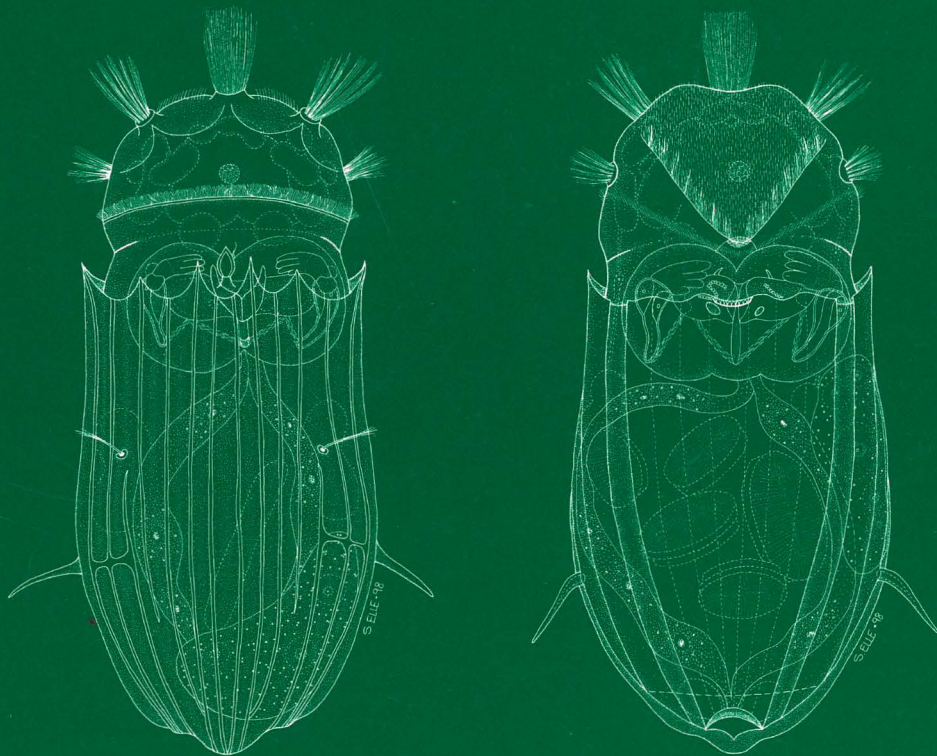


Marine Rotifera from
Ikka Fjord, SW Greenland

With the description of a new species
from the rare mineral ikaite

Martin Vinther Sørensen and Reinhardt Møbjerg Kristensen



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MARTIN VINTHER SØRENSEN
AND REINHARDT MØBJERG KRISTENSEN

Martin Vinther Sørensen and Reinhardt Møbjerg Kristensen:
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Scientific Editor:

Dr. Godtfred Høpner Petersen, University of Copenhagen, Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark

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Danish Polar Center
Strandgade 100 H
DK-1401 Copenhagen
Denmark
tel +45 3288 0100
fax +45 3288 0101
email dpc@dpc.dk

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Abstract

Martin Vinther Sørensen and Reinhardt Møbjerg Kristensen: *Marine Rotifera from Ikka Fjord, SW Greenland. With the description of a new species from the rare mineral ikaite*. Meddelelser om Grønland, Bioscience 51. Copenhagen, the Danish Polar Center, 2000.

The rotifers from Ikka Fjord, SW Greenland are described. The descriptions are based on light microscopy, scanning electron microscopy of whole mounted animals and of isolated trophi. A new marine rotifer, *Notholca ikaitophila* n. sp., was discovered inside the ikaite columns and from ikaite sand during this meiofauna investigation. The presence of movable lateral spines suggests a close relationship to the *Notholca striata* group. A full description of the new species is given. Beside the new species, eight other rotifer species, including four planktonic species, were found. Six of these are new to Greenland.

Beside the rotifer descriptions, notes are given on macro- and meiofauna in the fjord. An ecological note regarding the unique habitat for the meiofauna inside the ikaite columns is given for the first time. The interstitial meiofauna inside the ikaite columns is totally different from the eumarine meiofauna found on the surface of the ikaite columns.

Keywords: Rotifera, *Notholca* n. sp., taxonomy, ecology, Arctic, Greenland, ikaite columns, meiofauna.

Martin Vinther Sørensen and Reinhardt Møbjerg Kristensen, Zoological Museum, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark.

Introduction

Recently the unique ikaite tufa columns from Ikka Fjord, SW Greenland (Fig. 1) were reinvestigated (Buchardt et al. 1997). The tufa columns are formed by the mineral ikaite (calcium carbonate hexahydrate), which is dissolved in water seeping from alkaline cold springs at the bottom of the fjord. When the spring water meets the cold marine water with high calcium contents, the ikaite precipitates and a column is gradually formed (Buchardt et al, in press). Inside the hollow columns, the temperature is 4 °C, and the pH of the column water is 10.4. The water inside the columns has originated as meteoric water, and its ionic content differs strongly from that of local seawater (Buchardt et al., in press). The content of dissolved sodium and bicarbonate/carbonate is high in contrast to the subaerial spring water and the seawater, and this creates the high pH and a conductivity corresponding to a salinity of 9.3‰. It should be stressed that the conductivity of the column water is caused by the high Na⁺, HCO₃⁻, CO₃²⁻ content, and not by Cl⁻ as in seawater. The environment can be compared to that of an alkaline lake, and not to brackish water of low chlorinity. In this exceptional environment, a rich meiofauna was found including a new species of *Notholca*.

The column "garden" in Ikka Fjord is restricted to a 0.75 km² area (Buchardt et al. 1997). The area corresponds to the shoreline outcrops of the volcanic Grønneidal-Ika intrusive complex. In this intrusion carbonatite and cold homothermal springs are found. In the inner basin of the fjord, about one thousand columns have been observed. The largest columns may be more than 20 m high and have been known by Greenlanders since they settled there. An old Inuit myth tells that the white columns are frozen Norsemen, drowned in the Ikka Fjord after a battle with the intruding Inuits (Rink 1866). In 1963 geologists from the nearby cryolite company in Ivittuut described how a new cold metastable mineral, ikaite, builds the tufa columns (Pauly 1963a, 1963b). In spite of their great discovery, the unique phenomenon was totally neglected by the scientific world until recently.

In the summer of 1994, the biologist Dr. Henning Thing from the Danish Polar Center visited Ivittuut municipality. Supported by divers from the naval station in Grønneidal he collected several samples including the epifauna of the tufa columns as well as the white sediment (ikaite snow) from the reef-like structures in Ikka Fjord. The samples and one ikaite column were sent to the Zoological Museum, University of Copenhagen (ZMUC). Surprisingly, the large ikaite column had turned into white powder. People forgot that ikaite, according to Pauly (1963b), is only metastable in cold water below 6°C and disintegrates to calcite and water above this temperature. This obser-

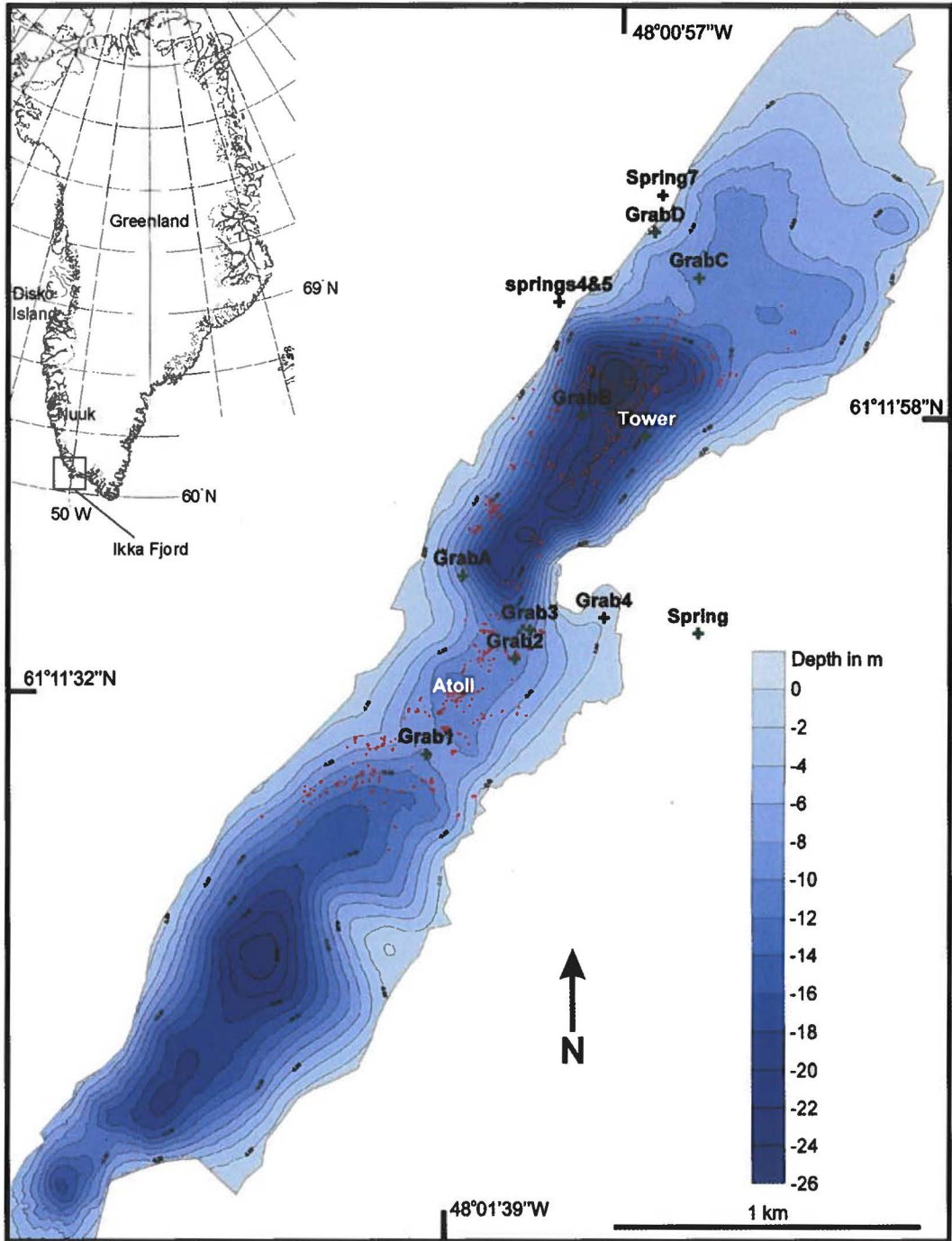


Fig. 1. Ikaite column survey and bathymetric map of the inner part of Ikka Fjord, SW Greenland. The largest ikaite columns (pillars) are shown in red. **Atoll**: the largest ikaite formation in the fjord. **Tower**: Rundetårn (The Round Tower), with "green ikaite". **Grab 1-4**: mini van Veen Grab samples with planktonic rotifers. **Grab A-D**: samples without planktonic rotifers. **Spring**: homothermal springs on both sides of the fjord. **Inset**: Map of Greenland showing the location of Ikka Fjord.

vation and the rich macrofauna on the ikaite columns as well as the unique meiofauna in the sediment awakened the interest for the column garden in Ikka Fjord.

Three Danish and one British expedition (1995-97) have explored the area. The geologists (Buchardt et al., in press) have set up a model for the formation of ikaite columns in Ikka Fjord. Cold homothermal springs (3°C) with a unique flora and fauna were found in 1997 on both slopes of the fjord (Kristensen 1998), and a full-scale investigation of the marine algae (Buchardt et al. 1996) and macrobenthos (Thorbjørn 1996) living on the columns was carried out. This book is the first dealing with the interesting meiofauna inside the columns as well as in the ikaite snow from the bottom of the carbonate reef-like structures. Furthermore, a description of the marine rotifers in the Ikka Fjord is given, including four extremely abundant species of the planktonic genus *Synchaeta* and a new species of the genus *Notholca*.

Materials and methods

Sampling, sorting and preparation

All material was collected by Reinhardt Møbjerg Kristensen during the 1997 expedition to Ikka fjord, 2-14 August 1997 (Fig. 1). *Notholca ikaitophila* n. sp. was found in samples of ikaite columns and ikaite snow, collected from the large column named the Tower (61°11'58"N, 48°00'57"W) and the area named the Atoll (61°11'32"N, 48°01'39"W). The planktonic rotifers were found in the Grab4 sample (61°11'41"N, 48°01'07"W), taken near the campsite (Fig. 1). Some of the collected material was preserved in 5% buffered formalin or 2% glutaraldehyde, while other was stored at 5°C until it could be examined. Thus, some of the specimens were still alive during the investigations.

The material was examined with the aid of a Zeiss stereomicroscope at 40x magnification. Specimens for light microscopical studies were preserved in 4% buffered formalin, placed between a glass slide and a cover slip, and then dehydrated through graded glycerine. The cover slip was sealed with Glyceel®. Live specimens and specimens mounted on slides were photographed on a Leica DM-RXA Nomarski microscope. All drawings were made with help of a drawing tube (camera lucida) at 1000x magnification.

Specimens for SEM were fixed in 5% buffered formalin, dehydrated through graded ethanol and then transferred to acetone for critical point drying. The dried specimens were mounted on aluminium stubs and sputter coated with gold. Trophi were extracted from specimens preserved in 5% buffered formalin. The specimens were placed on a circular cover slip, and by adding sodium hypochlorite, all soft parts were dissolved, leaving only the trophi. After washing in distilled water, the cover slip was transferred to an aluminium stub and sputter coated with gold. All SEM examinations were performed with a JEOL JSM-840 microscope.

Trophi terminology and morphology

This paper is intended not only for rotiferologists, but also for the broad range of people who share our interest in the Arctic sciences. In the following descriptions much attention is paid to the rotifer jaws, thus we have added this short passage to introduce the reader to their terminology and morphology. The following is primarily based on Markevich (1989), Nogrady et al. (1993), and De Smet (1997).

