

## Revision of *Bathypsilonema* species from Antarctica described by Steiner (1931) (Nemata: Epsilonematidae)

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### Abstract

A revision was made of the *Bathypsilonema* species from the German South Polar Expedition of 1901-1903 described by STEINER (1931), based upon type specimens from STEINER's collection. Two species were identified: *Bathypsilonema drygalskii* STEINER, 1931 and *B. brachycephalum* STEINER, 1931. *B. brachycephalum* is re-established as a valid species, characterized by a far anterior position of the amphideal fovea, 99-101 body annules and 42-51  $\mu\text{m}$  long spicules. Both species were also found among material from the U.S. Antarctic Research Program 1969-1970, and are redescribed.

**Keywords:** taxonomy, morphology, *Bathypsilonema*, Antarctica, free-living nematodes.

### Résumé

Révision des espèces de *Bathypsilonema* décrites par STEINER (1931) de l'Antarctique (Nemata: Epsilonematidae).

Une révision a été faite des espèces de *Bathypsilonema* décrites par STEINER (1931) de l'expédition allemande en Antarctique en 1901-1903, et cela basé sur des spécimens types de la collection de STEINER. Deux espèces ont été identifiées: *Bathypsilonema drygalskii* STEINER, 1931 et *B. brachycephalum* STEINER, 1931. *B. brachycephalum* est rétablie comme espèce valable, caractérisée par la position très antérieure de l'amphide, les 99-101 anneaux du corps et la longueur des spicules, 42-51  $\mu\text{m}$ . Ces deux espèces étaient aussi présentes dans le matériel provenant du Program Américain de Recherche en Antarctique de 1969-1970; les deux espèces sont redécrites.

**Mots-clés:** taxonomie, morphologie, *Bathypsilonema*, l'Antarctique, nématodes libres.

### Introduction

The genus *Bathypsilonema* was first proposed in 1927 by G. STEINER at the 101th meeting of the Helminthological Society of Washington, where he gave a short generic diagnosis in which he described *Bathypsilonema* as similar to *Epsilonema* but differentiated from it by "rings much stronger and fewer (only 80-90)". He did not designate a type species nor include any illustrations of the genus in the published note of the meeting (STEINER, 1927). In 1931 he published a large monograph on the family Epsilonematidae STEINER, 1927, where he gave a more extensive

diagnosis of the genus and described nineteen new species and one new subspecies in *Bathypsilonema*, each of which based upon a single specimen, either a female (8 species), a male (5 species) or a juvenile (6 species, 1 subspecies).

LORENZEN in 1973 considered all the *Bathypsilonema* species and *Epsilonella gracilis* described by STEINER (1931) as belonging to only one species, *B. drygalskii*, based upon a study of the literature.

In the early 1970's, while examining some STEINER slides for specimens belonging to the Draconematidae it was discovered that many of the specimens were STEINER's original material used for his 1931 monograph. For the first time since his 1931 publication, some of the original specimens had become available.

In the austral summer of 1969-1970, D.R. VIGLIERCHIO (Davis) and R.W. TIMM (Bangladesh) were part of the Antarctic Biology Program of the U.S. Antarctic Research Program sponsored by the National Science Foundation and collected many marine nematode samples from the bottom of the McMurdo Sound Region of Antarctica. This material contained numerous specimens of Epsilonematinae, including *Bathypsilonema*.

Upon examination of the *Bathypsilonema* species in STEINER's original specimens and detailed study of his descriptions and figures, we found all of them with a similar habitus and a more or less pronounced garland-like ornamentation (= "Kerbenornamentierung") of the adult body annules. Although, we distinguished two groups of species mainly based upon the number of body rings, and position of the amphids. In one group the number of body rings was smaller and the amphideal fovea situated at mid or posterior head region as in *B. drygalskii*. The second group included specimens with a larger number of body rings and with the amphideal fovea slightly larger and situated far anteriorly as in *B. brachycephalum* (♀); each species being described from a single specimen. Both species were also observed among the specimens from the more Recent American Antarctic expeditions.

*B. drygalskii* and *B. brachycephalum* are considered as valid species and are redescribed.

## Material and methods

### MATERIAL FROM STEINER'S COLLECTION

The epsilonematid specimens described by STEINER in 1931 were collected by the German South Polar Expedition of 1901-1903. Slides with type specimens and other specimens from STEINER's collection were put at our disposal by A. MORGAN GOLDEN (Beltsville, Maryland). Specimens were mounted in either balsam or glycerin. Most slides were clearly labeled in G. STEINER's handwriting indicating species, sex, number and location data.

All of the glycerin mounts had been sealed with paraffin and were either leaking or dry, but most of the specimens remained in a thin film of glycerin and could be salvaged and remounted. Therefore, glycerin was placed along the edges of the top cover glass of the original slide, gradually filling the mount, then the specimens were allowed to soak for one to two weeks. The top cover glass was gently removed, specimens transferred to clean glycerin, and placed in a dessicator for 72 hours. Specimens were then mounted in anhydrous glycerin.

Some of the balsam mounts were drying and cracking, and had to be remounted using the following procedure (GOLDEN, pers. comm.). If on metal slides, first the cardboard labels were removed, the mount removed and placed on a glass slide, then the slide and mount was completely immersed into a Balsam solution (50% mounting Balsam: 50% Xylene) in a glass petri dish. If a mount could not be removed, the metal slide was turned upside down in the Balsam solution. Mounts on glass slides were removed by cutting off the label section(s) of the slide with a glass cutter, leaving just the section containing the mount. Each mount section was then placed on a glass slide and immersed in the Balsam solution. The petri dish was then placed in a 43°C oven and checked each day. As soon as the cover glass floated free, specimens were removed using a warmed, very fine metal needle, and mounted one specimen per slide in mounting Balsam. The new mounts were thoroughly dried on a warming plate for one to two weeks.

The following type specimens were examined from the STEINER material: *Bathyepsilonema brachycephalum* (1 ♂, slide 41a = USDA T-390t), *B. cobbi*

(1 juv, slide 14 = USDA T-471t), *B. coilocricum* (1 juv, slide 5 = USDA T-463t), *B. crenatum* (1 juv, slide 14 = USDA T-471t), *B. cricotum* (1 ♀, slide 38 = USDA T-486t), *B. dicamptum* (1 ♀, slide 32 = USDA T-483t), *B. drygalskii* (1 ♂, slide 6 = USDA T-391t), *B. vanhoeffeni* (1 ♂, slide 32 = USDA T-483t). Other type material was not available; *B. condylocricum* (♀) mentioned on the original label of slide 6, was not recovered during remounting.

### RECENT U.S. ANTARCTIC SPECIMENS

They consist of two separate series of more recently collected specimens by the Smithsonian and the researchers of the University of California, Davis (UCD).

The Smithsonian sample (U.S.M.N.H. Acc. No. 226350), was put at our disposal by W.D. HOPE. It was collected on 28 January 1959 by Mr. WILSON on Cruise No. 611 of the ship North Wind during "Program Deep Freeze" No. 14, and donated to the Smithsonian Institution by J. TYLER. The sample was collected from bottom mud at a depth of 135 m using a triangular dredge, off Duke Ernst Bay, Weddell Sea, at Station NW-8, 77°40'S, 35°30'W. Specimens were preserved in 5% formalin in Antarctica. In Davis the selected specimens were transferred to FAA, and processed to anhydrous glycerin by THORNE's method (1961). This sample (UCD Antarctica 21) contained two males and one juvenile of *Bathyepsilonema drygalskii*, and one female and one juvenile of *B. brachycephalum*.

The second group of recent specimens was collected by D.R. VIGLIERCHIO and R.W. TIMM. Specimens were heat killed in sea water and preserved in 5% formalin in Antarctica. The samples were examined at Davis, specimens transferred to FAA, and processed to anhydrous glycerin by THORNE's method. Three samples from this expedition contained specimens of *Bathyepsilonema*.

— Ross Island, dredge through four ice holes, 1500 m, in front of Scott Base:

- sample Antarctica 10, collected 16 January 1970 at 540 m depth: *B. drygalskii*: 4 ♂♂, 3 ♀♀, 1 juv; *B. brachycephalum*: 10 ♂♂, 17 ♀♀, 14 juv.

- sample Antarctica 13, collected 10 January 1970 at 340 m depth: *B. drygalskii*: 2 ♀♀; *B. brachycephalum*: 1 ♂, 4 ♀♀, 1 juv.

— Ross island, a dredge at 89 m depth from aboard the U.S. Coast Guard Cutter "The Burton Island",

Fig. 1. — *Bathyepsilonema drygalskii* STEINER, 1931. Type male, USDA slide T-391t: A. surface view of entire male. B. Head region in surface view, right side. Male specimen from Antarctica, Duke Ernst Bay: C-D. Head region in surface view, respectively right side and left side.

