

## Marine Nematodes of Bothnian Bay, Finland: *Ethmolaimus hailuotoensis* n. sp. (Ethmolaimidae: Nemata)

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**Abstract:** *Ethmolaimus hailuotoensis* n. sp. from Bothnian Bay, northern Baltic Sea, is described and illustrated. *Ethmolaimus hailuotoensis* n. sp. has a strongly sclerotized luminal lining of the terminal esophageal bulb and esophagus. The most characteristic feature is a lateral series of large concentric, sclerotized rings with a fine, internal longitudinal oval sclerotization. In addition, *E. hailuotoensis* n. sp. is distinguished from other *Ethmolaimus* species by its smaller body size, fewer number of pre-cloacal supplements (7–8), conical tail, and the position of amphid posterior to the buccal cavity. Females of *E. hailuotoensis* n. sp. studied were hermaphroditic. *Ethmolaimus hailuotoensis* n. sp. coexisted with *E. pratensis*. *Ethmolaimus pratensis* from Bothnian Bay has a characteristic row of sublateral hypodermal glands, a character not before seen in *Ethmolaimidae*.

**Key words:** Baltic Sea, *Ethmolaimus hailuotoensis* n. sp., Finland, hermaphroditic female, marine nematode, nematode, new species, systematics taxonomy.

Bothnian Bay is the northernmost part of the Baltic Sea, with water salinities below 5%. Schiemer et al. (9) have studied free-living nematodes of the area. This article is one of several papers to be prepared on the taxonomy of free-living nematodes living in Bothnian Bay.

The subfamily Ethmolaiminae Filipjev & Schuurmans Stekhoven, 1941 contains at present *Ethmolaimus* de Man, 1880 (7) and *Trichethmolaimus* Platt, 1982 (7). *Trichethmolaimus hirsutus* (Gerlach 1956), the sole member of its genus, has unusually long somatic setae, which easily distinguish it from members of *Ethmolaimus* (7). There are three valid species in *Ethmolaimus*: *E. pratensis* de Man, 1880; *E. multipapillatus* Paramonov, 1926; and *E. dahli* Gerlach, 1953 (7).

### MATERIALS AND METHODS

Nematodes were collected with a Kajak-Hakala core sampler. Specimens were extracted from sediment with sieves having 0.5-, 0.2-, 0.1-, and 0.04-mm pores. The nematodes were fixed at room temperature in 4% formalin buffered with TAF. Specimens were processed to glycerol by means of two methods. Part of the mate-

rial was pipetted into a 79:1:20 solution of 96% ethanol, glycerol, and distilled water in 5-ml glass tubes and closed with Parafilm (American National Can, Greenwich, CT). The remaining material was transferred from formalin into a 1:3:3 (v:v:v) solution of glycerol–water–96% ethanol in vials and evaporated to pure glycerol at 40 C. Permanent slide mounts were studied with a Wild M20 microscope, and figures were drawn with the aid of a camera lucida.

### STATIONS

Nematodes were sampled from six stations extending from shallow coastal waters to deep sea. Station 1 was close to the shore at the mouth region of the river Oulujoki, in muddy sediment at a 22-m depth. Station 2 was a fine sandy to silty bottom at a 12-m depth and was located at Kattilankalla, close to the northeast shore of the island Hailuoto. Station 3 was fine sand sediment at a depth of 10 m, located about 16 km west of the island Hailuoto. Station 4 was in a 20-m-deep basin near the northwest shore of the same island. Here the bottom was soft with greenish silt covering a black sulfide zone underlying a more oxidized layer. At a 17-m depth at Station 4, the sediment was predominantly silty sand. Station 5 had a water depth of 80 m and a loose, well-oxidized muddy sediment. Station K was situated between Hailuoto Island and the continent at the southeast

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side of the island. Water depth was 5–6 m, indicating a littoral habitat. Sediment was sandy with some silt content.

# SYSTEMATICS

Ethmolaimidae Filipjev & Schuurmans Stekhoven, 1941

*Ethmolaimus* de Man, 1880

*Ethmolaimus hailuotoensis* n. sp.  
(Figs. 1–5)

## Description

Dimensions of the holotype male, paratype males, the allotype hermaphroditic female, the paratype hermaphroditic female, and the nongravid female given in Table 1.