All rotifers have a more or less complicated jaw apparatus (the *mastax*), and the hard parts of this are called the *trophi* (singular: *trophus*). The trophi are of

extremely great taxonomic importance and several species are recognised solely on trophus characters.

The morphological variation of the trophi is great within Rotifera, but it is however possible to divide the trophi into nine different types. In this paper three of these types of trophi will be demonstrated, namely the *forcipate* (Figs. 11-14), the *malleate* (Figs. 15-18, 38-40, 48-54) and the *virgate* trophi (Figs. 20-21, 24-25, 27-33).

The trophi are made up of 4 different kinds of jaw elements or *sclerites*. In different species some of these may be highly modified or even reduced. The central parts of the trophi consist of two paired sclerites, called the *rami* (singular: *ramus*). The rami are held together subbasally by a thin, flexible ligament, and the two sclerites can be moved independently by muscle action. Each ramus often contains a basal and a subbasal chamber, and each of these opens to the surface of the sclerite by a window or *fenestra*. The window of the basal chamber, which opens on the dorsal ramus surface, is called the *basifenestra*, while the window from the subbasal chamber, called *subbasifenestra*, opens ventrocaudally (Figs. 15-18, 48-50). An apical or lateral chamber with a window called *fenestrula* might be present. In forcipate trophi the basal and subbasal chambers are often called *scapus* and *bulla*, respectively (Figs. 12-14).

Another pair of sclerites, the *unci* (singular: *uncus*) is present apical or ventroapical to the rami. The unci might be rod-like bearing a single large tooth (Fig. 14) or plate shaped with several teeth (Figs. 15, 40). These sclerites are, together with the rami, responsible for handling and processing the food items, like for instance diatoms or other algae, bacteria, or even other rotifers.

A pair of sclerites, the *manubria* (singular: *manubrium*), are located lateral to the rami (Figs. 13, 15, 18, 49). The manubria are attached to the unci by thin flexible ligaments and are responsible for the movement of these. Each manubrium contains one to three chambers. When three chambers are present, they are referred to as the anterior, the medial, and the posterior chamber. In some cases, the outer walls of the chambers are thin, and the chamber will then be left open after treatment with sodium hypochlorite (Fig. 54). In other cases the chambers only open through a small fenestra in the proximal part of the sclerite (Figs. 16, 18, 54).

The fourth main sclerite is the unpaired *fulcrum*, which is positioned caudally between the rami (Figs. 11, 16, 18, 20-21, 24-25, 49). The fulcrum serves as muscle attachment site for the abductors, which are responsible for the opening of the rami.

Results

The ecosystem on the surface of ikaite columns

Along the length of the inner part of the Ikka fjord, the column garden varies a lot. The tufa formations may form tall reef-like structures with a central lagoon, as for instance the Atoll (Fig. 3), or thousands of smaller columns in small clusters as found in the middle of the fjord (Fig. 2). The tufa formations may also culminate in giant columns with pinnacled crowns like the Cathedral and the Tower (Fig. 6), which are found at the northern end of the fjord (Seaman 1998; Seaman & Jenner 1996). A column can grow 50 cm upwards in one year, and only the formation of sea ice during winter keeps the columns from reaching the surface of the fjord. The newly formed ikaite is easy to recognise by its pure white colour (Fig. 4).

During the last Ice Age, the fjord was covered and filled by a large glacier. Thus, the pillar garden cannot be older than the last deglaciation 9,600 years

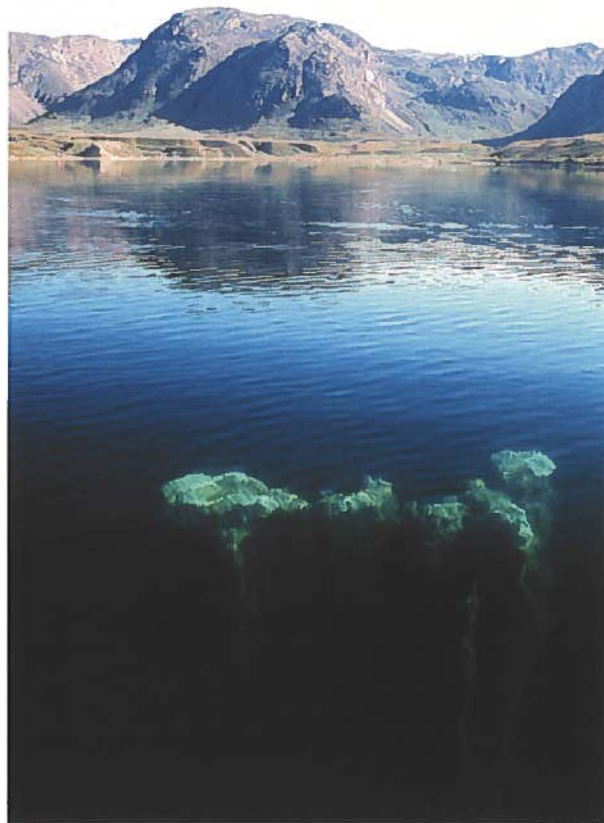


Fig. 2. The inner part of Ikka Fjord. The large ikaite column is ca. 20 m high and its top is 1.5 m below the low water mark (photo: Richard Martin).



Fig. 3. The Atoll. The photo shows the edge of the ikaite formation. The wall is to the left and the lagoon part to right. The lagoon part has a layer of soft ikaite snow. At this locality, the new species of *Notholca* was found in the ikaite snow. The lower part of the Atoll is encrusted by coralline red algae, *Clathromorphum compactum* and *Lithothamnion glaciale* (photo: Richard Martin).

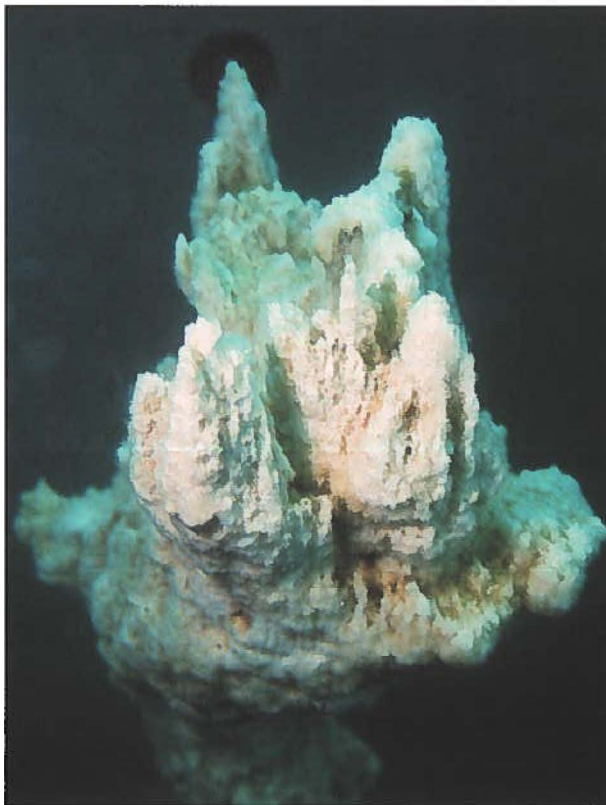


Fig. 4. The tip of an ikaite column. Note the new white ikaite formed recently. The ikaite column may grow up to 50 cm per year (photo: Richard Martin).

Fig. 5. The middle part of an ikaite column at about 10 m depth, with a rich marine macrofauna on its surface. The two species of echinoderms are the sea sun *Crossaster papposus* (right) and the sea urchin *Strongylocentrotus droebachiensis* (photo: Richard Martin).

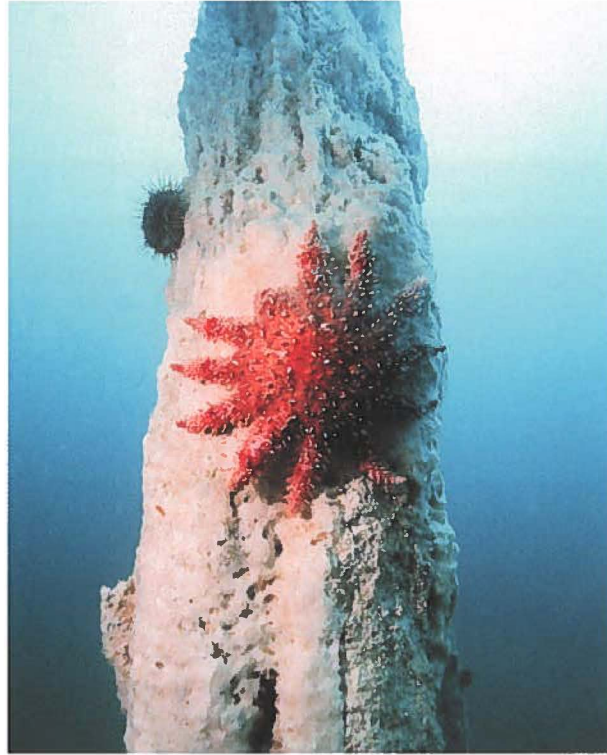


Fig. 6. A scuba diver (Lars Haumann) taking marine samples on the outer site of the Tower. Note that the wall is covered with the calcium carbonate-incrusted coralline red alga *Lithothamnion glaciale*. The coralline red alga encrusts and stabilises the lower part of the delicate ikaite columns. Furthermore, the *Lithothamnion* has a very rich eumarine meiofauna association (Photo: Richard Martin).





Fig. 7. Fresh, green ikaite from the Tower, collected 5 August 1997. The largest piece is 10 cm in diameter. Note the clear zonation in the ikait column. The euglenoid *Euglena* sp. and the cryptophyte, *Chroomonas ikaitensis* give the strong deep-green colour, while the yellow colour in the middle is caused by the diatom flora dominated by the diatom *Surirella brebissonii*. The new rotiferan species *Notholca ikaitophila* was found in the middle of the green ikaite.

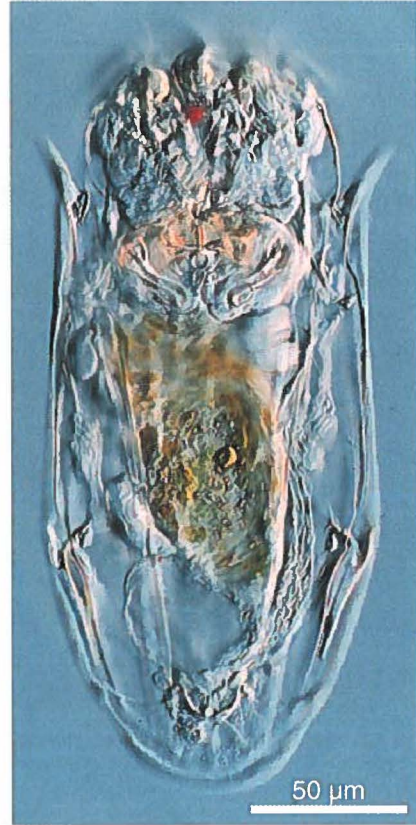


Fig. 8. A live *Notholca ikaitophila* n. sp. from green ikaite, the Tower. Paratypic female, ventral view, head protruded. Nomarski photo (DIC-optics).

ago (Funder 1989) and the rich flora and fauna on the surface of the ikaite columns is therefore not older than approximately 9,000 years. The high biodiversity on the columns is very surprising for such a young ecosystem and very unusual for an Arctic shallow-water fjord system. The dominating macrofauna on the ikaite columns consists of sea urchins, starfish, sea anemones, sea squirts and sea cucumbers, and it regards the fauna found on shrimp fields or on the offshore fishing banks. Until now, 116 macrofauna species have been recorded from the columns (Thorbjørn 1996). A few of these are common Arctic shallow-water species, such as *Mytilus edulis* and *Hiatella arctica*. The blue mussel (*M. edulis*) forms large colonies on the edge of the Atoll and the cave mussel (*H. arctica*) is found in cavities in the ikaite

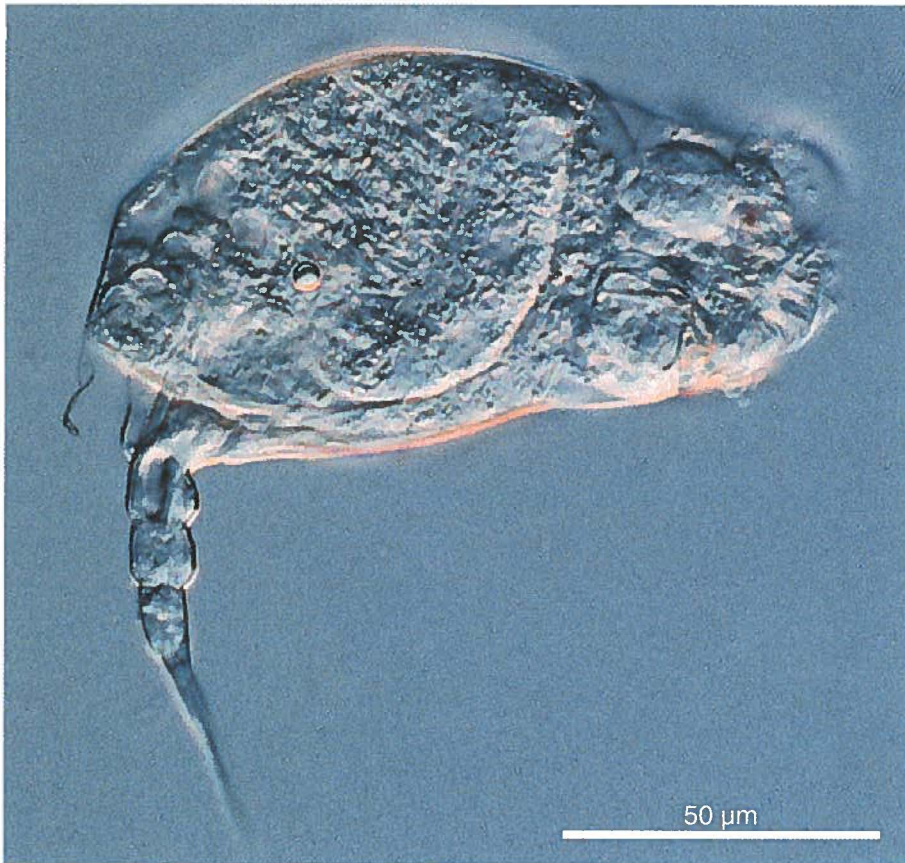


Fig. 9. *Colurella colurus*. Female, lateral view from green ikaite, the Tower. Nomarski-photo (DIC-optics).