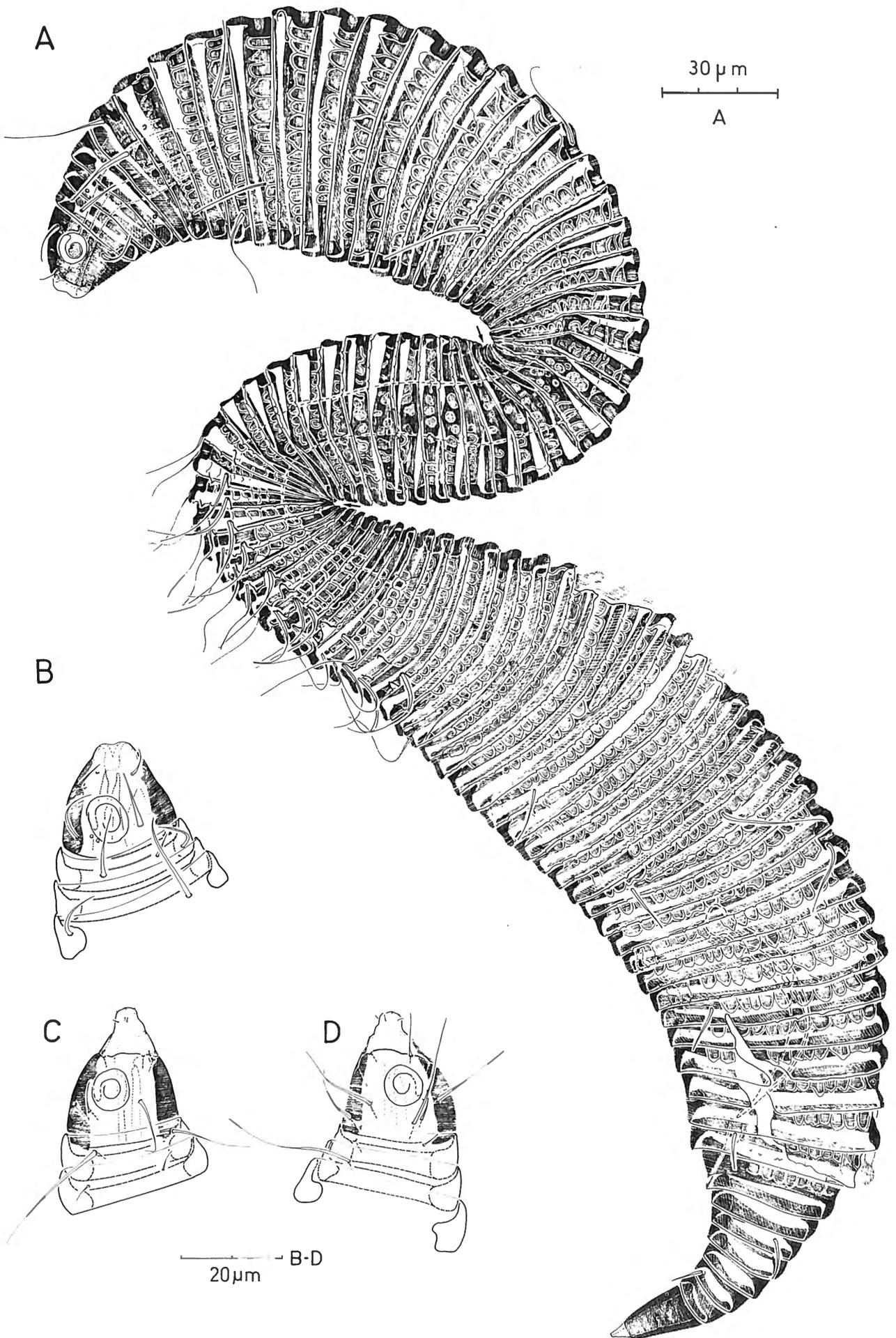


Table 1  
*Morphometric data of Bathyepsilonema drygalskii STEINER, 1931*

Characters	Steiner (1931)		Recent American Antarctic Expedition			
	Male type	Males	Females	j <sub>4</sub>	j <sub>3</sub>	j <sub>2</sub>
n	1	4	4	1	1	1
L (µm)	530	590-635 (609 ± 18)	565-665 (605 ± 38)	560	410	305
Number of body rings	89	87-89 (88.0 ± 0.8)	86-91 (89.0 ± 2.0)	85	85	93
Head width (µm)	21	19-22 (20.8 ± 1.3)	19-21 (20.0 ± 0.7)	17	16	14
Head length (µm)	22	23-25 (23.8 ± 0.8)	—	—	—	—
Amphid width (µm)	8	8.5-10 (9.5 ± 0.6)	8-9 (8.4 ± 0.4)	7	5.5	—
Amphid (%)	36	43.2-50.0 (45.8 ± 2.5)	38.1-47.4 (42.0 ± 3.5)	41.1	34.4	—
Setae lengths (µm)						
cephalic	6	8.5-11 (9.3 ± 1.2)	8.5-11 (9.6 ± 1.0)	8	8.5	7.5
subcephalic	13	18-20 (19.3 ± 0.9)	18-21 (19.3 ± 1.3)	14	16	—
somatic (pharyngeal)	17	25-29 (26.3 ± 1.9)	26-29 (27.8 ± 1.1)	21	28	—
anteriormost ambulatory seta of outer row	21	22-28 (25.8 ± 2.5)	22-30 (26.5 ± 2.9)	25	23	17
supporting setae	12	12-16 (14.3 ± 1.5)	21-22 (21.5 ± 0.5)	20	20	18
Pharynx (µm)	—	97-108 (102.5 ± 4.0)	98-102 (100 ± 2.0)	—	81	—
Tail	60	58-61 (60 ± 1.2)	51-60 (55.3 ± 3.3)	50	50	43
Max. body diam. (µm)	63	60-65 (62.0 ± 1.9)	64-72 (69.0 ± 3.6)	—	—	22
Phar. body diam. (µm)	60	56-57 (56.8 ± 0.4)	50-51 (50.5 ± 0.5)	—	—	33
Anal/cloacal body diam. (µm)	—	26-27 (26.3 ± 0.4)	22-26 (23.8 ± 1.5)	24	21	20
Min. body diam. (µm)	35	30-32 (31 ± 1.0)	29-33 (30.3 ± 1.6)	—	—	20
Non-annulated tail end (µm)	22	19-27 (22.8 ± 3.0)	26-28 (27 ± 1.0)	23	20	14
Spicule (µm)	66	62-71 (66 ± 3.2)	—	—	—	—
Gubernaculum (µm)	—	13	—	—	—	—
V %	—	—	68-71 (69.3 ± 1.1)	—	—	—
Ratios						
a	8.8	9.2-10 (9.9 ± 0.4)	8.2-9.5 (9.0 ± 0.6)	—	—	9.2
b	—	5.7-6.1 (6.0 ± 0.2)	5.9-6.8 (6.4 ± 0.5)	—	5.1	—
c	8.8	9.7-10.2 (10 ± 0.3)	10.2-11 (11 ± 0.6)	11.2	8.2	7.1
mbd/ (mbd)	1.8	1.9-2.1 (2.0 ± 0.1)	2.2-2.5 (2.3 ± 0.1)	—	—	1.6

at Backdoor Bay, Cape Royds, sample 14, collected 31 January 1970: *B. drygalskii*: 1 ♂; *B. brachycephalum*: 3 ♂♂, 4 ♀♀, 3 juv.

The *Bathypsilon* specimens from the recent U.S. Antarctic Expeditions are deposited in the nematode collections of The Smithsonian Institution, Washington D.C. (USNM): 14 slides, 35 specimens; the University of California, Davis (UNCN): 9 slides, 19 specimens and the Royal Belgian Institute of Natural Sciences, Brussels: (RIT) slide nos 89-94, 21 specimens.

***Bathypsilon drygalskii* STEINER, 1931**  
(Fig. 1A-D, 2A-E, 3A-B, 4A-C, Table 1)

All synonyms of *Bathypsilon drygalskii* as in LORENZEN (1973) except for *B. condylocricum* STEINER, 1931, *B. cricotum* STEINER, 1931 and *B. dicampterum* STEINER, 1931 which all represent *Bathypsilon brachycephalum* STEINER, 1931.

A redescription of *B. drygalskii* is based upon the type specimen, other specimens from the STEINER collection and specimens from the Antarctic U.S. Expedition of 1969-1970.

MEASUREMENTS

See Table 1.

DESCRIPTION

*Male type specimen*: Body epsilon-shaped, clearly enlarged in pharyngeal and posterior body regions. Cuticle with 89 large rings, overlapping by hyaline outerlayer. Ringwidth at level pharyngeal bulb: 11.5 µm with a 7.5 µm wide ring base. Overlap direction reversal occurs dorsally at level of ventral body curvature in ring 37, ventrally between rings 28 and 29 at level of dorsal curvature (Fig. 1A, arrows). Anterior and posteriormost annules are homogeneous massive rings; from the fifth annule on with a garland-like ornamentation of the outer cuticular layer. This ornamentation is formed by fine ridges protruding at the overlapping annule edge as small spines, which are most obvious ventrally at level ventral bend and in between the ambulatory setae. Ridges also more pronounced ventrally and precloacally. The cuticular ridges delimit large rectangular vacuoles, well marked in the narrow body zone.

The different structure types of the annules recognized by STEINER (1931) and described as: vasuolar, fungus- or spongelike, granular or vesicular types do not all represent different structures, some types are due to fixation. They can be reduced to the two previously described types (smooth and garland-like with vacuoles and ridges).

Somatic setae arranged in eight longitudinal rows in pharyngeal region; most setae broken off. Ambulatory setae long, finely tapered distally to an open tip; knee-like bent at proximal third; insertion point marked by cleft in upper cuticle. Arranged in six longitudinal subventral rows: the inner rows with twelve to thirteen setae, the intermediate rows with nine to twelve setae, and the outer rows with nine to twelve setae followed by four supporting setae. A few setae are broken off.