*Male* ( $n = 4$ ): Body tapering anteriorly and posteriorly (Fig. 3). Cuticle punctate (Figs. 1B,C; 2B, E; 4A,B; 5D) with irregular circles of dots. Lateral field 6.4–8.0  $\mu\text{m}$  wide at midbody (Fig. 2B). In region of lateral field, ventral and dorsal dots smaller than lateral dots (Fig. 2B). Lateral field not present in cylindrical esophageal region (Figs. 1B; 4A,C) or on tail (Figs. 1C; 2E; 4B,D). Cuticle thin, hypodermis thick. Posterior to amphid, body laterally bearing 22 (esophageal region 6, midbody 12, tail 4; counted on one specimen) oval, sclerotized rings each with a small, narrow, lon-

gitudinal structure inside, ring dimensions 1.4–1.6  $\mu\text{m} \times 1 \mu\text{m}$  (Figs. 1B,C; 2B; 4B). Hypodermal gland finely granulated, 5–7  $\mu\text{m}$  in diameter, close to sclerotized ring in midbody. Submedian somatic setae short, 2–3  $\mu\text{m}$  long (Fig. 1C). Head end truncate, corners rounded (Figs. 1B; 2A; 3). Labial papillae six, in two circles (Fig. 2A). Cephalic setae four, 3.2–4.0  $\mu\text{m}$  long (Figs. 1B; 2A). Vestibulum shallow, wide, with 12 sclerotized sections (Fig. 2A), median part cup-shaped; posterior part narrow, 6.4–7.0  $\mu\text{m}$  long, surrounded by longitudinal musculature (Fig. 2A). Three teeth at anterior margin of posterior part (Fig. 2A); dorsal tooth larger than two subventral teeth (Fig. 2A). Amphid posterior to buccal cavity, 3.6–4.5  $\mu\text{m}$  wide, spiral-shaped, overlapping one-quarter of its length (Figs. 1B; 2A; 4A). Esophagus cylindrical, diameter 3–4  $\mu\text{m}$ , luminal lining strongly sclerotized, extending into basal bulb (Figs. 1B,2A). Basal bulb 12–14.4  $\mu\text{m}$  long, 9.6–11.0  $\mu\text{m}$  wide; luminal lining crescentic in lateral view, strongly sclerotized, 6.4–7.2  $\mu\text{m}$  long, 1.0–1.4  $\mu\text{m}$  wide (Fig. 1B). Cardia drop-shaped (Fig. 1B). Renette cell ventral, 9.6  $\mu\text{m}$  long, 4  $\mu\text{m}$  wide, anterior end 8  $\mu\text{m}$  posterior to esophagus, ampulla at anterior margin of basal bulb 5.6  $\mu\text{m}$  long, 3.9  $\mu\text{m}$  wide, opening ventrally through a 0.5  $\mu\text{m}$ -wide pore.

TABLE 1. Measurements and ratios of holotype male, paratype males, allotype hermaphroditic female, paratype hermaphroditic female, and nongravid paratype female of *Ethmolaimus hailuotoensis* n. sp.

Character	Holotype male	Paratype males (n = 3)		Hermaphroditic females		Nongravid female
		Mean	Range	Allotype	Paratype	
Measurements (μm)						
Body length	471	356.3	320–425	326	319	356
Esophagus length	62	57.0	52–62	57	53	64.4
Tail length	68	56.0	48–68	48	51	61.6
Body width	13	13.4	13.0–13.6	17	18	14.4
Head width	6	6.3	6–7	6	7	7
Body width at end of esophagus	11	11.3	10–12	11	12	12
Anal width	10		10	10	10	10
Spicule length	17	17.0	17–19			
Ratios						
a	36.2	26.5	24–32	18.1	17.7	24.7
b	7.6	6.2	5.6–6.8	5.7	6.0	5.5
c	6.9	6.4	6.2–6.8	6.8	6.2	5.8
V				49.7	47.9	50.0