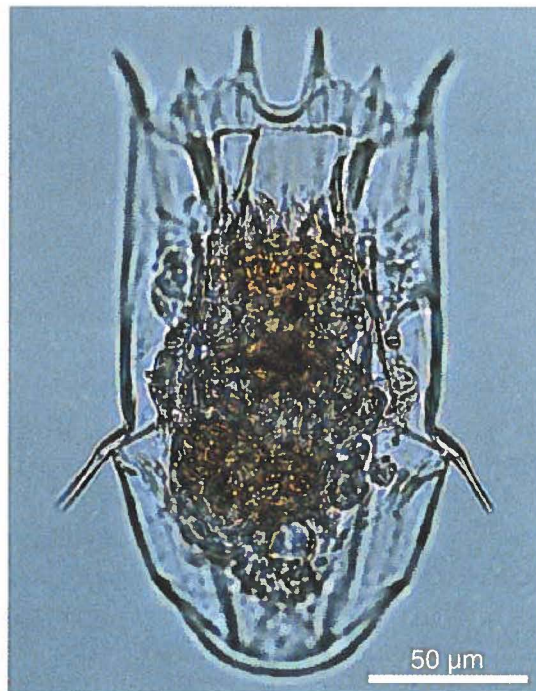


Fig. 10. *Notholca ikaitophila* n. sp. from ikaite snow, the Atoll. Paratypic female, ventral view, head retracted. Note the lateral spines and the single red eyespot in the middle. Phase contrast photo.

columns. The tidal zone barnacle *Semibalanus balanoides* is rare on the columns, but it is found abundantly on the rocky shores in Ikka Fjord. Two other species of barnacles, *Balanus crenatus* and *B. balanus*, are very common on the columns about two metres below the low water mark.

The species diversity and numbers of macroalgae on the columns are very low compared to Arctic rocky shores. A few poisonous brown algae, such as *Desmarestia viridis*, are avoided by the sea urchins, and these are common on some of the older ikaite columns. As in true coral ecosystems, the coralline red algae play a major role in stabilising the delicate porous ikaite columns. The coralline red algae (*Lithothamnion glaciale/tophiforme*, *Clathromorphum circumscriptum* and *C. compactum*) encrust and support the lower part of the columns, and may also be involved in transforming the soft and thermolabile ikaite into the very hard and stable calcite.

For the meiofauna investigations, scuba divers collected all kinds of different ikaite materials ranging from newly formed white ikaite from the tip of the column, over green ikaite from the middle zone, to old ikaite with coralline red algae (Fig. 6) and "dead ikaite" from broken columns. Especially the old ikaite with *Lithothamnion* had a very rich meiofauna. Two species of *Echinoderes* (Kinorhyncha) were found. The first, *Echinoderes peterseni*, was described from Disko Fjord (Higgins & Kristensen 1988) from the interstitial part of *L. glaciale*, so it was not surprising to find it on the surface of the columns. The other was a yet undescribed *Echinoderes* with large red eyes. The latter species was very rare in the ikaite (only two specimens), but it is perhaps associated with the green alga *Ulothrix* and not the red algae. Two species of tardigrades, *Styraconyx qivitoq* and *S. nanoqsunguak* were found on the surface of the columns encrusted with *Lithothamnion*. Both species were described from carbonate sand in Disko Bay (Kristensen & Higgins 1984). *S. qivitoq* feeds on bryozoans, which are sucked out from their cheilostome, while *S. nanoqsunguak* eats eumarine diatoms. The eumarine rotifers were very rare on the surface of the columns and only one specimen of *Colurella unicauda* was found from the lower part of the Atoll. The meiofauna on the surface of the ikaite columns is clearly eumarine and not at all related to the interstitial fauna inside the columns.

The ecosystem inside the ikaite columns

In a cross section of an ikaite column there exist outstanding gradients of several biotic and abiotic parameters, and in this very special habitat a rich carbonatophilous meiofauna was found.

On the surface of the lower part of the column the salinity is between 32-33‰, the temperature 1°C and the pH about 8.2. In the middle of the porous column, Na^+ , HCO_3^- , CO_3^{2-} maintain a conductivity equal to a "salinity" of

9‰, the temperature varies between 3.9°C and 4.8°C and the pH is about 10.4. In a cross section (Fig. 7) of the ikaite from the Tower collected 5 August 1997, a clear zonation is observed in the colour of the ikaite. Outermost a red layer can be present if the column is encrusted with *Lithothamnion* or a yellow one if numerous marine diatoms are present.

The next layer, the so-called "green ikaite", consists of the cryptophyte *Chroomonas ikaitensis* (see Kristiansen & Kristiansen 1999). The layer is very broad and may be malachite-green or have a deep green colour caused by the presence of euglenoids. This green *Euglena* is a flagellate without a flagellum, but it can never the less move relatively fast. When the samples were stored in a refrigerator in darkness, the *Euglena* left the ikaite samples and could later be found as a green zone on the top of the collection vial. The meiofauna in the "green ikaite" is very special, with ciliates, turbellaria, gastrotrichs and a few copepods, but it is totally dominated by rotifers. About 80% of the meiofauna in the green ikaite from the Tower consists of one rotifer species, *Notholca ikaitophila* n. sp.

The innermost layer in the porous ikaite can be yellow if the brackish-water diatom *Surirella brebissonii* is present or pale rose to grey if sulphur bacteria are present. It is still possible to smell the sulphur in the seep water several hours after sampling. In newly formed ikaite the innermost layer would usually be spiculous and snow white.

The ecosystem in the ikaite snow

Several sediment samples were collected by scuba divers from 2-3 meters depth in the middle of the Atoll, in the so-called "lagoon". Furthermore, the blue mussel *M. edulis* with sediment was collected at the outer edge of the Atoll. The sediments consist of coarse ikaite sand to very fine ikaite mud (ikaite snow). The conductivity in the interstitial water from the sediment was measured with a refractometer. The salinity varied from 10 to 23‰. The carbonate-rich ikaite snow had a very rich meiofauna that differs from the meiofauna collected with the mini van Veen grab in the mud outside the column garden in the cold bottom of the fjord. The interstitial water in the cold mud has a very high salinity, about 34-36.0‰ (Thorbjørn 1996; pers. comm. Høpner Petersen), perhaps formed during winter by brine formation.

The rotifer fauna in the ikaite snow resembles the fauna found inside the ikaite columns. In fact, the same species, *Notholca ikaitophila* n. sp., was dominating. Another component of the meiofauna was a new species of the eutardigrade genus *Halobiotus*. The species is new to science, but could not be described because it was in a special stage, pseudosimplex 2. This stage is known to tolerate fresh water (Kristensen 1982). The active stage may be found later in the year, just before the fjord is covered with sea ice. Several

interstitial polychaetes were found associated with the byssus threads of *M. edulis*, e.g. a yellow *Dinophilus* and a greenish *Nerilla*, but the eutardigrade *Halobiotus crispae* was not present. This species is elsewhere in Greenland an indicator species for eumarine condition in the byssus threads of *M. edulis* (Kristensen 1982).

The rich copepod fauna in the ikaite snow was remarkable, as it was dominated by cyclopid copepods and not of harpacticoid copepods, which elsewhere dominate meiobenthos outside the column garden in the fjord.

Recorded Rotifera

Dicranophoridae Haring, 1913

Encentrum Ehrenberg, 1838

The genus is recognised by animals having an illoricate or semiloricate body with an oblique corona and relatively short foot and toes. Trophi are forcipate and relatively simple, very often with an intramalleus inserted between the manubrium and unci (only missing in two species). De Smet (1997) recently divided the genus into three subgenera: *Encentrum*, *Isoencentrum* and *Pseudoencentrum*, all solely recognised by trophi characters.

Until 1997 only three species, *E. graingeri* Chengalath, 1985, *E. marinum* (Dujardin, 1841), and *E. porsildi* Sørensen, 1998, have been recorded from marine waters in Greenland (Sørensen 1998). Recently Funch & Sørensen (in press) recorded three more species, *E. algente* Haring, 1921, *E. cf. tenuidigitatum* De Smet, 2000, and *E. limicola* Otto, 1936 from Disko Island.

Encentrum limicola Otto, 1936

The species was found in ikaite snow from the Atoll and inside a small column from the Tower collected by divers. It has previously been recorded from littoral psammon and algae in Germany, the Baltic Sea, Spitsbergen and the Arctic Sea (De Smet 1997). The species is new to Greenland.

Encentrum limicola is recognised by its pointed toes with swollen bases and robust trophi with one pair of apical ramus teeth, one pair of preuncinal teeth, and club-shaped intramallei with triangular laterobasal extensions (Figs 11-14) (De Smet 1997).

The specimens collected in Ikka Fjord were all strongly contracted because of the formalin fixation, and observations on whole animals were therefore impossible. However, their trophi were easily prepared for LM and SEM. The trophi from the recorded species only diverge from earlier recordings in being 1-2 µm larger.

Measurements: Trophi: 35-36 µm; rami: 12-14 µm; unci: 9 µm; manubria: 22-24 µm; fulcrum: 12-15 µm.

Proalidae Haring & Myers, 1924

Proales Gosse, 1886

The genus is recognised by animals having an illoricate or semiloricate body with relatively short toes. The corona is oblique and well developed, without

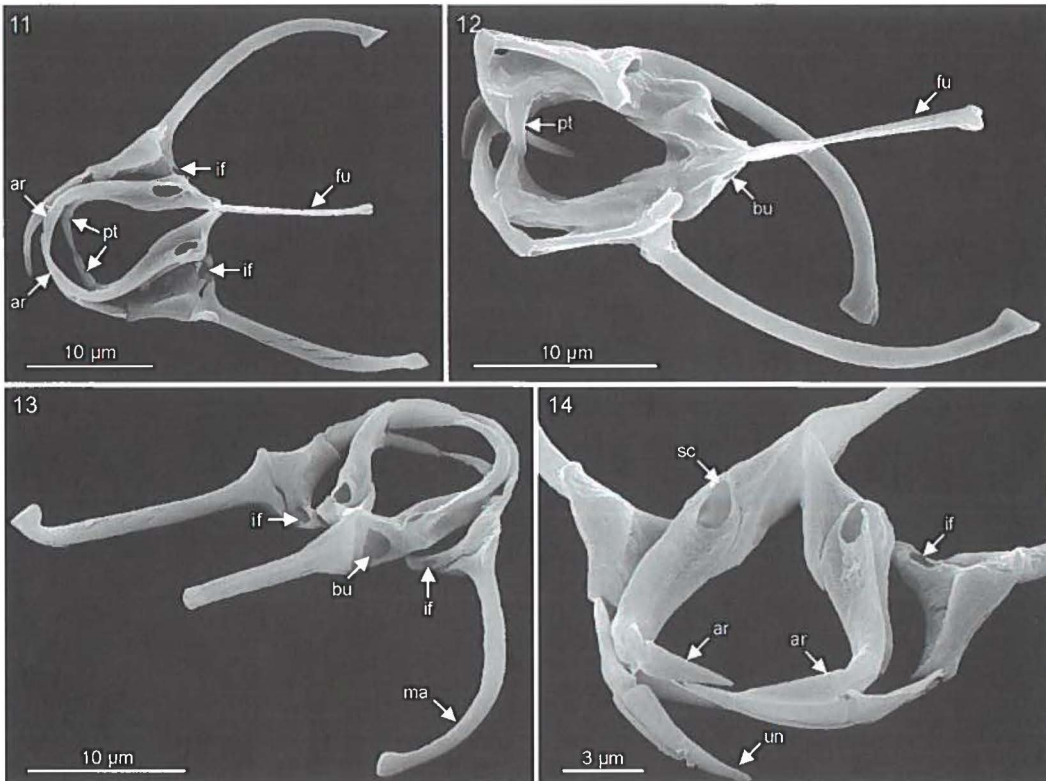


Fig. 11. *Encentrum limicola*. SEM of trophi, dorsal view. Legend: ar: apical ramus tooth; fu: fulcrum; if: intramalleus fenestra; pt: preuncinal tooth.

Fig. 12. *Encentrum limicola*. SEM of trophi, ventral view. Legend: bu: bulla; fu: fulcrum; pt: preuncinal tooth.

Fig. 13. *Encentrum limicola*. SEM of trophi, dorsocaudal view. Legend: bu: bulla; if: intramalleus fenestra; ma: manubrium.

Fig. 14. *Encentrum limicola*. SEM of trophi, dorsoapical view. Legend: ar: apical ramus tooth; if: intramalleus fenestra; sc: scapus; un: uncus.

long cirri. The trophi are malleate, or modified virgate.

Only one marine species, *P. reinhardti* (Ehrenberg, 1934), has been recorded in Greenland (Ehrhardt & Svendsen 1994; Sørensen 1998).

Proales reinhardti (Ehrenberg, 1834)

A few specimens of *P. reinhardti* were found in ikaite from the Atoll. The species has been found at several localities in Arctic and temperate regions (Chengalath 1985; De Smet 1996; Friedrich 1997; Kutikova 1970; Sørensen 1998).

The species is recognised by the fusiform body, and a relatively long foot formed by two pseudosegments and two lanceolate toes. Trophi are modified malleate (Figs. 15-17).

