

The enchytraeid fauna of the Palearctic tundra (Oligochaeta, Enchytraeidae)

By BENT CHRISTENSEN and KLARA DOZSA-FARKAS



Biologiske Skrifter 52

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Abstract

Christensen, B. & Dozsa-Farkas, K. The enchytraeid fauna of the Siberian tundra (Oligochaeta, Enchytraeidae).

We have examined samples collected by the trans-siberian Swedish-Russian Ecology Expedition 1994, and critically evaluated the relevant literature and existing museum collections from previous expeditions to Siberia. Eleven species are described as new to science and the total number of enchytraeid species recorded from the Palearctic tundra is now 56. This indicates a species richness comparable to that of terrestrial habitats in ecologically more heterogeneous temperate regions. In the genera *Mesenchytraeus*, *Henlea*, *Bryodrilus* and *Cognettia* species diversity in the tundra is even higher than in temperate regions, which is contrary to the generally accepted poleward decline in diversity. The genera *Fridericia* and *Achaeta* follow the normal pattern with only few species in the Arctic. It is concluded that the Palearctic tundra in general and the Amphiberingian region in particular harbour a rich endemic fauna with a strong dominance of *Mesenchytraeus* and *Henlea* species.

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Introduction

The Enchytraeidae are among the dominant animal groups in northern soil ecosystems, and while the European fauna is well studied our knowledge is still incomplete for other parts of the world, and particularly so for the vast tundras of the northern Palearctic.

The pioneer works are those of Eisen (1878, 1879 and 1904) and Cejka (1910, 1912, 1914). More recently Nurminen (1980) reported from a number of tundra sites in northern Russia and western Siberia, and Piper et al. (1982) studied a locality in the easternmost part of the region. We report here the results from the Swedish-Russian Tundra Ecology Expedition in

1994 which more or less covers the areas in between the two latter studies. In addition we have reinvestigated the collections from previous Swedish expeditions to the Arctic upon which Eisen's classical studies were based.

The modest literature on the subject would seem to indicate a relatively high species diversity, particularly so in the Amphi-Beringian region and a predominance of endemic *Mesenchytraeus* species. In addition to providing further basic information, the aim of the present study is to address these ideas concerning species richness, endemism and dominance of particular genera in the Siberian tundra.

Material and methods

The sampling sites are shown in Fig. 1. Soil samples appr. 5 cm in depth were taken in both wet and mesic habitats, kept in plastic bags at a few degree C° and brought to the laboratory. Worms were extracted using the wet funnel technique, and immediately studied alive under the microscope. Selected individuals were fixed, stained and mounted for later detailed inspection.

Descriptions of species new to science follow conventional practice. In cases where the original description of a species date from a time when it was not fully appreciated what was required of a species definition in order to secure recognition we present additional infor-

mation based upon our observations. In some cases later authors have supplemented descriptions of Arctic species by observations on what they thought to be con-specific European representatives. In cases where this identity is doubtful, we clarify the original species definition based upon observations on worms from the Arctic. For species fully described in the recent literature only the findings are mentioned.

For each genus the main taxonomic criteria of all species recorded from the region are summarised in tabular form, meant as an aid in narrowing down the number of species to consider. In this way we hope that the present con-

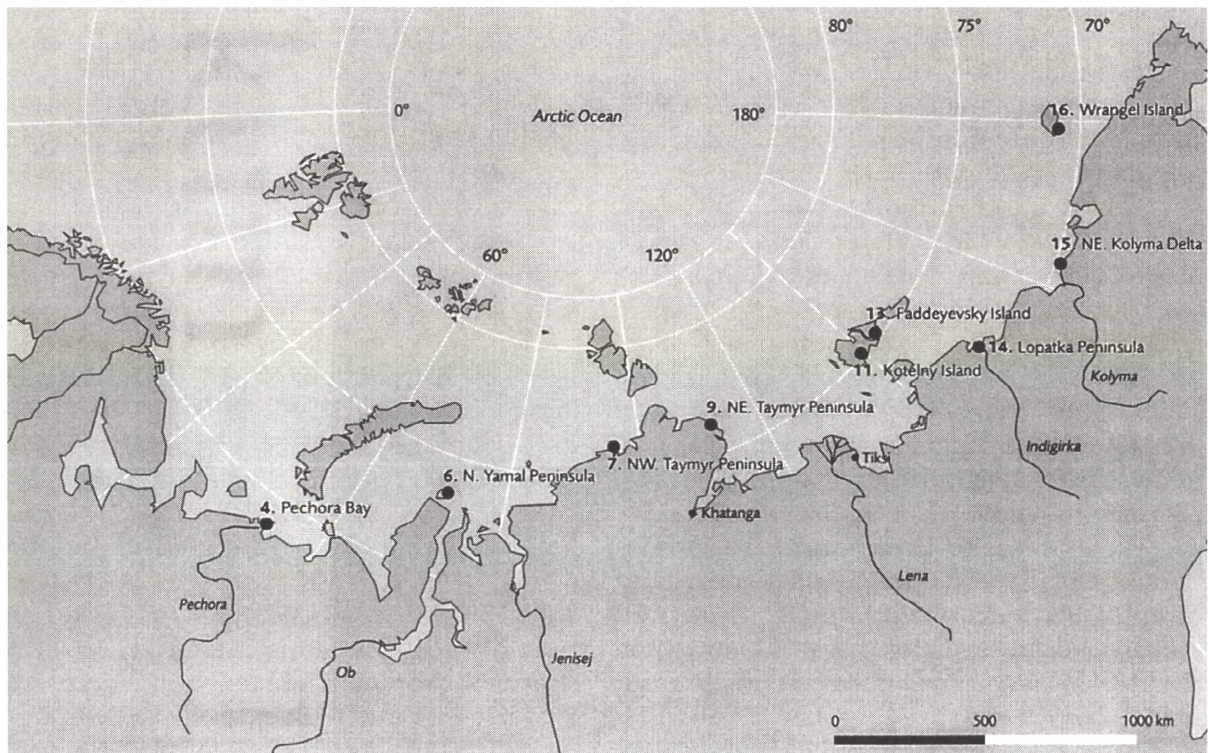


Fig. 1. Map of sampling sites.

tribution together with other easily available literature may serve as a basis for future studies on the enchytraeid fauna in the Arctic. Dimensions of worms and organs were taken from live specimens except in the case of museum collections.

The nomenclature follows that of Nielsen and Christensen (1959) except when noted. Species recorded in this study (including holo-

types) are deposited as whole-mounts or preserved in 70% ethanol in the Department of Zoology and Ecology, Eötvös Lorand University, Budapest, Hungary (abbreviations A, Co, He, M, Ma and P). Contact person Klára Dózsa-Farkas. To supplement the Eisén collection there alcohol preserved specimens are also deposited in Riksmuseet, Stockholm (abbreviation: SMNH).

Results

Genus *Mesenchytraeus* Eisen, 1878

Chief taxonomic criteria of the species recorded from the region are given in Table I.

Mesenchytraeus melanocephalus sp. n. (Fig. 2)

Holotype: M. 2. (70 % ethanol)

Type locality: Kotelny Island; leg. S. Jonasson.

Paratypes: P.39-41 3 specimens (whole mounts in euparal) from NE Taymyr Peninsula, NE Kolyma Delta and N Yamal Peninsula, P.42-43 6 specimens (70% ethanol) from N Yamal Peninsula, Wrangel Island and Kotelny Island, SMNH TYPE-5067 from Wrangel Island; leg. T. Christensen and S. Jonassen.

Material examined: Recorded from sts. 6, 9, 11, 15 and 16.

Etymology: The species name refers to numerous pigment cells in the anterior end of the body.

Description: Medium sized, 14-22 mm long, diameter 0,5-0,7 mm. Segments (38) 44-58. Colour redbrown to darkbrown due to pigment cells in the outer layer of epidermis. Pigments located peripherally in the individual cells which form a netlike pattern. These cells are particularly numerous in the antecleitar region and increase in density towards the prostomium. There is some individual variation in the intensity of the pigmentation. Clitellum extends over 1/2XII-XIII. Setae (Fig. 2 B) sigmoid and with nodulus: (0),1,2-(0),1,2,3: 2,3,4,5,(6)-2,3,4. In the dorsolateral bundles VI-VIII only one enlarged seta present (length 110 μ m against 49-92 μ m in other setae). In the setal sacs usually two large cells with redbrown granules (Fig. 2 B). Head pore at 0. Brain (Fig. 2 A) as long as wide (appr. 140 μ m), incised posteriorly. Two primary septal glands at IV/V and V/VI, lobed secondaries in V and VI, in both cases the second pair is often

poorly developed. Chloragogen cells intensely redbrown (45-57 μ m). Dorsal vessel arises in XVIII-XX, blood light red. Lymphocytes (Fig. 2 G) oval but often with pointed ends (25-35 μ m long and 7-8 μ m wide) and containing faintly yellow refractile granules. Nephridia (Fig. 2 C) from VI/VII, and their shape typical of the genus *Mesenchytraeus*. Seminal vesicles may extend from X-XVIII, but are often absent or poorly developed in otherwise sexually mature individuals. Egg sac may extend to XXI. Sperm funnel (Fig. 2 F) 2-3 times as long as wide (length 140-340 μ m), the length appr. one fourth the diameter of the worm, collar not visible. The funnel gradually merges with a 5-6 times longer sperm duct (31-37 μ m wide). Atrium small, entally with 5-6 oval glands and near the male opening are seen two large accessory glands (Fig. 2 F). Spermathecae (Fig. 2 D,E) free, ectal duct 200-240 μ m long and 40-50 μ m wide, two elongate diverticulae with distinct lumen at the transition to the ampulla which is appr. 100-250 μ m long and 40-44 μ m wide. The spermathecae are usually confined to segment V but may extend into the anterior half of VI.

Remarks: Among the species with two diverticulae and a free spermatheca this species is most similar to *M. arcticus* Bell, 1962. But *M. arcticus* is not intensely pigmented, it is larger (about 70 segments) and has more setae per bundle none of which are enlarged.

M. chromathophorus Altman, 1936 and *M. gelidus* Welch, 1916 are both strongly pigmented, but their spermathecae extend backwards until segment IX and X, they have more setae in the dorsolateral bundles and none of these are enlarged. *M. harrimanni* Eisen, 1904, *M. obscurus* Eisen, 1904 and *M. maculatus* Eisen, 1904 are also pigmented but are much larger than the present species.

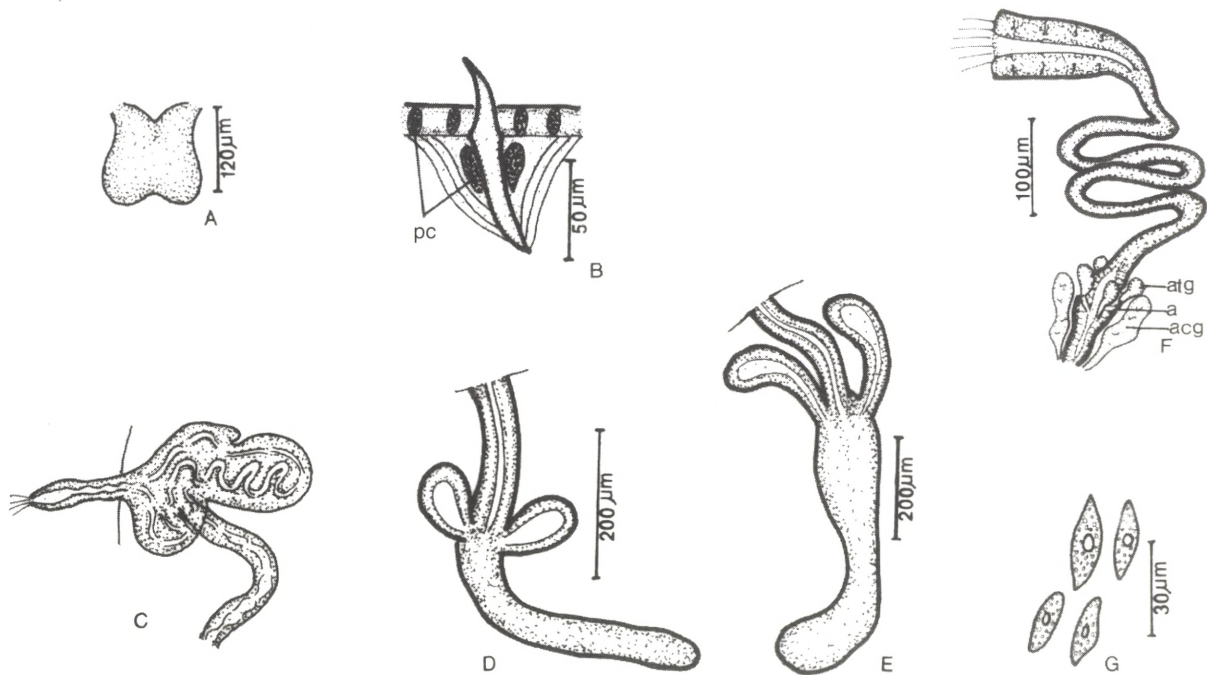


Fig. 2. *Mesenchytraeus melanocephalus* n.sp.

A: brain; B: setae (pc: pigment cells); C: nephridia; D and E: spermatheca; F: sperm funnel, sperm duct and mail opening (a: atrium, atg: atrial glands, acg: accessory glands); G: lymphocytes.

***Mesenchytraeus torbeni* sp. n.** (Fig. 3)

Holotype. M.3.

Type locality: N Yamal Peninsula, leg. T. Christensen

Paratypes: P.44-46. 4 specimen (preparatum) from N Yamal Peninsula and NE Taymyr Peninsula, P.47-51 52 specimens (70 % ethanol) from N Yamal Peninsula, NE Taymyr Peninsula, Wrangel Island and Kotelny Island, SMNH TYPE-5068 from N Yamal Peninsula; leg. S. Jonasson and T. Christensen.

Material examined: Recorded from sts. 6, 9, 11 and 16.

Etymology: Named in the honour of Torben Christensen.

Description. Small species, 5-9 mm long, diameter 0,3-0,4 mm (in the clitellar region 0,37-0,46

mm). Segments 25-38. The colour is yellowish but in some regions intensely white due to accumulations of lymphocytes. Cuticular glands scarce, the individual cells of irregular outline and containing small yellowish granules. Clitellum extends from XII-XIII, poorly developed gland cells arranged in rows. Setae sigmoid and with nodulus: 1,2,3,4(1),2,3,4,5,(6,7):2,3,4,5-2,3,4,5; length of the larger setae appr. 55 µm, no particularly enlarged setae. Head pore at 0. Brain (Fig. 3 C) 125 µm long and 94 µm wide, incised posteriorly. Two primary septal glands at IV/V and V/VI, three lobed secondary septal glands in V, VI and VII, occasionally the latter pair is small or even missing. Chloragogen cells present from V and yellow-grey in transmitted light. Dorsal vessel arises in

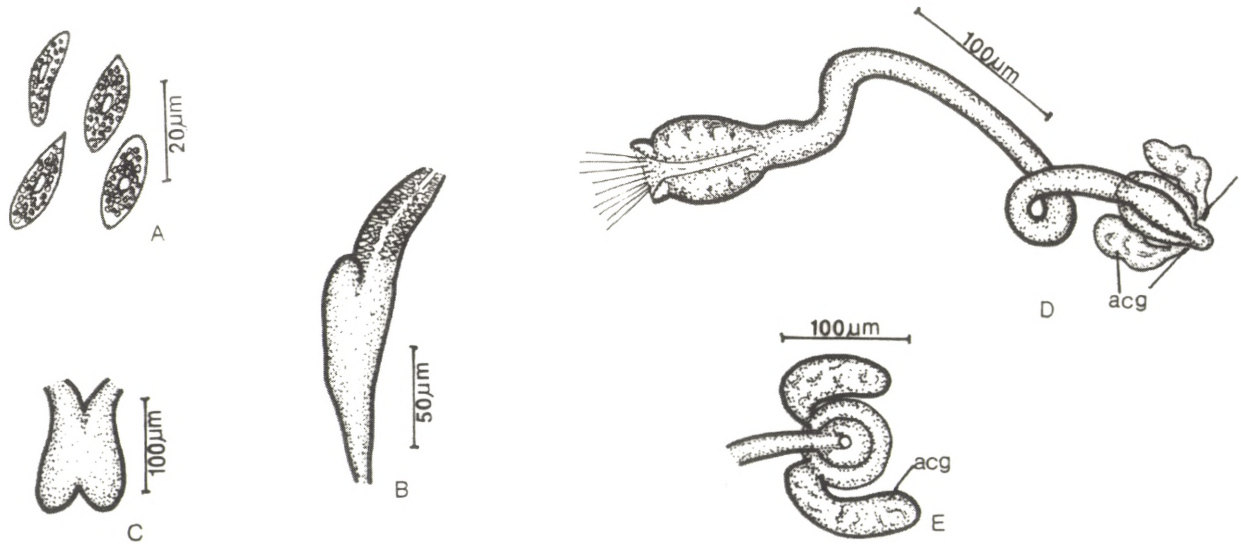


Fig. 3. *Mesenchytraeus torbeni* n. sp.