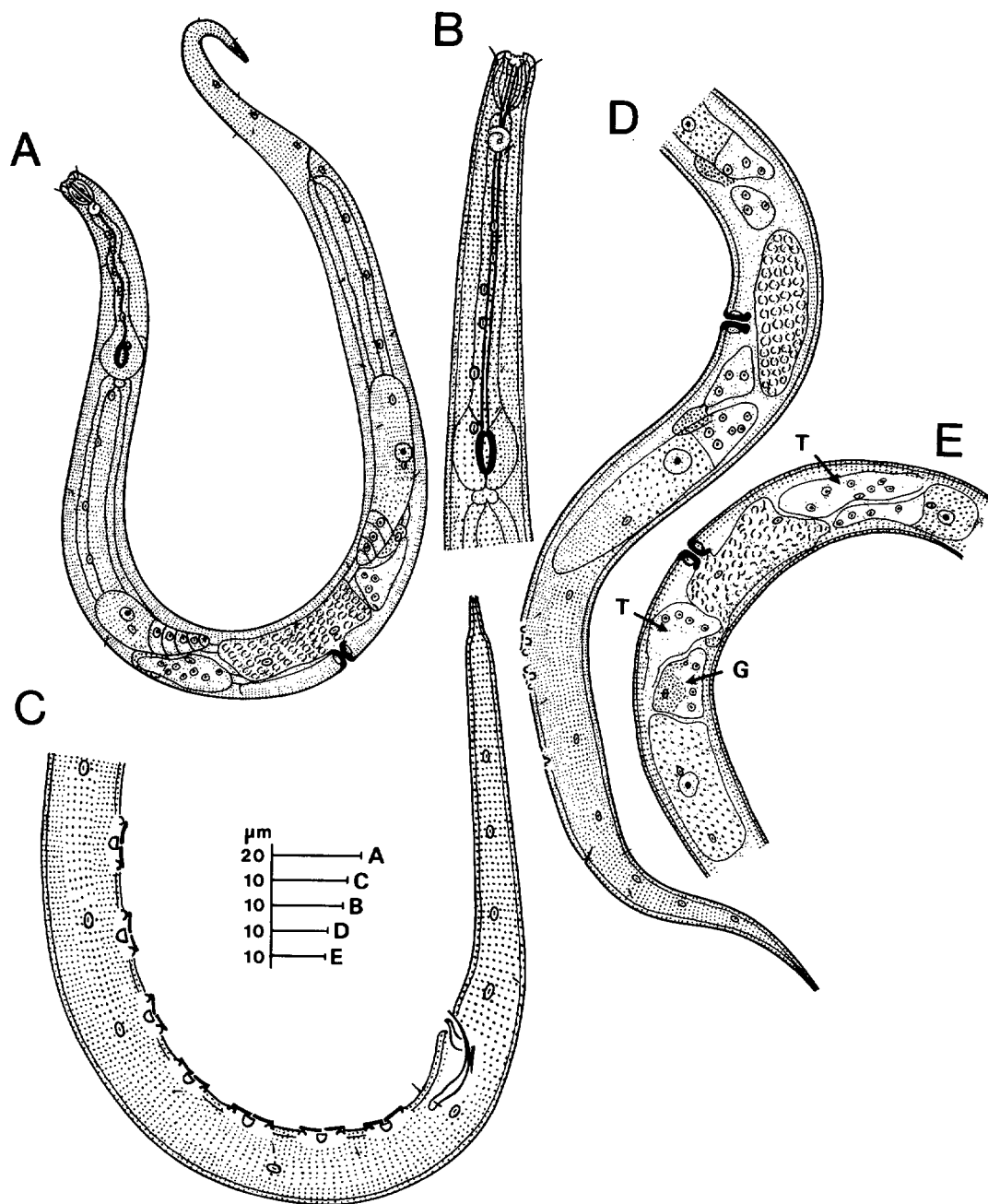


FIG. 1. *Ethmolaimus hailuotoensis* n. sp. A) Total view of hermaphroditic female. B) Anterior end of male. C) Posterior end of male. D) Posterior end of hermaphroditic female possessing preanal supplements. E) Gonads of hermaphroditic female, with testis (T) on both sides of vulva and granular pouch (G) close to ovary.

Diorchic, testes opposed (Figs. 3; 5A). Anterior testis left, posterior right of intestine ( $n = 3$ ). Ventral seta 1.2–2.4  $\mu\text{m}$  long, 6.4–9.6  $\mu\text{m}$  from cloaca (Fig. 1C). Spicule arcuate; manubrium 1.2  $\mu\text{m}$  wide, 1.8–2  $\mu\text{m}$  long, with weakly sclerotized walls,

pointed proximal end; blades tapering to narrowly rounded tips (Figs. 1C; 2D; 4D–G). Proximal one-fourth of spicule almost cylindrical, 1.2–1.5  $\mu\text{m}$  wide, 4  $\mu\text{m}$  long (Figs. 1C; 2D; 4D). Gubernaculum a U-shaped membrane, enveloping spicules,

