC2 together explained about 72% of the variance.

General distribution of meiobenthic nematodes

The meiobenthos in the Arctic Kongsfjord comprised of Kinorhyncha, Foraminifera, Nematoda, Oligochaeta, Tintinnida, Copepoda and Ostracoda. Foraminifera (41%) and Nematoda (41%) were the most abundant group of meiobenthos followed by Tintinnida (14%) Copepoda (2%) and Ostracoda (2%) (Figure 3.). Nematodes representing ten families Comesomatidae, Linhomoeidae, Leptsomatidae, Oncholaimidae, Thoracostomopsidae, Cyatholaimidae, Chromadoridae, Selachinematidae, Oxystomatidae, Sphaerolaimidae belonging to the three orders, Chromadorida, Monhysterida and Enoplida were identified in the present study. They showed higher diversity in the inner fjord than the outer fjord. According to their functional groups Selective deposit feeders include *Terschellingia longicaudata, T. communis, T. gourbaultae, Leptostomatum elogatum,* and *Halalaimus* sp. Non- selective deposit feeders include *Sabatieria* sp. such as *S. ornata, S. punctata, S. praedatrix* and *S. elongata.* The epistrate feeders include *Dorylaimopsis* sp., *Dorylaimopsis punctata, Marylynnia complexa, Neochromadora poecilosoma* and predators include *Viscosia* sp., *V. langruensis, Thoracostoma setosum, T. cornatum, Sphaerolaimus gracilis, S. paradox, Parasphaerolaimus* sp. *Oncholaimus paralangruensis, Adoncholaimus crassicaudus,* and *Halichoanolaimus robustus.* Among the species identified *Dorylaimopsis* sp.(67%) was the dominant one followed by *Sabatieria* sp. (14%) and *Terschellingia longicaudata* (5%).

Functional trait analysis

Nematode feeding type and Tail shape

In all stations the nematode assemblages differed significantly, the assemblages were dominated by non-selective deposit feeders (1B) and epistrate feeders (2A) followed by predators (2B), whereas the selective deposit feeders (1A) were comparatively lower (Table 3.). The epistrate feeders (Fig. 4.) were dominated by *Dorylaimopsis* sp. (96%) and *Dorylaimopsis punctata* (4%). The selective deposit feeders (Figure 5.) were dominated by *Terschellingia longicaudata* (46%) followed by *Halalaimus* sp. (25%) *and Terschellingia communis* (23%). The non-selective deposit feeders (Fig. 6) were dominated by *Sabatieria* sp. (83%) followed by *Sabatieria praedatrix* (11%) and *Sabatieria ornata* (6%). The predators (Fig. 7.) were dominated by *Halichoanolaimus robustus* (68%), followed by (26%) *Viscosia* sp. and *Thoracostoma cornatum* (6%).

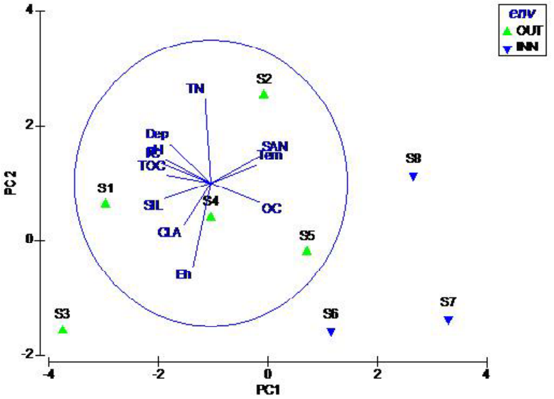

Fig. 2. Principal-component analysis derived from the contribution of environmental parameters

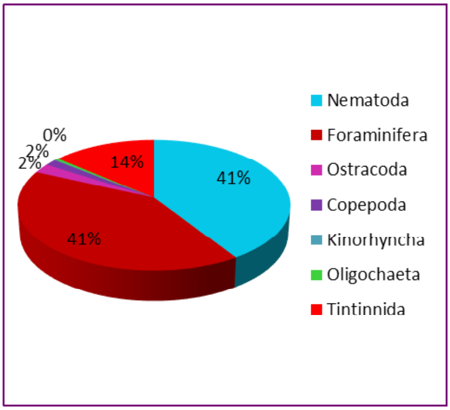

Fig. 3. Percentage combosition of Meiobenthos in Arctic Kongsfjord

Fig. 4 *Dorylaimopsis punctata* (Ditlevsen, 1918) 2A: Buccal cavity with scraping tooth or teeth, epistrate (diatom) feeders.