A: Lymphocytes; B: spermatheca; C: brain; D: sperm funnel, sperm duct and mail opening; E: mail opening, ventral view (acg: accessory glands).

XII- XIV, blood colourless. Lymphocytes (Fig. 3 A) ellipsoid or spindle-shaped (15-20 μm long), they have a distinct nucleus and are packed with granules that appear black in transmitted light. Nephridia beginning at VI/VII, and their shape typical of the genus. Seminal vesicles absent or small (XII and XIII). Sperm funnel (Fig. 3 D) 1.5 times as long as wide, 75 μm long roughly corresponding to one third the diameter of the worm, collar narrower than the width of the funnel. The funnel gradually merges with a 5-6 times longer sperm duct (15 μm wide). Atrium present, and near the male opening are seen two large accessory glands (Fig. 3 E) and some smaller penial glands (sensu Eisen) but these are often difficult to see. Spermatheca (Fig. 3 B) consists of a 40-60 μm long granulated ectal duct devoid of glands, it widens into an ampulla with a more or less prominent forwardly directed diverticulum. The ampulla gradually merge into the ental duct which communicates with the oesophagus in V.

Remarks: Among the *Mesenchytraeus* species with white lymphocytes (dark in transmitted light) this species is most similar to *M. argentatus* Nurminen, 1973 (same size and setal formula) but in the latter the spermatheca has no diverticulum and there are no accessory glands at the male opening. *M. chaunus* Piper et al., 1982 and *M. diverticulatus* Piper et al., 1982 are larger and has free spermathecae. *M. kuehnelti* Dózsa-Farkas, 1991, is also larger and has an entirely different type of spermatheca without diverticulum. At st. 11 we observed a few individuals with a higher number of setae (up to 10 in the anterior ventral bundles) and four accessory glands at the male opening.

***Mesenchytraeus sveni* sp. n.** (Fig. 4)

Holotype: M.4. (70 % ethanol)

Type locality: N Yamal Peninsula.

Paratypes: P.52 3 specimens (70 % ethanol) from N Yamal Peninsula.

Material examined: Recorded from st. 6.

Etymology: Named in honour of Sven Jonasson.

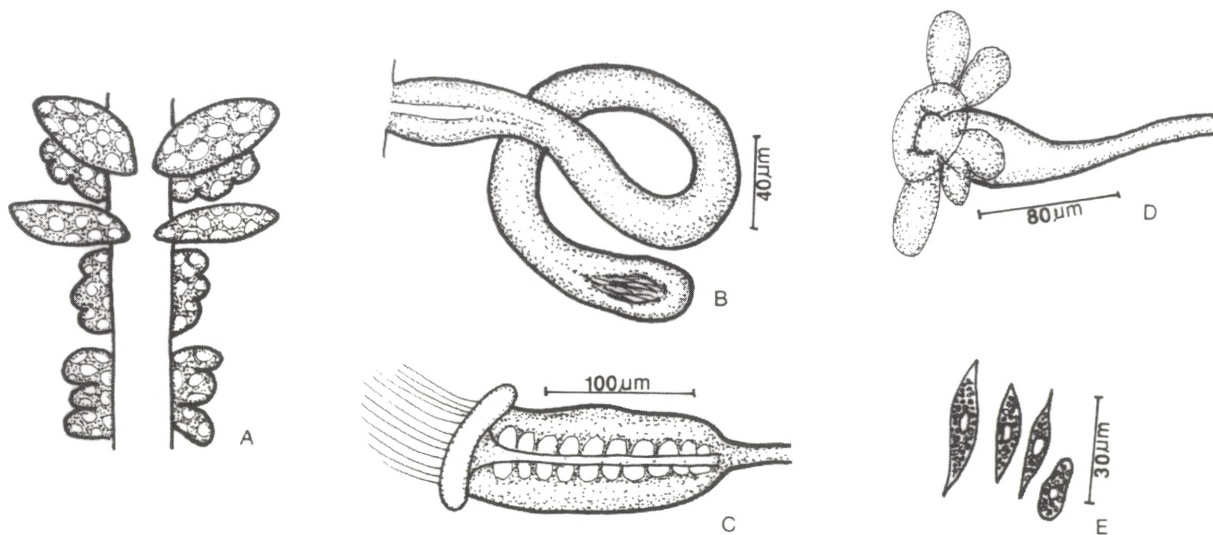


Fig. 4. *Mesenchytraeus sveni* n. sp.

A: septal glands; B: spermatheca; C: sperm funnel; D: male opening ; E: lymphocytes.

Description: Small to medium sized species, 7,4-15 mm long, diameter appr. 0,44 mm. Segment 41-47 Colour redbrown but more whitish where lymphocytes aggregate. Cutaneous glands scarce, containing small yellowish granules. Clitellum extends from XII-1/2XIII, poorly developed. Setae sigmoid with nodulus: (2,3),4,5,6,7-6,5,4:5,6,7,(8)-4,5,6,7. No enlarged setae. Head pore at 0. Brain about as long as wide (150 µm) slightly incised posteriorly. Two primary septal glands at IV/V and V/VI and secondary septal glands in V, VI and VII (Fig. 4 A), the latter may be small or even absent. Chloragogen cells from IV, with orange coloured droplets. Dorsal vessel arises in XIV-XV, the blood is faintly red. Lymphocytes (Fig. 4 E) elongate spindle-shaped (40 µm long) with a distinct nucleus and containing refractile granules that appear dark in transmitted light. Nephridia beginning at VI/VII and are typical for the genus. Seminal vesicles in XIII-XIV. Sperm funnel (Fig. 4 C) 2-3 times as long (200 µm) as wide, the collar is wider than the width of the funnel, the sperm duct of medium

length and four atrial glands are present (Fig. 4 D). Penial glands absent. Spermatheca (Fig. 4 B) free and confined to V. The ectal duct short and wide, extending into a somewhat narrower ampulla which is appr. 5 times as long as the duct.

Remarks: This species is in some ways similar to *M. chaunus* Piper et al. 1982 but it is smaller and has no enlarged setae.

***Mesenchytraeus cf. flavus* (Levinsen, 1884)**

Material examined: Recorded at st. 4.

At the westernmost station at Pechora Bay individuals were found that are similar to *M. flavus* in somatic characters such as number of segments and setae, number and shape of septal glands and in size and colour of lymphocytes and chloragogen cells. However, even when an egg sac with developing eggs was present, sperm funnel, sperm duct and spermatheca were always poorly developed.

Remarks: These finds may represent a parthenogenetically reproducing form.

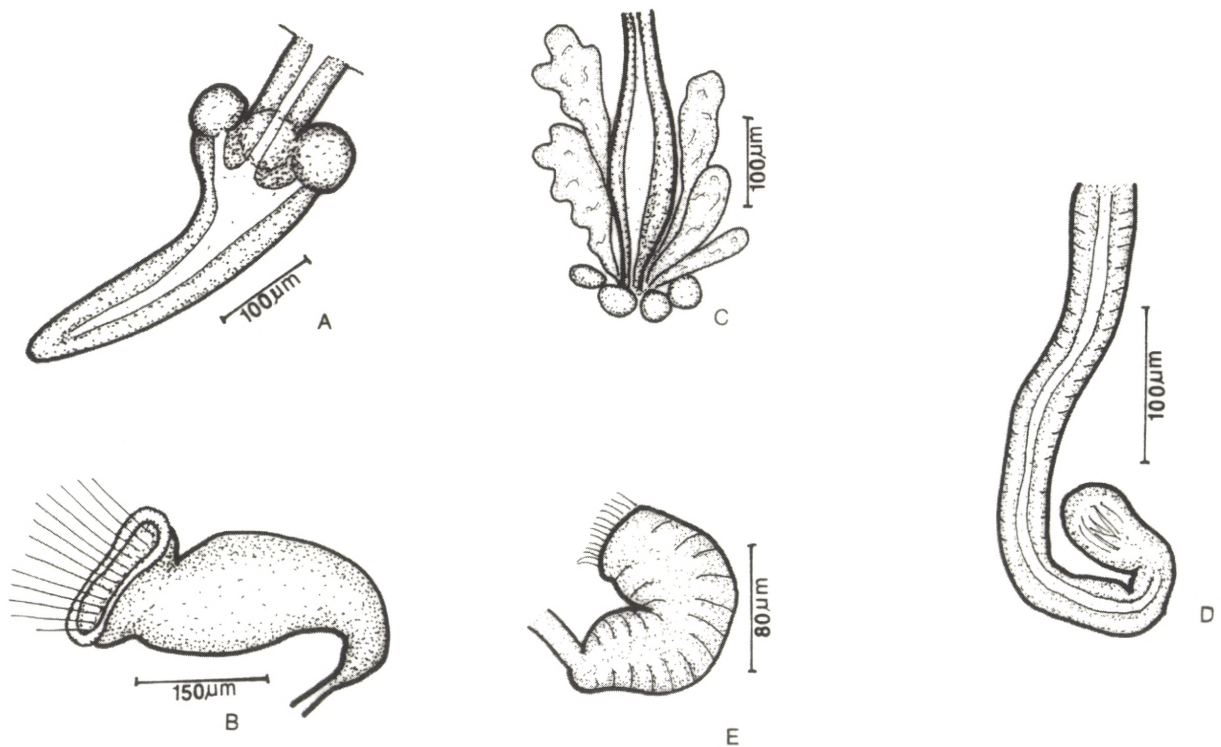


Fig. 5 A-C. *Mesenchytraeus mirabilis* Eisen; 1878

A: spermatheca; B: sperm funnel; C: mail opening; D-E: *Mesenchytraeus falciformis* Eisen; 1878 D: spermatheca; E: sperm funnel.

***Mesenchytraeus mirabilis* Eisen, 1878** (Fig. 5 A-C)

Material examined: Recorded at st. 13.

Previous record: Mesenkin, on the right shore of Yenisey (Eisen 1878)

Two mature individuals were found, and we amend the original description by the following points: Number of segments 49 and 64. Length 10-15 mm. Colour of live worms light brown. Setae: 2,3,4-2,3,4:5,6,7-5,6, no enlarged setae. Dorsal vessel arises at XII/XIII, blood reddish. Seminal vesicles extend backwards into XIV. Sperm funnel (Fig. 5 B) appr. 3 times as long (400 μm) as wide, collar well developed and wider than the funnel. Atrium elongate and 4-5 accessory glands at the male

opening (Fig. 5 C). Spermatheca (Fig. 5 A) similar to Eisen's description and drawings.

***Mesenchytraeus chaunus* Piper et al, 1982.**

Material examined: Recorded at st. 15. SMNH: Nordiska Oligochaeta 3675.

Previous record: Chaun Bay (Piper et al. 1982).

We amend the original description with the following details: Segments 53-60, live specimens 14-19 mm long. The length of the enlarged setae 126 μm against 98-119 μm in other setae. Lymfocytes 28-38 μm long. Sperm funnel 360-660 μm long and up to four times as long as wide. We found only 2 or 3 atrial glands against 4-6 in Piper et al. op. cit.

***Mesenchytraeus arcticus* Bell, 1962**

Material examined: Collections from the Kolyma Expedition 1910, Zoologisches Museum, Hamburg

Based upon an inspection of undetermined material from the above expedition we include this Alaskan species in the Siberian fauna.

***Mesenchytraeus asiaticus* Eisen, 1904 (Fig. 6 A-C)**

Material examined: Type collection in Riksmuseet, Stockholm.

Previous record: Tschukschland.

We amend the original description at the following points: Medium sized, 46-57 segments. Setae: 2,3,4-2,3:4,5,6-3,4,5, no enlarged setae. Two primary septal glands at IV/V and V/VI and three pairs of secondaries in V, VI and VII. Lymphocytes 9-13 μm long. Sperm funnel (Fig. 6 B) 3-4 times as long (330-400 μm) as wide.

Sperm duct unusually long. The atrium well developed and with 4-5 large glands entally (Fig. 6 C). Round the male opening a ring of prominent penial glands. Spermatheca (Fig. 6 A) free extending backwards into VII or VIII (according to Eisen into VI) where the ental part of the ampulla is loosely coiled. The ectal duct appr. 700 μm long and has a diameter of 40-50 μm . Near the opening the wall appears stouter. At the transition between ectal duct and ampulla a single diverticula like extension.

***Mesenchytraeus falciformis* Eisen, 1879 (Fig. 5 D-E)**

Material examined: Type collection in Riksmuseet, Stockholm,

Previous record: Matotskin Scharr.

We amend the original description at the following points: Medium sized, 38 and 39 seg-

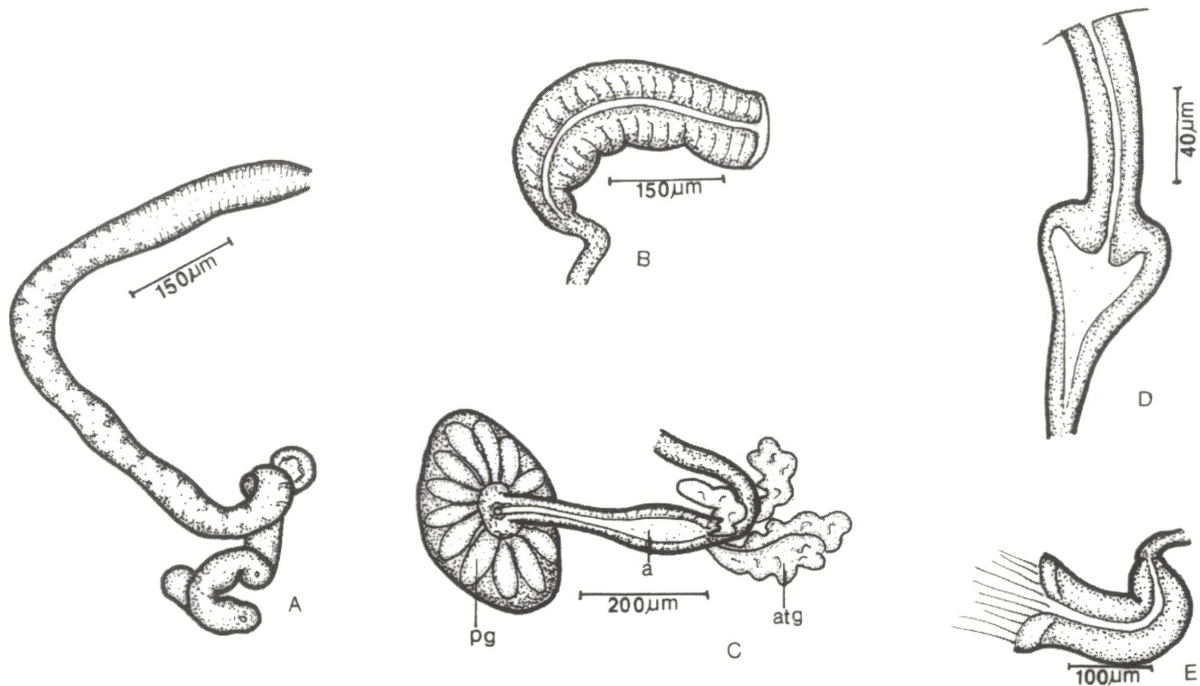


Fig. 6 A-C. *Mesenchytraeus asiaticus* Eisen; 1904

A: spermatheca; B: sperm funnel; C: mail opening (a: atrium, atg: atrial glands, pg: penial glands). D-E: *Mesenchytraeus* sp. D: spermatheca; E: sperm funnel.

ments (Eisen: 50 segments). Setae: 3,4,5-3,4:4,5,6-4,5,6, none enlarged. Two primary septal glands at IV/V and V/VI and two pairs of secondaries in V and VI. Lymphocytes 13-20 µm long. Sperm funnel (Fig. 5 E) three times as long (100-180 µm) as wide. Sperm duct short, penial apparatus with some accessory and penial glands. Spermatheca (Fig. 5 D) free extending backwards in VII or VIII. The ampulla

appr. one third the length of the ectal duct. No diverticula.