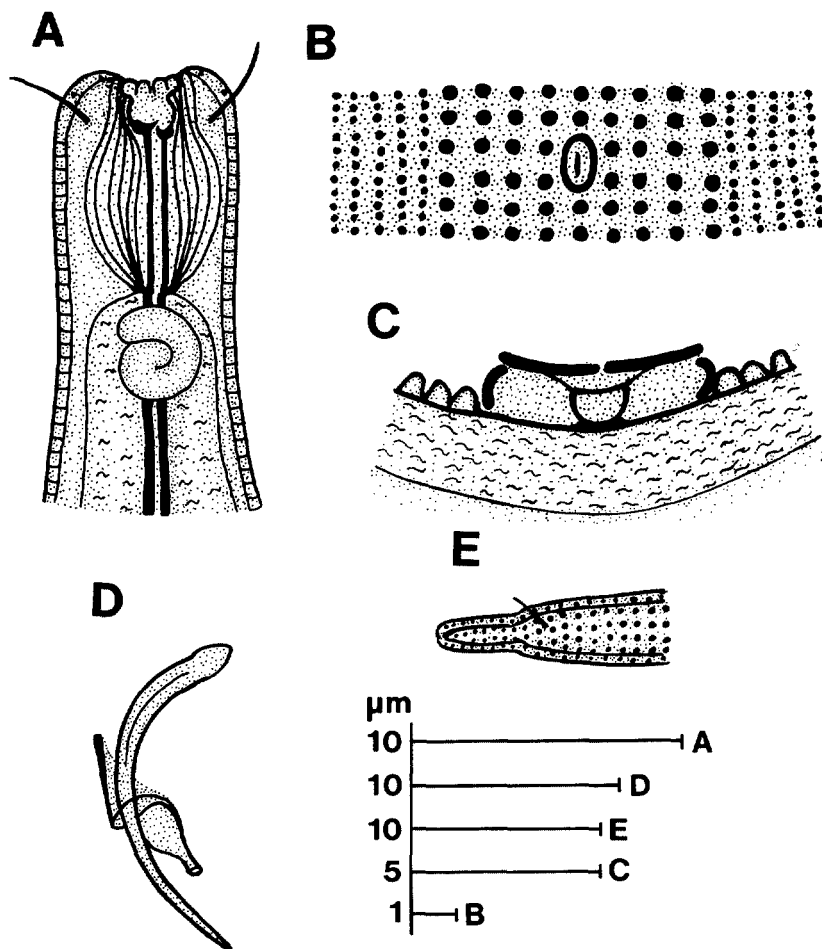


FIG. 2. *Ethmolaimus hailuotoensis* n. sp. A) Head of male. B) Midbody cuticular pattern of male. C) Precloacal supplement of male. D) Copulatory apparatus. E) Tail tip of male.

distal end narrowing laterally (Figs. 2D; 4D–G). Tail conoid, six cloacal body diameters long (Figs. 1C; 3). Tail end punctate (Figs. 1C; 2E; 5D). Precloacal supplements articulated, seven ( $n = 3$ ) or eight ( $n = 1$ ), 6–7  $\mu\text{m}$  wide; cup wall continuous (Figs. 1C; 2C; 3; 4E).

**Female (hermaphroditic;  $n = 2$ ):** Body widest at vulva, gradually tapering at each end (Fig. 1A,D). Lateral sclerotized rings 25 (esophageal region 6; midbody 15; tail 4; counted on one specimen), with longitudinal bar (Fig. 1A,D,E). Labial papillae six, in two circles. Cephalic setae four, 3–4  $\mu\text{m}$  long (Fig. 1A). Tubular part of buccal cavity 6–7  $\mu\text{m}$  long. Amphid 2–3  $\mu\text{m}$  in diameter; posterior to buccal cavity (Fig. 1A). Didelphic, amphidelphic, ovaries reflexed

(Figs. 1A,D,E; 5B). In one female, three preanal supplements (Figs. 1D; 5B; C) two anteriormost structurally similar to corresponding male organs, 5  $\mu\text{m}$  in diameter; posterior one smaller, 2  $\mu\text{m}$  in diameter (Figs. 1D; 5B,C); other female without supplements (Fig. 1A). Vagina vera 6  $\mu\text{m}$  long, with curved, 1- $\mu\text{m}$ -thick, hyaline walls (Figs. 1D,E; 5B). Both females with two testes, one on each side of vulva (Figs. 1D,E; 5B). Granular pouch or duct present close to ovary (Fig. 1D,E).

#### Diagnosis

*Ethmolaimus hailuotoensis* n. sp. is characterized by strongly sclerotized luminal linings of the terminal esophageal bulb and esophagus; a row of lateral large sclero-