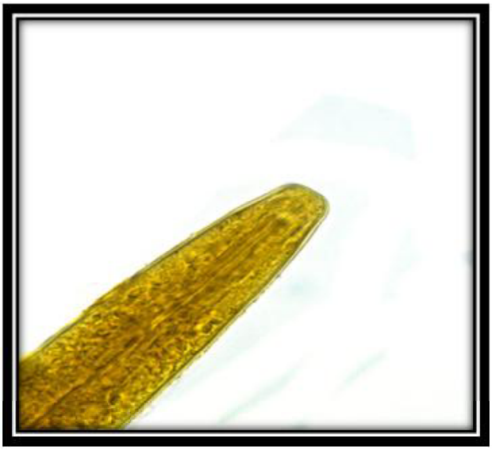

Fig.5 *Terschellingia longicaudata* (De Man, 1907) 1A: no buccal cavity or a fine tubular one, selective deposit (bacterial) feeders.

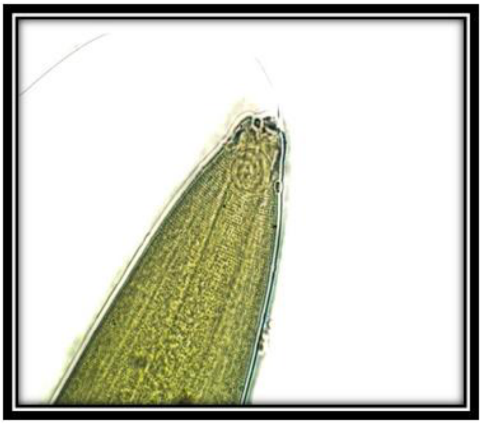

Fig.6. *Sabatieria praedatrix* (De Man, 1907) 1B: Large but unarmed buccal cavity, non-selective deposit feeders.

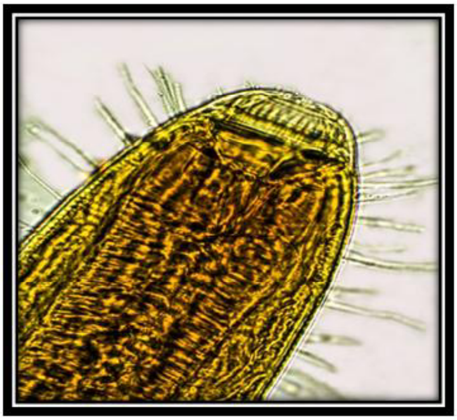

Fig.7. *Parasphaerolaimus paradoxus* (Ditlevsen, 1918) 2B: Buccal cavity with large jaws, predators /Omnivores.

Table .2 Variation in Environmental parameters of the sediment

Stations	Depth	pH	Eh (mV)	Temp (°C)	Sand (%)	Silt (%)	Clay (%)	TOC (g/kg)	IC (g/kg)	OC (g/kg)	TN (g/kg)
Stn.1	204	6.42	2	-4	3	73.31	22.5	31.33	24.44	8.69	1.925
Stn.2	149	6.14	1.3	-2.6	18.58	60.79	20	31.23	20.68	10.55	3.5
Stn.3	152	6.49	-1	-5.3	3.21	74.9	21.4	36.24	27.08	9.16	0.525
Stn.4	302	5.78	2.7	-1.4	9.6	69.87	19	36.95	23.68	13.27	1.225
Stn.5	147	5.73	2.2	-1.4	12	67.1	19.4	30.51	14.45	16.06	0.875
Stn.6	68	5.32	-2	-1.3	11.65	64	23.1	30.75	15.44	15.28	0.7
Stn.7	45	5.56	3.1	-1.3	19.7	59	20	22.86	6.37	16.49	0.875
Stn.8	79	5.6	-4	-1.3	20.2	65	14.8	27.11	10.41	16.7	1.05

Functional traits were subjected to PCA analysis for identification of the functional diversity of the meiobenthic nematodes and also to understand the influence of environmental parameters. Principal component analysis showed that the selective deposit feeders dominated in station7 followed by station 8 and 6, the sediment fraction in these areas were sandy with high organic carbon content. Temperature was also higher in these stations (inner fjord) (Fig. 8). Non-selective deposit feeders showed diversity in all stations and dominated in station 8 followed by station 3, 4 and 7, were the sand, clay and organic carbon influences the distribution of non-selective deposit feeders (Fig. 9). Epistrate feeders showed diversity in all stations and the organic carbon in the sediment was positively correlated. They are dominated in station 4 followed by station 3, 7 and 8 where the sediment fraction was composed of clay, sand and silt (Fig. 10). Predators are dominated in station 4 followed by station 7 and 3. Clay and silt were influencing these feeding groups and organic carbon was also higher in these stations (Fig. 11).