Head with labial region retracted. Head cuticle, except for labial region, thickened, sclerotized, forming a helmet. Four cephalic setae, two broken off; each seta followed by a pore on the left side of the head or a short seta on the right side (Fig. 1B,C). Four subcephalic setae present: one subdorsal and one ventrosublateral seta on each side; dorsosublaterally near posterior border of amphideal fovea are two pores (? one of them an insertion site of a subcephalic seta). In the original drawing (STEINER, 1931, Fig. 9) an additional subventral subcephalic seta was drawn on the left side at about mid-amphid level, but only a vague indication of its insertion was observed in the type specimen. Amphideal fovea spiral, slightly more than one coil, ventrally whirled; its diameter 36% of the corresponding head width.

Digestive system and reproductive system obscure. Spicules, 66 µm long, shaft strongly curved, with ventral flange and marked manubrium. No copulatory thorns.

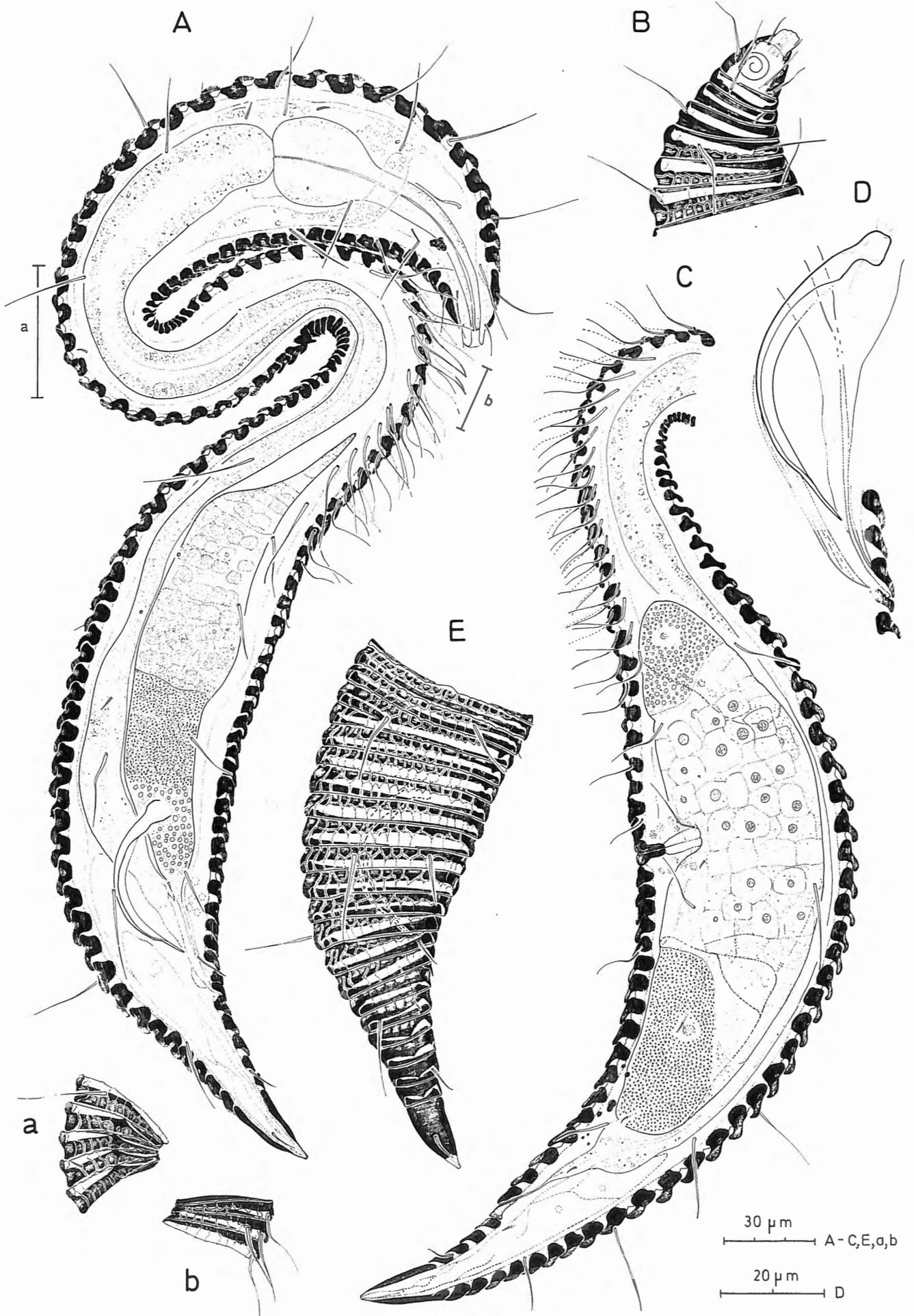
Tail with seven annules. Endring 33% of total tail length. Caudal glands and spinneret present.

*Males* (based on specimens from STEINER's collection and from Recent U.S. Antarctic Expeditions): They largely agree with the type specimen, providing information on the variability of morphometric data and morphological features. Most specimens slightly flattened and the internal structures not always well preserved.

Cuticle with 85-88 annules in STEINER's specimens, 87-91 (mean value 88) in Recent U.S. Antarctic specimens; inversion in direction of annules dorsally between rings 35-38, ventrally in zone between the 26 to the 28th ring. Annules similar to the type specimen, representing the different structure types as described in STEINER (1931), all with a garland-like ornamentation of vacuoles and more or less pronounced ridges.

Ambulatory setae knee-like bent as in the type specimen, arranged in six well defined longitudinal rows: the inner rows have eleven to fourteen setae, the intermediate rows twelve to thirteen setae and the outer rows twelve to thirteen setae, followed by four shorter, fine, straight supporting setae (Fig. 2A).

Head with labial region usually retracted. Four cephalic setae, in most specimens, followed by two sub-



dorsal and two subventral pores, with or without inserted seta(e). In *B. pachycricum* STEINER, 1931, e.g., a seta was present subdorsally. Number and arrangement of subcephalic setae variable. In STEINER's specimens two to four subcephalic setae arranged on a single row or on two transverse rows were shown in original figures. In the U.S. Antarctic specimens a different number of subcephalic setae was counted on the head: six (2 ♂♂), eight (2 ♂♂) or nine setae (3 ♂♂). The number and arrangement varied between right side (3-4 setae on a single row) and left side (3-5 setae on one or two rows) of the head in a single specimen (Fig. D, E) and between specimens.

Usually, the following configuration was present on one side of the head: a short dorsosublateral seta near the amphid base, a longer subdorsal and a longer laterosubventral seta; additionally we observed per head side one subventral seta, a laterosubdorsal seta; if two rows of subcephalic setae are present, the second or posterior row is formed by a subventral and a laterosubdorsal or two laterosubventral setae.

Amphideal fovea as in type specimen, lying in the posterior half of the head i.e. clearly behind the insertion of the cephalic setae, its diameter 43-50% of the corresponding head width.

Stoma small, with a minute dorsal tooth and two (?) subventral denticles. Pharynx narrow cylindrical, slightly enlarged in front of nerve ring and with a pronounced terminal bulb with well sclerotized lumen. Small brownish pigmented granules present in the pseudocoel at the level of annules 3-5 in several specimens.

Male reproductive system with a single outstretched testis, extending anteriorly up to the ventral body curvature. Spicules 62-71 µm (62 µm in *B. vanhoeffeni* STEINER, 1931), same structure as in the type specimen; gubernaculum 13 µm long, a thin structure. One pair of paracloacal setae present at the level of, or just anterior to the cloaca. No copulatory thorns nor supplements present.

Tail with six to seven annules, including the conical shaped endring with a pair of lateral somatic setae (often broken off). Caudal glands well developed, extending beyond the cloaca.

*Females*, based on data from STEINER (1931) and on specimens from the Recent U.S. Antarctic expeditions: similar to males for most characteristics. Habitus as in males but caudal arc larger. Cuticle with 86-90 rings (according to STEINER's descriptions),

86-92 (90) annules in Recent U.S. Antarctic specimens, with inversion in direction dorsally in the zone between annules 34 to 38, ventrally between rings 27 to 30; ornamented as in male. Ambulatory setae as in male, arranged in six longitudinal subventral rows, all anterior to the vulva: the inner rows with thirteen to fifteen setae, the intermediate rows with twelve to nineteen setae and the outer rows with thirteen to seventeen setae followed by three to four supporting setae. There are one or two pairs of vulval setae anterior to the vulva and one pair posterior to it.

Head and amphideal fovea as in male but slightly smaller in diameter. Four cephalic setae, followed by two subdorsal and two subventral pores (= insertion sites); a setae was drawn subdorsally in the original figure of *B. allocotum* STEINER, 1931 (Fig. 5a). Subcephalic setae showing variability in their arrangement between right and left side of the head in a single specimen and between specimens. STEINER's specimens with three to four subcephalic setae on one side of the head, arranged on two, respectively one row (STEINER, 1931). The Recent U.S. Antarctic specimens all have eight subcephalic setae, usually four on each side of the head and arranged on a single circle as follows: one subventral, one laterosubventral, one shorter laterosubdorsal and one subdorsal; the short laterosubdorsal seta can be accompanied by a pore. In two specimens the subcephalic setae were arranged on two rows on one side of the head.