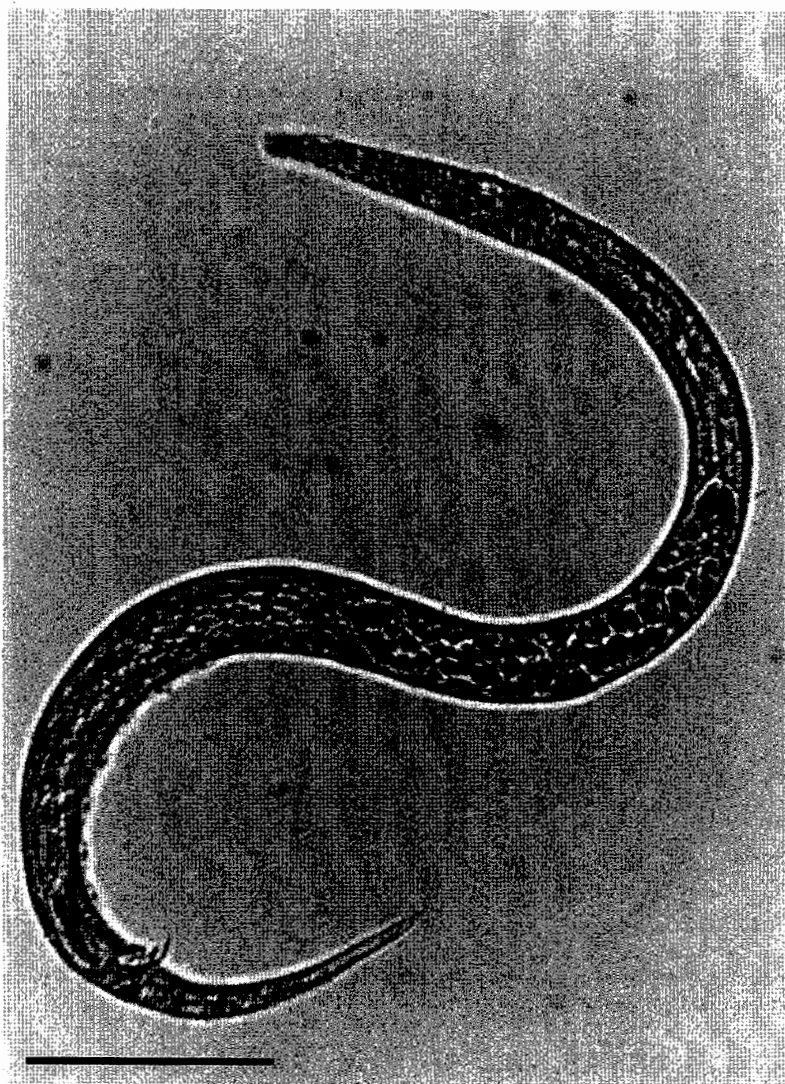


FIG. 3. Photomicrograph of *Ethmolaimus hailuotoensis* n. sp. Total view of male. Scale bar = 50  $\mu$ m.

tized rings; males with 7–8 precloacal supplements; gravid hermaphroditic females with three preanal supplements or without supplements; immature female lacking preanal supplements.

#### *Relationships*

*Ethmolaimus hailuotoensis* n. sp. resembles *E. pratensis* de Man, 1880 (3,5) in gubernaculum structure. Both species have a lateral sclerotized piece and membrane (3,5) and in both species the lateral piece, or gubernaculum (3), is connected by a membrane to a sclerotized rod at dorsal side of

spicules (3), or the membrane itself is sclerotized (5). The lateral piece is present also in *E. multipapillatus* Paramonov, 1926 (8) and the rod-like piece in *E. dahli* Gerlach, 1953 (2). *Ethmolaimus hailuotoensis* n. sp. is similar to *E. pratensis* in having heterogeneous cuticle (3,7) and setose cephalic setae (3,5,7) and to *E. pratensis* and *E. multipapillatus* (8) in that cuticular rows anastomose laterally in the midbody region. The tail shape of *E. hailuotoensis* n. sp. is conical and similar to the almost conical (1) or conical tail (8) of *E. multipapillatus*.