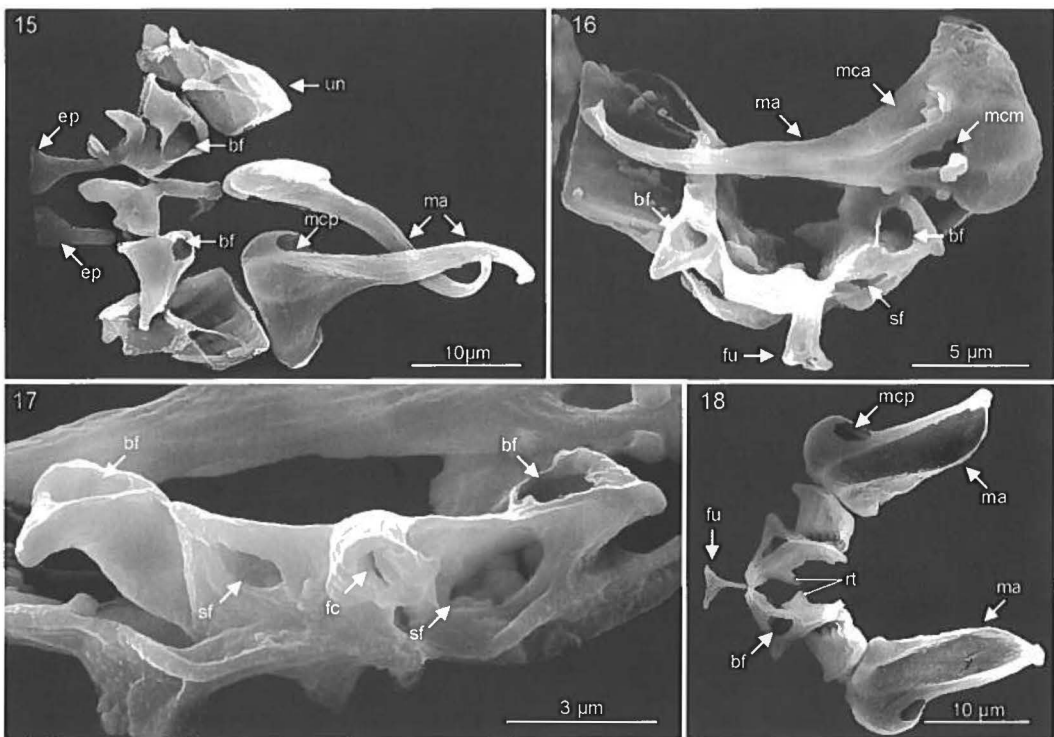
SEM studies on the trophi (Figs. 15-17) reveal that both rami have a subbasifenestra (ventral fenestra, see Fig. 16). The right subbasifenestra was overlooked by De Smet (1996), (pers. com. De Smet). Unci are relatively large, compared to the rami, and have one large and four smaller teeth each. A brush-border of scleropili, forming a subuncus, is present at the internal surface of each uncus. Manubria have well-developed proximal parts forming three chambers (Figs. 15-16). In the examined specimens, medial and poste-

Fig. 15. *Proales reinhardti*. SEM of trophi, dorsal view, rami opened. Legend: bf: basifenestra; ep: epipharyngeal plates; ma: manubrium; mcp: manubrial chamber, posterior; un: uncus.

Fig. 16. *Proales reinhardti*. SEM of trophi, dorsal view, rami closed. Legend: bf: basifenestra; fu: fulcrum; ma: manubrium; mca: manubrial chamber, anterior; mcm: manubrial chamber, medial; sf: subbasifenestra.

Fig. 17. *Proales reinhardti*. SEM of trophi, dorsocaudal view. Legend: bf: basifenestra; fc: fulcral cavity; sf: subbasifenestra.

Fig. 18. *Colurella unicauda*. SEM of trophi, dorsal view. Legend: bf: basifenestra; fu: fulcrum; ma: manubrium; mcp: manubrial chamber, posterior; rt: ramus teeth.



rior manubrial chambers have fenestrae, while the anterior chambers are fully opened. The distal parts of manubria are thin and bend at the tips. The epipharyngeal elements are rod-like, and broaden out apically. The apical parts have longitudinally arranged furrows.

Measurements: Trophi: 35 μm ; rami: 9 μm ; unci: 13 μm ; manubria: 25 μm ; epipharyngeal elements: 6 μm .

Lepadellidae Harring, 1913

Colurella Bory de St Vincent, 1824

The genus is recognised by animals having a laterally compressed lorica, often with a ventral sulcus. Trophi are malleate. The species in the genus are solely recognised by lorica characters. The trophi play no taxonomic role and have been neglected in systematic studies.

Only one marine species, *C. unicauda* Godske Eriksen, 1968, has been recorded in Greenland (Andersen 1990) until now.

Colurella colurus (Ehrenberg, 1830)

The species was found in ikaite snow from the Atoll and the green ikaite from the Tower. It is known as a cosmopolite and can be found in fresh and brackish waters as well as in coastal marine waters. In the Arctic, the species has been recorded from Canada (Chengalath & Koste 1989; De Smet & Bafort 1990; De Smet & Beyens 1995) and Svalbard (De Smet 1988, 1993). The species is new to Greenland.

The species is recognised by its blunt-spined posterior lorica and relatively long toes (Fig. 9). It can be confused with *C. uncinata* (Müller, 1773), but this species has relatively shorter toes. It also approaches *C. adriatica* Ehrenberg, 1831, but this species usually has more pronounced posterior lorica spines and a less elongate lorica.

Measurements: Lorica length: 83-93 μm ; lorica height: 46-51 μm ; toes: 30-36 μm .

Colurella unicauda Godske Eriksen, 1968

The species was found both in ikaite snow from the Atoll and on the surface of the ikaite columns. Originally, it was described from a tidal pool in the Espegrend area, Norway, and it has also been found at Tvärminne, Finland (Godske Eriksen 1968) and in Disko Fjord, Disko Island, Greenland (Andersen 1990). Before the species was described, it has probably been recorded at the Norwegian and Swedish west coast, at Novaja Zemlja in the Barents Sea, and in brackish waters from Belgium, but either identified as *C.*

adriatica Ehrenberg, 1831, or remained unidentified (Godske Eriksen 1968). De Ridder (1981) suggested *C. unicauda* to be limited to the Palaearctic Region, but the findings in Greenland suggest that it has a Holarctic distribution.

The species is easily recognised by having a single, large toe and long acute extensions posteriorly at the lorica.

Rami have well-developed basifenestrae and subbasifenestrae. A large triangular tooth is present on the internal surface of each ramus (Fig. 18, rt). The tooth on the right ramus is more stout than the tooth on left. Unci have six or seven teeth. The most subbasal tooth is larger than the rest. Manubria have large proximal heads, formed by the walls of anterior, medial and posterior chambers. The posterior manubrial chamber opens through a well-defined fenestra (Fig. 18, mcp). The distal parts of the manubria are flattened and formed by the walls of the anterior and medial chambers. Both chambers are fully open after treatment with hypochlorite. The distal parts of the manubria are twisted along their own axis. Fulcrum is relatively short. It is narrow distally, but broadens out proximally, which makes it appear triangular in dorsal view (Fig. 18). In lateral view, the fulcrum is bent ventrally.

Measurements: Lorica length: 138-141 μm ; lorica height: 70-75 μm ; toes: 34-36 μm .

Synchaetidae Hudson & Gosse, 1886

Synchaeta Ehrenberg, 1832

The genus *Synchaeta* contains a group of planktonic rotifers, in which most of the species in the Northern Hemisphere are restricted to boreal and temperate regions (Koste 1978). In Ikka Fjord the species *S. cf. monopus*, *S. triophthalma*, and two unidentified species, *Synchaeta* sp. 1 and *Synchaeta* sp. 2., were found in extremely high numbers in the water column. Together these species represent the most abundant zooplankton group in the fjord. Both of the identified species are new to Greenland.

Members of the genus have modified virgate trophi. The trophi are comprised of very delicate sclerites, which appear soft and flexible when prepared. Manubria and incus are curved, which effects that the trophi have a globular form in the living animal. However, the sclerites flatten totally out when prepared for SEM (Figs. 27-33).

The rami are made up of two large, but very thin, lateral lamellae, and a central basal region with two minor, ventrally displaced lamellae. Alulae may be present. In some species numerous scleropili are present at the internal ramus surfaces (Figs. 20-21, 24). No fenestrae were found on any of the examined species. Fulcrum is large, often equal to or longer than the ramus length. Unci are large and flattened with several teeth. A pair of preuncinal teeth (by

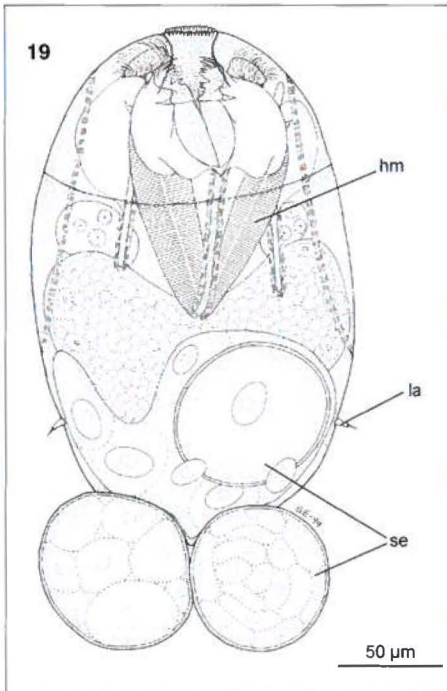


Fig. 19. *Synchaeta cf. monopus* from Grab4, Ikka Fjord. Female habitus, carrying two subitaneous eggs, ventral view, head retracted. Legend: hm: hypopharyngeal muscle; la: lateral antenna; se: subitaneous egg.

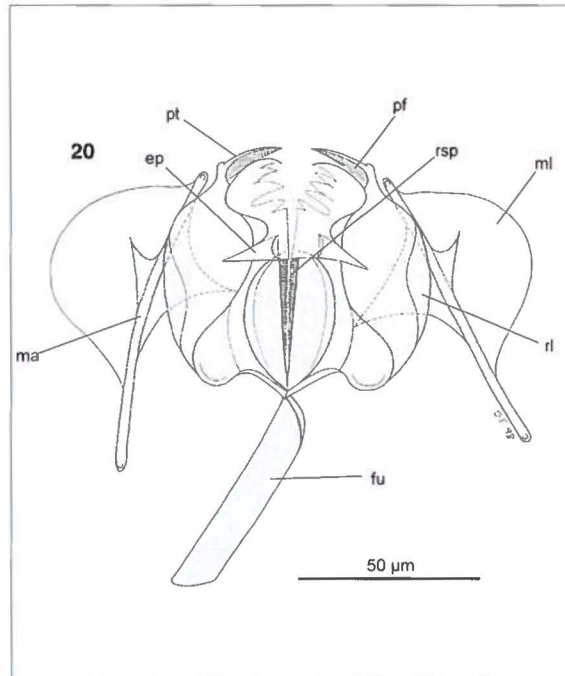


Fig. 20. *Synchaeta cf. monopus*. Trophi, ventral view. ep: epipharynx; ma: manubrial alula; ml: manubrial lamella; pf: preuncinal fringes; pt: preuncinal tooth; rl: ramus lamella; rsp: ramal scleropili.

Koste (1978) referred to as "hauptzähne") may be present apical to the unci (Figs. 20-21, 24, 27, 29-30). A paired epipharynx is located sublateral to the unci, at their ventral side. The epipharynx is made up by two coneshaped elements, which are connected by two semi-circular lamellae (Figs. 20-21, 24-25, 29, 32-33). The manubria are rod-shaped, often with alulae and large, crescentic or semicircular lamellae.

Synchaeta cf. monopus Plate, 1889

On the Northern Hemisphere the species has been recorded from the North Sea, the Barents Sea, the Baltic Sea and the Black Sea (Arndt et al. 1990; Koste, 1972; Kutikova 1970). The species is recognised by its swollen body and its reduced foot and the presence of only one, rudimentary, toe (Fig. 19). Due to these features, the recorded specimens were identified as *S. cf. monopus*, but it should be noted that they diverge from those in former descriptions on some critical points. In the specimens from Ikka Fjord the lateral antennae were located lateral on the posterior half of the trunk and not caudally as described

by Rousselet (1902). Furthermore, several of the recorded specimens were carrying one or two subitaneous eggs, while Rousselet (1902) notes that *S. monopus* does not carry its eggs.

The collected specimens were strongly contracted, so the morphology of the wheel-organ could not be examined. Trophi were extracted from some of the collected specimens and prepared for light microscopy and SEM (Fig. 27). Outer margins of rami + unci are semicircular. Rami have large semicircular lateral lamellae and two ventral lamellae (Figs. 20, 27). Internal ramus surface with a row scleropili (Fig. 20, rsp). The fulcrum is longer than the rami and broadest terminally (Fig. 27). The unci are asymmetric: The right uncus has one apical, dorsally displaced preuncinal tooth, three basal teeth, and two subbasal, partly fused teeth. The left uncus has one apical, dorsally displaced preuncinal tooth (Figs. 20, 27, pt), four basal teeth, and two subbasal, partly fused teeth (Figs. 20, 27). Preuncinal structures are comprised of some extremely delicate fringes (Fig. 20, pf) which are attached to the preuncinal tooth. Manubria have a large crescentic lamella and triangular alula (Figs. 20, 27).

Measurements: Trunk length (retracted): 144-154 μm ; trunk width (retracted): 117-132 μm ; subitaneous eggs: 44-49 μm .

Synchaeta sp. 1

This species could not be identified to any known species. Most of the preserved specimens were strongly contracted, and during the initial sorting, they were confused with *S. monopus* because of their size and globular appearance. However, it appeared that some of the specimens had a short foot with two toes, thus they could not be identical to *S. monopus*.