Remarks: Welch (1921) reports this species from Greenland.

Mesenchytraeus sp. (Fig 6 D-E)

Material examined: One mature specimen from st. 16.

Our observations are as follows: One promi-

Table I Genus *Mesenchytraeus*
1) – 6): recorded by previous authors

species	length/segments		color	setae	spermatheca	spermathecal diverticula
	mm	no				
<i>torbeni</i>	5-9/25-38		yellowish with	none enlarged	attached in V	1
<i>svetae</i> ¹	7-10/36-48		pale white	none enlarged	free, into IX/X	1
<i>tundrus</i> ¹	7-10/37-53		pale white	none enlarged	free, into IX/X	0
<i>falciformis</i>	/38-50		?	none enlarged	free, into VIII	0
<i>sveni</i>	8-15/41-47		redbrown with white patches	none enlarged	free, in V	0
<i>mirabilis</i>	10-15/49-64		light brown	none enlarged	free, in V	3-4
<i>melanocephalus</i>	14-22/44-58		red/dark brown	enlarged, d.VI-VIII	free, in V	2
<i>chaunus</i>	14-19/52-66		white patches	enlarged, d.VI-X	free, into X	(1)
<i>arcticus</i>	15-20/64-70		pale white	none enlarged	free, in V (VI)	2
<i>primaevus</i> ²	10/52		?	none enlarged	attached in V	2
<i>kontrimavichusi</i> ¹	c.12/47-59		pale white	enlarged, v.V-IX	(free), into VII	1
<i>asiaticus</i>	10-14/40-57		light yellow	none enlarged	free, into VII/VIII	1
<i>fenestratus</i> ²	15-20/60		?	none enlarged	free	0
<i>eiseni</i> ³	20*/		light brown	none enlarged	attached	2
<i>konyamensis</i> ⁴	15*/62-70		yellow grey	enlarged, d.VI-VIII	attached	2
<i>variabilis</i> ³	21*/64		?	none enlarged	attached	2
<i>kinikaidi</i> ⁵	21*/67		?	none enlarged	attached	2
<i>obscurus</i> ⁵	22*/78-91		brown	none enlarged	free, into IX/X	2
<i>tetrapodus</i> ⁶	10-17/55-76		pinkish white	enlarged, v.VI-VII	attached, IX/X	1-2
<i>viivi</i> ⁶	10-14/59-61		yellow white	none enlarged	attached in V	1-2
<i>cf. flavus</i>	30-35/59-66		yellow	none enlarged	?	?
<i>sp.</i>			whitish	none enlarged	attached	0

*) fixed specimens 1) Piper et al. (1982) 2) Eisen (1879) 3) Cejka (1914) 4) Michaelsen (1916) 5) Eisen (1904) 6) Timm, T. and Popchenko, V. (1978).

ment row of cuticular glands on each segment. Setae:3,4,5-3,4,5:4,5-4,5 Dorsal vessel arises in XIV, the blood reddish. 3 primary and 3 secondary septal glands. Sperm funnel (Fig. 6 E) two times as long as wide. Spermatheca (Fig. 6 D) with a rather long ectal duct and an onion-shaped ampulla that gradually merge into a narrow ental duct which communicates with the oesophagus.

Remarks: Similar to an unnamed specimen recorded by Nurminen (1970) from near Jakobshavn, Greenland.

Genus *Cernosvitoviella*, Nielsen and Christensen 1959

Cernosvitoviella cf. *pusilla* Nurminen, 1973. (Fig. 7)

Material examined: Recorded from st. 9. SMNH: Nordiska Oligochaeta 3676.

Since the worms we collected differ in some details from Nurminen's description, our observations are given: Small species, 5-6 mm long. Segments: 21-27. Colour white and slight-

ly reddish due to lymphocytes and blood. Clitellum XII-1/2XIII, glands cells irregularly arranged and absent ventrally. Head pore at 0. Setae sigmoid and with nodulus: (3),4,5,7-2,3,4,5:(3,4),5,6,7,8 -2,3,4,5. The brain short and deeply incised posteriorly (about 140 μ m long). Two primary and two secondary septal glands, the second secondary pair is lobed. Chloragogen cells filled with clear droplets. Lymphocytes (Fig. 7 C) oval, two types present: transparent and dark (in transmitted light). Nephridia typical of *Cernosvitoviella*. Dorsal vessel arises in XII or XIII, blood faintly red. Sperm funnel (Fig. 7 D) small and cylindrical, 2 times as long as wide, 50-70 μ m long. Collar of the same width as the funnel itself. A relatively long sperm duct without any expansion and appr. 5 times as long as the funnel. No penial bulb, but a number of small glands round the male opening (Fig. 7 D). One or two mature eggs present at a time. The ectal duct of the spermatheca (Fig. 7 A,B) with thick walls and a distinct canal. The ampulla elongate, ectally it is narrower than the duct but entally

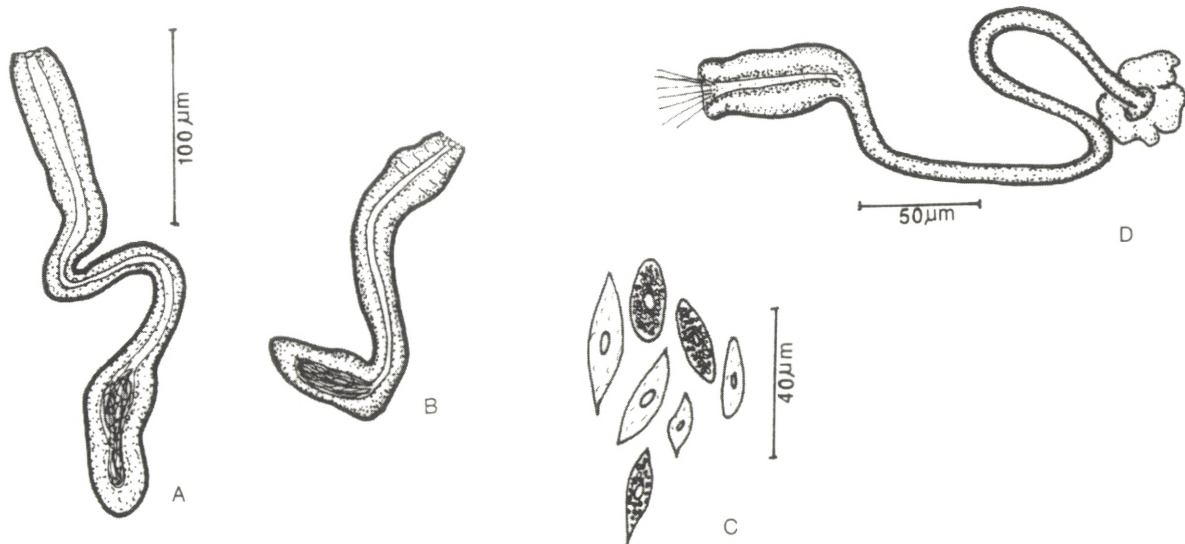


Fig. 7. *Cernosvitoviella* cf. *pusilla* Nurminen; 1973

A and B: spermathecae; C: lymphocytes; D: sperm funnel, sperm duct and male opening.

widening into a saclike expansion. Free in V, occasionally extending into VI. No glands at the ectal orifice.

Remarks: The only major difference from Nurminen's (1973) description is the presence of white granules in some of the lymphocytes in our specimens.

Genus *Cognettia* Nielsen and Christensen, 1959

Chief taxonomic criteria of the species recorded from the region are given in Table II.

Cognettia bisetosa sp. n. (Fig. 8)

Holotype: Co.2 (70 % ethanol).

Type locality: Wrangel Islands; leg. S. Jonasson.

Paratypes: P.53-55 35 specimens from N Yamal Peninsula, Lopatka Peninsula and Wrangel Island, SMNH TYPE-5069 from N Yamal Peninsula; leg S. Jonasson and T. Christensen.

Material examined: Recorded from st. 4, 6, 14 and 16.

Etymology: The species name refers to the presence of only two setae in most bundles.

Description: Small worms, 4-6 mm long and 0,20-0,26 mm in diameter. Segments: 27-29. Setae sigmoid without nodulus: 2-2 : 2(3)-2. Anterior setae 36-44 μ m long posterior 38-48 μ m. Clitellum extends over XII-1/2XIII, the gland cells irregularly arranged and absent ventrally (Fig. 8 C). Two postpharyngeal bulbs present. The brain (Fig. 8 B) incised posteriorly and two times as long (120 μ m) as wide. The septal glands (Fig. 8 A) compact and of regular outline, the two anterior primary glands usually united dorsally at IV/ V and V/VI, the posterior pair free dorsally. Two pairs of smaller secondary septal glands in V and VI, the latter somewhat lobed. The transition between oesophagus and intestine at VI/VII is rather marked, and the intestine extends its diameter

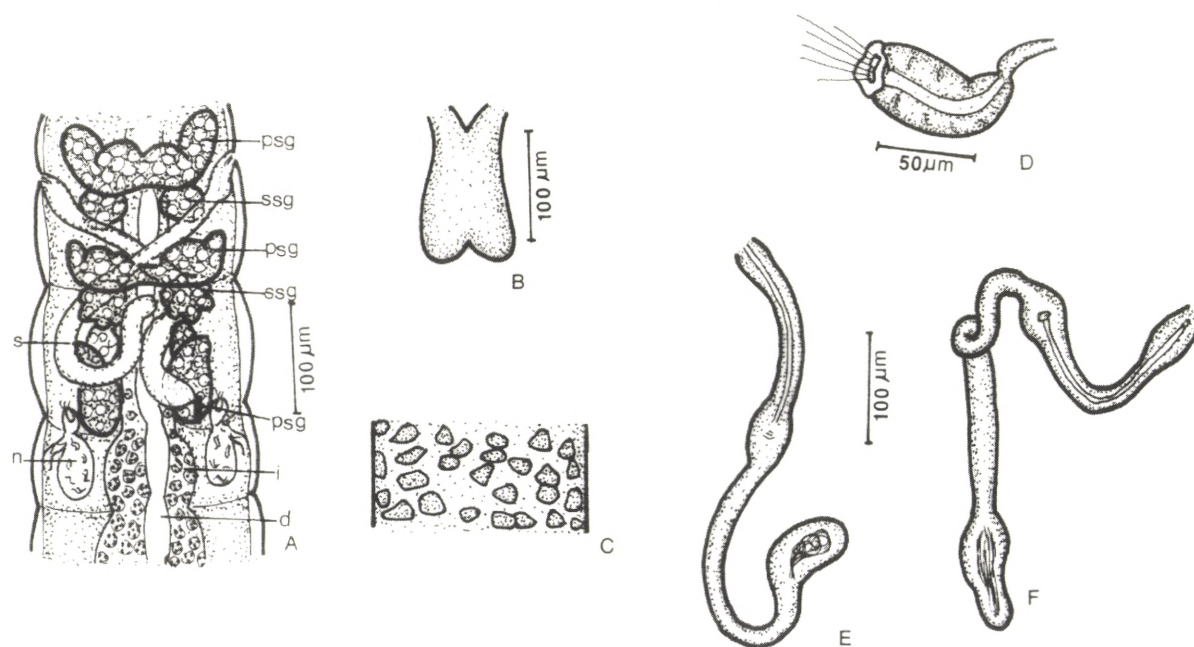


Fig. 8. *Cognettia bisetosa* n. sp.

A: segment IV-VII, dorsal view (dv: dorsal vessel, i: intestine, n: first nephridium, psg: primary septal glands, ssg: secondary septal glands, s: spermatheca); B: brain; C: clitellar glands; D: sperm funnel; E and F: spermathecae.

through VII and VIII (Fig. 8 A). Few chlo-rogen cells in V, densely present from VII, di-ameter 19-24 μm . The lymphocytes scarce in number, circular and transparent, diameter 12-15 μm . The anteseptale of the nephridia consists of funnel only, the postseptale elongate and the narrow efferent duct arises antero-ven-trally near the septum. Present from VI/VII. The dorsal vessel arises in XII and the blood is colourless. The seminal vesicle small or absent, sperm funnel (Fig. 8 D) small (70-100 μm in length) about two times longer than wide, the collar low and less wide than the funnel. Sperm duct of medium length, penial bulb small and compact (appr. 50 μm wide). The spermatheca (Fig. 8 E,F) consists of an ectal duct that ental-ly increases its diameter into an enlargement which extends into a long duct with distal sperm-containing ampulla. The spermatheca extends backwards into VI occasionally into VII. Normally no glands at the ectal orifice but

sometimes a glandular structure can be seen. One mature egg present at a time.

Remarks: The species is distinguished from *C. lapponica* Nurminen, 1965 by its smaller size, number of setae, united septal glands, smaller and stouter sperm funnel and a longer sper-matheca, and from *C. hibernica* Healy, 1975 by its longer spermatheca, cylindrical sperm fun-nel and compact penial bulb.

***Cognettia quadrosetosa* sp. n.** (Fig. 9)

Holotype: Co.3 (70 % ethanol).

Type locality: N Yamal Peninsula, leg T. Chri-stensen.

Paratypes: P.56-57 10 specimens from N Yamal Peninsula and Wrangel Island, SMNH TYPE-5070 from N Yamal Peninsula; leg. S. Jonasson and T. Christensen.

Material examined: Recorded from sts. 6 and 16.

Etymology: The species name refers to the pre-sence of four setae in some setal bundles.

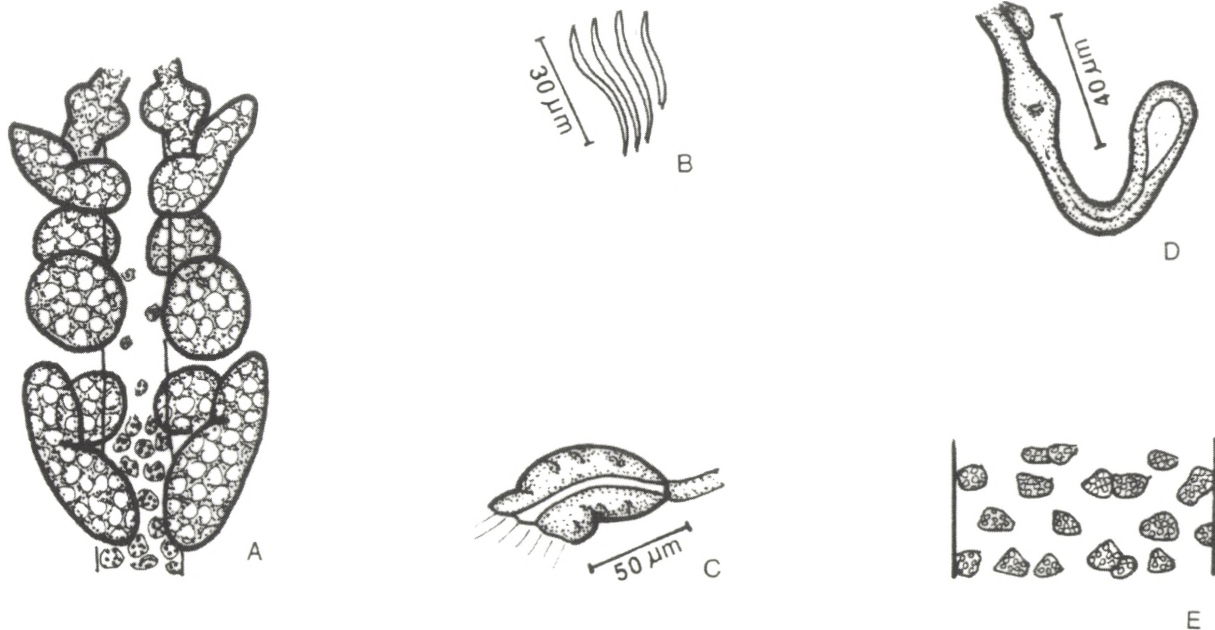


Fig. 9. *Cognettia quadrosetosa* n.sp.