From *E. multipapillatus* (8), *E. hailuotoen-*

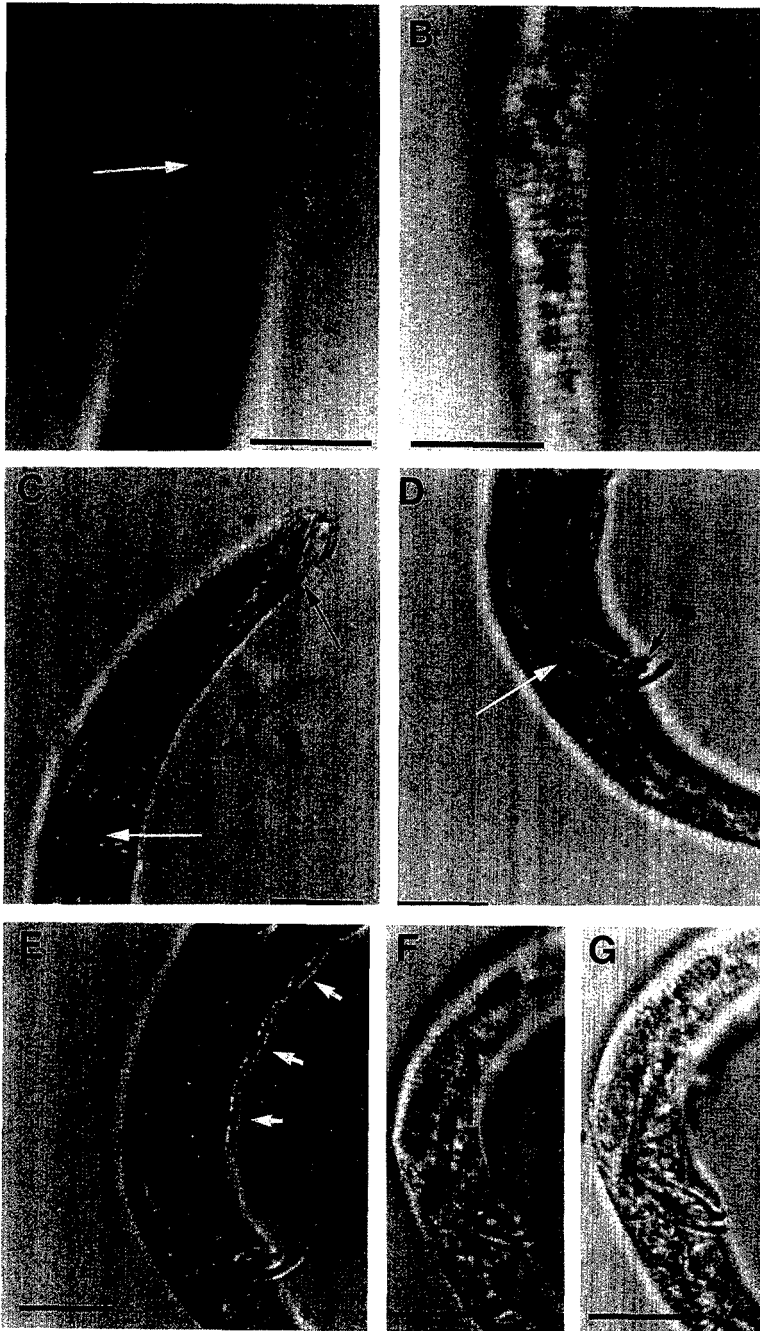


FIG. 4. Photomicrographs of *Ethmolaimus hailuotoensis* n. sp. A) Anterior end of male, amphid (arrow), and homogeneous cuticle. B) Tail of male with lateral oval rings (arrows). C) Anterior region of female, with sclerotized luminal linings of esophagus and basal bulb (white arrow), and junction between buccal cavity and esophagus (black arrow). D) Left copulatory apparatus of male: spicule (long arrow) and lateral piece (short arrow). E) Left copulatory apparatus of same male as in D: three of seven precloacal supplements (small arrows) and lateral piece (gubernaculum) enveloping spicule (long arrow). Note dorsal rod-like sclerotization. F–G) Right copulatory apparatus of another male. Scale bars = 10  $\mu$ m.

