

A synopsis of the Hethidae (Nematoda: Rhigonematida) with descriptions of five new species of *Heth* Cobb, 1898 from diplopods from Papua New Guinea

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Summary. Five new species of the genus *Heth* Cobb, 1898: *H. costata* sp. n., *H. ortonwilliamsi* sp. n., *H. xaniophora* sp. n., *H. sutherlandi* sp. n. and *H. zeuglocantha* sp. n. are described from two species of diplopod from Papua New Guinea. The new species can be distinguished mainly on the basis of their cuticular ornamentation and disposition of lateral spines of the female cervical region and presence or absence of cuticular somatic ridges or lateral alae. Scanning electron micrographs of the cephalic and cervical regions of three of the species are presented. A synopsis of the family Hethidae is provided together with a list of species and a diagnosis of the genus *Heth*. Also, a bibliography is appended.

Key words: Rhigonematida, Hethidae, *Heth*, generic diagnosis, new species, diplopod hosts, scanning electron microscopy, Papua New Guinea.

The genus and type species, *Heth juli*, were illustrated, but not described, by Cobb (1898) from female specimens in the gut of a diplopod, '*Iulus*' sp, collected in Moss Vale, New South Wales, Australia. In the same paper, Cobb also illustrated males, but erected a separate genus and species, *Streptogaster papillatus*, presumably because of the marked sexual dimorphism of the cervical region. Baylis and Daubney (1926) and Artigas (1929) both attempted to give a formal diagnosis of the genus but misinterpreted the male spicular arrangement. Subsequent to Cobb's illustration of *H. juli* a number of other species have been named, largely from South America (Artigas, 1929; Dollfus, 1952; Kloss, 1961, 1965; Adamson, 1982, 1985, 1987). Chitwood (1935) described two species, one from Central America and the other from the Philippines and Sumatra and also correctly interpreted the spicular arrangement. Many species in the genus are poorly characterized although Adamson (1982) fully described two new species from Venezuela and the West Indies and subsequently redescribed five

species from South America, together with detailed morphological studies of both the male and female anterior regions (Adamson, 1983). Adamson (1983) also proposed *H. schubarti* Dollfus, 1952 as a synonym of *H. artigasi* Dollfus, 1952 and established two groups for *Heth* species based on whether the cervical collar comprised a small number of spines with separate bases or, as in the type species, a large number of smaller spines with their bases fused to form a continuous band of cuticle. A further two new species of *Heth* were described from *Rhinocricus bernardinensis* from Paraguay (Adamson, 1985); one species was described from various diplopods in New Zealand (Bowie, 1986). Another species was described from Paraguay (Adamson, 1987) and two unusual species were found in a *Rhinocricus* sp. from Cuba (Spiridonov, 1989).

Most species have been reported from the intestine of various species of tropical spirobolid diplopods, particularly from the Rhinocricidae and the genus *Rhinocricus*. They appear to be distributed in

Southern and Central America (Brazil, Panama, Paraguay, Venezuela, West Indies), Australasia (Australia, New Zealand, Papua New Guinea) and the Orient (Philippine Islands, Sumatra). Spiridonov (1989) observed live specimens feeding and speculated that the pectinate pseudolabia, which pulsated several times a second, were used to scrape bacteria from the gut wall. SEM studies of the oral region (Fig. 2 & 6) often show accumulations of bacteria and fine detritus beneath the pseudolabia. The genus currently contains 32 nominal species, with the taxonomic status of several being uncertain. Males are not known for, or reliably ascribed to, the majority of species, however females have several useful and reliable diagnostic characters.