Female reproductive system didelphic, amphidelphic with reflexed ovaries, both branches to the right side in two specimens. Spermathecae obscure; uterus with large cells. Vulva located between rings 65-66 or 66-67, at 68-71% of the total body length from anterior end. Tail with five or six annules, including conical shaped endring which bears a pore (= insertion of a seta which is broken off?) laterally about halfway down.

*Juveniles*. Among STEINER's material were seven juvenile specimens, apparently belonging to the second stage in *B. amphibolum* STEINER, 1931, with two rows of eight ambulatory setae; the third stage in *B. adenorhynchum* STEINER, 1931, with two rows of twelve ambulatory setae, and the fourth stage in *B. rhomaleum* STEINER, 1931 and *B. rhomaleum* var. *pleocricum* STEINER, 1931, *B. cobbi* STEINER, 1931 and *B. crenatum* STEINER, 1931 with six longitudinal rows of ambulatory setae and *B. coilocricum* STEINER, 1931 with four rows of thirteen ambulatory setae in the outer rows, eleven in the inner rows.

Fig. 2. — *Bathyepsilonema drygalskii* STEINER, 1931. Male: A. Total specimen from Cape Royds, with indications of the levels a, b with a detail of the body cuticle in surface view. B. Head region in surface view. D. Copulatory apparatus (specimen from Duke Ernst Bay). E. Surface view of posterior body region (specimen from Cape Royds). Female: C. Posterior body region with reproductive system (specimen from Scott Base).

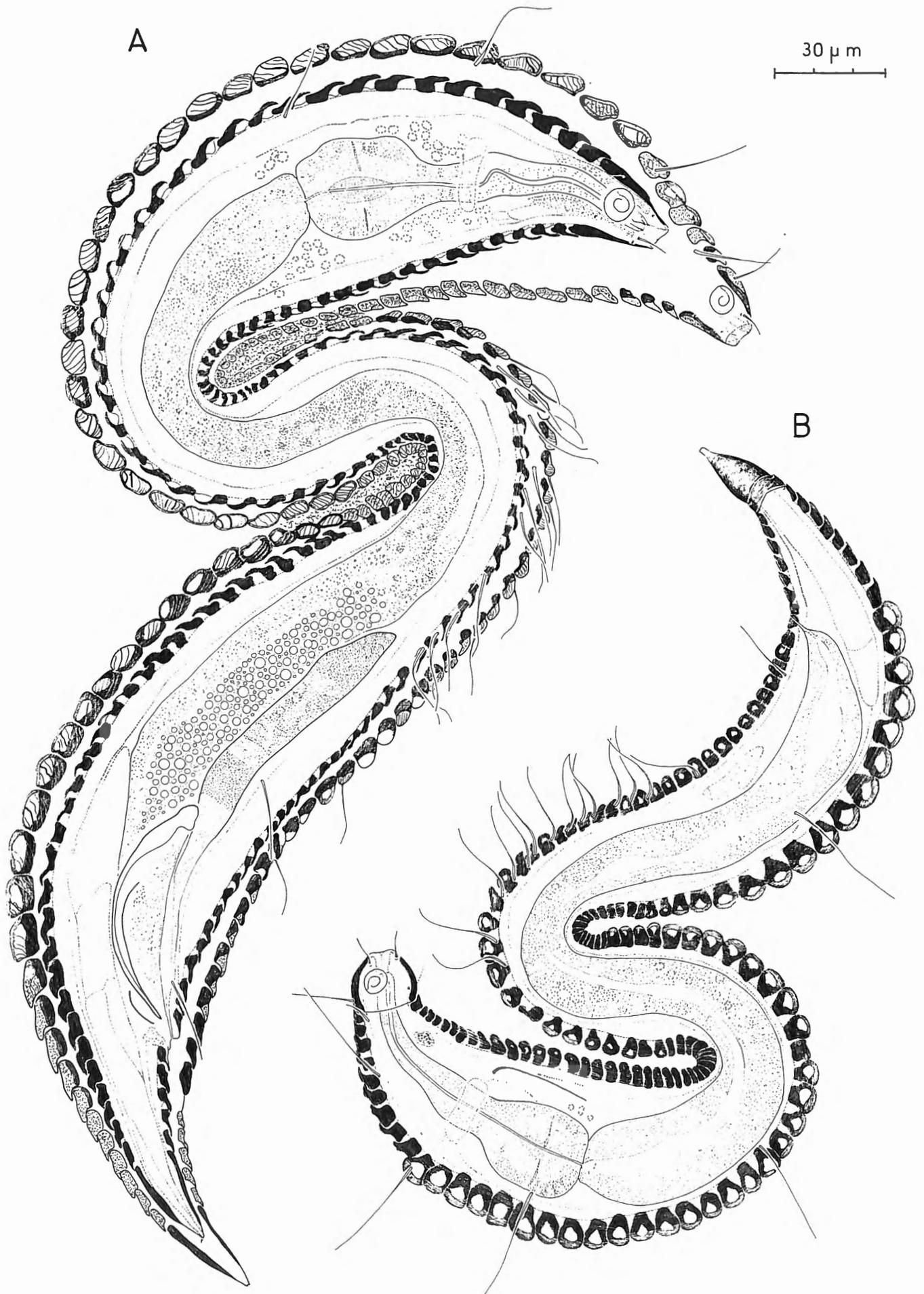


Fig. 3. — *Bathyepsilonema drygalskii* STEINER, 1931. Juveniles: A. Fourth stage, molt to male, entire specimen (Duke Ernst Bay). B. Third stage, = entire specimen (Scott Base).

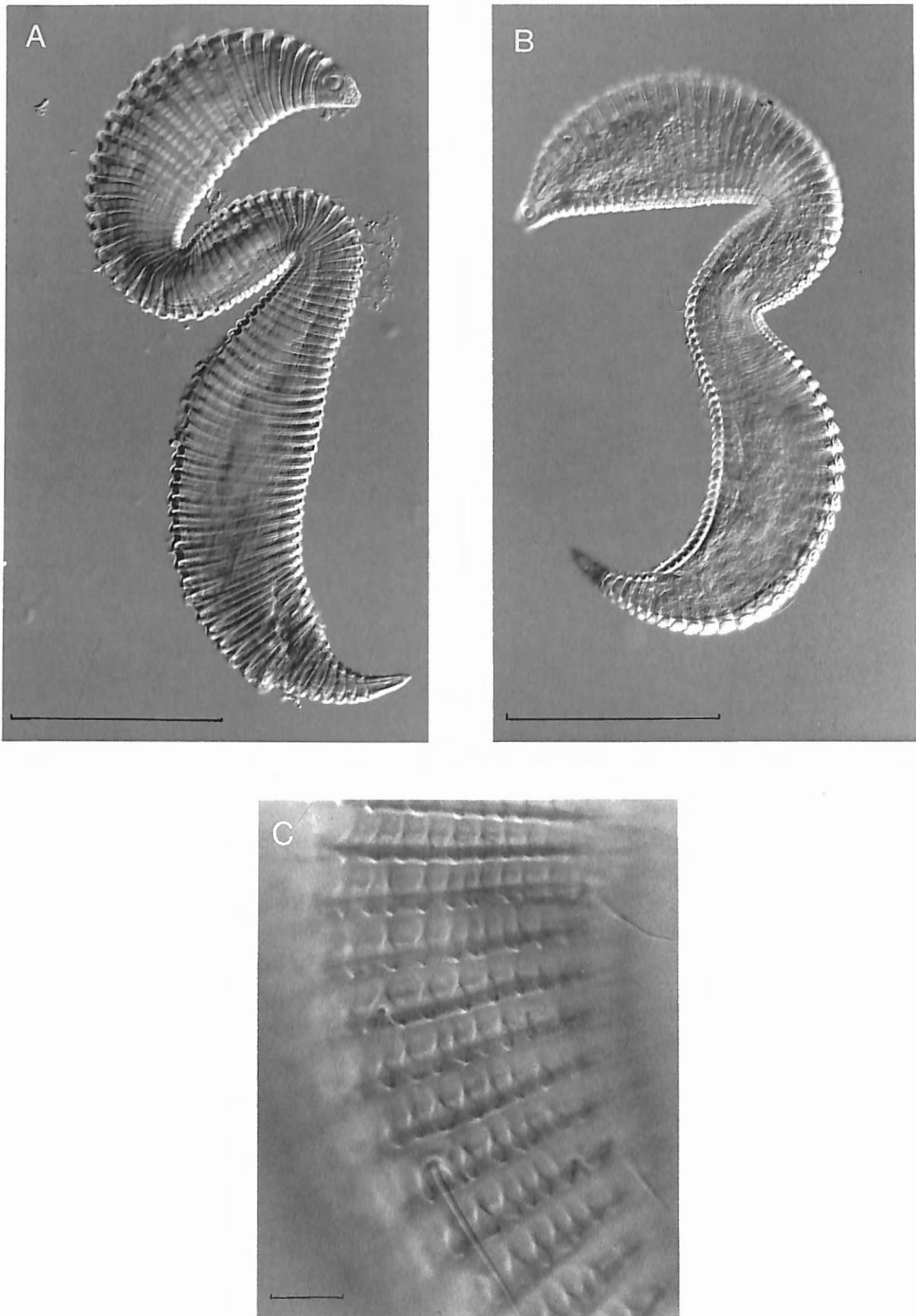


Fig. 4. – *Bathypsilonema drygalskii* STEINER, 1931. A. Male type specimen in toto (bar = 100  $\mu$ m). B. Juvenile type specimen of *Bathypsilonema coilocricum*, total view (bar = 100  $\mu$ m). C. Detail of the body cuticle in precloacal region of a male specimen from Duke Ernst Bay (bar = 10  $\mu$ m).