A: septal glands; B: setae; C: sperm funnel; D: spermatheca; E: clitellar glands.

Description: Small worms, 5-7 mm long and 0,20-0,24 mm in diameter. Segments 26-31. Colour whitish. Setae (Fig. 9 B) sigmoid without nodulus: 3,4-3:4,5-3,4. Anterior setae 34-47 µm long, posterior 50-52 µm. The lateral seta in each bundle slightly shorter than the medial ones. Clitellum extends over XII-1/2XIII, gland cells with refractile globules and arranged in irregular rows (Fig. 9 E). Brain deeply incised posteriorly and two times as long (125 µm) as wide. Three pairs of primary septal glands free dorsally, secondary glands present in IV, V and VI, all compact and of regular outline (Fig. 9 A). Chloragogen cells present from IV and form a dense layer from VI, diameter of individual cells 35-50 µm. Lymphocytes oval, longest diameter 35 µm, transparent and scarce in number. Nephridia from VI/VII, shape as in other members of the genus. Dorsal vessel arises in XIII, blood colourless. Seminal vesicles small. Sperm funnel (Fig. 9 C) small, 1,5 times as long (75-77 µm) as wide. Sperm duct of medium length, penial bulb small. Spermatheca (Fig. 9 D) free in V, ectal duct two times as long as the ampulla which is slightly wider than the duct and has a distinct lumen. A small sessile gland at the ectal opening.

Remarks: Within *Cognettia* only *C. aliger*, Michaelsen and Vereschchagin, 1930, and the present species regularly has more than three setae in the ventral bundles, but the former is distinguished by having up to 7-8 setae, and so-called "sexual flaps" i.e. glandular outgrowth from the clitellum are unique to this species.

Cognettia piperi sp. n. (Fig. 10)

Holotype: Co.4 (70 % ethanol)

Type locality: Lopatka Peninsula; leg. S. Jonasson.

Paratypes: P.58-59 18 specimens (70% ethanol) from Lopatka Peninsula and NE Kolyma Delta, SMNH TYPE-5071 from NE Kolyma Delta; leg S. Jonasson.

Material examined: Recorded from sts. 14, 15 and 16.

Previous record: Chaun Bay

Etymology: Named in honour of Stephen R. Piper.

Description: This is a formal description of a species mentioned in Piper et al. (1982) as *Species incertae sedis*. Medium sized, 12-20 mm long (Piper et al: 12-15 mm). Segments: 45-52 (Piper et al: 56, sd 9,3). Body colour whitish, semitransparent. Cutaneous glands not arranged in regular rows, their colour range from orange to dark brown and the outline of the individual glands irregular (Fig. 10 F). Clitellum extends over XI-1/2XIII, the glands arranged in transverse rows. Setae sigmoid and simple pointed: 2-2(1):1,2,3-1,2,3. The brain (Fig. 10 A a) incised posteriorly and anteriorly. Three pairs of primary septal glands with ventral lobes and two pairs of secondary glands in V and VI (Fig. 10 A). Dorsal vessel arises in XIV-XVII, blood colourless. Lymphocytes (Fig. 10 D) numerous and oval (longest diameter 20-24 µm), they contain fine granules and are light brown in juveniles and dark brown in adult individuals. Nephridia of most segments are like

Table II Genus *Cognettia*

species	length/segment		no. of setae	septal glands primary+secondary	spermatheca
	mm	no			
<i>bisetosa</i>	4-6	26-31	2	3 + 2	into VI/VII
<i>quadrosetosa</i>	5-7	26-31	3-4(5)	3 + 3	in V
<i>lapponica</i>	6-8	32-37	(2)3	3 + 2	in V
<i>piperi</i>	10-20	45-52	1-3	3 + 2	in V
<i>glandulosa</i>	15-25	/	2-3	4(5) + 4	into VII/VIII

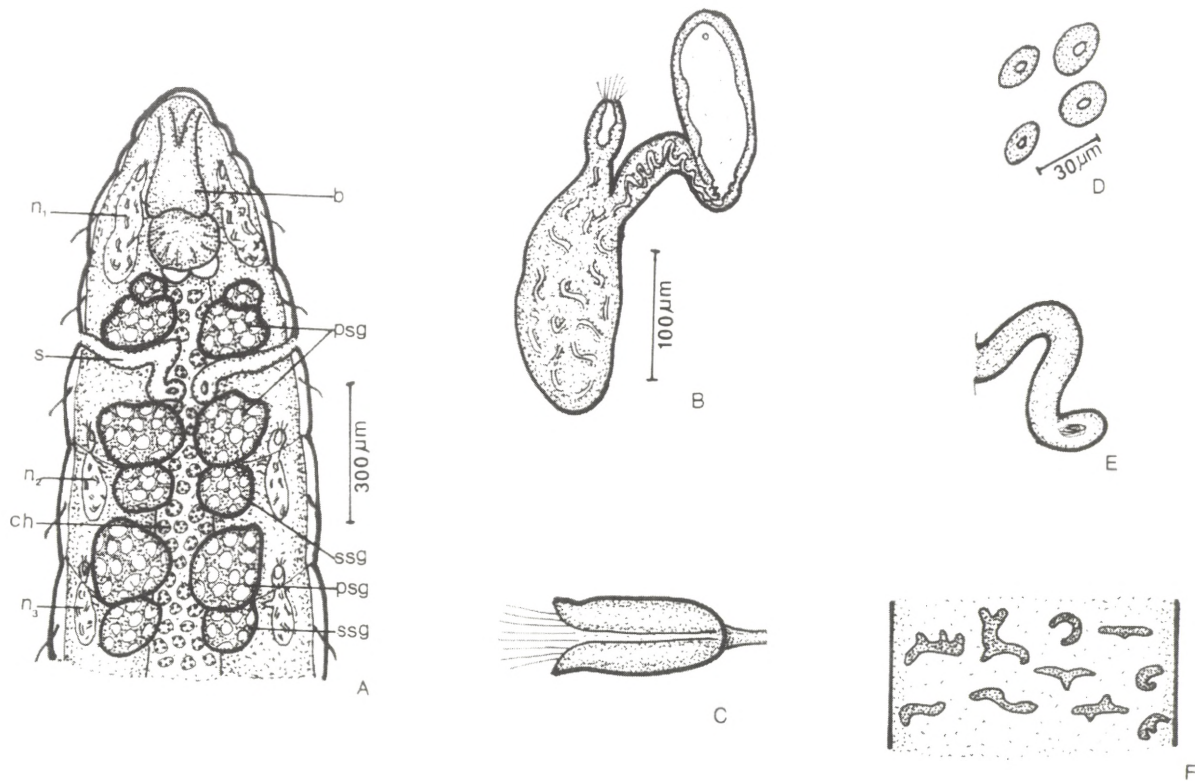


Fig. 10. *Cognettia piperi* n. sp.

A: anterior segments (0-VII), dorsal view (b: brain, ch: chloragogen cells, n₁: anterior nephridium, n₂: second nephridium, n₃: third nephridium, s: spermatheca, ph: pharynx, psg: primary septal glands, ssg: secondary septal glands); B: anterior nephridium; C: sperm funnel; D: lymphocytes; E: spermatheca; F: cutaneous glands.

the nephridia of typical *Cognettia*, but a distinctive feature of this species is a highly specialised pair at II/III with a large postseptale. The colour is brownish and the efferent duct which arises antero-ventrally extends distally into a hollow enlargement (160x80 µm), that undergoes periodic contractions. It opens directly to the exterior, and the short intervening duct drawn by Piper et al. was not observed (Fig. 10 B). The following nephridia (Fig. 10 A n₂, n₃) at V/VI are of normal size and without hollow ampulla. Chloragogenous cells present from IV, their diameter appr. 10 µm, containing red-brown granules. Seminal vesicles poorly devel-

oped; sperm funnel (Fig. 10 C) cylindrical, 2,5 times as long as wide, but often difficult to see. Spermatheca (Fig. 10 E) free, with an ectal duct that never exceeds the length of one segment and entally with a small sperm-containing ampulla. No glands at the ectal orifice.

Remarks: Only *C. clarae* Bauer, 1993, has a pair of nephridia anterior to the septal glands, but they are of normal size and without ampulla. In addition this species has three primary and three secondary septal glands, a more elongate sperm funnel and a conspicuous gland at the ectal orifice of the spermatheca.

***Cognettia glandulosa* (Michaelsen, 1888).**

Material examined: Recorded from sts. 14 and 16.

Previous records: Taymyr Peninsula (Nurminen 1980), Chaun Bay (Piper et al. 1982)

The identification based upon somatic characters and in particular upon the arrangement of primary and secondary septal glands. The absence of sexually mature individuals indicates a predominance of asexual reproduction through fragmentation.

***Cognettia lapponica* Nurminen, 1965.**

Material examined: Recorded from sts. 4, 6, 14, 15 and 16. SMNH: Nordiska Oligochaeta 3677.

Previous record: Chaun Bay (Piper et al. 1982).

Apparently a widely distributed species in the Arctic region. Our observations agree with Nurminen's original description, and in Table 2 it is compared with the two related species described in this paper.

Genus *Henlea* Mich., 1889

Chief taxonomic criteria of the species recorded from the region are given in Table III.

***Henlea adiverticulata* sp. n. (Fig. 11)**

Holotype: He.1 (70% ethanol).

Type locality: NW Taymyr Peninsula; leg. T. Christensen.

Paratypes: P.60-62 14 specimens (70% ethanol) from NW Taymyr Peninsula, NE Taymyr Peninsula and Wrangel Islands, SMNH TYPE-5072 from NW Taymyr Peninsula; leg. S. Jonasson and T. Christensen.

Material examined: Recorded from sts. 7, 9 and 16.

Etymology: The species name refers to the absence of intestinal diverticulae.

Description: Small to medium sized species, length 10-16 mm, diameter 0,55-0,6 mm. Segments: 37- 41. Cuticular glands light brown and arranged in three rows per segment. Clitellum

extends from XII-1/2XIII, the gland cells arranged in regular rows. Setae: (2)3,4(5)-3,4: 3,4,5,6-2,3,4, unequal in size within each bundle. Brain (Fig. 11 A) rounded posteriorly, slightly longer than wide, 160 μ m in length. Three pairs of septal glands, the posterior pair elongate. Dorsal vessel (Fig. 11 D dv) arises in VIII, blood colourless. Lymphocytes (Fig. 11 B) nearly discoid, with a characteristic concentrically arranged internal structure, diameter 40 – 50 μ m. Nephridia (Fig. 11 C) with few canals in the anteseptale and the efferent duct tends to arise mid-ventrally on the postseptale, otherwise of the *Henlea* type, the anteriormost pair at VI/VII. One pair of oesophageal glands in VI (Fig 11 D oea), often connected to the oesophagus through a narrow duct-like basis. The transition between oesophagus and intestine (Fig. 10 D) at VII/VIII is rather marked; dorsal, ventral and lateral external grooves in VIII often tend to accentuate the suddenness of the transition. Seminal vesicles small. Sperm funnel (Fig. 11 E) appr. 3 times as long as wide, 160-240 μ m long and gradually tapering towards the duct, collar distinct and wider than the funnel itself. The efferent duct long and narrow, penial bulb small and compact (90 μ m). Spermatheca (Fig. 11 F) with a well developed ampulla, and two or three large, elongate glands at the ectal orifice. Ental ducts of moderate length and united before joining the oesophagus.

Remarks: This species belongs to the group of *Henleas* with a sudden expansion of the gut at VII/VIII, but without diverticulae associated to this transition (subgenus *Henleanella* sensu Cernovitov, 1931). It is a close relative of *H. perpussilla* but is larger, has fewer setae, larger lymphocytes, a spermatheca with a distinct ampulla and with well-developed glands at the ectal orifice. In addition the sperm funnel is relatively longer than wide and with a collar wider than the funnel itself. In *H. heleotropha* Stephenson, 1922, and *H. ghilarovi* Nurminen, 1980, the

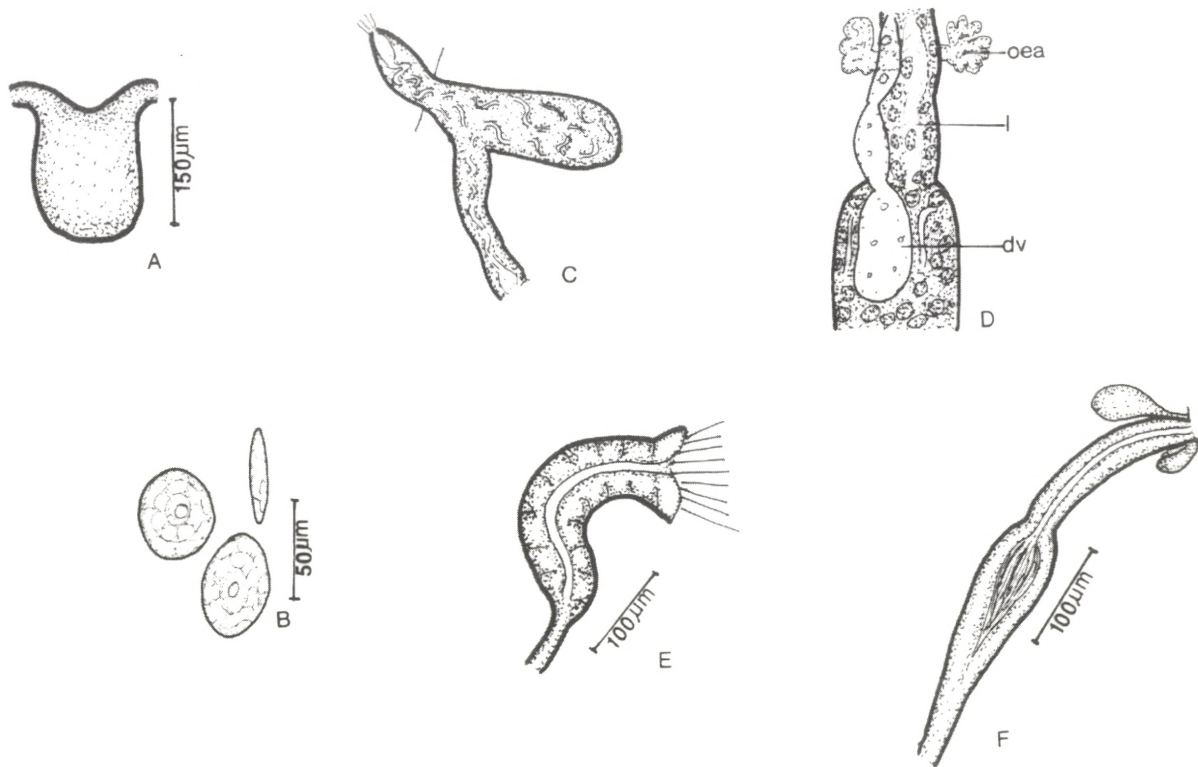


Fig. 11. *Henlea adiverticulata* n.sp.