Conical, clavate, long filiform were the most prevalent tail shapes in majority of stations. Nematodes were assigned to four tail-shape groups, which are common in free-living marine nematodes: short or round, elongated or filiform, conical, and clavate (Table 3). PCA derived from four tail shape groups showed that clay and silt were more influencing the majority of tail shape groups. Conical tail shape was dominated in station 4, where the sediment was composed of silt and clay (Fig. 12).The clavate tail shapes were dominated in the sandy regions and dominated in station 8 (Fig. 13). Long and filiform tails showed maximum diversity in all stations and are dominated in station 1, 3, 4, 7, and 8. Sand, silt, clay, organic carbon, Eh and water temperature was the major factors influencing these tail shape groups (Fig. 14). Short and round tail shapes were dominated only in station 4, comparatively very low in other stations, were the sediment fraction contain higher content of silt and clay with higher content of organic carbon (Fig. 15).

Total length and body shape

The average length of adult nematodes ranged from 1 to 4mm, and the majority of all recoded individuals occurred in three length categories (<1, 1-2 and 2-4mm) (Table 4.). The outer fjord was dominated by 2-4mm size categories (41%), and the inner fjord was dominated by 53% <1ìm length category. Most of them are dominated in sandy region with organic carbon rich environment and temperature is also having a role in their distribution. The majority of the nematodes were slender. The outer fjord were dominated by stout animals (45%) followed by (31%) slender groups and inner fjord were dominated by long and thin animals (59%) followed by slender groups (41%) (Table 4).

The PCA derived from four body length category showed that majority of the nematodes comes under the category of 2-4 mm. Length of <1 mm category were dominated in station 8 and sand was the more influencing factor of this category (Fig. 16.). In the case of 1-2mm category both sand and clay were the most influencing factors. Station 8 showed maximum diversity followed by stations 3, 4 and 7; the organic carbon was also high in these regions (Fig. 17.). Length category of 2-4 mm showed diversity in all stations; clay, sand and silt were the influencing factors (Fig. 18.). Length of >4 mm showed diversity in station 8 followed by station 4; were the region is sandy (Fig. 19).

Table .3 Functional trait matrix showing the percentages of all individuals belonging to four nematode feeding categories (1A-Selective deposit feeders, 1B-Non-selective deposit feeders, 2A- Epistrate feeders, 2B-Predators or omnivores) and four tail - shape categories.

Depth	1A	1B	2A	2B	Short & round	long & filiform	Clavate	Conical
204	6	1	7	3	0	16	11	40
149	5	11	8	0	0	8	11	0
152	8	17	14	23	0	16	15	20
302	8	16	25	37	67	16	24	40
147	9	0	10	2	0	8	7	0
68	17	9	9	8	0	8	11	0
45	76	14	14	30	34	16	11	0
79	57	37	17	0	0	16	13	0

Table .4 Functional trait matrixes showing the percentage of all individuals belonging to four body length categories and three body shape categories.

Depth	<1mm	1-2mm	2-4mm	>4mm	Slender	Stout	Long and thin
204	6	4	7	0	7	25	1
149	12	8	8	0	7	0	10
152	6	15	13	0	13	0	16
302	17	19	24	4	23	75	18
147	0	4	10	0	18	0	8
68	17	6	9	0	10	0	0
45	0	17	15	31	8	0	8
79	45	30	18	66	17	0	42

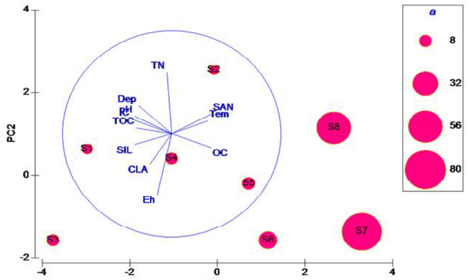

Fig. 8. Principal-component analysis derived from the contribution of selective deposit feeders (1A)