Table 2  
*Morphometric data of Bathyepsilonema brachycephalum STEINER, 1931*

Characters	Steiner (1931)		Recent American Antarctic Expedition		
	Male type	Males	Females	j <sub>4</sub>	j <sub>3</sub>
n	1	7	10	8	5
L (µm)	415	450-595 (535 ± 46)	420-560 (503 ± 35)	385-525 (440 ± 43)	320-385 (342 ± 31)
Number of body rings	95	95-99 (97.0 ± 1.2)	92-101 (97.4 ± 2.5)	90-96 (93.1 ± 1.8)	87-94 (90.0 ± 3.1)
Head width (µm)	19	18-22 (20.6 ± 1.4)	17-22 (19.6 ± 1.4)	17-19 (18.0 ± 0.6)	15-18 (16.0 ± 1.4)
Amphid width (µm)	8.5	9.5-10 (9.8 ± 0.2)	8-9 (8.4 ± 0.3)	8-9 (8.3 ± 0.4)	6.5-8 (7.2 ± 0.6)
Amphid (%)	45	43.2-52.0 (48.6 ± 3.2)	40.0-50.0 (42.9 ± 2.7)	42.1-50.0 (46.2 ± 2.7)	43.3-46.7 (44.8 ± 1.4)
Setae lengths (µm)					
cephalic	—	7-9.5 (7.8 ± 0.9)	6.5-8.5 (7.5 ± 0.6)	6.5-7.5 (7.3 ± 0.4)	6-6.5 (6.3 ± 0.2)
subcephalic	—	16-21 (18.6 ± 1.4)	15-19 (17.6 ± 1.4)	7.5-18 (14.9 ± 4.3)	13-17 (15 ± 2.0)
somatic (pharyngeal)	20	16-27 (23.2 ± 3.5)	23-27 (24.8 ± 1.5)	22-25 (23.8 ± 1.2)	24
anteriormost ambulatory seta of outer row supporting setae	20	16-19 (24.9 ± 3.9)	26-29 (27.8 ± 0.9)	25-29 (27.3 ± 1.5)	22-24 (23.0 ± 1.0)
Pharynx (µm)	83	10-15 (12.6 ± 1.7)	14-21 (18.4 ± 2.0)	17-20 (18.2 ± 1.2)	20
Tail (µm)	42	91-98 (95.3 ± 2.3)	81-98 (90.7 ± 5.7)	79-93 (86.5 ± 5.0)	76-80 (78.3 ± 1.7)
Max. body diam. (µm)	42	48-60 (53.7 ± 3.9)	46-59 (51 ± 4.1)	46-52 (50 ± 2.1)	46-51 (48.3 ± 2.1)
Phar. body diam. (µm)	50	40-50 (45.6 ± 3.4)	47-62 (53.9 ± 4.6)	31-49 (41.3 ± 6.7)	25-34 (28.3 ± 4.0)
Anal/cloacal body diam. (µm)	49	41-56 (45.4 ± 4.9)	41-35 (46.5 ± 4.2)	39-59 (46.8 ± 4.7)	33-45 (37.3 ± 5.4)
Min. body diam. (µm)	20	21-23 (22.6 ± 0.7)	19-24 (21.2 ± 1.5)	21-23 (22.2 ± 0.7)	18-23 (20.3 ± 2.1)
Non-annulated tail end (µm)	27	24-28 (26.9 ± 1.4)	26-31 (28.3 ± 1.9)	24-29 (27.3 ± 1.8)	21-25 (22.7 ± 1.7)
Spicule (µm)	19	19-25 (21.7 ± 2.2)	18-23 (21.0 ± 1.3)	18-25 (20.0 ± 2.6)	16-18 (17 ± 0.8)
Gubernaculum (µm)	42	44-51 (48.0 ± 2.6)	—	—	—
V %	—	6-11 (8.5 ± 1.8)	—	—	—
Ratios			64-68 (66.4 ± 1.3)	—	—
a	8.3	9.8-13.0 (11.7 ± 1.3)	7.8-11.0 (9.5 ± 1.1)	8.1-10.0 (9.4 ± 0.7)	8.6-9.7 (9.2 ± 0.5)
b	5.0	4.8-6.1 (5.6 ± 0.4)	5.0-6.4 (5.5 ± 0.5)	4.2-5.6 (5.1 ± 0.5)	4-5.1 (4.4 ± 0.5)
c	9.9	9.4-10.0 (10.0 ± 0.4)	8.6-10.0 (9.8 ± 0.8)	7.4-10.0 (8.8 ± 1.2)	6.7-7.5 (7.1 ± 0.3)
mbd/ (mbd)	1.9	1.6-2.1 (1.8 ± 0.2)	1.6-2.1 (1.9 ± 0.2)	1.6-1.9 (1.7 ± 0.1)	1.5-1.8 (1.6 ± 0.1)

Among the Recent U.S Antarctic specimens three juvenile stages were present: the fourth, third and second stage.

*Fourth stage juvenile* (Fig. 3A): Only one young male specimen molting to an adult available. Similar to adult. Cuticle with 85 annules (89 in future male), deformed, swollen, granulated, some rings with swollen vacuoles. Ambulatory setae arranged in four longitudinal subventral rows: the inner rows with nine setae each, the outer rows with ten setae followed by two supporting setae.

Labial region retracted. Four cephalic setae. One pair of subdorsal subcephalic setae observed. Amphideal fovea spiral; its diameter 41% of the corresponding head width. Future male with reproductive system fully developed, testis reaching to posteriormost ambulatory setae; its spicules and gubernaculum well developed: spicules 65  $\mu$ m long, gubernaculum 14  $\mu$ m long. Tail with six rings, including non-annulated tail end; similar for future male. Caudal glands and spinneret present.

*Third stage juvenile* (Fig. 3B): Single specimen observed, similar to fourth stage, specimen swollen due to fixation. Cuticle with 85 annules which are swollen, deformed or vacuolated. Somatic setae in six longitudinal rows in pharyngeal region. Ambulatory setae in two longitudinal subventral rows of thirteen setae, followed by two supporting setae.

Head region swollen, labial region retracted. Four cephalic setae; only two subcephalic setae observed: one right subdorsal and one left subventral. Amphideal fovea spiral, its diameter 34% of corresponding head width. Pigmented granular spots present in the pseudocoel at level of rings three and four. Genital primordium of a small number of cells. Tail with eight rings, including conical endring. Caudal glands extending anteriorly beyond anus.

*Second stage juvenile*: Description based upon a single specimen described as *B. amphibolum* STEINER, 1931. Cuticle with 93 rings (counted subdorsally on original plate 25 fig. 1). Ambulatory setae in two longitudinal subventral rows of eight setae each, followed posteriorly by one supporting seta. Four cephalic setae, no subcephalic setae. Amphideal fovea spiral as in other stages. Reproductive system not described nor figured. Tail with twelve rings ventrally, thirteen dorsally, including conical endring.

*First stage juveniles*: unknown.

*Diagnosis emended*: *Bathyepsilonema drygalskii* STEINER, 1931 is characterized by the number of body rings 88 in male, 89 in female (mean values), the position of the amphideal fovea in the posterior head region, the garland-like ornamentation of the annules, and in males by the length and shape of the spicules: 66 to 71  $\mu$ m, curved ventrally and with offset manubrium and velum.

#### TYPE MATERIAL

Male type, slide USDA T-391t.

#### OTHER MATERIAL

See materials and methods.

#### TYPE LOCALITY AND HABITAT

Gausz-station, Wilhelm II Coast, Antarctica, marine residue sample collected at a depth of 385 meters, on 6 December 1902 by the German South Polar Expedition.

#### OTHER LOCALITIES

See materials and methods.

### ***Bathyepsilonema brachycephalum* STEINER, 1931** (Fig. 5A-I, 6A-E, 7A-D, Table 2)

Syn.: *Bathyepsilonema condylocricum* STEINER, 1931 syn. n.

*Bathyepsilonema cricotum* STEINER, 1931 syn. n.

*Bathyepsilonema dicampteryum* STEINER, 1931 syn. n.

*Bathyepsilonema (Epsilonella) gracilis* (STEINER, 1931) LORENZEN, 1973, syn. n.

*Epsilonella gracilis* STEINER, 1931 syn. n.

In STEINER's collection, the group of epsilonematids with a relative high number of body rings and a garland-like ornamentation of the cuticular rings and a far anterior position of the amphideal fovea on the head was represented by five species; each of them originally described upon a single specimen. Three of them: *B. brachycephalum*, *B. cricotum*, *B. dicampteryum* were available for study.

#### MEASUREMENTS

See Table 2.