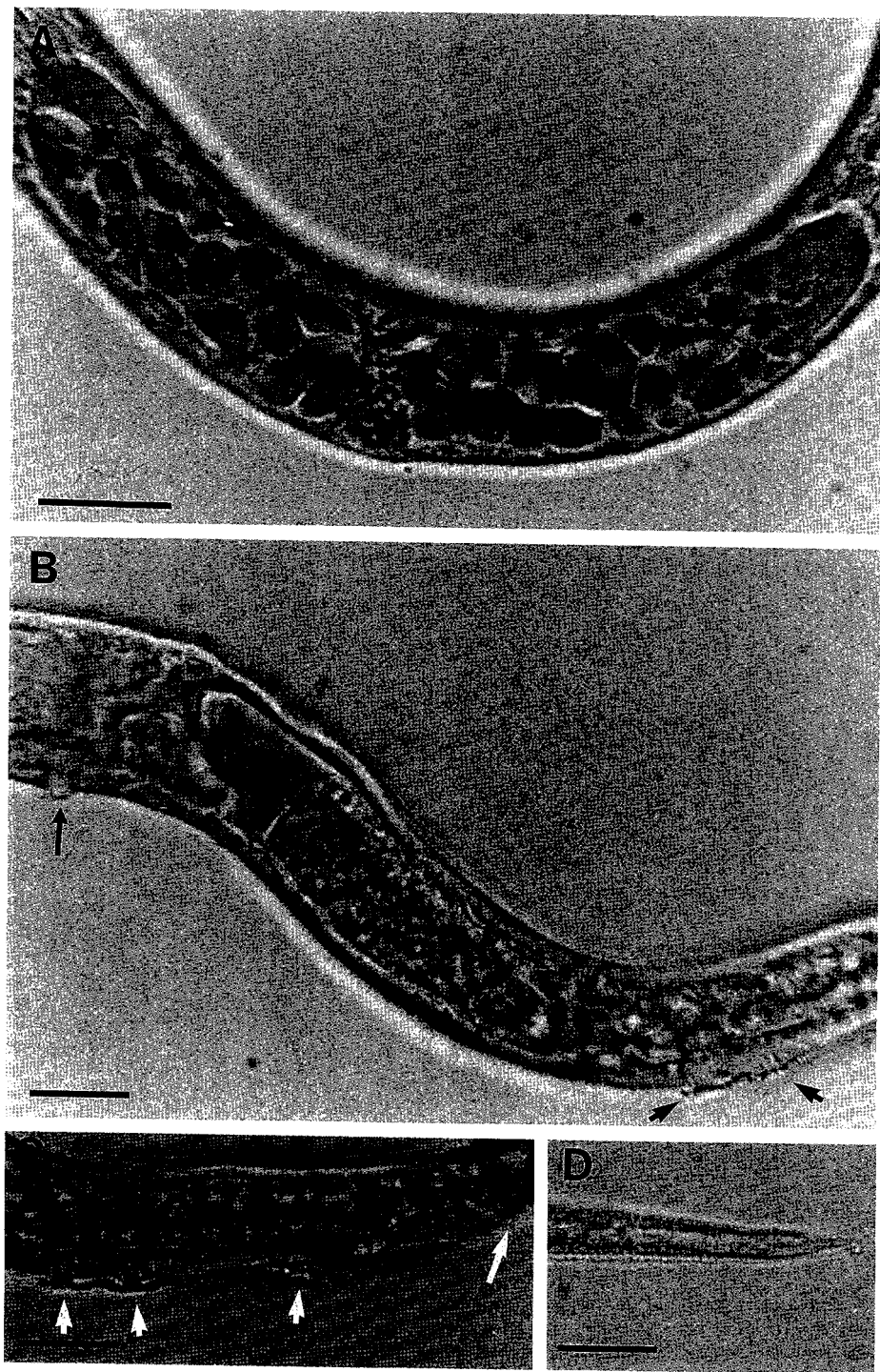


FIG. 5 Photomicrographs of *Ethmolaimus hailuotoensis* n. sp. A) Testes of male. B) Ovary, vulva (long arrow), and two of three preanal supplements (small arrows) in hermaphroditic female. C) Preanal supplements (small arrows) and anus (long arrow) of hermaphroditic female. D) Tail end of male. Scale bars = 10  $\mu$ m.

sis n. sp. can be differentiated by the heterogeneous cuticle and from *E. pratensis* (3,7) by the homogeneous cuticle on the anterior portion of the body. In *E. hailuotoensis* n. sp., the lateral field does not extend on the anterior body end as in *E. pratensis* (3,7). *Ethmolaimus hailuotoensis* n. sp. differs from the other species of *Ethmolaimus* in having a series of large, lateral sclerotized rings in the cuticle and the strongly sclerotized luminal lining of the terminal esophageal bulb and esophagus, whereas *E. pratensis* (7) and *E. multipapillatus* (7) have only small lateral pores and a terminal lumen without such sclerotization (1,3,5). *Ethmolaimus hailuotoensis* n. sp. is generally a smaller species (L = 425–471  $\mu\text{m}$ , males; 319–326  $\mu\text{m}$ , females) compared to *E. pratensis* (L = 425–991  $\mu\text{m}$ , males; 387–1,123  $\mu\text{m}$ , females) (3), *E. dahli* (L = 710–750  $\mu\text{m}$ , males; 745–775  $\mu\text{m}$ , females) (2), and *E. multipapillatus* (L = 1,233  $\mu\text{m}$ , male; 830–987  $\mu\text{m}$ , females) (1). The distal three-fourths of the spicules in *E. hailuotoensis* n. sp. are generally more slender than spicules in *E. pratensis* (3,5,8) and *E. dahli* (2). *Ethmolaimus hailuotoensis* n. sp. differs from *E. pratensis* (3,5) in lacking ventral alae on the spicules. *Ethmolaimus hailuotoensis* n. sp. has fewer precloacal supplements (7–8) than *E. pratensis* (9–17), *E. multipapillatus* (17–24), or *E. dahli* (20–21) (8). In females of *E. pratensis* from Bothnian Bay, the terminal end of ovary is bluntly rounded, whereas in *E. hailuotoensis* n. sp. it is truncate.