A: brain; B: lymphocytes; C: nephridium; D: transition between oesophagus and intestine at VII/VIII (dv: dorsal vessel, oea: oesophageal appendages, l: lumen of oesophagus ciliated); E: sperm funnel; F: spermatheca.

dorsal blood vessel arises IX. *H. montana* Rota, 1994 has more setae and the spermatheca has 4 large glands at the ectal orifice.

***Henlea conchifera* sp. n.** (Fig. 12)

Holotype: He.2 (70% ethanol)

Type locality: Faddeyevsky Island; leg. S. Jonasson.

Paratypes: P.63-66 25 specimens (70% ethanol) from Faddeyevsky Island, NE Taymyr Peninsula, NW Taymyr Peninsula, Wrangel Island, SMNH TYPE-5073 from Faddeyevsky Island; leg. S. Jonasson and T. Christensen.

Material examined: Recorded from sts. 7, 9, 13 and 16.

Etymology: The species name refers to the cockle-shaped intestinal diverticulae.

Description: Medium sized to large species, length 13-17 mm, diameter 0,5-0,66 mm. Segments 44- 53. Setae: (1)2,3(4)-2,3(4,5):2,3,4,5-2,3(4). Colour light brown, cuticular glands usually in three regular rows. Clitellum extends over XII-XIII, gland cells small and irregularly arranged. The brain (Fig. 12 B) deeply incised posteriorly, slightly longer than wide, appr. 180 µm long. Chloragogen cells present from VI and dense from VII, with brownish granules. Lymphocytes (Fig. 12 E) oval, with light brown, fine granules, length 30-40 µm. Nephridia from V/VI and of the usual type for this genus. Septal glands not united dorsally and with ventral lobes; the third pair elongate. The oesophageal glands (Fig. 12 A) in VI elongate (330 µm long) and closely attached to the lat-

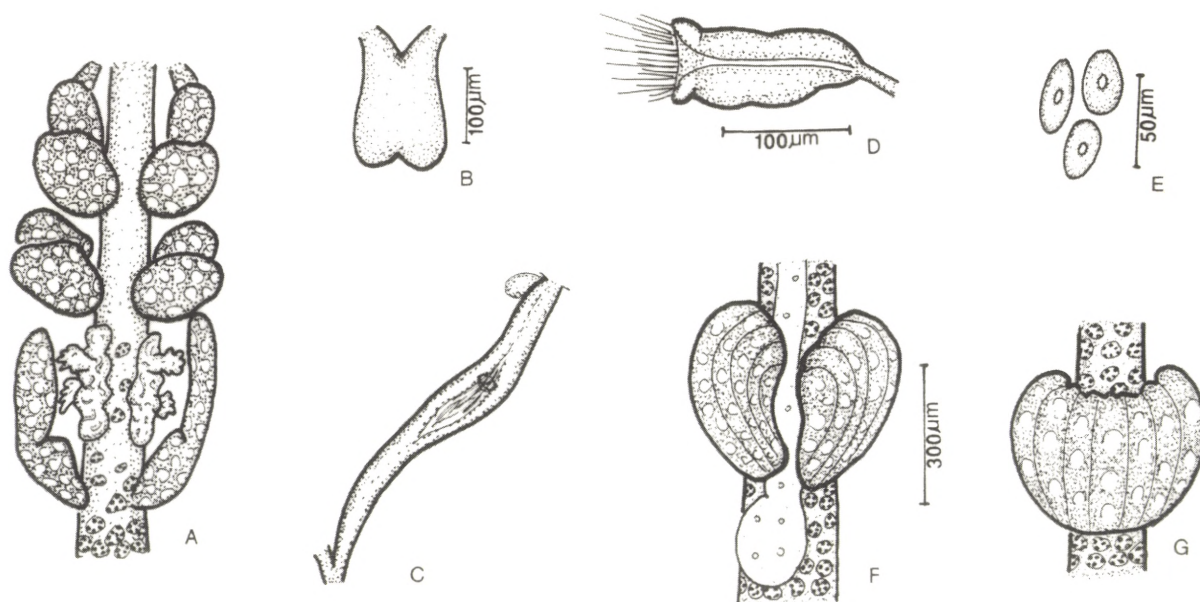


Fig. 12. *Henlea conchifera* n.sp.

A: septal glands and oesophageal appendages; B: brain; C: spermatheca; D: sperm funnel; E: lymphocytes; F: intestinal diverticulae, dorsal view; G: intestinal diverticulae, ventral view.

eral walls of oesophagus, two extensions present on each side. Intestinal diverticulae (Fig. 12 F,G) arise at VIII/IX and extend forward throughout VIII. Viewed dorsally they become gradually wider towards the anterior and the outline may somewhat resemble a pair of cockle shells, ventrally they are completely united. Chloragogen cells present on the diverticulae in varying densities, the wall is lengthwise folded. The dorsal vessel arises in IX, and heart-like expansions present in VII, VIII and IX. The sperm funnel (Fig. 12 D) small, cylindrical, 2,5-3 times longer than wide (appr. 150 µm in length). Collar well developed and of the same width as the funnel itself. The sperm duct long and narrow, penial bulb small and compact, appr. 140 µm. The spermatheca (Fig. 12 C) is simple as in most *Henlea* species. The ectal duct of medium length, the ampulla is slightly wider and extends gradually into a long ental duct. The ental ducts unite before join-

ing the oesophagus dorsally. Only one not very conspicuous gland at the ectal orifice.

Remarks: This species is easily recognised by the shape of its intestinal diverticulae.

***Henlea tolli* Michaelsen, 1901** (Fig. 13)

Punahenlea dicksoni Nurminen, 1980.

Henlea parva Cejka, 1904.

Material examined: Recorded from sts. 6, 7, 9, 14 and 16. SMNH: Nordiska Oligochaeta 3678.

Previous records: New Siberien Isl., Kotelnj (Michaelsen), Yenisey Bay (as *Punahenlea dicksoni* Nurminen, 1980), New Siberien Isl. (as *Henlea parva* Cejka, 1912).

Our observations, which only differ from the original description in a slightly lower number of segments, are as follows: Length 14-21 mm, diameter 0,5-0,6 mm. Segments 43-47 (53). Setae: 1,2,3-1,2:2,3,4(1)2. Blood occasionally light red or even colourless, particularly so in juvenile individuals. One pair of oesophageal

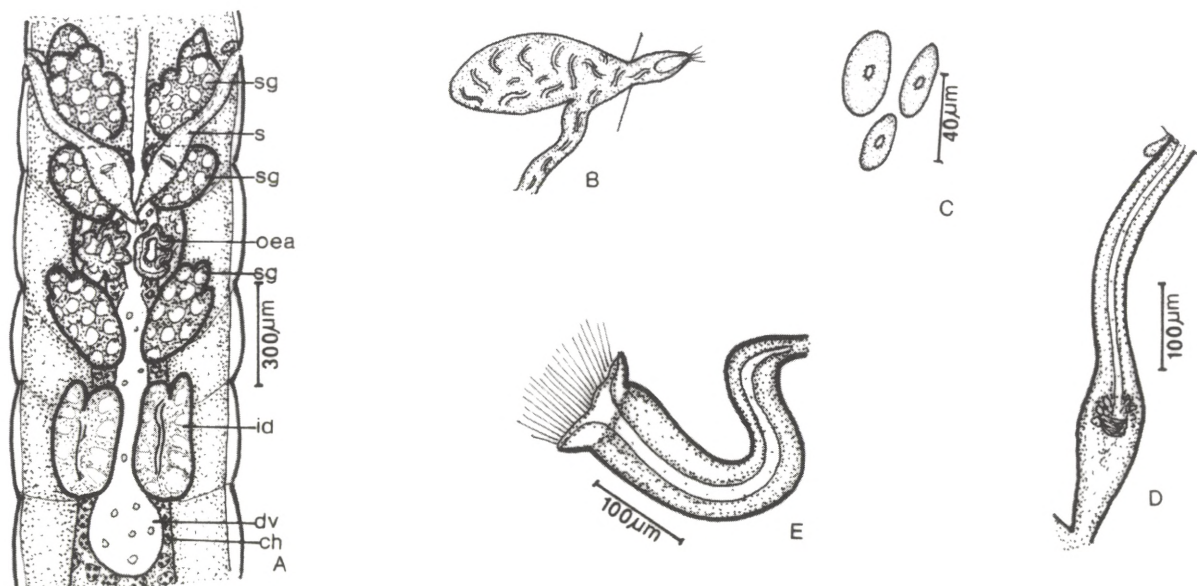


Fig. 13. *Henlea tolli* Michaelsen, 1901.

A: segment IV-IX, dorsal view (ch: chloragogen cells, dv: dorsal vessel, id: intestinal diverticulae, oea: oesophageal appendages, s: spermatheca, sg: septal glands); B: nephridium; C: lymphocytes; D: spermatheca; E: sperm funnel.

appendage in VI with several peripheral and a central chamber (Fig. 13 A oea). Intestinal diverticulae (Fig. 13 A id) arise laterally at VIII/IX. They extend anteriorly in VIII where they divide into dorsolateral and ventrolateral lobes. Nephridia are shown in Fig 13 B. Sperm funnel (Fig. 13 E) 3-4 times longer (300-400 μm) than wide, gradually tapering towards the long ectal duct. The collar slightly wider than the funnel itself. Spermatheca (Fig. 13 D) with a distinct ampulla, gland cells at the ectal orifice in some individuals.

Remarks: The distinctive features of this species are: red blood and large heart-like expansions in VII, VIII and IX, relatively few setae per bundle, well-developed seminal vesicle, distinct ampulla on spermatheca and *Bryodrilus*-like oesophageal glands. It is distinguished from *H. udei* (Eisen, 1904) redescribed by Holmquist (1968), by its smaller size and in having a much shorter ectal duct of the spermatheca. We con-

sider *Punahenlea dicksoni* Nurminen, 1980, and *Henlea parva* Cejka, 1904, as synonyms of *H. tolli*.

***Henlea perpusilla* Friend 1911**

Material examined: Recorded from sts. 4, 7, 9, 13, 14 and 16. SMNH: Nordiska Oligochaeta 3679 from NW Taymyr Peninsula.

Previous records: Taimyr Peninsula (Nurminen 1980), Yenisey Bay (Nurminen 1980), Chaun Bay (Piper et al 1982).

A widely distributed and complex species with three different chromosomal types (Nielsen and Christensen, 1959), but this aspect was not studied in the present context.

***Henlea diverticulata* Cejka, 1912** (Fig 14)

Material examined: Recorded from sts. 13 and 14. SMNH: Nordiska Oligochaeta 3680 from Lopatka Peninsula.

Previous records: Kotelny Isl. (Cejka 1912), Chaun Bay (Piper et al 1982).

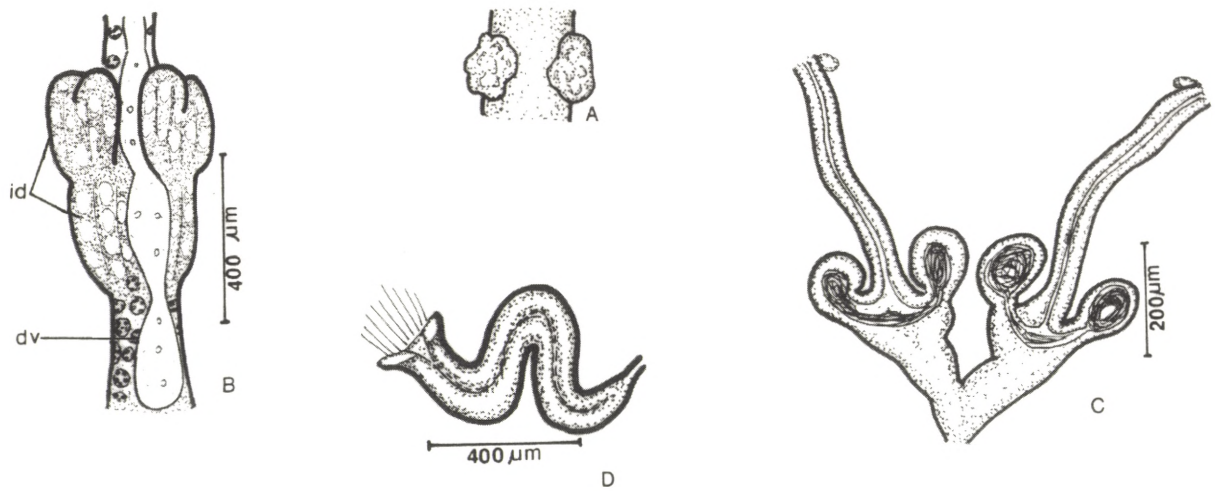


Fig. 14. *Henlea diverticulata* Cejka, 1912.

A: oesophageal appendages in VI; B: intestinal diverticulæ (VIII-X), dorsal view (dv: dorsal vessel, id: intestinal diverticulæ); C: spermathecae; D: sperm funnel.

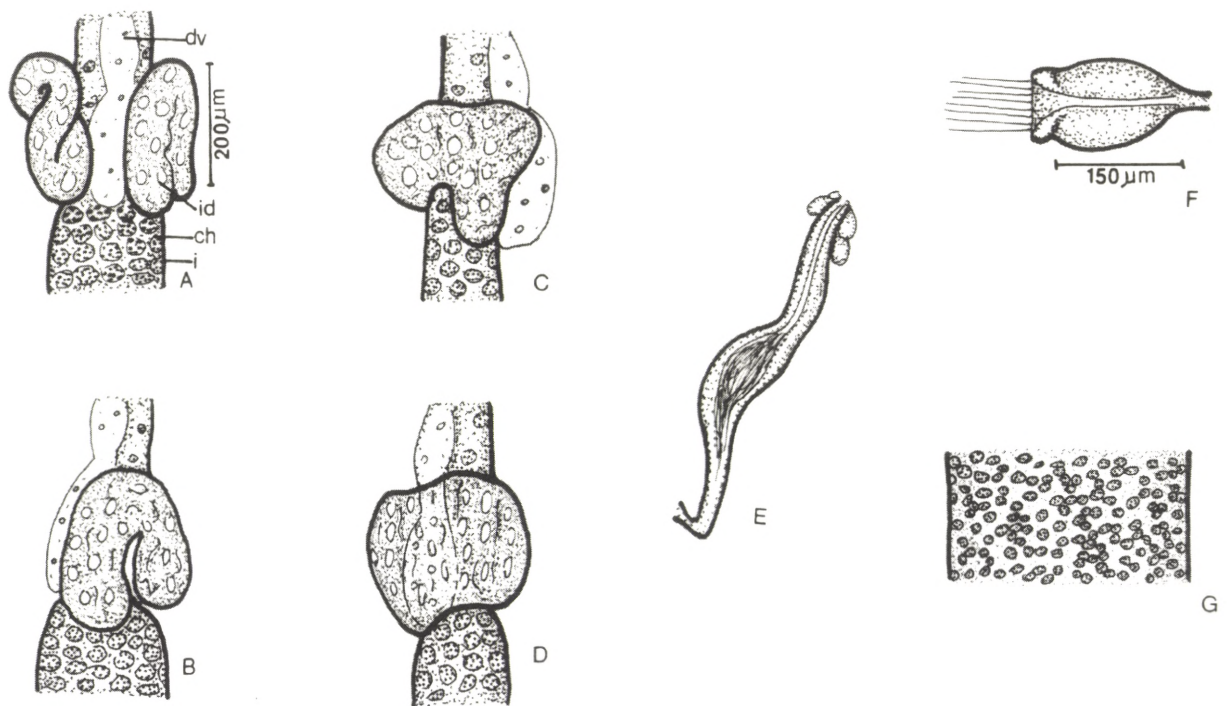


Fig. 15. *Henlea glandulifera* Nurminen, 1970.

A: intestinal diverticulæ, dorsal view; B-D: variations in the shape of the intestinal diverticulæ, lateral view (dv: dorsal vessel, ch: chloragogen cells, i: intestine, id: intestinal diverticulæ, oe: oesophagus); E: spermatheca; F: sperm funnel; G: clitellar glands.

Details of oesophageal appendages, intestinal diverticulae, spermatheca and sperm funnel are clarified in fig. 14.