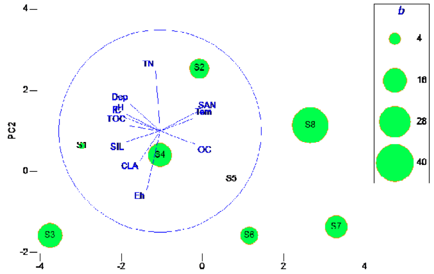

Fig. 9. Principal-component analysis derived from the contribution of non-selective deposit feeders (1B)

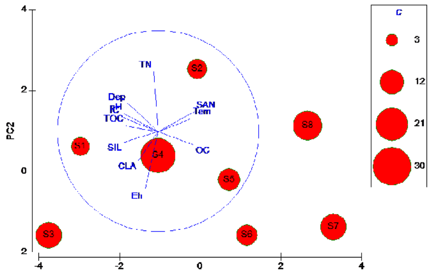

Fig. 10. Principal-component analysis derived from the contribution of epistrate feeders (2A)

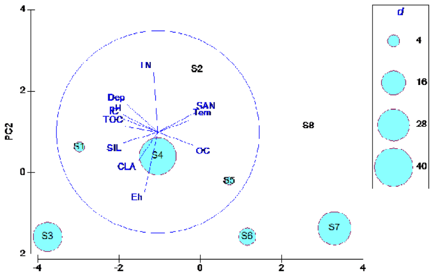

Fig.11. Principal-component analysis derived from the contribution of predators (2B)

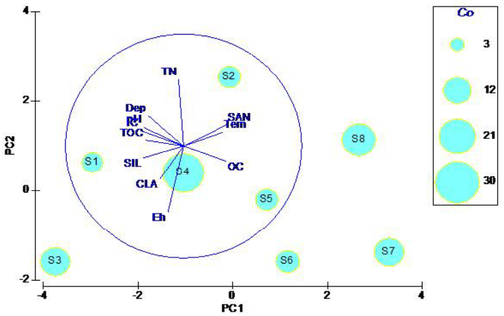

Fig. 12. Principal-component analysis derived from the contribution of conical tail groups

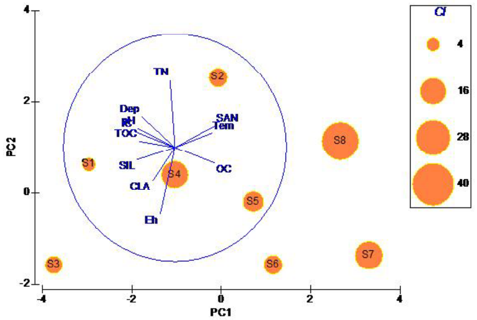

Fig. 13. Principal-component analysis derived from the contribution of clavate tail groups

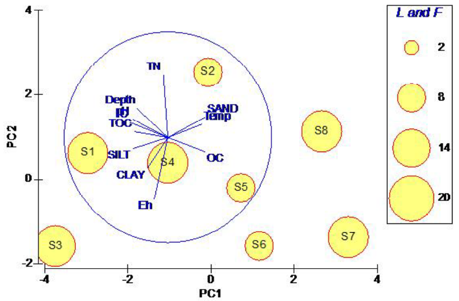

Fig. 14. Principal-component analysis derived from the lond and thin tail groups

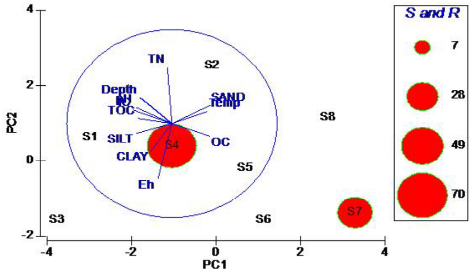

Fig. 15. Principal-component analysis derived from the contribution of short and round tail groups

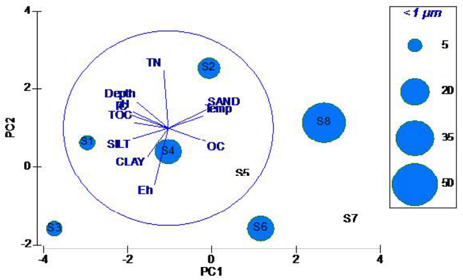

Fig.16. Principal-component analysis derived from the contribution of body length category <1mm