#### Type Locality

Bothnian Bay, Baltic Sea. Silty sand bottoms at depths of 6–17 m close to the island Hailuoto, in water of low salinity (<3%). Associated with *Axonolaimus spinosus* (Bütschli, 1874), *Chromadorita fennica* Jensen, 1979, *Ethmolaimus pratensis* De Man, 1880, *Ironus tenuicaudata* De Man, 1876, *Leptolaimus elegans* (Schuurmans Stekhoven and De Coninck, 1933), *Microaimus globiceps* De Man, 1880, *Sphaerolaimus gracilis*, 1876, *Theristus setosus* (Bütschli, 1874), and *Tripyla setifera* Bütschli, 1873.

#### Type Specimens

Holotype (male), collected at Station 2, type slide No. BBf 56, deposited in the Zoological Museum, Helsinki, Finland. Allotype (female) (Station 4), type slide No. BBh 23, and paratype male (Station 4), slide No. BBg 98, deposited in the Nematode Collection of the Instituut voor Dierkunde, Gent, Belgium. Two paratype males and one female (Stations 2, 4, K) deposited in the "Nematodensammlung des Instituts für Meeresforschung" in Bremerhaven, Germany.

#### Remarks

Large cuticular pores are present in many species of Neotonchinae (*Ethmolaimidae*) and in *Trichethmolaimus hirsutus* (7), but hitherto have not been reported in species of *Ethmolaimus*. Such pores are typical in members of *Cyatholaimidae* (4).

Electron microscopy studies of *Acanthonchus duplicatus* Wieser & Hopper, 1959 revealed that the large pores are actually rings of dense material occurring in the middle cuticular layer (10). The bar inside the ring was a narrow pore aperture leading into a hypodermal gland (10). The whole structure was termed a "hypodermal pore complex" (10). The number, type (the orientation of the pore aperture), and distribution of hypodermal pore complexes was shown to be of great taxonomic importance in *Cyatholaimidae* (4). In the light microscope, sclerotized rings in *E. hailuotoensis* n. sp. resemble the rings of hypodermal pore complexes (4,10). The presence of this pore type in *Ethmolaimus hailuotoensis* n. sp. and possibly in *Trichethmolaimus hirsutus* (7) clearly shows that *Ethmolaiminae* is closely related to *Cyatholaimidae*, as suggested by Jensen (5). *Ethmolaimus hailuotoensis* n. sp. is particularly related to *Pomponematinae*, because *Pomponema tessellatum* Wieser and Hopper, 1967 is the only species having longitudinal pore apertures. Other *cyatholaimid* taxa have transverse or diagonal pore apertures (4). Among *Ethmolaimidae*, eight of the 26 valid species have lateral differ-



entiation (7). In *Ethmolaimus pratensis* and *Gomphonema typicum* Wieser & Hopper, 1966 the differentiation starts just posterior to amphid, otherwise usually from the base of the esophagus (7). *Ethmolaimus hailuotoensis* n. sp. is unique because differentiation ends at the base of the cylindrical esophageal region.

In Bothnian Bay *E. pratensis*, there is a row of sublateral hypodermal glands in males, females, and juveniles. The hypodermal glands, which occur close to the somatic setae, contain large granules, similar in appearance to the granules of the renette cell. However, it could not be determined if there is a hypodermal pore in the cuticle or if the setae are tubular. It is possible that the variable lengths of somatic setae of *E. pratensis* in the southern Finnish archipelago (5) are associated with hypodermal glands. Hypodermal glands have not been previously observed in the family Ethmolaimidae.

The presence of both ovaries and testes in females of *E. hailuotoensis* n. sp. indicates that they are hermaphroditic. It is suggested that sperm fertilizing the eggs may originate from the normal male or from the same hermaphroditic female. The occurrence of both gonads in the same individual is rare in nematodes (6). The only verified example is the hermaphroditic male of *Heterogonema ovomaculis* Van Waerebeke & Remillet (Mermithida), which produces both eggs and sperm (6). Females of *H. ovomaculis* are normal, and they cross-fertilize with hermaphroditic males.

The copulatory apparatus of *Ethmolaimus hailuotoensis* n. sp. has the characteristics of a typical ethmolaimid copulatory appa-

ratus: Arcuate spicule, rod-like gubernaculum, and sclerotized lateral piece (7). Because lateral piece and rod are connected to each other with a membrane in *E. pratensis* (3) and in *E. hailuotoensis* n. sp., perhaps the whole structure is to be considered as a gubernaculum.

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