***Henlea heletropha* Stephenson, 1932**

Material examined: Recorded from st. 16.

Previous records: Yenisey Bay (Nurminen 1980).

***Henlea glandulifera* Nurminen, 1970** (Fig. 15)

Material examined: Recorded from sts. 7 and 16. SMNH: Nordiska Oligochaeta 3681.

Previous record: Yenisey Bay (Nurminen 1980)

Variations in the shape of the intestinal diverticulae are shown in Fig. 15 A-D, sperm funnel in Fig 15 F, spermatheca in Fig. 15 E, and clitellar glands in Fig. 15 G.

Remarks: Nurminen (1970) described this species from Greenland.

***Henlea ochracea* (Eisen, 1878) augm. Nurminen, 1973** (Fig. 16)

Material examined: Recorded from sts. 7, 9 and 11. SMNH: Nordiska Oligochaeta 3682.

Previous records: Novaja Semlja at Cap Grebeni and Waigatsh (Eisen 1878), Yenisey, Sapotsh-naja Korga (as *Archienchitraeus tenella*, Eisen,

1878), New Siberien Isl., W Taimyr Peninsula (as *Hepatogaster birulae*, Cejka, 1910), New Siberien Isl., Yenisey Bay, Kusjkin Ins. (as *Hepatogaster sibericus*, Cejka, 1910).

Corresponds to Eisen's rather incomplete description and Nurminen's extension (Fig. 16).

Remarks: This species differs from *H. ventriculosa* in having more robust spermathecae (Fig. 16 A) in particular the ectal duct is much wider and has a ring of prominent glands (40-70 μm in length) at the ectal orifice. *H. irkutensis* Burov, 1929 is much larger.

Genus *Bryodrilus* Ude, 1892

Chief taxonomic criteria of the species recorded from the region are given in Table IV.

***Bryodrilus divarticulatus* Cernosvitov, 1928** (Fig. 17)

Material examined: Recorded from sts. 7, 9 and 13. SMNH: Nordiska Oligochaeta 3683.

We supplement Cernosvitov's description at the following points: Small to medium sized species, 7-12 mm long and 0,4-0,5 mm in diameter. Segments 31-41. Number of setae varies

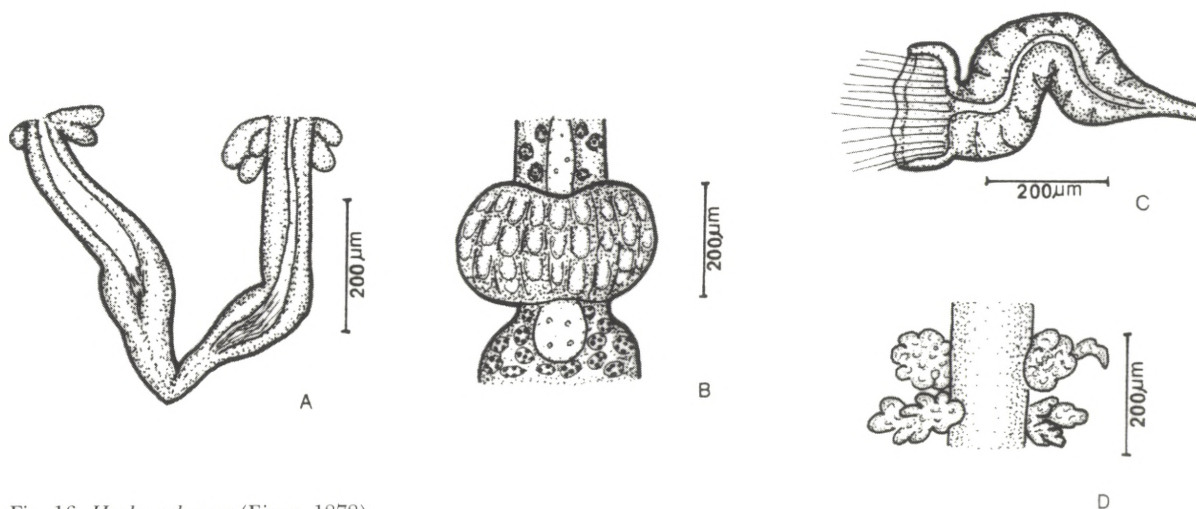


Fig. 16. *Henlea ochracea* (Eisen, 1878).

A: spermathecae; B: intestinal diverticulae in VIII; C: sperm funnel; D: oesophageal diverticulae in VI.

Table III Genus *Henlea*
1) – 2): recorded by previous authors

species	length/segments mm no	intestinal diverticula	origin of dorsal vessel	lymfocytes	spermathecal ampulla	no. of setae
<i>perpusilla</i>	5-10/25-36	0	VIII	granulated	indistinct	2-6
<i>heleotropha</i>	8-10/c. 40	0	IX	granulated	slightly dilated	4-7
<i>adiverticulata</i>	10-16/37-41	0	VIII	no granules	distinct	3-6
<i>palmeni</i> ¹	13-16/52-55	0	VIII	?	distinct	4-6
<i>ghilarovi</i> ¹	25-30/54-61	0	IX	?	distinct	3-6
<i>nasuta</i> ^{1 2}	13-18*/61-75	2	VIII	brownish	distinct	4-6
<i>glandulifera</i>	8-10/39-40	2	VIII	no granules	slightly dilated	3-6
<i>conchifera</i>	13-17/44-53	4	IX	light brown	slightly dilated	2-5
<i>tolli</i>	13-21/43-53	4	IX	finely granulated	distinct	1-4
<i>ochracea</i>	13-17/49-58	4	IX	finely granulated	distinct	2-7
<i>taymirensis</i> ¹	25/60	4	IX	?	distinct	4-6
<i>diverticulata</i>	12-20/41-59	4	X	light brown	two diverticulae	1-4

*) fixed specimens 1) Nurminen (1980) 2) Eisen (1879)

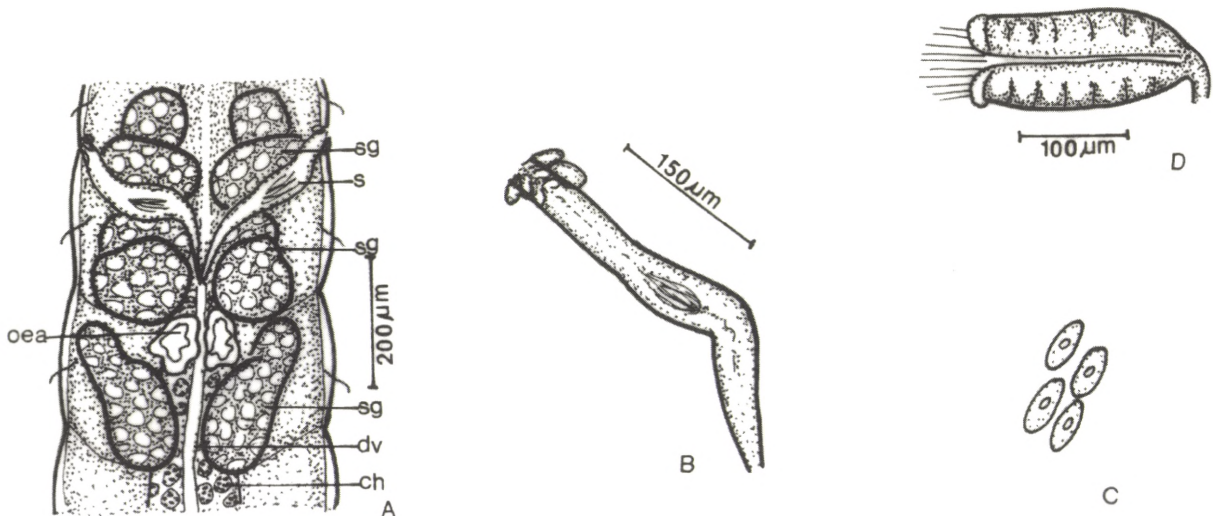


Fig. 17. *Bryodrilus diverticulatus* Cernosvitov, 1928.

A: IV-VII dorsal view (ch: chloragogen cells, dv: dorsal vessel, oea: oesophageal appendages, s: spermatheca, sg: septal glands); B: spermatheca; C: lymphocytes; D: sperm funnel.

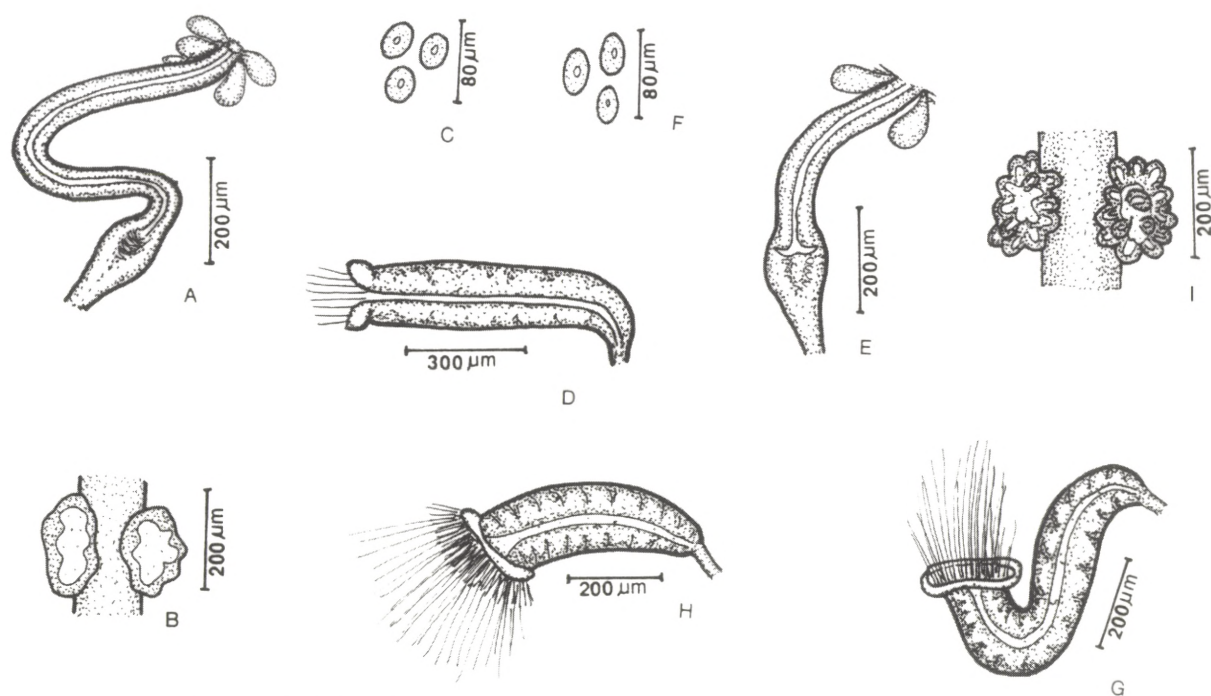


Fig. 18 A-D. *Bryodrilus borealis* Cejka, 1912.

A: spermatheca; B: oesophageal appendages in VI; C: lymphocytes; D: sperm funnel. E-I: *Bryodrilus arctica* (Bell, 1962). E: spermatheca; F: lymphocytes; G-H: sperm funnels; I: oesophageal appendages.

from 2-6 per bundle. Oesophageal glands (Fig. 17 A oea) in VI with a large central chamber of wavy outline. Lymphocytes oval, transparent (Fig. 17 C) Seminal vesicle small or absent. Sperm funnel (Fig. 17 D) 2-3 times as long (200 µm) as wide, the duct long and narrow. The penial bulb large, 200-300 µm. Details of spermatheca shown in fig. 17 B.

***Bryodrilus borealis*, Cejka, 1912** (Fig. 18 A-D)

Material examined: Recorded from sts. 13 and 16. SMNH: Nordiska Oligochaeta 3684.

Previous records: Kotelný Isl. (Cejka 1912), Taimyr Peninsula and Yenisey Bay (as *B. chernovi* Nurminen, 1980).

We supplement Cejka's original description by the following observations: Medium sized to large species, live specimens 20-30 mm long and 0.8-1.0 mm wide, segments 48-56. Small

yellow-brown cuticular glands in up to 8 transverse rows. Up to 5 rarely 6 setae in the ventral bundles. Clitellar glands small and arranged in regular rows. The discoid lymphocytes (Fig. 18 C) light brown and finely granulated. Dorsal vessel arises in XII-XIV. Pulsating oesophageal appendages (Fig. 18 B) in VI with several peripheral and one large central chamber. Seminal vesicle large, extending forward to IX. Occasionally unpaired ventral "sexual papillae" present in IV or V and XI. Sperm funnel (Fig. 18 D) appr. 4 times as long as wide, collar of the same width as the funnel itself. Penial bulb medium large (240-300 µm). The spermatheca (Fig. 18 A) has a long ectal duct and some glands at the ectal orifice.

Remarks: The distinctive features of this species are the long ectal duct of the spermatheca with glands at the ectal orifice and the numerous

Table IV Genus *Bryodrilus*
1): recorded by previous author

species	length/segments		oesophageal diverticulae	spermathecal duct	penial bulb
	mm	no			
<i>parvus</i>	4-8	22-29	compact granulated	medium length	small
<i>diverticulatus</i>	7-12	31-41	central chamber only	short	large
<i>arctica</i>	16-21	40-52	peripheral and central chamber	medium length	very large
<i>borealis</i>	20-30	40-56	peripheral and central chamber	long	medium
<i>chernovi</i> ¹	30	52-70	lobed	long	?

1) Nurminen (1980)

yellow-brown discoid lymphocytes. It is very similar to *B. chernovi* Nurminen, 1980, the only major difference is the absence of glands round the ectal orifice of the spermatheca in the latter. The two species are perhaps identical.

***Bryodrilus arctica* (Bell, 1962)** Fig. 18 E-I)

Material examined: Recorded from sts. 11, 13, 14, 15 and 16. SMNH: Nordiska Oligochaeta 3685.

Previous record: Chaun Bay (Piper et al. 1982).

We supplement Bell's description at the following points: Medium sized to large, 16-21 mm long. Segments: 40-52. Two pairs of oesophageal glands (Fig. 18 I) in VI with numerous peripheral and one large central chamber. The collar of the sperm funnel well developed and occasionally much wider than the diameter of the funnel itself (Fig. 18 G,H) Very large penial bulbs, longest diameter 240-340 µm. Details of the spermatheca shown in figure 18 E.

Remarks: Like Piper et al, 1982, we believe the sudden enlargement of the intestine in VII described by Bell is due to the fixing and preserving procedures. Bell (1962) described this species from Alaska.

***Bryodrilus parvus* Nurminen, 1970**

Material examined: Recorded from sts. 7, 9, 11, 13 and 16. SMNH: Nordiska Oligochaeta 3686. Recent description in Nurminen, 1970.

Genus *Friderica* Michaelsen, 1889

Chief taxonomic criteria of the species recorded from the region are given in Table V.

***Friderica callosa* (Eisen, 1878)** (Fig. 19)

Material examined: Recorded from sts. 7, 9, 11, 13, 14 and 16. SMNH: Nordiska Oligochaeta 3687.

Previous records: Vorogora Selo, Surgutskoj, Troitskoj, Chantoiskoj, Potapovskoj, Verschinskij, Dudino, Mesekin, Jefremov Kamen, Dickson Harbour, Novaja Semlja: Besimenaja, Matotschkin, Vorogova Selo (Solowets Isl., White Sea) (Eisen 1878, 1879); Taimyr Peninsula, Yenisey Bay (Nurminen 1980).

We extend Eisen's rather meagre description with observations on live worms collected by us and upon a reinspection of Eisen's type material in Riksmuseet, Stockholm and Zoologisches Museum, Hamburg.