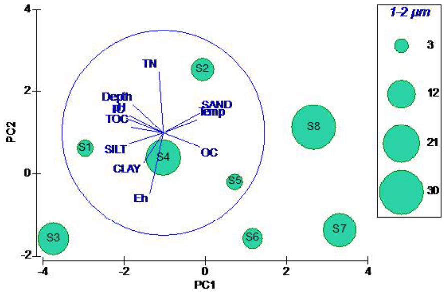

Fig. 17. Principal-component analysis derived from the contribution of body length category 1-2mm

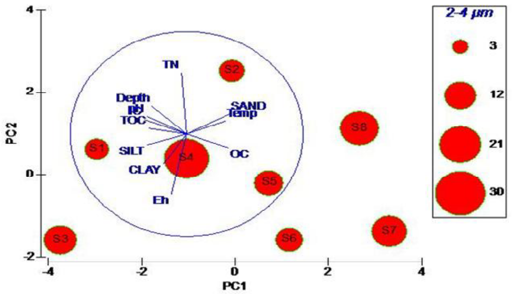

Fig. 18. Principal-component analysis derived from the contribution of body length category 2-4mm

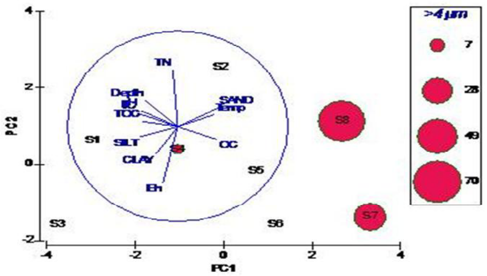

Fig.19. Principal-component analysis derived from the contribution of body length category >4mm

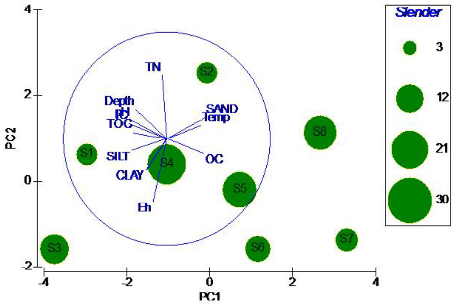

Fig. 20. Principal-component analysis derived from the contribution of slender body shape category

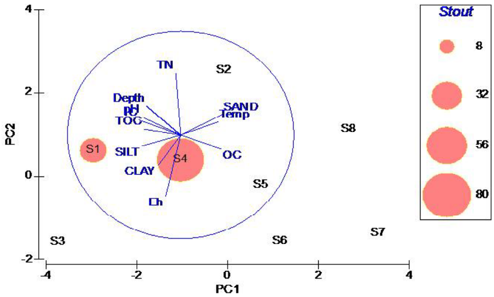

Fig. 21. Principal-component analysis derived from the contribution of stout body shape category

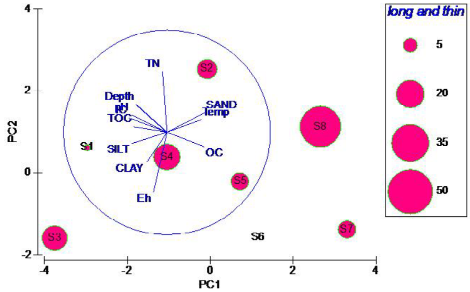

Fig. 22. Principal-component analysis derived from the contribution of long & thin body shape category

Three body shape groups were subjected to PCA analysis; slender shape groups were dominated in station 4 followed by stations 3, 5, and 8 were the region had high composition of clay and silt. Other influencing factors include organic carbon, Eh and temperature (Fig. 20). Stout body shape category dominated in station 4; were the clay content was high (Fig. 21). Long and thin shaped groups were dominated in station 8; sand, temperature, Eh and organic carbon were the influencing factors (Fig. 22).

DISCUSSION

Environmental parameters

The sediment characters show variations in all the eight stations of the Arctic Kongsfjord. Temperature of the sediment increases towards the inner fjord. A variation in temperature is due to the inflow of fresh and cold glacial melt waters, which are controlled by the glacial activity. The pH also increases from the outer fjord to the inner fjord and the Eh values to varied among each stations, outer fjord showing higher value when compared with the inner fjord. This seemed to be concordant with the work by Bijoy Nandan *et al.* (2016).