The body is broad and globular or slightly oval (Fig. 22). Toes are small and the foot is very short. A pair of lateral antennae is present at the posterior part of the trunk. A small tube surrounds the base of each antenna. A large circumapical band and a smaller oral band make up the corona. One pair of well-developed auricles is present posterior to the circumapical band (Fig. 22, au), and a pair of smaller auricles may be present between the large auricles and the circumapical band (Fig. 22). The head has three pairs of styli: A median pair, a dorsolateral pair, and a lateral pair (Fig. 22).

Trophi were extracted from some of the collected specimens and prepared for light microscopy and SEM (Fig. 28). Trophi are characteristic in having very large manubria – longer than the incus (Figs. 21, 28). Rami resemble those in *S. monopus*. Fulcrum is shorter than the rami and curved with a dorsally pointed tip (Fig. 28). The unci are slightly asymmetric in shape but each with same number of teeth. Both unci have one apical, dorsally displaced preuncinal tooth, four basal teeth and two subbasal, partly fused teeth (Fig 21). Preuncinal fringes are not present. Manubria are very large with crescentic lamellae and alulae (Figs. 21, 28).

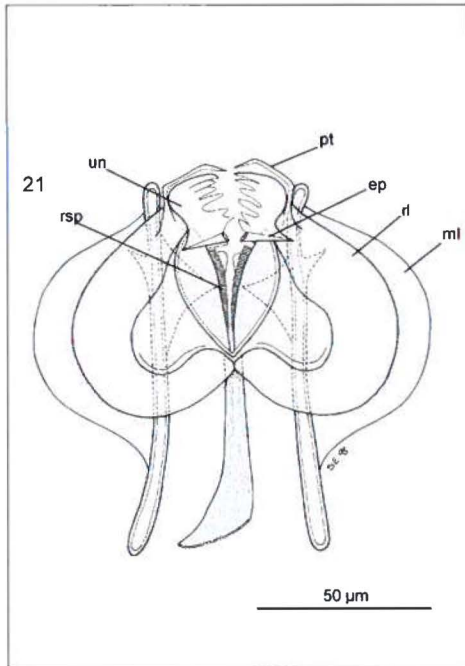


Fig. 21. *Synchaeta* sp. 1. Trophi, ventral view. Legend: ep: epipharynx; ml: manubrial lamella; pt: pre-uncinal tooth; rl: ramus lamella; rsp: ramal scleropili; un: uncus.

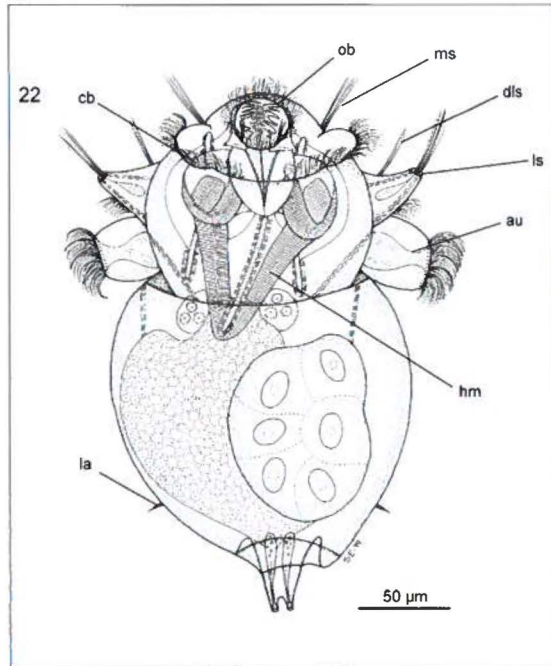


Fig. 22. *Synchaeta* sp. 1. from Grab4, Ikka Fjord. Female habitus, ventral view, head protruded. Legend: au: auricle; cb: circumapical band; dls: dorso-lateral stylus; hm: hypopharyngeal muscle; la: lateral antenna; ls: lateral stylus; ms: median stylus; ob: oral band.

Measurements: Trunk length: 210-277 μm ; trunk width: 167-172 μm ; foot: 14-16 μm ; toes: 7-10 μm .

Synchaeta triophthalma Lauterborn, 1894

The species is found widespread in coastal marine and brackish waters, and is considered cosmopolitan (De Ridder 1981; Koste 1978; Kutikova 1970; Zelinka, 1927). The species is recognised by its single toe and single lateral antenna on the left side of the foot basis (Fig. 23).

The collected specimens were well preserved; thus, it was possible to study the wheel-organ and external morphology in SEM (Figs. 34-35). A circumapical band with two lateral auricles and a horseshoe-shaped oral band form the corona (Figs. 23, 34-35). In the description given by Rousselet (1902), the oral band is interpreted as a band of stiff hairs (sensoria), but in SEM it is clear that the band is made up by a ciliary band for food collection (Figs. 34-35).

Trophi were extracted from some of the collected specimens and prepared

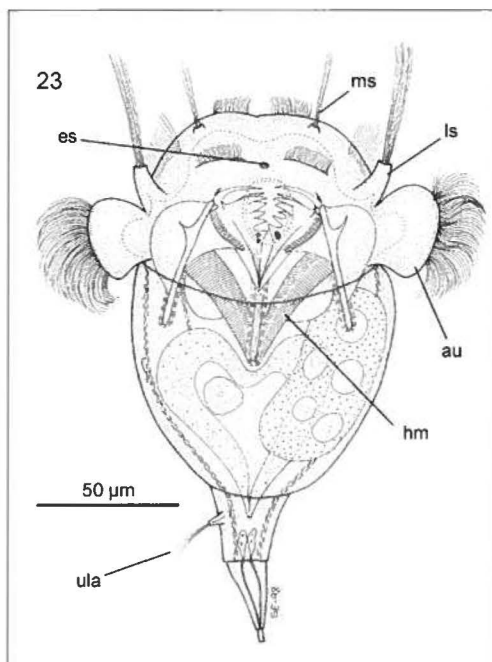


Fig. 23. *Synchaeta triophthalma* from Grab4, Ikka Fjord. Female habitus, dorsal view, head protruded. Legend: au: auricle; es: eyespot; hm: hypopharyngeal muscle; ls: lateral stylus; ms: median stylus; rl: ramus lamella; ula: unpaired lateral antenna.

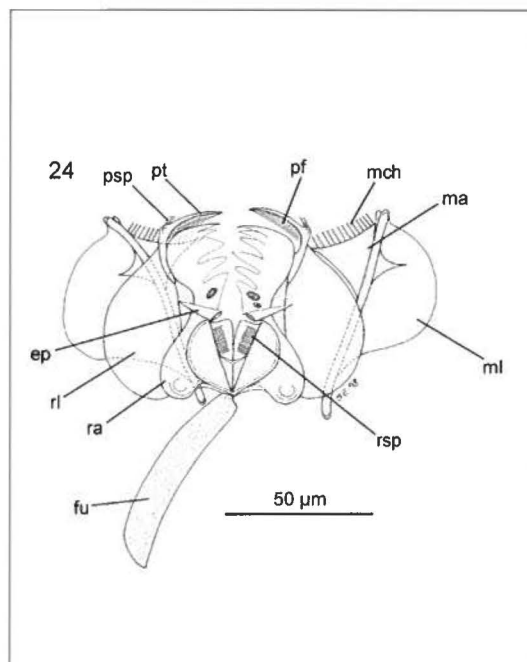


Fig. 24. *Synchaeta triophthalma*. Trophi, ventral view. Legend: ep: epipharynx; fu: fulcrum; ma: manubrial alula; mch: manubrial cuticular hairs; ml: manubrial lamella; psp: preuncinal scleropili; pf: preuncinal fringes; pt: preuncinal tooth; ra: ramus alula; rsp: ramal scleropili.

for light microscopy and SEM (Figs 32-33). Rami + unci are longer than wide. The ventral lamellae on the rami are triangular (Fig. 32). The internal surface of each ramus has a row of scleropili (Fig. 24, rsp). Fulcrum is equal to the rami length. The unci are asymmetric: The right uncus has one apical, dorsally displaced preuncinal tooth, four basal teeth and only a single subbasal tooth, with one or two holes. The left uncus has one apical, dorsally displaced preuncinal tooth, five basal teeth and one subbasal tooth with two holes (Figs. 24, 32-33). The holes in the subbasal unci parts may be remains after a fusion of teeth. Preuncinal teeth support delicate fringes (Fig. 24, pf) as found in *S. monopus*. A tuft of scleropili (Fig. 24, psp) is present at the base of each preuncinal tooth. Manubria have a large crescentic lamella and a triangular alula. The anterior edge of the manubrial alula has a row of scleropili (Figs. 24, 33, msp).

Measurements: Trunk length: 149-163 μm; trunk width: 96-105 μm; foot: 34-35 μm; toes: 5-6 μm.

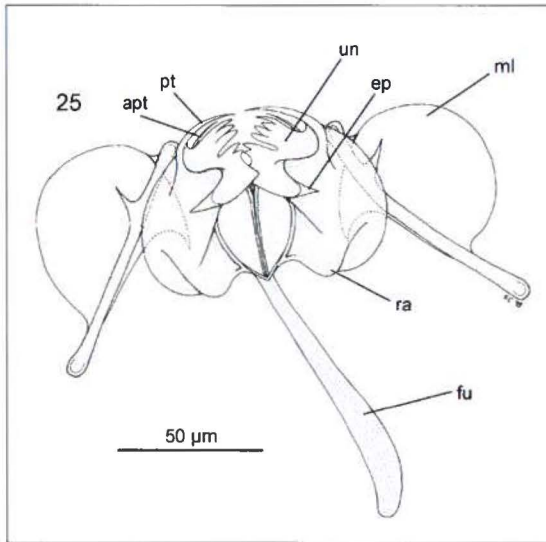


Fig. 25. *Synchaeta* sp. 2. Trophi, ventral view. Legend: apt: associated preuncinal tooth; ep: epipharynx; fu: fulcrum; ml: manubrial lamella; pt: preuncinal tooth; ra: ramus alula; un: uncus.

Synchaeta sp. 2.

Another species of *Synchaeta* remained unidentified (Fig. 26). The species has a large head with two pair of styli and a long dorsal antenna. The trunk and foot are conical. A pair of lateral antennae is located at the anterior half of the trunk. Small tubes surround the basal parts of the antennae. The toes are relatively short with flattened tips. The species resembles *S. vorax* Rousset, 1902,

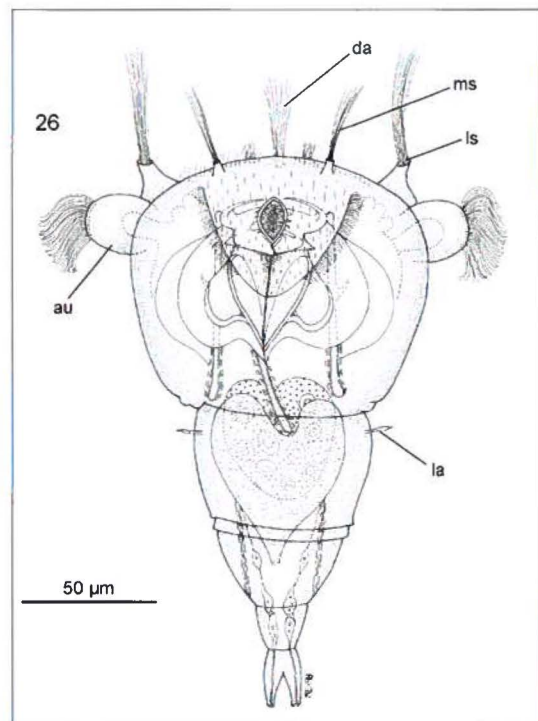


Fig. 26. *Synchaeta* sp. 2. from Grab4, Ikka Fjord. Female habitus, ventral view, head protruded. Legend: au: auricle; da: dorsal antenna; la: lateral antenna; ls: lateral stylus; ms: median stylus.

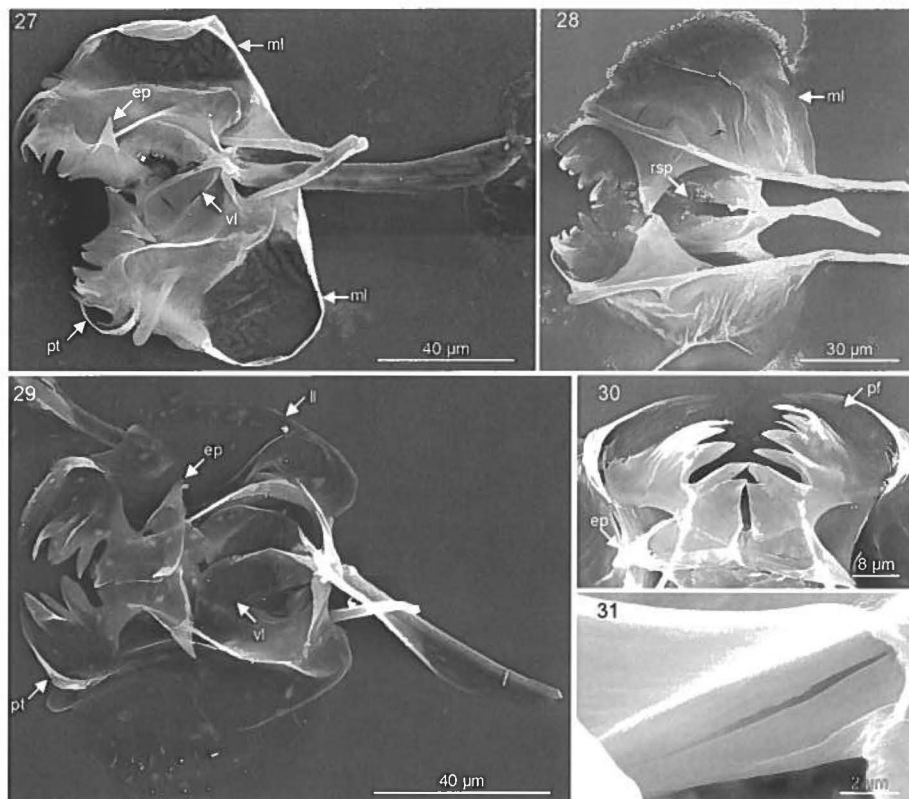


Fig. 27. *Synchaeta* cf. *monopus*. SEM of trophi, ventral view. Legend: ep: epipharynx; ml: manubrial lamella; pt: preuncinal tooth; vl: ventral ramus lamella.