#### DESCRIPTION

*Male type specimen*: Body epsilon-shaped, enlarged in pharyngeal and posterior body regions; Body broken during remounting and six annules missing. Cuticle with 95 annules, overlapping by hyaline outer-layer. Ring overlap direction reversal in narrow body zone, dorsally between rings 39 and 40, ventrally between rings 30 and 31. First two anterior rings and tail rings are smooth; in between, annules with garland-like ornamentation of the outer cuticle consisting of fine ridges protruding at the overlapping annule edge as small spines (strongest developed in between

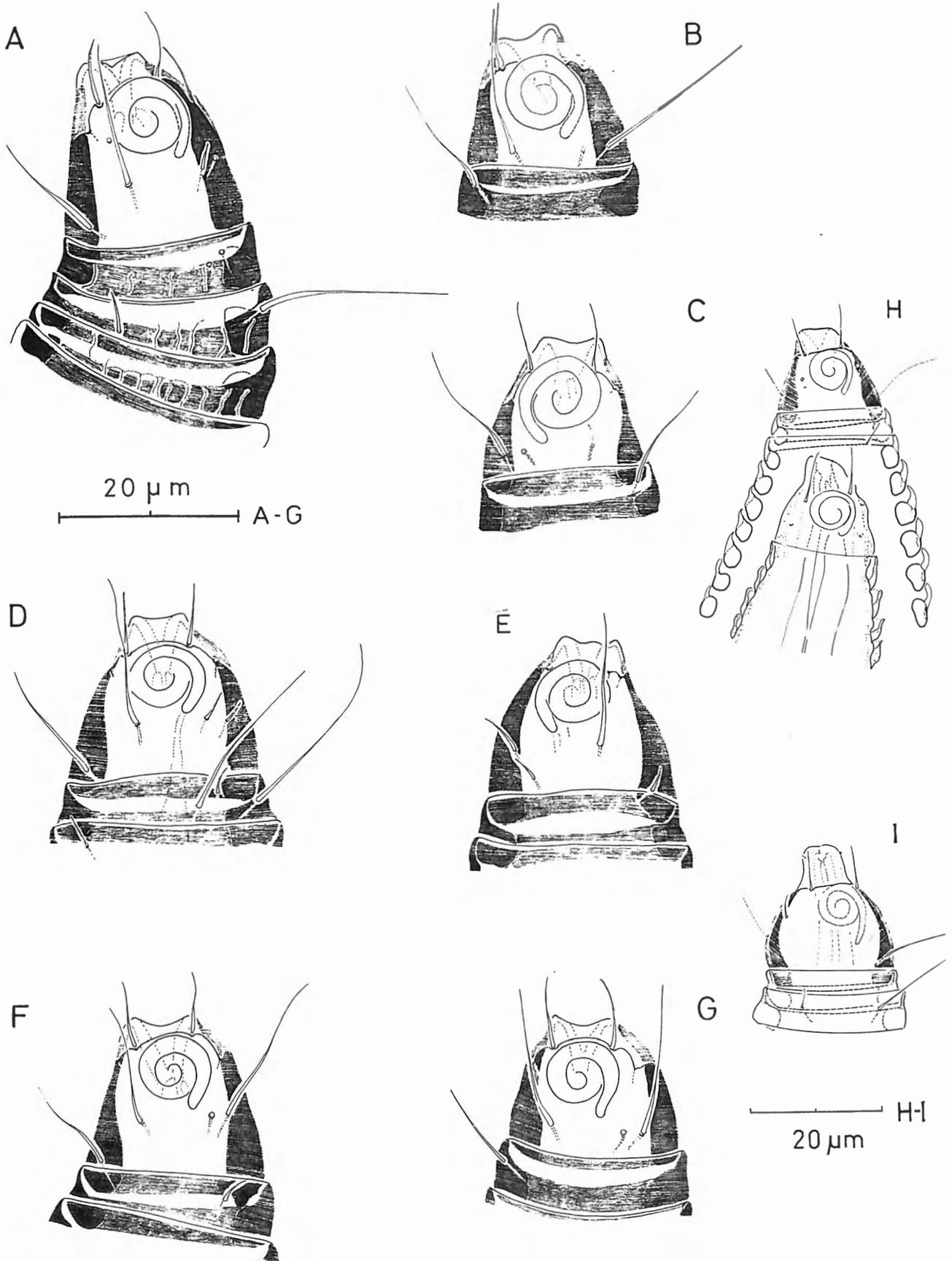


Fig. 5. — *Bathypsilonema brachycephalum* STEINER, 1931. Head region in surface view: A. Male specimen from Cape Royds. B-C. Male specimen from Cape Royds, respectively left side and right side of head. Females: D-E, specimen from Scott Base, respectively left side and right side. F-G. specimens from Scott Base. Juveniles: H. Third stage, molt to fourth stage, a specimen from Scott Base. I. Fourth stage juvenile, specimen from Scott Base.

ambulatory setae) and delimiting large rather faint vacuoles in ring base. At level of dorsal and ventral curvature, annules with ring base respectively anteriorly and posteriorly directed in lateral field. Annules widest at level pharyngeal bulb: 8.5  $\mu\text{m}$  with a 5.7  $\mu\text{m}$  wide base, narrower posteriorly: 5.7  $\mu\text{m}$  with a 4.3  $\mu\text{m}$  wide base in caudal arc in front of copulatory apparatus (measurements taken subdorsally).

Somatic setae arranged in eight longitudinal rows on pharyngeal region (several broken off). Ambulatory setae long, finely tapered distally, caudally knee-like bent; insertion point marked by a cleft in the cuticular ring base. Arranged in six longitudinal subventral rows: two inner and two intermediate rows obscure, number of setae not to determine beyond doubt; the two outer rows with ten to eleven setae per row, followed posteriorly by five supporting setae (counted by their insertion).

Labial region retracted. Head helmet slightly swollen. Four cephalic setae, all broken off as well as the subcephalic setae. Four pores were observed posterior to the insertion of the four cephalic setae, at about mid-amphid level. Insertion of subcephalic setae apparently as follows: one laterosubventral, one laterosubdorsal on both sides of the head. Amphideal fovea large spiral, one and a half coil; its diameter 45% of the corresponding head width, and situated far anteriorly on the head. Pharynx with a slight median swelling in front of nerve ring, posterior bulb well developed.

Reproductive system monorchic, outstretched; testis extending to posteriormost ambulatory setae. Spicules 42  $\mu\text{m}$  long, shaft curved ventrally with ventral flange; manubrium expanded. Gubernaculum obscure.

Tail with eight rings, including conical endring; the latter is 36% of the total tail long and possesses one seta on each side in the anterior half. Caudal glands and spinneret present.

*Males*, based on specimens from Recent U.S. Antarctic Expeditions: Similar to type specimen. Cuticle with 95-99 (97, mean value) annules. Overlap direction reversal on narrow body region, dorsally between rings 37 and 38, 38 and 39 or 40 and 41; ventrally on ring 28, or between rings 28 and 29, 29 and 30, 30 and 31. Ring edges spiny scalloped-shaped, except on first three anterior rings and posterior tail rings where smooth.

Somatic setae usually long (a few short setae), arranged in eight longitudinal rows in pharyngeal region. Ambulatory setae arranged in six longitudinal subventral rows: two inner rows of ten to twelve setae, two outer rows with eight to twelve setae followed posteriorly by three to five supporting setae.

Head with labial region retracted. Four fine cephalic setae inserted at anterior border of helmet; one pore posterior to each seta. Five to seven subcephalic setae

arranged on a single transverse row or nine setae arranged on two transverse rows (the posterior row with one subventral and one laterosubdorsal seta on one side and a single subventral seta on the other side of the head). Most specimens with six subcephalic setae arranged on the same level: one subventral or one laterosubventral, one laterosubdorsal and one subdorsal. Amphideal fovea as in type specimen, far anterior on the helmet near the base of the cephalic setae; its diameter 43-53% of the corresponding head width.

Stoma small, with a small dorsal tooth and two minute subventral ones. Pharynx with slight median swelling in front of nerve ring; posterior bulb well developed. Finely granular pigment spots usually present, subdorsally opposite the third or fourth ring.