Medium sized species, 12-24 mm long, diameter 0,5-0,55 mm. Segments: 40-50. Small cu-

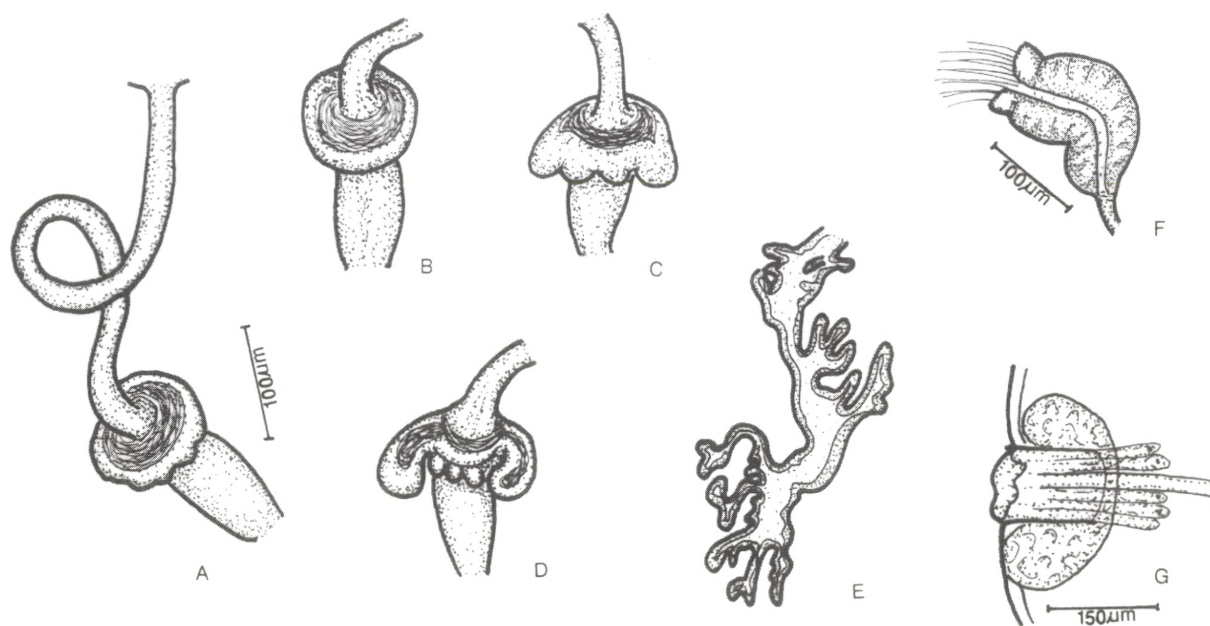


Fig. 19. *Fridericia callosa* (Eisen, 1878).

A-D: variations in the shape of the spermatheca; E: peptonephridium; F: sperm funnel; G: penial bulb.

taneous glands in 4-7 rows on each segment. Clitellum extends over XII-1/2XIII, the gland cells small and nearly regularly arranged in double rows. Head pore and dorsal pores as usual for the genus. Setae usually absent in the dorsal bundles but in some specimens a few are present: 0(1,2)-0(1,2):1,2(3,4)-1,2(3). The brain 140 µm long and 110 µm wide, its hind margin slightly convex. Peptonephridia (Fig. 19 E) of c-type, with several branches. Nuclei in the large lymphocytes appeared granulated, the cells transparent and oval, 32-40 µm long. The small anucleate lymphocytes 4-8 µm. Seminal vesicles appeared well developed, they contain several dark corpuscles (parasite infection?) but very few developing spermatogonial morulae. Sperm funnel (Fig. 19 F) cylindrical, 1,5-2 times longer than wide, 160-190 µm long. The collar well developed and of the same width as the funnel itself. The penial bulb (Fig. 19 G) very large, the strands which connects the pe-

nis to the inner side of the body wall are very conspicuous. Spermatheca (Fig. 19 A-D) with a very long and narrow ectal duct, the ampulla onion-shaped with a distinct lumen where the sperm (when present) is concentrated in a regular ring. No glands at the ectal orifice.

Remarks: Eisen (1878) noticed two different forms of this species: one slender and transparent the other more stout and opaque, but he claims that there are no anatomical differences. Nonetheless, two of his illustrations (Fig. 21p and 21q) indicate that he observed spermathecal ampullae both without and with diverticula-like extensions. We made the same observation, cf. Fig. 19 A-D. In some specimens the ampulla had two larger entally bent diverticulae and 4-6 small, less developed in between. Normally such a difference would justify the description of a new species. However, in all other characters including the characteristic reduction in number of setae, the two forms

Table V Genus *Fridericia*
1) – 3): reported by previous authors

species	length/segments		no. of setae	diverticula	spermatheca		pepto-nephridia
	mm	no			ectal duct	glands at orifice	
<i>bulbosa</i> ¹	5-15/25-38		2	0	medium	1(2)	a-type
<i>bulboides</i> ²	5-12/26-44		4	0	medium	1	b-type
<i>bisetosa</i> ³	10-20/48-65		2	2	medium	1	a-type
<i>callosa</i>	12-24/40-50		0-4	0(5-6)	long	0	c-type
<i>ratzeli</i> ¹	20-35/38-70		4-9	5-10	short	2(1)	c-type

1) Nurminen (1980) 2) Piper et al (1982) 3) Cejka (1914)

are completely identical, and for the time being we consider the different types of spermathecae as intra-specific variation. It seems obvious that later authors such as Ude (1901), Bülow (1957) and Nielsen and Christensen (1959), have extended Eisen's original description by observations upon what was believed to be conspecific European specimens. This identity is doubtful, at least as far as the two latter references are concerned.

Genus *Achaeta* Vejd., 1877

Achaeta macrocyta sp. n. (Fig. 20)

Achaeta sp. (?*camerani*) Piper et al. 1982

Holotype: A.2. (70% ethanol).

Type locality: NE Kolyma Delta; leg. S. Jonasson.

Paratypes: P.67 5 specimens (70% ethanol) from NE Kolyma Delta; leg. S. Jonasson.

Material examined: Recorded from sts. 14 and 15.

Previous record: Chaun Bay (Piper et al 1982).

Etymology: The species name refers to the large lymphocytes.

Description: Small species, length 6-8 mm, diameter 0,18-0,25 mm. Segments 28-32. Colour whitish. Head pore at 0. Setae and setal follicles absent. One pair of lens-shaped epithelial cells dorsally in most segments. Three pairs of septal glands with ventral lobes and connected dor-

sally. Two secondary septal glands in IV and V (Fig. 20 A). Chloragogen cells from IV, densely present from VI/VII. Lymphocytes (Fig. 20 F) particularly large, elongate oval, 38-63 µm long, viewed perpendicular completely transparent, from the sides somewhat opaque. Nephridia of the usual *Achaeta* type from VI/VII. The dorsal vessel originates in VIII with large dilations in VIII, VII and VI, blood colourless. Seminal vesicle small. Sperm funnel (Fig. 20 B) 1,5-2 times longer than wide, 80 µm long or appr. half the diameter of the worm. A distinct collar of same width as the funnel itself. The sperm duct wound into a loose spiral. The penial opening (Fig. 20 B,C) surrounded by two rows of glands. Spermatheca (Fig. 20 A s, E) free, extending backwards into VIII, the ampulla elongate. No glands at the ectal orifice.

Remarks: Among species without setal follicles only *A. silvatica* Nurminen, 1973, is similar, but the present species is longer, has much larger lymphocytes, has secondary septal glands and a larger sperm funnel.

Genus *Marionina* Michaelsen, 1889

Chief taxonomic criteria of the species recorded from the region are given in Table VI.

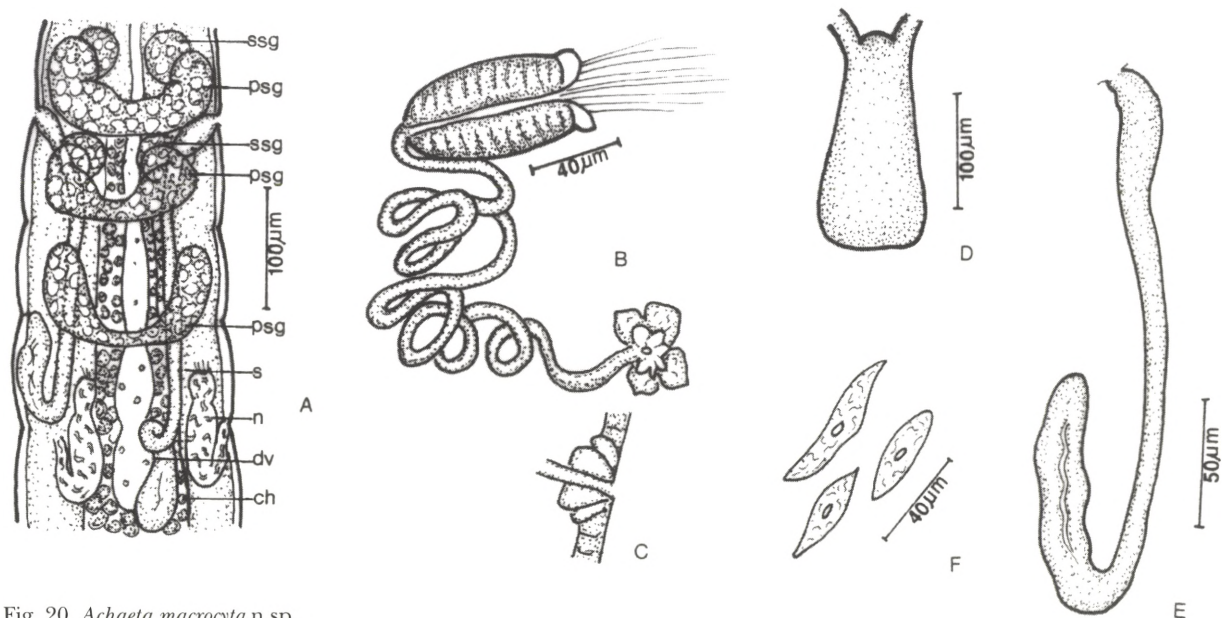


Fig. 20. *Achaeta macrocyta* n.sp.

A: segment IV-VIII, dorsal view (ch: chloragogen cells, dv: dorsal vessel, n: anterior nephridium, s: spermatheca, psg: primary septal glands, ssg: secondary septal glands); B: sperm funnel, sperm duct and penial opening; C: penial opening, lateral view; D: brain; E: spermatheca; F: lymphocytes.

***Marionina nordica* sp. n.** (Fig. 21 A-F)

Holotype: Ma.1 (70% ethanol).

Type locality: NW Taymyr Peninsula; leg. T. Christensen.

Paratypes: P.68-70 6 specimens (70% ethanol) from NW Taymyr Peninsula and Wrangel Island, SMNH TYPE-5080 from NW Taymyr Peninsula; leg. S. Jonasson and T. Christensen.

Material examined: Recorded from sts. 7 and 16.

Etymology: Only known from some of the northernmost stations.

Description: Small species, 7-10 mm long. Segments: 27-32. Setae straight: 2-2:3-3. Clitellum extends from XII-1/2XIII, glands arranged in regular rows. The brain truncate or slightly concave posteriorly, appr. 2 times as long as wide, 150 µm long. No oesophageal and intestinal diverticula. Three pairs of primary septal glands, none of them united dorsally and the third pair is somewhat elongate (Fig. 21 A). The anteseptale of the nephridia (Fig. 21 F) small, with few or no coils of the nephridial

canal. Postseptale elongate, the efferent duct arises mid-ventrally. Chloragogen cells from VI and form a dense covering from VII. Lymphocytes (Fig. 21 H) oval, transparent and about 40 µm long. Dorsal vessel originates in XII-XIII, blood colourless. Seminal vesicle present but rather small. Sperm funnel (Fig. 21 G) large, about 180 µm long and 3-3,5 times longer than wide. Collar distinct and usually narrower than the funnel itself. The efferent duct long and narrow. Penial bulb small and compact. One mature egg at a time. Spermatheca (Fig. 21 B,C) with a long ectal duct, a distinct and usually pear-shaped ampulla which gradually tapers into a relatively short ental duct. The ental ducts from either side unite into a common duct which join the oesophagus dorsally. One or two small occasionally indistinct gland cells at the ectal orifice.

Remarks: Among the *Marionina* species with similar spermatheca this species is most similar to *M. canadensis* Dash, 1970, but the latter is

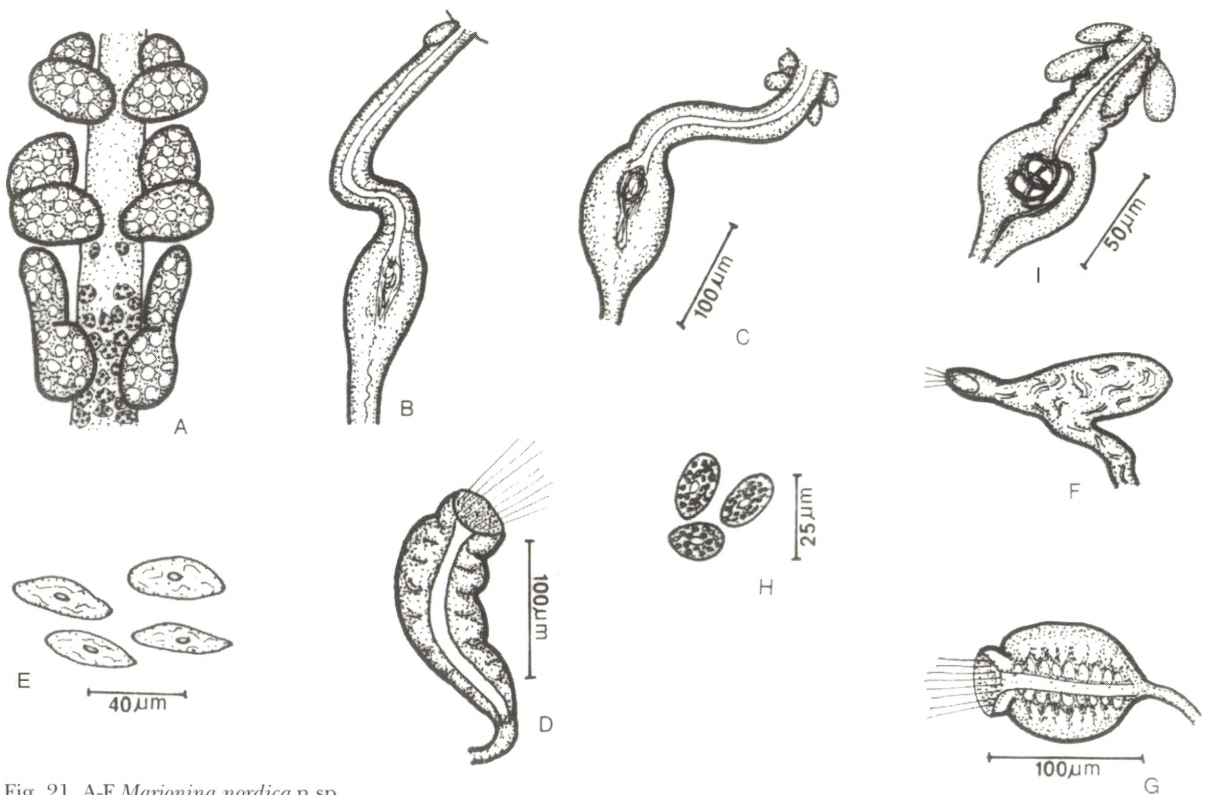


Fig. 21. A-F. *Marionina nordica* n.sp.

A: septal glands; B and C: spermatheca; D: sperm funnel; E: lymphocytes; F: nephridium. G-I: *Marionina aporus* Stephenson, 1925. G: sperm funnel; H: lymphocytes; I: spermatheca.

smaller (3-5 mm) and the sperm duct is short. *M. tubifera* Nielsen and Christensen, 1959 and *M. dirksi* Bell, 1942 have more setae (4-6). *M. eleonorae* and *M. brendae*, Rota, 1995 are very small (Smaller than 2 mm).

***Marionina macrobulbi* sp. n.** (Fig. 22)

Holotype: Ma 2. (70% ethanol)

Type locality: Faddeyevsky Island; leg. S. Jonasson.