Fig. 28. *Synchaeta* sp. 1. SEM of trophi, dorsal view. Legend: ml: manubrial lamella; rsp: ramal scleropili.

Fig. 29. *Synchaeta* sp. 2. SEM of trophi, ventral view. Legend: ep: epipharynx; ll: lateral ramus lamella; pt: preuncinal tooth; vl: ventral ramus lamella.

Fig. 30. *Synchaeta* sp. 2. SEM of trophi detail, ventral view, showing unci. Legend: ep: epipharynx; pf: preuncinal fringe.

Fig. 31. *Synchaeta* sp. 2. SEM of trophi, caudal view; detail showing furrow in ramus which might be a rudimentary subbasifenestra or just an artefact.

or *S. johanseni* Harring, 1921, but the dorsal antenna is much longer than in *S. johanseni*, and *S. vorax* does not have tubes surrounding the bases of the lateral antennae. Beside this, none of the two species have flattened tips on their toes.

Trophi were extracted from some of the collected specimens and prepared for light microscopy and SEM (Figs. 29-31). Rami + unci are semicircular. Lateral and ventral lamellae on rami are crescentic (Figs. 25, 29). A pair of narrow

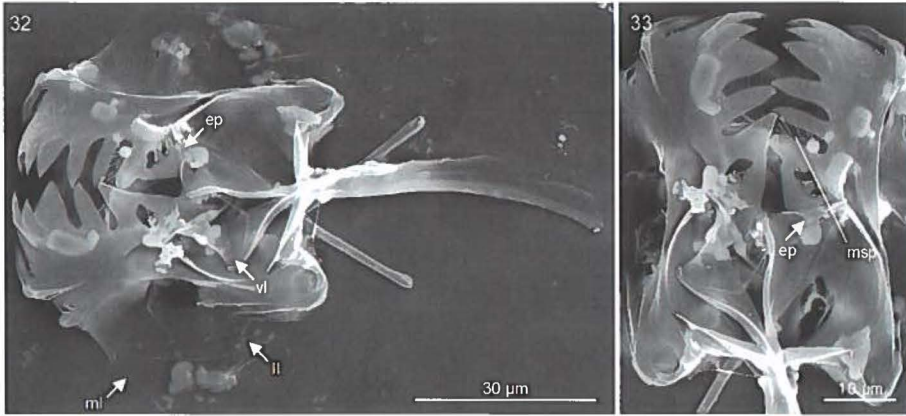


Fig. 32. *Synchaeta triophthalma*. SEM of trophi, ventral view. Legend: ep: epipharynx; ml: manubrial lamella; ll: lateral ramus lamella; vl: ventral ramus lamella.

Fig. 33. *Synchaeta triophthalma*. SEM of trophi, ventral view; detail showing unci. Legend: ep: epipharynx; msp: manubrial scleropili.

openings present on the caudal surface of each ramus could be interpreted as rudimentary subbasifenestrae (Fig. 31). However, they might also just be artefacts. Fulcrum is equal to the rami length. The unci are asymmetric: The right uncus has one apical, dorsally displaced preuncinal tooth with a very thin

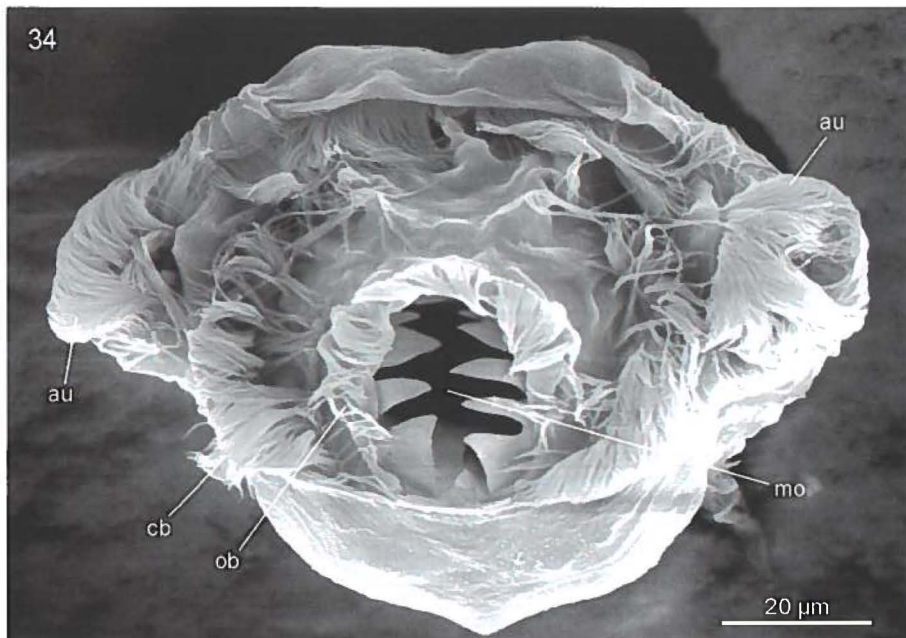


Fig. 34. *Synchaeta triophthalma*. SEM, frontal view. Legend: au: auricle; cb: circumapical band; mo: mouth; ob: oral band.

associated tooth (Fig. 25, apt), three basal teeth and two subbasal teeth. The left uncus has one apical, dorsally displaced preuncinal tooth with a very thin associated tooth, four or five basal teeth and two subbasal teeth (Figs. 25, 29-30). Some of the investigated specimens had four medium-sized basal teeth on the left uncus, while others had a very fine tooth inserted between the third and fourth teeth (compare Figs. 29 and 30). *Synchaeta* sp. 2 was the only recorded *Synchaeta* species that displayed polymorphism in respect to the uncinal denticulation. Manubria have one large crescentic lamella and an alula (Fig 25).

Measurements: Trunk length: 97-130 μm ; trunk width: 107-110 μm ; foot: 64-88 μm ; toes: 8-10 μm .

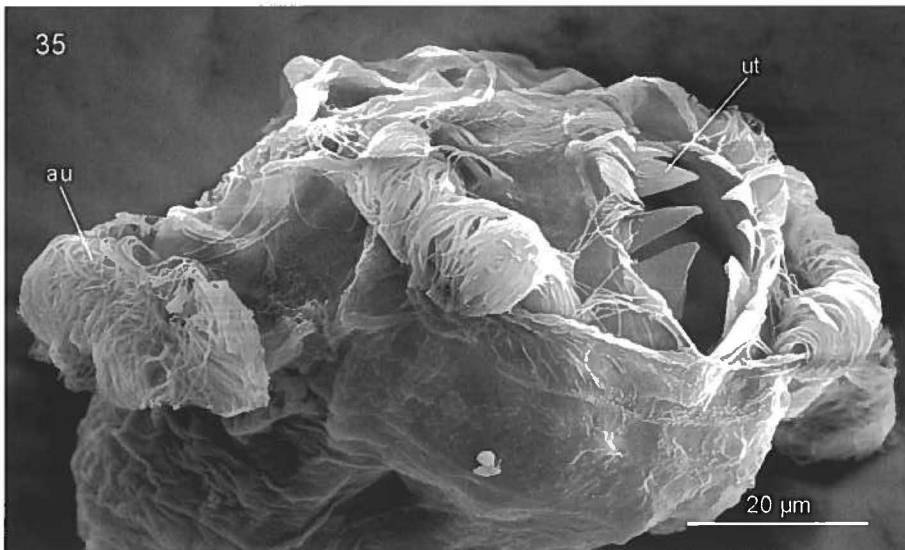


Fig. 35. *Synchaeta triophthalma*. SEM, laterofrontal view. Legend: au: auricle; ut: uncinal tooth.

Description of *Notholca ikaitophila* n. sp.

Brachionidae Ehrenberg, 1838

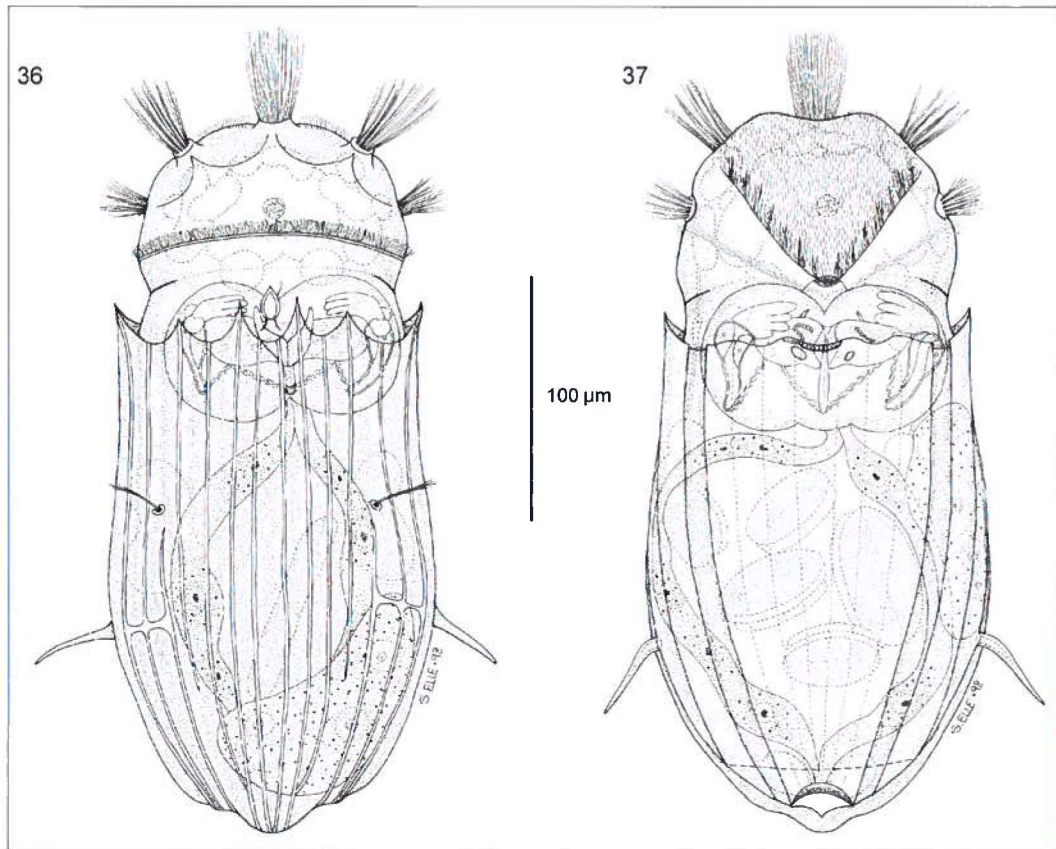
Notholca Gosse, 1886

The genus is recognised by its loricate body with four or six spines anteriorly on the dorsal plate. The posterior part of the dorsal plate may be rounded or with a highly variable caudal extension. The dorsal plate is always broader than the ventral. Trophi are malleate. See Pejler (1958-62) for a description of the internal structures in *Notholca*.

The genus is represented on the Northern Hemisphere as well as the Southern one, but most species seem to have a limited distribution (Pejler

Fig. 36. *Notholca ikaitophila* n. sp. Paratypic female from green ikaite, dorsal view.

Fig. 37. *Notholca ikaitophila* n. sp. Paratypic female from green ikaite, ventral view. Note the five diatoms, *Surirella brebissonii*, in the midgut.



1977). Most species are found in polar and temperate regions and the genus is considered to be cold stenothermal (Pejler & Berzins 1989). Eleven endemic species have been recorded from Lake Baikal, Russia, and it has been proposed that this area was the centre of speciation for the genus (Kutikova 1980).

Until 1997 two marine species, *N. angakkoq* Sørensen, 1998, and *N. liepetterseni* Godske Björklund, 1972 have been recorded from Greenland (Andersen 1990, Sørensen 1998). Recently, *N. cf. marina* Focke, 1961, *N. psammarina* Buchholz & Rühmann, 1956, and *N. striata* (Müller, 1786) were recorded from Disko Island (Funch & Sørensen, in press).

Material examined

Type material was collected at 10 m water depth 10 August 1997 from the ikaite column the Tower, Ikka Fjord, SW Greenland (61°11'58"N, 48°00'57"W).

Holotype: Female mounted in glycerine on a slide, and deposited in the Zoological Museum, University of Copenhagen, ZMUC ROT-132.

Paratypes: 12 specimens mounted in glycerine (ROT-133 to ROT-144), and four trophi (ROT-145 to ROT-148), and three specimens prepared and mounted for SEM (ROT-149 to ROT-151), all deposited in ZMUC.

Diagnosis

Body loricate; lorica divided into a dorsal and a ventral plate. Dorsal plate with a distinct longitudinal striation and six anterior spines. Anteromedian part of ventral lorica edge with a row of comb-like structures, each with two to eight small teeth. Two movable lateral spines. One single, spatulate, monociliate dorsal antenna with a medial cleavage. Paired, multiciliate lateral antennae, with ear-shaped apertures.

Trophi malleate, asymmetrical. Unci with rod-shaped teeth; right uncus with three well developed teeth that do not tend to fuse, and two minute, rudimentary teeth; left uncus with four teeth (3rd tooth made up of two fused teeth). Fulcrum short and curved, with dorsally pointing tip.