MATERIALS AND METHODS

The following five new species were all obtained from two species of diplopod from Papua New Guinea collected and preserved in hot 4% formalin in December, 1982 by Dr. J. A. Sutherland. One of the diplopods was a large, grey millipede about 15 cm long, possibly *Polyconoceras* sp., and also contained *Ichthyocephaloides dasyacanthus* Hunt & Sutherland, 1984, *Carnoya fimbriata* Hunt & Sutherland, 1985 several undescribed species of *Rhigonema* and the lastomatids. The second diplopod was smaller, banded with black and gold, and contained many nematodes including *Carnoya perbella* Hunt & Sutherland, 1985, *C. strobilina* Hunt & Sutherland, 1985, *Travassosinema morobecola* Hunt, 1993 and undescribed species of *Ichthyocephaloides* and *Rhigonema*. The *Heth* species described here share the general characters of the genus in the structure of the oesophagus and genital tract with the major diagnostic features in the female being the cuticular ornamentations of the cephalic and cervical regions. To avoid repetition in the individual descriptions a detailed general diagnosis is given, followed by the individual descriptions in which only those characters of specific diagnostic importance are emphasized.

Nematodes were processed by a slow evaporation technique and mounted in anhydrous glycerine. Selected specimens were processed from fixative

through a graded series of ethanol, critical point dried, mounted on stubs, coated with 750A of gold and examined with the SEM.

Family HETHIDAE Skrjabin & Shikhobalova, 1951 (Travassos & Kloss, 1960)

Diagnosis. Rhigonematida, Ransomnematoida. Monoxenous parasites of diplopods. Sexually dimorphic in the cephalic and cervical regions. Female with complex, well developed lateral pseudolabia and cervical ornamentation of varying type and complexity. Oesophagus comprising a long, tubular procorpus, distinct isthmus and valvate basal bulb. Vulva located posteriorly near the anus. Genital tracts two, anteriorly directed and with a common uterus. Eggs few in number and thin shelled. Male without the pseudolabia and cervical ornamentation of the female. Oesophagus similar in form to that of the female. Spicules fused except for a short distance proximally; gubernaculum broad and trough-like. Copulatory papillae typically 15 in number. Preanal midventral sucker present.

Type and only genus: *Heth* Cobb, 1898

Type species: *H. juli* Cobb, 1898

Genus *Heth* Cobb, 1898 (syn. *Streptogaster* Cobb, 1898)

Diagnosis. Hethidae. Small to medium sized nematodes about 1.3 to 4 mm long and sexually dimorphic in the cervical region.

Female. Body subcylindrical with a conoid to subulate tail. Cephalic extremity with a lateral pair of convex pseudolabial plates which overhang the head tissue and are attached to the body cuticle for a short distance laterally, but are unattached on the remaining edges, thus forming a dorsal and ventral aperture joined by a dorso-ventral slit. The dorsal and ventral edge of each pseudolabial plate usually touching the corresponding edge of the other plate. The free margins of each plate are fringed with delicate cuticular processes, shortest along the dorso-ventral slit, but longer and comb-like along the dorsal and

ventral margins. The body cuticle beneath the dorsal and ventral edges of each pseudolabium is extended to form four slightly concave flanges with pectinate margins so that the head appears to consist of two pairs of fringed bivalves separated distally by the dorso-ventral slit. Each pseudolabial plate is supported by one dorsal and one ventral cuticular strut which fan out distally. The four body flanges beneath the pseudolabial plates also have a cuticular reinforcement and, on the posterior margin, bear a number of small, sharply recurved spines. Each pseudolabium bears a prominent amphidial aperture and there are four cephalic papillae below the pseudolabia. Cuticular adornment of the cervical region may consist of transverse rows of minute spinelets, continuous or discontinuous spined collars, spined combs of various size located anterior to the collar, lateral cuticular lappets, various arrangements of pairs and/or single large spines and small cuticular studs with or without a fringe of spines on their posterior margins. Lateral alae may be well developed or, more commonly, completely absent. The oesophagus comprises a long muscular procorpus, a short isthmus and a valvate basal bulb. The buccal cavity consists of a globular anterior part containing one dorsal and two ventro-lateral bosses fringed with fine processes and a tubular, ribbed, posterior part. The vulva is well posterior and the genital tracts pro-didelphic. The tail is long, subulate, attenuating to a fine point.