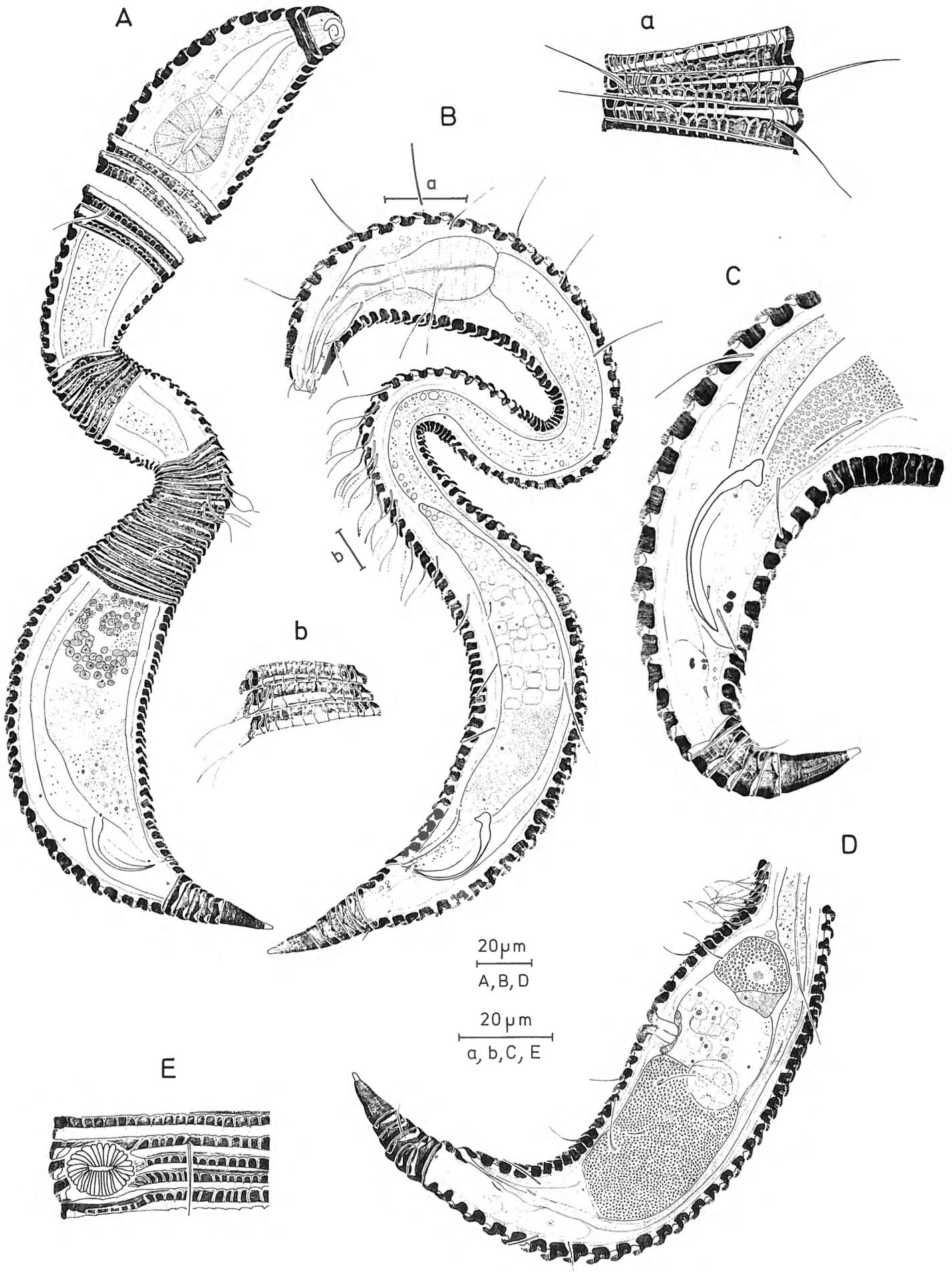
Reproductive system monorchic; testis extending anteriorly almost to the posteriormost ambulatory setae or to the ventral curvature in one specimen. Usually, one pair of anal setae near the cloaca. Spicules 44-51 (48)  $\mu\text{m}$  long, similar as in type specimen; gubernaculum 6-11 (8.5)  $\mu\text{m}$  long, thin, parallel to the spicules and rather obscure.

Tail with seven to nine (usually eight) annules, including terminal ring. Conical endring with a pair of lateral setae on its anterior half. Caudal glands and spinneret as in type.

*Females*, based on Steiner's specimens and on specimens from the Recent U.S. Antarctic Expeditions: Similar to males for most characteristics; body with slightly wider caudal arc. Cuticle with 93-101 (97.6, mean value of 25 specimens). Ring overlap direction reversal dorsally on rings 38, 39 or 40 or in between two rings in the zone between annules 37 and 40, ventrally between two rings in the zone between rings 28 and 32. Ambulatory setae arranged in six longitudinal subventral rows: two inner rows with eleven to fourteen setae; two intermediate rows with eleven to thirteen setae and two outer rows with nine to thirteen setae followed posteriorly by three to four supporting setae.

Labial region retracted (partially or completely), rarely extended, with six labial external setae. Four cephalic setae, each followed by a pore, rarely by one or two seta(e). Four to six subcephalic setae arranged on a single row or on two rows on one side of the head (one female) or seven to nine setae arranged on two rows, arrangement similar to males. Amphideal fovea as in male; its diameter 40-50% of the corresponding head width.

Reproductive system didelphic, amphidelphic with reflexed branches, usually to the left side of the body; in some specimens anterior branch to the left side, posterior branch to the right side. Uterus with large cells, spermathecae obscure. Vulva on rings 68, 69 or 70 or between two rings in the zone between rings 67 to 70.



Tail with six to eight annules, including non-annulated tail end. Caudal glands well developed, extending anteriorly beyond the anus. Spinneret present.

*Juveniles:* Among STEINER's material we did not observe any juvenile specimens. Among the Recent U.S. Antarctic Material, two juvenile stages were present: the fourth and third stage.

*Fourth stage juveniles:* Similar to adults in many aspects. Body epsilon-shaped with swollen pharyngeal region and a non-swollen caudal arc (when swollen, artefact due to fixation). Cuticle with 90-96 (93: mean value) annules, swollen with enlarged vacuoles due to fixation in several specimens. Ring overlap direction reversal dorsally at ventral bent: between rings 43-44; ventrally at level of dorsal bent: between two successive rings in the zone between the 28nd and the 32nd annule. Ambulatory setae arranged in five longitudinal rows: the medioventral row with five to eight setae, the two inner subventral rows with four to eight setae each, both outer subventral rows with eight to eleven setae followed posteriorly by two supporting setae.

Head in many specimens globularly swollen due to fixation, except in labial region. Cuticle thickened, forming a helmet anteriorly demarcated at the level of the insertion of the cephalic setae. Labial region extended or retracted. Four cephalic setae, followed by four pores: the insertion sites of setae (usually broken off) lying nearly up to nearly at mid-amphid level. Posterior to the amphideal fovea, often only two subcephalic setae present (one subdorsal, one subventral on the same head side or on opposite sites) without any notion of other insertions; rarely four subcephalic setae present showing variability in their localisation (a pair of subdorsal, a pair of subventral or e.g. right head side with one subdorsal and one subventral seta, left side with one subdorsal and one laterosubdorsal setae). Amphideal fovea as in adults, large spiral, its diameter 42-50% of corresponding head width and lying far anteriorly on the head: its anterior border converging with the anterior edge of the helmet.

Pharynx as in adults. Reproductive system nearly completely developed; juvenile males with spicular primordium.

Tail with seven to nine annules, including conical endring; the latter with the insertion of a lateral somatic seta in its anterior half. Caudal glands well developed, spinneret present.

*Third stage juveniles:* Similar to fourth stage. Body cuticle with 85-90 (mean 87) annules; overlap direc-

tion reversal as in fourth stage (in one specimen, annules reversed dorsally three times: between rings 25-26, 29-30 and 48-49). Ambulatory setae arranged in two longitudinal subventral rows of ten to eleven setae (some may be broken off), followed posteriorly by two supporting setae.

Head as in fourth stage. Four cephalic setae followed by four pores (= insertion sites) up to mid-amphid level. One or two subcephalic setae (one subdorsal and one subventral) observed; no other insertion marks. Amphideal fovea as in fourth stage.

Digestive system as in former stages. Reproductive system not yet fully developed. Tail with eight to ten annules, including non-annulated conical end ring. Caudal glands well developed; spinneret present.

*Second stage juveniles:* Not observed.

*First stage juvenile:* Based upon a single specimen described as *Epsilonella gracilis* STEINER, 1931. Body with 97 annules (counted subdorsally on original figure). Amphideal fovea large spiral, slightly over one coil, far anteriorly on the head, with the anterior border at the level of the insertion of the cephalic setae.

#### DIAGNOSIS EMENDED

*Bathyepsilonema brachycephalum* STEINER, 1931 is characterized by the number of body rings 97 (mean value) in male and female, the position of the amphideal fovea far anteriorly on the head, the annulation with a garland-like ornamentation of spiny ridges and vacuoles, and in males by the length of the spicules, 44-51  $\mu\text{m}$ .

#### RELATIONSHIP

*B. brachycephalum* is closely related to *B. drygalskii* possessing a similar habitus: a relatively stout epsilon body shape and annular ornamentation. It differs from it in possessing more but narrower annules, a more anterior position of the slightly larger amphideal fovea than in *B. drygalskii*. *B. brachycephalum* differs in males in possessing shorter spicules.

#### TYPE MATERIAL

Male type, slide USDA T-390t.

#### OTHER MATERIAL

See materials and methods.

Fig. 6. — *Bathyepsilonema brachycephalum* STEINER, 1931. A. Male type specimen in toto with details of the body cuticle in surface view. B. Male from Duke Ernst Bay, with indications of levels a and b with a detail of the body cuticle in surface view. C. Copulatory apparatus and tail region. Female: D. Genital system and tail, specimen from Cape Royds. E. Vulva in oblique ventral view, specimen from Scott Base.