Benthic communities are greatly affected by the sedimentary environment and its texture. The nature of substratum determines the morphology, dominance pattern, feeding and interaction of benthic species. (Etter and Grassle, 1992; Snelgrove and Butman, 1994). Krishnapriya (2014) reported that the sediment in Kongsfjord system was more silty when compared with sand and clay. In our study both the outer and inner fjord were dominated by silt and the clay fraction was ascending towards the outer fjord. The sand dominated in the shallow region of the Kongsfjord. In our study the sediment composition graph showed that the percentage of silt and clay do not show large variation whereas the sand faction showed variation in each stations, in the present study, the total carbon in the sediment were higher in the outer fjord, than the inner fjord. The inorganic carbon content was increases in the inner fjord, whereas the organic carbon was slightly lower in the inner fjord than the outer fjord. These observations are in conformity with the work by Krishnapriya (2014). The total carbon and total organic carbon were higher in the outer fjord, while the inorganic carbon was higher in the inner fjord. The decreasing concentration of organic matter in the sediment could be the result of glacial mixing (Holte and Gulliksen, 1998), among the three forms of carbon present in the sediment, the major form of carbon was the total organic carbon which is available to the food web.

Nematodes occur in all substrates, sediments, climatic zones and water depths. Individuals of 80-95% and 50–90% of the biomass of meiobenthos usually consists of nematodes (Heip *et al.*, 1985; Soetaert *et* *al.*, 1995). According to the present study, the meiobenthic nematodes contributed 41% of the meiobenthic community in the Arctic Kongsfjord. The inner fjord was more diverse than the outer fjord, because the shallow inner fjord regions were dominated by sand. Studies by Heip *et al.* (1985), Coull (1988), Giere (2009) showed that the shallow sublittoral sandy sediments are generally characterised by highly diverse meiobenthic communities, of which nematodes usually represent the dominant taxonomic group (Brown and McLachlan, 1990). The low abundance of total meiofauna and nematodes was related to the low concentrations of organic matter and bacterial density representing the primary food sources. Sediment properties like grain size are known to directly influence meiofaunal density and diversity (Gray, 2002). Somerfield *et al.* (1995) recorded that the meiofauna are more sensitive to sediment structure especially nematodes. So the granulometric composition has an important role in the distribution of nematodes. The meiofaunal communities and their morphological characteristics vary among sediment types and with sediment profile (Giere, 2009).

Functional Trait analysis

The functional composition of nematodes was strongly linked to the organic-carbon and dissolved-oxygen concentration (Singh and Ingole, 2016). Previous research has linked a rapid response and strong relationship between food type and feeding traits in nematodes (Vanaverbeke *et al.*, 2011; Culhane *et al.*, 2014). Given that nematode feeding traits vary over many environmental gradients and with changing environments (Kazemi-Dinan *et al.*, 2014; Vanaverbeke *et al.*, 2011). In the present study nematode assemblages differed significantly in all 8 stations of Kongsfjord; the assemblages were dominated by non-selective deposit feeders (1B) and epistrate feeders (2A) followed by predators (2B), whereas the selective deposit feeders (1A) were comparatively low. PCA ordination showed that the selective deposit feeders and non-selective deposit feeders (1B) was dominated in inner fjord were the areas were rich in organic carbon and sand and the region were shallow with higher temperature. Non-selective deposit feeders mostly prefer homogeneous mud and fine sand, they have well developed but weakly cuticularized buccal cavity. Food particles, often larger bacteria, detritus and diatom cells, are taken up using the lips and the anterior buccal cavity (Nehring, 1992; Moens and Vincx, 1997). Selective deposit feeders are found in more heterogeneous (fine) sandy areas. Epistrate feeders and predators dominated in the outer fjord, probably because of the higher organic content of the sediment. Epistrate feeders have been found to feed on microbiota by scraping them off solid surfaces or mucus threads with their teeth. Higher amounts of organic matter enriched the growth of diatoms and ciliates which can contribute significantly to food for epistrate feeders Gambi *et al.* (2003). The relative proportion of each of the four Wiesers feeding types in a community depends on the nature of the available food, which may perhaps explain their prominence on exposed substrata (Platt and Warwick, 1980).