Description

Body loricate; lorica divided into a ventral and a dorsal plate. Dorsal plate convex, larger than ventral plate and ornamented with a distinctive longitu-

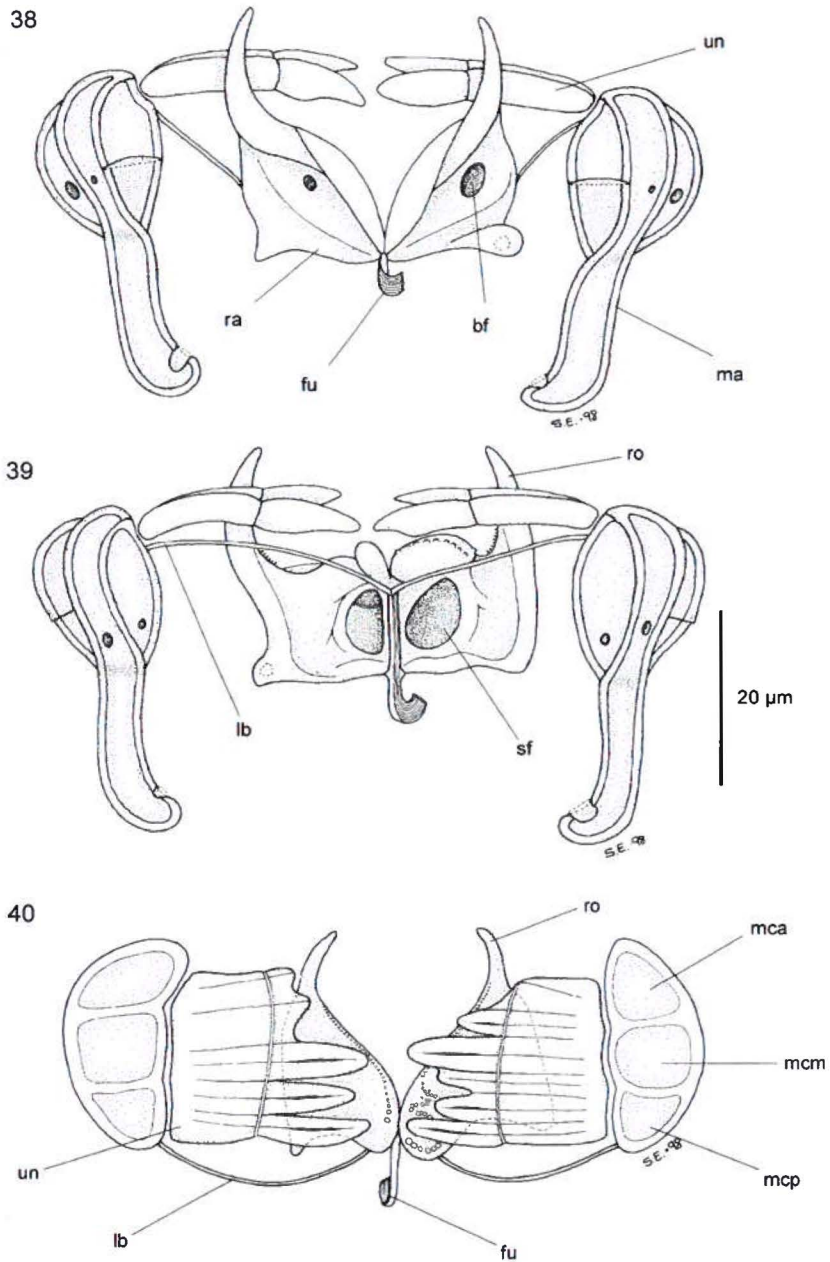


Fig. 38. *Notholca ikaitophila* n. sp. Trophi, dorsal view. Legend: bf: basifenestra; fu: fulcrum; ma: manubrium; ra: ramus; un: uncus.

Fig. 39. *Notholca ikaitophila* n. sp. Trophi, ventral view. Legend: lb: ligamentous band; ro: rostellum; sf: subbasifenestra.

Fig. 40. *Notholca ikaitophila* n. sp. Trophi, apical view. Legend: fu: fulcrum; lb: ligamentous band; mca: manubrial chamber, anterior; mcm: manubrial chamber, medial; mcp: manubrial chamber, posterior; ro: rostellum; un: uncus.

dinal striation (Figs. 36, 41); striation visible in live as well as fixed specimens. Ventral plate straight. Six anterior spines protrude from the dorsal plate. No posterior extensions are found. Two, paired, moveable, lateral spines present at the posterior half of the dorsal plate (Figs. 36-37, 41); anteromedian part of ventral lorica edge with a row of small comb-like structures, each bearing two to eight small teeth, measuring 0.2-0.4 μm (Fig. 47).

Corona formed by a large, ventral, supraoral buccal field, a postoral cingulum, and five frontal or laterofrontal ciliate lobes, all carrying tufts of cirri; lateral margins of buccal field with powerful cilia forming the pseudotroch (Figs. 36-37, 44-45). Oesophagus short; no protuberances were observed. Two unstalked gastric glands present, attached to anterior part of stomach. No constriction between stomach and intestine (Fig. 37). Three pairs of protonephridia present, positioned in the proximal, medial and distal parts of the body, respectively.

Brain large, saccate. One single, red cerebral eye present. Dorsal antenna spatulate and monociliate; a medially positioned cleavage runs from the proximal part of the antenna, splitting it into two flattened halves (Figs. 42-43). Lateral antennae positioned at dorsal lorica plate; antennae are multiciliate, with ear shaped apertures (Figs. 36, 46).

Trophi malleate (Figs. 38-40, 48-54). Manubria flattened, slightly triangular in lateral view; walls of medial and posterior chambers well developed, forming the rod-like caudal section; apertures of medial and posterior chambers found at external surface of proximal part of manubrium; traces of the anterior chamber can be recognised at internal surface of the sclerite (Fig. 54, ac); joint section with two well developed articulation furrows, fusing directly at uncus. Unci asymmetric with rod-shaped teeth; right uncus with three well developed teeth (tooth 1-3, counting from subbasal part of uncus) and two indistinct rudimentary teeth, positioned apically; left uncus with two big (tooth 1 and 3) and two small teeth (tooth 2 and 4, counting from subbasal part of uncus); tooth 3 and 4 teeth partly fused; tooth 3 probably formed by two totally or in a few cases partly fused teeth (Figs. 40, 51). A subuncus with a large number of small teeth (scleropili) is present at the internal surface of each uncus (Fig. 52, sc). Five to seven articulation furrows are present at both unci. Rami asymmetric, triangular in dorsal and apical view; left ramus generally more developed than right. Dorsal surface of rami with paired basifenestrae; basifenestra at right ramus slightly larger than basifenestra at left (Fig. 38, bf). An apically pointed rostellum protrudes from the dorsal surface of each ramus (Figs. 38-40, 48-49, ro); basal and subbasal parts of rostellum form a ridge at the basal parts of rami, which causes each ramus to appear triangular in apical view (Fig. 40). Ventral surface of rami flattened, with paired circular or oval subbasifenestrae; subbasifenestra at left ramus larger than subbasifenestra at right (Figs. 39, 49-50). Lateral edges of rami folded towards the ventral surface; a small chamber in the fold of the right ramus edge is visible in

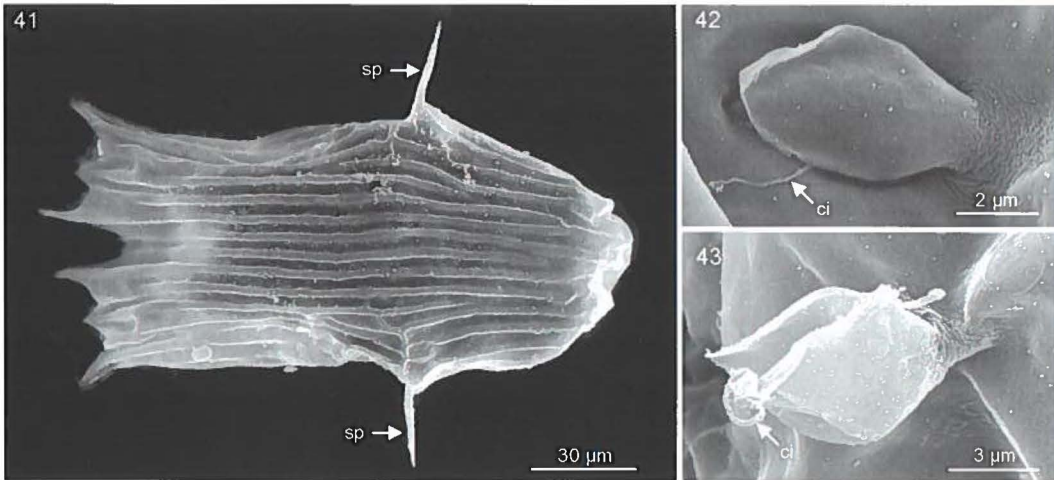


Fig. 41. *Notholca ikaitophila* n. sp. SEM of female habitus, dorsal view. Legend: sp: lateral movable spine.

Fig. 42. *Notholca ikaitophila* n. sp. SEM of dorsal antenna with closed sensillar structure. Legend: ci: cilium.

Fig. 43. *Notholca ikaitophila* n. sp. SEM of dorsal antenna with split (open) sensillar structure. Legend: ci: cilium.

the light microscope. A basal apophysis is present at each ramus; apophysis at left ramus significantly larger than apophysis at right; a curved row of tubercles runs from the apical part of left apophysis toward the internal edge of rostellum; a similar band of tubercles is present at right rostellum, but no tubercles are present at the basal apophysis (Figs. 39-40, 51). A pair of sclerotised ligaments connects the proximal part of manubria with the ventral surface of the rami. Fulcrum is short and curved in lateral view with a dorsally pointed tip; joining rami in the area between the subbasifenestrae (Fig. 53); light microscopic observations reveal that fulcrum is formed by hollow, longitudinally orientated tubes.

A subitaneous egg measures $89 \times 139 \mu\text{m}$. No resting eggs were found. No males were found.

Measurements: Dimensions and measurements are given in Table 1. Length of lorica is measured from the tip of the median spines to the posterior end of the lorica; body length is the length of the lorica minus the median spines; width measured at the widest part of the dorsal plate. The lorica dimensions and the length of the anterior spines are highly variable. During swimming, the lorica is long and slender, while specimens with contracted longitudinal muscles appear short and broad. Measurements on trophi are given in Table 2.

Table 1. Measurements of *Notholca ikaitophila* n. sp. Abbreviations: l.l.: lorica length; b.l.: body length, calculated as lorica length minus length of median spines; w.: width, measured at widest part of dorsal plate; m.sp.: median dorsal spines; l.sp.: lateral dorsal spines; m.l.sp.: movable lateral spines.

| | Range | Mean | SD | SE |
|---------|-----------------------|-------------------|--------|--------|
| l.l. | 189-235 μm | 213 μm | 11.790 | 14.447 |
| b.l. | 172-213 μm | 193 μm | 10.803 | 12.513 |
| w. | 84-144 μm | 114 μm | 15.292 | 19.063 |
| m.sp. | 8-27 μm | 20 μm | 4.618 | 6.088 |
| l.sp. | 6-18 μm | 11 μm | 3.437 | 4.051 |
| m.l.sp. | 30-40 μm | 33 μm | 2.219 | 2.868 |
| n | 13 | | | |

Table 2. Measurements on trophi of *Notholca ikaitophila* n. sp.

| | Range | Mean | SD | SE |
|----------|---------------------|------------------|-------|-------|
| Trophi | 32-46 μm | 38 μm | 3.584 | 4.782 |
| Rami | 17-26 μm | 21 μm | 2.000 | 2.503 |
| Unci | 16-27 μm | 23 μm | 3.360 | 4.297 |
| Manubria | 24-32 μm | 29 μm | 2.112 | 2.552 |
| Fulcrum | 6-11 μm | 9 μm | 1.123 | 1.431 |
| n | 10 | | | |

Etymology

Ikaite, a cold thermostable mineral described from Ikka Fjord, *philum* (Greek), loving.

Differential notes

Notholca ikaitophila n. sp. belongs to the *Notholca striata*-group, which now holds five species, and can be distinguished from the other species in the genus by the presence of lateral movable spines. The species within the *Notholca striata*-group look very similar and can only be separated by fine details.

Notholca ikaitophila n. sp. differs from the other species in the group in having ear-shaped apertures from the lateral antennae (Fig. 46), a spatulate dorsal antenna, which is totally cleaved and only carrying a single cilium (Figs. 42-43), and in having the most pronounced striation on the dorsal lorica plate. Beside this, *N. ikaitophila* n. sp. is one of the largest species in the group, but it should be noted that its size overlaps with both *N. bipalium* and *N. angakkoq* (Koste 1978; Sørensen 1998).

It can easily be recognised from *N. striata* because of the difference in size.