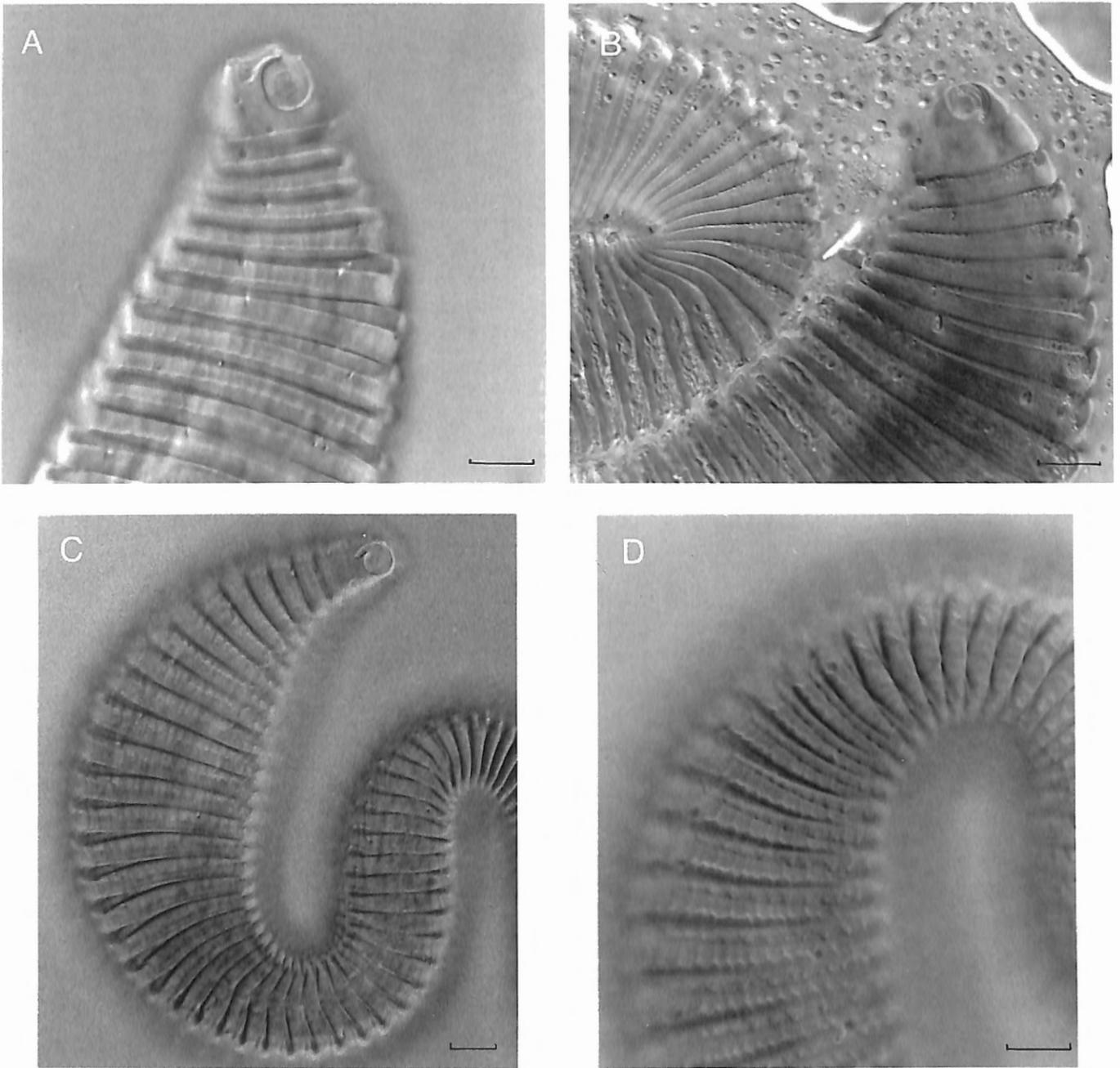


Fig. 7. – *Bathyepsilonema brachycephalum* STEINER, 1931. Anterior body region: A. Type female. B. Female type specimen of *Bathyepsilonema dicampterus*. C. Female type specimen of *Bathyepsilonema cricotum*. D. Detail of body cuticle, female type specimen of *B. cricotum*, (bar = 10  $\mu$ m).

#### TYPE LOCALITY AND HABITAT

Gauss-station, WILHELM II Coast, Antarctica, marine residue sample collected at a depth of 385 meters, on 5 January 1903 by the German South Polar Expedition of 1901-1903.

#### OTHER LOCALITIES

See materials and method.

#### Discussion and conclusions

The genus *Bathyepsilonema* was first proposed by G. STEINER in 1927. Then in 1931 he redescribed the genus, and included illustrations and species descriptions. Throughout the literature two dates, 1927 and 1931, have been used for the genus; we have concluded that the correct citation is STEINER, 1927. This conclusion is based upon Articles 11, 12, 15, and 51 of the 1985 International Code of Zoological Nomen-

clature and A. MAGGENTI (pers. comm.).

STEINER (1931) based the majority of the differentiations between the nineteen species and one subspecies of *Bathyepsilonema* described, mainly upon the exact number of body rings, the presence of partial rings, the ornamentation of the rings and pattern of the ambulatory setae. LORENZEN (1973) reduced the number of *Bathyepsilonema* species of STEINER (1931) to a single species *Bathyepsilonema drygalskii*.

Original type material and newly available specimens from Antarctica revealed the presence of a second valid species: *Bathyepsilonema brachycephalum* STEINER, 1931 among the species of *Bathyepsilonema* described by STEINER (1931). Both *Bathyepsilonema* species of STEINER (1931): *B. drygalskii* and *B. brachycephalum* possess large body annules with a garland-like ornamentation of spiny ridges and vacuoles and six longitudinal rows of fine knee-like bent ambulatory setae, but differ mainly in number of body rings respectively 86-91 against 93-101 annules and in size and position of the amphideal fovea.

Herewith, the actual number of valid *Bathyepsilonema* species is raised to eight: *B. brachycephalum* STEINER, 1931, *B. compactum* CLASING, 1984, *B. dermoglyphum* GOURBAULT & DECRAEMER, 1987, *B. drygalskii* STEINER, 1931, *B. lissum* CLASING, 1984, *B. monniotorum* GOURBAULT & DECRAEMER, 1987, *B. spongiosum* CLASING, 1986 and *B. vulgare* GOURBAULT & DECRAEMER, 1987.

STEINER (1931) characterized the genus *Bathyepsilonema* mainly upon: a strong body, clearly bent, with 80 to 105 rings, a strong well developed cuticle, knee-like bent ambulatory setae and spiral amphids.

LORENZEN (1973) omitted the number of body rings and the clearly ornamentation from the genus diagnosis and made a new extended diagnosis.

We agree with the diagnosis of LORENZEN (1973) emended by CLASING (1984) except for the position of the ambulatory setae which we observed as extending from the ventral curvature to just anterior to the vulva, the outer row on both sides followed by supporting setae. Also the rather low number of the relatively large annules can be included in the genus diagnosis as well as the garland-like ornamentation of the cuticle present in the majority of the species, exceptionally cuticle smooth (*B. lissum*) or vacuolated only, i.e. without ridges (*B. monniotorum*).

#### Remarks

STEINER (1931, p. 182) observed two crowns of setae on the head: an anterior one of four submedian setae and a posterior one of six setae (= "one submedian, two lateral"), often incomplete, exceptionally with more setae. He considered the posterior crown as similar to the somatic setae. GERLACH (1952) also observed them in *B. pustulatum*; he did not consider

them as real cephalic but as subcephalic setae.

According to LORENZEN (1973), epsilonmatids have typically four cephalic setae and eight subcephalic setae, the latter differentiated from the third circle of anterior sensorial organs (= cephalic setae) since they arise during the embryonic development. In *Bathyepsilonema* as in *Epsilonema*, they insert on a single circlet. LORENZEN (1973) redescribed *B. drygalskii* with eight subcephalic setae as a result of combining the original illustrations of *B. drygalskii* and *B. vanhoeffeni*. We observed that *B. drygalskii* females have eight subcephalic setae but not always with a typical arrangement (= one subdorsal, one laterosubventral, one subventral and one short laterosubdorsal) as e.g. in a female with one laterosubventral, one subventral (more posteriorly), one subdorsal, one subdorsal (more anteriorly), one short subdorsal on the left side and on the right side of the head with one laterosubventral, two laterosubdorsal, one anteriorly. Male specimens of *B. drygalskii* have also eight subcephalic setae arranged typically or aberrantly (one subventral, two fine laterosubventral and one subventral, one subdorsal, one laterosubventral, two laterosubdorsal) or possess a number of subcephalic setae varying between six and nine; a small laterosubdorsal setae is always present.

In *B. brachycephalum*, males have five to seven subcephalic setae, but mostly six; females four to nine subcephalic setae; they are arranged in one or two rows.

Other species of the genus were described with eight subcephalic setae: *B. compactum*; arranged on one row, but number never complete due to missing seta(e), *B. lissum*: subcephalic setae on two rows, but one pair always broken off, and *B. vulgare*: on one row; a few species only with six subcephalic setae in one row: *B. dermoglyphum* and *B. monniotorum*.

The irregularity in number of subcephalic setae may be explained by setae broken off or by the presence of additional setae (= "ergangzungsborsten") as described by LORENZEN (1973) for species of *Metepsilonema* (*M. bermudae* LORENZEN, 1973, *M. callosum* LORENZEN, 1973 and *M. hagmeieri* STAUFER (1924)). However, those setae were differentiated by their length and development. In *Bathyepsilonema*, the subcephalic setae usually do not show a great difference in length and data of this feature in juvenile stages is rather poor. In most species of *Bathyepsilonema*, and clearly in the species from Antarctica, we observed shortly posterior to the insertion of the cephalic setae to about mid-amphid level, the presence of four pores (= insertion sites of setae, mostly broken off), rarely of four short setae, subdorsally and subventrally inserted. Similar pores/setae were exceptionally observed in *Epsilonema*, but are well developed in *Perepsilonema* species where they are considered as four of the eight subcephalic setae. In *Leptepsilonema*

six of the eight subcephalic setae are situated anterior to the amphideal fovea, they are long well developed setae and they will not be mistaken for "additional setae".

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