Paratypes: P.71. 2 specimens (70% ethanol) from Faddeyevsky Island; leg. S. Jonasson.

Table VI Genus *Marionina*

species	length/segments		no	setae		seminal vesicle
	mm	no		length within bundles		
<i>minutissima</i>	2-3	23-25	0-2	equal		absent
<i>aporus</i>	4-6	20-26	2	equal		large
<i>argentea</i>	4-7	19-26	2	equal		absent
<i>macrobulbi</i>	7-10	26-35	2-5	unequal		small
<i>nordica</i>	7-10	27-32	2-3	equal		small

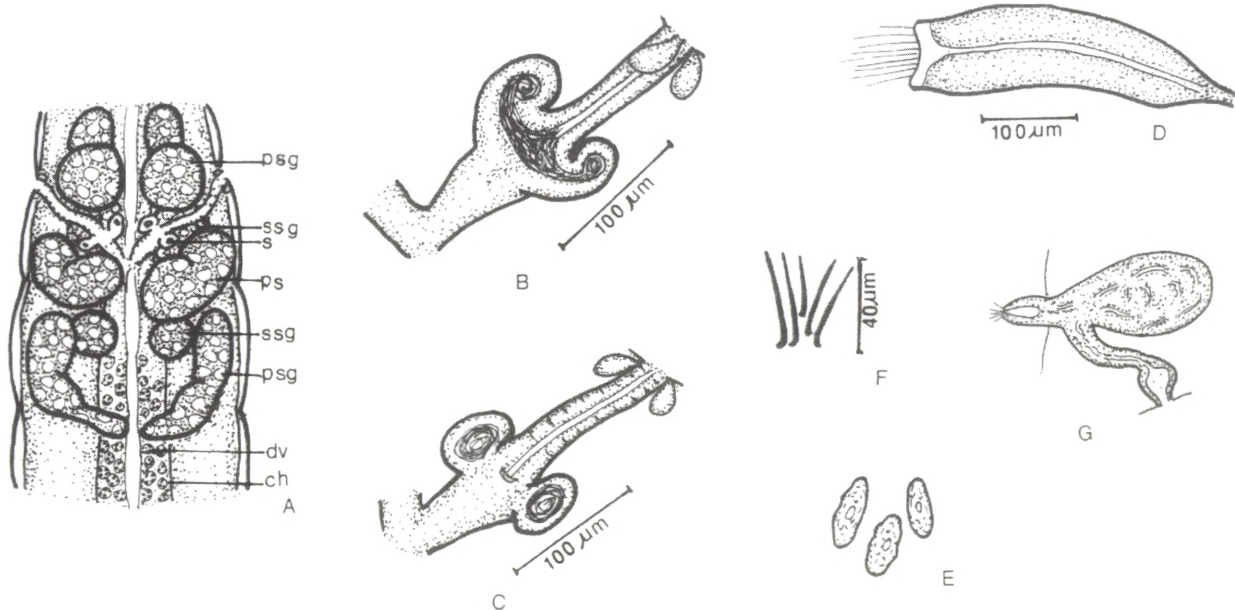


Fig. 22. *Marionina macrobulbi* n.sp.

A: segment IV-VII, dorsal view (ch: chloragogen cells, dv: dorsal vessel, s: spermatheca, psg: primary septal glands, ssg: secondary septal glands); B- C: spermatheca; D: sperm funnel; E: lymphocytes; F: setal bundle; G: nephridium.

Material examined: Recorded from st. 13.

Etymology: The species name refers to the large penial bulbs.

Description: Small species, 7-10 mm long, diameter 0.3-37 mm. Segments 26-35. Whitish and transparent. Clitellum XII-1/2XIII, the gland cells small, arranged in transverse rows. Setae (Fig. 22 F) straight, those in the middle of bundle shorter than the outer ones: 2,3,4-2,3,4;4,5-2,3. Three pairs of primary septal glands with ventral lobes and two pairs of secondary septal glands, none are united dorsally and the third pair of primary glands elongate (Fig. 22 A). The brain two times as long as wide, truncate or slightly concave posteriorly. Lymphocytes (Fig. 22 E) oval, finely granulated and transparent. The anteseptale of the nephridia (Fig. 22 G) consist of funnel only, the postseptale elongate with the efferent duct arising antero-ventrally. The nephridial canal extends into a small ampulla immediately be-

fore the ectal opening. Seminal vesicle present in XI. Sperm funnel (Fig. 22 D) large, cylindrical, 250-300 µm long, 3-3,5 times longer than wide, collar of the same width as the funnel itself. The efferent duct long and narrow (6-7 µm wide). Penial bulb very large and compact, 150 µm. The ectal duct of the spermatheca without glands along its length (90 µm), but 2-3 large glands at the ectal orifice. The ampulla with two spherical, sperm containing diverticulae bent towards the ectal duct. The ental duct from both sides unite before they join the oesophagus dorsally (Fig. 22 A s, B, C).

Remarks: The species may be related to a group of species placed by Rota (1995) in the genus *Oconnorella*.

***Marionina argentea* (Michaelsen, 1889)**

Material examined: Recorded from st. 11.

Recent description in Nielsen and Christensen (1959).

***Marionina aporus* Stephenson, 1925** (Fig. 21 G-I)

Material examined: Recorded from st. 16. SMNH: Nordiska Oligochaeta 3688.

Since Stephenson's description was based upon not fully mature individuals the following details are clarified: Segments up to 26, and length up to 5,5 mm. Clitellar glands arranged in regular transverse rows, dense ventrolaterally but less closely packed on the lateral and dorsal side. Nephridia present from VII/VIII, occasionally present on one side only. Seminal vesicle very large extending forward to IX/X. Sperm funnel (Fig. 21 G) slightly longer than wide, 80-150 μm long. Collar distinct and appr. $\frac{1}{2}$ - $\frac{2}{3}$ the width of the funnel itself. Penial bulb compact, appr. 50 μm . The spermatheca (Fig. 21 I) has a distinct, almost spherical ampulla (40-50 μm) where the sperm is concentrated in a few large, coiled strands. The length of the ectal duct equal the diameter of the ampulla, it

is covered by a dense layer of gland cells, and round the ectal orifice larger glands form a rosette, the length of these cells appr. $\frac{2}{3}$ the length of the ectal duct (30 μm).

Remarks: This species is similar to *M. argentea* in having dark lymphocytes (in transmitted light) (Fig. 21 H), only two setae pr. bundle, absence of dorso-lateral setae in II and identical septal glands. The differences are a much larger seminal vesicle, a much more conspicuous spermathecal ampulla and a rosette of large gland cells round the ectal orifice in the present species. *M. miniampullacea* Shurova, 1978 differs from this species in the same characters, and may be identical to *M. argentea*.

***Marionina minutissima* Healy, 1975**

Material examined: Recorded from st. 15. SMNH: Nordiska Oligochaeta 3689.

Our observations agree with Healy's original description.

Discussion

Problems at the species level are discussed under the heading "Remarks" in the above treatment of individual species. Here we address some general aspects of our findings.

It has been generalised that Enchytraeidae reach their greatest density in tundra and bog habitats (O'Connor, 1967; MacLean et al., 1980). The highest values for the former habitat are recorded from the Alaskan tundra at Barrow (MacLean et al., 1977), where Enchytraeidae amounts to appr. 65% of the total invertebrate biomass. In the Palearctic Piper et al. (1982) report a range from 12.460-23.350 ind./m² in four undisturbed tundra sites near Chaun Bay in north-eastern Siberia, values that fall around the median for the tundra sites summarised in MacLean (op. cit.). Being mainly grazers upon micro-organisms enchytraeids probably stimulate the decomposition of organic matter and accelerate the turnover of energy and cycling of the nutrient in this ecosystem. As such Enchytraeidae may be an important component even in a global context if higher temperatures cause an increased release of greenhouse gases such as carbon dioxide and methane from the Arctic tundra.

It has been proposed (MacLean et al., 1977) that the Enchytraeidae, in contrast to other faunal groups, show a considerable species richness in tundra compared with more temperate ecosystems. The data compiled in Table VII support this view. A total of 56 species are now recorded from palearctic tundra sites, a figure only slightly below the number of species found in non-marine habitats in temperate regions, here exemplified by the intensely studied Danish and Hungarian faunas. A vast but ecologically fairly uniform tundra may not be fully comparable with two restricted but more heterogeneous regions, but considering the relatively modest sampling efforts in the Arctic, the number of species already recorded here is indeed quite impressive.

A closer inspection of Table VII reveals strong differences between genera in species richness. A particularly striking feature is the high number of *Mesenchytraeus* species in the tundra compared with temperate regions. The figures suggest a fairly steep gradient with only two species in central European Hungary through seven species in northern European Denmark to no less than 22 species in the tundra. The

Table VII Species abundance in the Palearctic tundra compared with that of two temperate regions
number/frequency

	total no	<i>Mesenchytraeus</i>	<i>Cernosvitoviella</i>	<i>Cognettia</i>	<i>Henlea</i>	<i>Bryodrilus</i>	<i>Fridericia</i>	<i>Achaeta</i>	<i>Marionina</i>
Palearctic tundra	56	22/39,3%	1/1,8%	5/8,9%	12/21,4%	5/8,9%	5/8,9%	1/1,8%	5/8,9%
Denmark ^{1 2}	63	7/11,1%	3/4,8%	2/3,2%	6/9,5%	1/1,6%	18/28,5%	9/14,3%	8/12,7%
Hungary ¹	62	2/3,2%	3/4,8%	2/3,2%	5/8,1%	2/3,2%	24/38,7%	4/6,5%	4/6,5%

1) Genera absent in the tundra not mentioned 2) Only non-marine species included

slope of this gradient is strongly contrary to the generally accepted view that the decrease in species diversity goes pole-ward. Three additional genera, *Henlea*, *Cognettia* and *Bryodrilus*, also show a higher species diversity in polar compared with temperate regions. Detailed studies on the occurrence of enchytraeids in different soil types in Germany have shown that members of the above genera are particularly abundant in soils with a high content of organic matter (Graefe and Schmelz, 1999 and Graefe, pers. comm.). This may explain their strong dominance in tundra ecosystems, and the fact that the species richness actually exceeds that of non-polar regions indicates that it is conditions related to the soil rather than a harsh temporal regime with long periods of frost in winter that determine species diversity in these genera, see also Rota et al. (1998). The genera *Fridericia* and *Achaeta*, with very few species in the tundra, show a distributional pattern contrary to that of the above mentioned genera and follow the generally accepted poleward decline. However, the underlying explanation may be the same since most European members of these genera prefer mineral soil enriched with humified organic matter (Graefe, op. cit.).

Only 13 of the species recorded from the Palearctic tundra are also found outside this region. Four of these (*Henlea glandulifera*, *Bryodrilus arctica*, *B. parvus*, *Cognettia lapponica*) are reported from the taiga (Nurminen, 1977, Piper et al. 1982 and Rota et al., 1998) but not from more southerly habitats leaving nine species (*Mesenchytraeus flavus*, *Henlea perpusilla*, *H. heleotropha*, *H. nasuta*, *Cognettia glandulosa*, *Fridericia bulboides*, *F. bisetosa*, *F. ratzeli* and *Mari-onina argentea*) with a wide distribution extending from temperate into polar regions. This means that the majority of enchytraeid species found in the Palearctic tundra are apparently

endemic to this region perhaps including immediately neighbouring more southerly areas. This rich complement of species is dominated by members of the genera *Mesenchytraeus* and *Henlea* in particular and to some extent also by *Bryodrilus* and *Cognettia* species.

In the present survey by far the highest number of species (19) is recorded from the easternmost station on Wrangel Island. Piper et al. (1982) reported a species diversity in the same range from a locality (Chaun Bay) on the mainland in eastern Siberia and raised the question whether the Amphi-Beringian region harbour a particularly rich enchytraeid fauna characteristic of this region. The Alaskan enchytraeid fauna is as yet incompletely described but preliminary observations indicate that it may be even more diverse than the eastern Siberian fauna. It is premature to discuss this possibility in greater detail, but it raises the interesting question whether the invasion of the vast northern tundra following the latest glaciation has occurred through immigration of local southern faunal elements or through dispersal of pre-adapted species from refugia such as the Amphi-Beringian region.

Acknowledgement. This paper is a direct result of the Swedish-Russian Tundra Ecology Expedition 1994 and we particularly thank Torben R. Christensen, Sven Jonasson and Terry Callaghan for sampling in the field. We also thank C. Erséus and K. Sindemark at Riksmuseet, Stockholm, and M. Dzwillo and H. Ruhberg at Zoologisches Museum, Hamburg for the opportunity to re-investigate museum collections from previous expeditions and B. Healy for critically reading the manuscript. Special thanks to the Soros Foundation and the Danish Rectors Conference for covering travel expenses for K. Dozsa-Farkas.

Appendix 1

Overview of sampling stations and species diversity.

Numbering of stations according to the Swedish-Russian Ecology Expedition 1994. Survey of dominant plant species given in Christensen et al. (1995), further particulars in Grönlund and Melander (1995).

St. 4. Pechora Bay (68°30,7'N;52°47,5'E), 25/8/94:

Mesenchytraeus cf. flavus, *M. sp.*, *Cognettia bisetosa*, *C. lapponica*, *Henlea perpusilla*, *Fridericia juv.*

St. 6. N. Yamal Peninsula (72°43,7'N;70°43,2'E) 18/8/94:

Mesenchytraeus melanocephalus, *M. torbeni*, *M. sveni*, *Cognettia bisetosa*, *C. quadrosetosa*, *C. lapponica*, *Henlea tolli*.

St. 7. NW. Taymyr Peninsula (75°52,7'N;94°33,9'E) 16-17/8/94:

Henlea adiverticulata, *H. conchifera*, *H. glandulifera*, *H. ochracea*, *H. perpusilla*, *H. tolli*, *Bryodrilus diverticulatus*, *B. parvus*, *Fridericia callosa*.

St. 9. NE. Taymyr Peninsula (76°28.1'N;111°13,8'E) 11/8/94:

Mesenchytraeus melanocephalus, *M. torbeni*, *Cernosvitoviella cf. pusilla*, *Henlea adiverticulata*, *H. conchifera*, *H. ochracea*, *H. perpusilla*, *H. tolli*, *Bryodrilus diverticulatus*, *B. parvus*, *Fridericia callosa*.

St. 11. Kotelny Island (75°03,5'N;140°11,4'E) 1/8/94:

Mesenchytraeus melanocephalus, *M. torbeni*, *Henlea ochracea*, *Bryodrilus arctica*, *B. parvus*, *Fridericia callosa*, *Marionina argentea*.

St. 13. Faddeyevsky Island (75°29,6'N;143°44,5'E) 10/8/94:

Mesenchytraeus mirabilis, *Henlea conchifera*, *H. diverticulata*, *H. perpusilla*,

St. 14. Lopatka Peninsula (72°11,1'N;148°26,3'E) 14-15/7/94:

Cognettia bisetosa, *C. glandulosa*, *C. lapponica*, *C. piperi*, *H. diverticulata*, *H. perpusilla*, *H. tolli*, *Bryodrilus arctica*, *Fridericia callosa*, *Achaeta macrocyta*.

St. 15. NE Kolyma Delta (69°21,3'N;163°34,8'E) 18/7/94:

Mesenchytraeus chaunus, *M. melanocephalus*, *Cognettia lapponica*, *C. piperi*, *Bryodrilus arctica*, *Achaeta macrocyta*, *Marionina minutissima*.

St. 16. Wrangel Island (70°57,4'N;179°33,4'E) 23/7/94:

Mesenchytraeus melanocephalus, *M. torbeni*, *Cognettia bisetosa*, *C. glandulosa*, *C. lapponica*, *C. quadrosetosa*, *C. piperi*, *Henlea adiverticulata*, *H. conchifera*, *H. glandulifera*, *H. heleotropha*, *H. tolli*, *H. perpusilla*, *H. ventriculosa*, *Bryodrilus arctica*, *B. borealis*, *B. parvus*, *Fridericia callosa*, *Marionina aporus*.

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