In nematodes, the tail plays an important role in locomotion, which in turn depends on sediment type (Riemann, 1974). Tail types are diverse and variable and have been suggested as an effective method of characterising nematode communities. Functionally, tail type has been shown to respond to variation in sediment composition and depth profile (Schratzberger et al. 2007; Vanaverbeke *et al.*, 2007; Brustolin *et al.*, 2012) rather than changes in diet/ food resources. Clavate, conical, long filiform were the most prevalent tail shapes in outer fjord and comparatively very low in inner fjord. In the present study clavate tails were dominated in sandy regions of inner fjord, conical tails were prevalent in sand and muddy sediment and long filiform tails were dominated in clay sediments in outer fjord. Riemann (1974) considered that clavate type of tail morphology to be typical of the inhabitants of the interstitial spaces in sand and conical tail that could be a special adaptation to ûne sand and muddy sediments, where only an incomplete interstitial system exists. He also reported that, some individuals with a long, filiform tail have a partly sessile existence in which tail morphology plays a crucial role. They have a special adaptation to fine sand and muddy sediments where only an incomplete interstitial system exists. In these sediments, the tail would enable animals to retract from dead-end interstitial passageways that are too narrow to allow the worm to turn around and escape.

The present study revealed that majority of the nematodes were slender and stout, dominated in outer fjord and their length were in the range of 2-4ìm and >4ìm and stout animals were comparatively low. Vanhove *et al.* (1995) and Soetaert *et al.* (2002) noted that length and width are important functional attributes for describing chemical stress, metabolic rate, the ability to move or migrate and vulnerability to predation. In fact, the size of animals is an integrative feature strongly correlated with their morphology, locomotion, feeding mode, and other characteristics. Most authors have related nematode length and width to granulometry, in concordance with the BIOENV (Biota Environment) analysis, which revealed that body shape was significantly correlated with sand and clay. Pronounce body elongation in nematodes species is adaptive characteristics related to low oxygen partial pressure and epidermal uptake of dissolved organic matter (Jensen, 1987). The increasing proportions of long and thin nematodes from the shelf to deeper stations possibly signify that a large body size could facilitate easy burrowing into the sediment.

The nematodes with different functional characteristics differ from their abilities to respond to environmental stresses and disturbance, thereby providing resilience to the community. Environmental conditions thus influence the importance of functional complementarity in structuring communities (Hooper et al. 2005). Nematode assemblages were dominated by non-selective deposit feeding and epistrate feeding organisms, which can make full use of particulate organic matter. Moreover, the content of organic matter can partially explain the spatial patterns of the distribution of free-living nematodes in some habitats (Olafsson and Elmgren, 1997; Schratzberger *et al.*, 2006). Body size was well correlated with silt, clay, sand and organic carbon, whereas tail shape and body length was correlated with clay, silt and organic carbon. This pattern shows the properties of sediment-related factors, which are also important to morphological characteristics of species.

The present study is an attempt to understand the functions of meiobenthic nematode communities in the Kongsfjord Svalbard. From the present study the following conclusions can be arrived. The meiofauna are more sensitive to sediment structure especially nematodes. So the granulometric composition has an important role in the distribution of nematodes. Free-living nematodes are one of the most dominant metazoan groups in both biomass and abundance and are important consumers that contribute to benthic marine environments in many ways including oxygenation, bioturbation and carbon cycling in marine sediments. Free-living nematodes are an abundant and diverse component of the meiofauna in the Arctic Kongsfjord. The effects of environmental parameters were more evident in taxonomic groups than in functional traits. Although numerous factors that could be important for the formation and persistence of nematode communities. Organic carbon plays a vital role in structuring nematode communities and certain functional adaptations among different species may play an important role in determining the ecosystem function. The present study supports the previous findings that nematodes are the taxon most tolerant of variation in environmental parameters. Among the four feeding groups epistrate feeders dominated (47%) followed by non-selective deposit feeders (32%) with slender body shape having conical tails with a body length of 2-4 mm. Improving our understanding of diversity and functional relationships across ecosystems will require a categorisation of species attributes that can be related to function. However, obtaining a greater knowledge of the functional roles of meiobenthic nematode species will be the key to improve the sensitivity and interpretation of biological traits analyses of marine benthic communities. Information at the species level may not provide the full range of understanding regarding ecosystem function because many species overlap in function and because closely related species may have differing functional roles (Maurer, 2000; Munari, 2013; Kalogeropoulou *et al.*, 2014; Culhane *et al.*, 2014) Trait analysis therefore provides a different type of information that may enhance our understanding of community structure, ecosystem function, and human impacts (Culhane *et al.*, 2014).

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