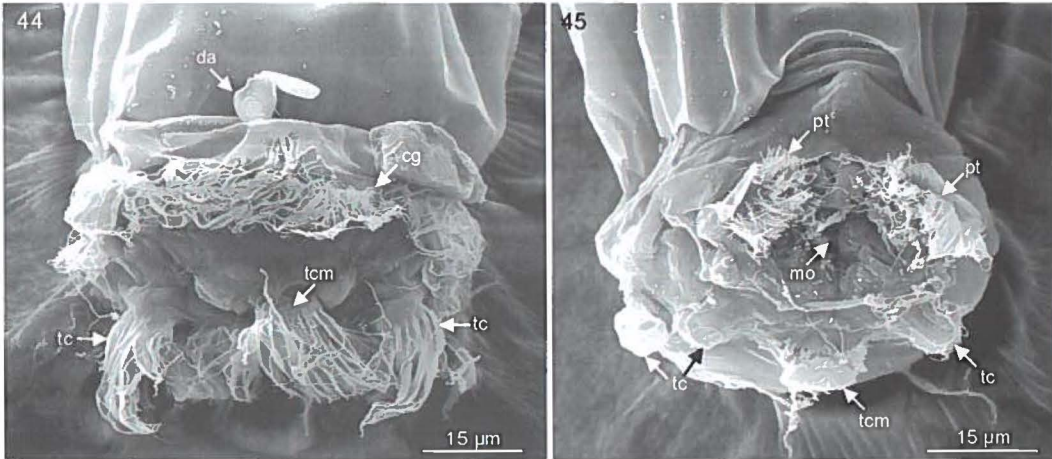


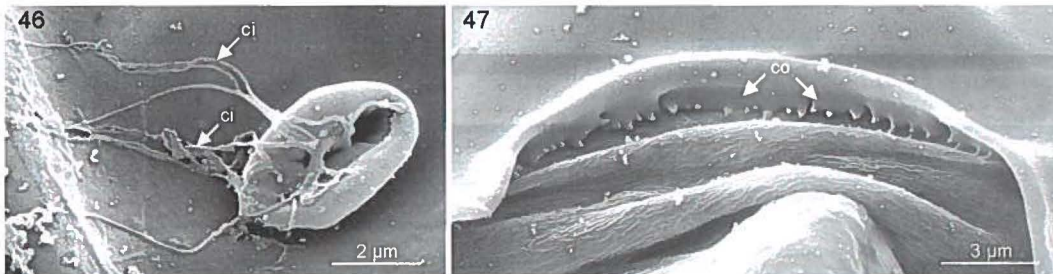
Fig. 44. *Notholca ikaitophila* n. sp. SEM of head and corona, dorsoapical view. Legend: cg: cingulum; da: dorsal antenna; tc: tuft of cirri; tcm: median tuft of cirri.

Fig. 45. *Notholca ikaitophila* n. sp. SEM of head and corona, ventroapical view. Cilia in buccal field and cingulum have been removed with ultrasound. Legend: mo: mouth; pt: pseudotroch; tc: tuft of cirri; tcm: median tuft of cirri.

Beside this, the ramal tubercles in *N. striata* is very small and inconspicuous, while they are large and well developed in *N. ikaitophila* n. sp. This trait is easily recognised in a light microscope. It differs from *N. liepetterseni*, which has a smooth or almost smooth dorsal lorica plate (Andersen 1990; Sørensen 1998). *N. angakkoq* and *N. ikaitophila* is very similar, but some details in the trophi morphology are divergent. The uncinial teeth in *N. ikaitophila* are rod-shaped and rounded at tips, while those in *N. angakkoq* are flattened and pointed (Sørensen 1998).

Fig. 46. *Notholca ikaitophila* n. sp. SEM of lateral antenna, consisting of an ear-shaped opening with a tuft of cilia. Legend: ci: cilia.

Fig. 47. *Notholca ikaitophila* n. sp. SEM of anteromedian part of ventral lorica edge (close-up from Fig. 45). Legend: co: comb-like structures bearing small teeth.



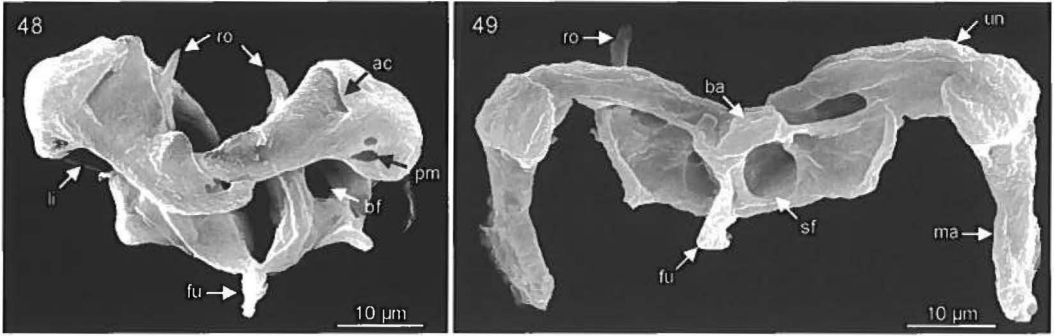


Fig. 48. *Notholca ikaitophila* n. sp. SEM of trophi, dorsal view. Legend: ac: rudiments of anterior manubrial chamber; bf: basifenestra; fu: fulcrum; li: ligament; pm: window from posterior manubrial chamber; ro: rostellum.

Fig. 49. *Notholca ikaitophila* n. sp. SEM of trophi, ventral view. Legend: ba: basal apophysis; fu: fulcrum; ma: manubrium; ro: rostellum; sf: subbasifenestra; un: uncus.

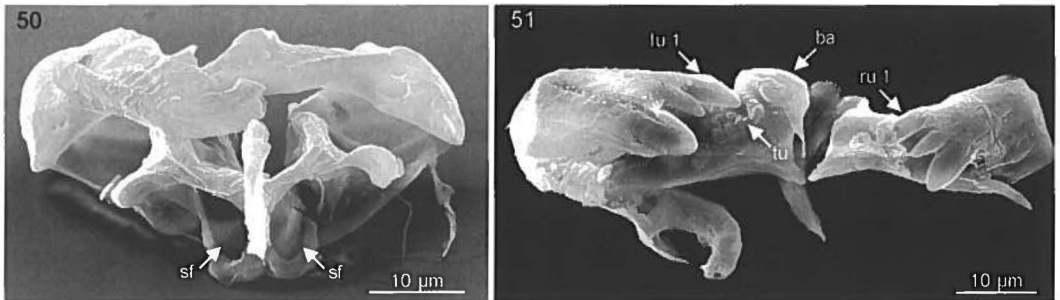
There are no recent morphological data on *Notholca bipalium*, so the species should be collected from its type locality in Denmark and redescribed, before it can be included in a comparison.

Taxonomic considerations

The presence of moveable lateral spines suggests that *N. ikaitophila* n. sp. forms a monophylum with *N. striata* (Müller, 1786), *N. bipalium* (Müller, 1786), *N. liepetterseni* Godske Björklund, 1972, and *N. angakkoq* Sørensen, 1998, here referred to as the *Notholca striata* group. Beside the moveable lateral spines, the group shares following similarities: Brackish or marine, lack of posterior

Fig. 50. *Notholca ikaitophila* n. sp. SEM of trophi, dorsocaudal view. Legend: sf: subbasifenestra.

Fig. 51. *Notholca ikaitophila* n. sp. SEM of trophi, frontal view. Legend: ba: basal apophysis; tu: row of tubercles; lu 1: left uncinal tooth 1; ru 1: right uncinal tooth 1.



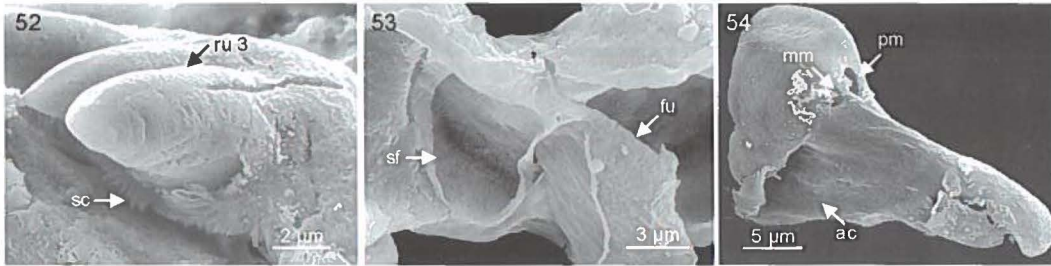


Fig. 52. *Notholca ikaitophila* n. sp. SEM of trophi detail. Legend: sc: brushborder of subuncinal scleropili; ru 3: right uncinal tooth 3.

Fig. 53. *Notholca ikaitophila* n. sp. SEM of trophi detail. Legend: fu: fulcrum; sf: subbasifenestra.

Fig. 54. *Notholca ikaitophila* n. sp. SEM of isolated right manubrium. Legend: ac: rudiments of anterior manubrial chamber; mm: window from medial manubrial chamber; pm: window from posterior manubrial chamber.

extensions and fusion of tooth 3 and 4 at left uncus, the so-called “abgewandelter Uncus-typ” (Focke 1961).

Some authors have regarded the group as one single species, containing a number of forms or subspecies (von Hofsten 1911-12, Harring 1921, Carlin 1943, Kutikova 1980, Nogrady & Wallace 1995) while others have kept them as separate species (Lang 1934, Focke 1961, Godske Björklund 1972, Koste 1978, Sørensen 1998) [note that *N. liepetterseni* and *N. angakkoq* were described in 1972 and 1998, respectively, and are therefore not applicable for any of the references, which are earlier than 1972]. This confusion has primarily been caused due to the lack of consistent differential characters. Among rotiferologists the problem with separation and definition of species is well known. Several species reproduce exclusively by parthenogenesis and the reproductive biology of species with males is often poorly known. The classic species concept based on reproductive barriers between species is therefore inapplicable for most rotifer species. One way to separate species is the presence of discontinuous variation between individuals at one locality (Pejler 1977). Ghilarov (1967) found that *N. striata* and *N. bipalium* occurred simultaneously in one rock-pool on an island in the White Sea, and if one accept that species can be distinguished by on discontinuous variation, Ghilarov's finding would serve as an argument for separating the species in the *Notholca striata* group.

Another way to separate species is the use of morphological characters that are presumed to be useful on different taxonomic levels. Kutikova (1980) suggests a number of characters that could be used separate *Notholca* groups on superspecies, species, and subspecies level. At the species level Kutikova (1980) mentions characters connected to the size and ornamentation of the lorica. The *Notholca striata* group contains species with an almost smooth

lorica (*N. liepetterseni*) as well as species with deep longitudinal furrows (*N. angakkoq* and *N. ikaitophila* n. sp.), so this serves also as an argument for regarding the members of the group as distinct species.

Until the description of *N. angakkoq*, the members of the *Notholca striata* group were recognised only by lorica and spine length and dimensions. These features were used despite the fact that they overlapped. Sørensen (1998) demonstrated the need of morphological characters to distinguish between the species of the group and gave differential notes on the species *N. angakkoq*, *N. liepetterseni* and *N. ikaitophila* n. sp. (referred to as *Notholca* n. sp. 1). However, a revision of the *Notholca striata* group, and especially a reinvestigation of *N. striata* and *N. bipalium*, is still needed.

Ecological considerations concerning *Notholca ikaitophila* n. sp.

Notholca ikaitophila n. sp. lives in the brackish spring water inside the ikaite columns and in the ikaite snow in the middle of the largest ikaite structure, the Atoll. No specimens were found on the outer surface of the columns, where the salinity is much higher. The highest abundance of individuals was found in the green zone of the ikaite (see Fig. 7).

It has been proposed that *Notholca* spp. feed more or less exclusively on diatoms (Thane-Fenchel 1968; Pejler & Bērziņš 1989), but the new species also feeds on small euglenoids (*Euglena* sp.). The dominating food item in the midgut of *N. ikaitophila* n. sp. was the diatom *Surirella brebissonii*. This diatom is swallowed in one piece and several specimens could still be seen in a whole-mount preparation of the rotifer (Fig. 37). The diatom *S. brebissonii* is well known from brackish water and fresh water with high electrolyte content.

A very rich eumarine diatom flora was located on the surface of the ikaite column, but the rotifer does not seem to eat these diatoms. This observation confirms that *N. ikaitophila* n. sp. only lives in the brackish water inside the columns and avoids contact with the marine water in the fjord.

In culture, *N. ikaitophila* n. sp. eats *Euglena* sp., which is grabbed and squeezed by the trophi of the rotifer before it is swallowed. *Notholca ikaitophila* n. sp. was not observed to eat the cryptophyte *Chroomonas ikaitensis*. This is very interesting because the rotifers always were found associated with the "green ikaite" at the Tower. The deep-green colour (Fig. 7) of the ikaite is given by the mass occurrence of the cryptophyte (Kristiansen & Kristiansen 1999).

In culture the species survived and reproduced in salinities ranging from 9 to 29‰ and at temperatures of 3-5°C. In sea-water from Ikka Fjord the culture died out in a few days.

Concluding remarks

The ikaite columns have a strong conductivity gradient from the middle of the column with spring water (conductivity equal to a "salinity" of 9‰) to the surface surrounded with marine water (32‰). The lagoon of the largest formation of ikaite, the Atoll, was dominated by column water. This condition makes up a very special biota for meiofauna. While the meiofauna on the outside of the columns is exclusively eumarine, the animals inside the columns and in the ikaite snow are related to the brackish water or even the freshwater fauna. A similar condition is found in the large ponds formed during summer on multi-year sea ice, where for instance the copepod fauna, as in the ikaite snow, consists almost only of cyclopid copepods (Kristensen pers. obs.). In most marine sediments, including the cold mud at the bottom of Ikka Fjord, the copepod fauna is normally dominated by harpacticoids. It is still too early to conclude whether the meiofauna inside the ikaite columns belongs to ice biota, or whether it is a totally new fauna which is only found in the new ecosystem, the column garden in Ikka Fjord.

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While working on the descriptions of rotifers from Ikka Fjord, SW Greenland, the authors of this book discovered a new marine rotifer, *Notholca ikaitophila* n. sp. (see front cover illustration) inside the ikaite columns and from ikaite sand. The presence of movable lateral spines suggests that this new species has a close relationship to the *Notholca striata* group.

Besides the new species, eight other rotifer species, including four planktonic species, were found. Six of these are new to Greenland.

Besides the rotifer descriptions, this book has information on macro- and meiofauna in the Ikka Fjord as well as an ecological note regarding the unique habitat for the meiofauna inside the ikaite columns.

Martin V. Sørensen, born 1972, is doing a Ph.D.-study about the homologies in the jaw apparatuses between the gnathiferan groups, including Rotifera, Gnathostomulida, and a new, yet undescribed taxon from a cold spring at Disko Island.

Reinhardt M. Kristensen, born 1948, is full professor of invertebrate zoology at Zoological Museum, University of Copenhagen, Denmark. He has been working with the morphology and systematics of a broad range of meiofauna animals, especially tardigrades, kinorhynchans, loriciferans and cycliophorans.