Male. The male lacks the complex cuticular structure of the female anterior end, the head region being low and rounded with four cephalic papillae and a ring of six inner papillae around the oral aperture. The buccal cavity is simple and contains three processes, one dorsal and two subventral, which may have fine cuticular lamellae. The oesophagus is similar to that of the female. The spicules are fused for nearly all of their length, but are separate proximally. A large, trough-like gubernaculum is present. A large round to oval midventral sucker is located some distance anterior to the cloaca. There are typically 15 copulatory papillae comprising seven paired and a single, ventral, preanal papilla. The tail is long, subulate and then attenuating to a fine point. It is not

always possible to reliably ascribe males to females of the same species, as populations may be comprised of several species.

Type species: *Heth juli* Cobb, 1898 (syn. *Streptogaster papillatus* Cobb, 1898)

Other species: *H. amazonensis* Kloss, 1965; *H. artigasi* Dollfus, 1952, (syn. *H. schubarti* Dollfus, 1952); *H. baracoa* Spiridonov, 1989; *H. bifidispiculum* Adamson, 1982; *H. clunyi* Adamson, 1985; *H. costata* sp. n.; *H. dimorphum* Chitwood, 1935; *H. hamatus* Bowie, 1986; *H. hexaspinosum* Chitwood, 1935; *H. imias* Spiridonov, 1989; *H. insularis* Kloss, 1965; *H. macrocephala* Kloss, 1965; *H. magnavulvaris* Adamson, 1985; *H. maicuru* Kloss, 1961; *H. mauriesi* Adamson, 1982; *H. orthopori* Adamson, 1987; *H. ortonwilliamsi* sp. n.; *H. parartigasi* Adamson, 1985; *H. perarmatum* Dollfus, 1952; *H. sinediscus* Kloss, 1965; *H. spinalatum* Kloss, 1965; *H. spinosum* Artigas, 1929; *H. sutherlandi* sp. n.; *H. travassosi* Dollfus, 1952, (syn. *Clementeia tubulifera* Dollfus, 1952); *H. travilhoi* Dollfus, 1952; *H. tuzetae* Dollfus, 1952; *H. xaniophora* sp. n.; *H. zeuglocantha* sp. n.

Species inquirenda: *H. duvidosum* Artigas, 1929

Note. Dollfus (1952) used the term '*Heth-Streptogaster*' for species where only the male was described. Some earlier authors retained the genus *Streptogaster* for species where only the male had been described. Kloss (1965) regarded *Clementeia tubulifera* Dollfus, 1952, a species described only from males, as a species of *Heth*, probably *H. travassosi* Dollfus, 1952. Also the male described with the female of *Clementeia clementei* Artigas, 1930 is regarded as belonging to a species of *Heth*.

Distribution. Central and South America, West Indies, Australia, New Zealand, Papua New Guinea, Philippines, Sulawesi, Sumatra.

Hosts. Found in the intestine of tropical and subtropical Spirobolida and Polydesmida, with most species being reported from the spirobolid family Rhinocricidae. Genera from which *Heth* have been reported include *Erythrodesmus*, *Icosidesmus*,

Leptodesmus, *Polyconoceras*, *Pseudonannolene*, *Rhinocricus*, *Scaphiostreptus*, *Spirobollelus*, *Spirobolus* and *Spirostreptus*. Several species of *Heth* have been found in the same host, which may indicate that niche diversification, perhaps involving differing feeding strategies, as having evolved, presumably over a long period of time.

DESCRIPTIONS

Heth costata sp. n. (Figs. 1 & 2. A, B)

Female (n=13): L=2.39 (2.16-2.60) mm; width = 183 (146-214) μ m; oesophagus = 353 (341-384) μ m; tail = 877 (800-987) μ m; head to vulva = 1.44 (1.28-1.59) mm; stoma = 65 (62-68) μ m; a = 13.0 (10.9-15.2); b = 6.8 (6.1-7.5); c = 2.7 (2.6-2.9); V = 60.4 (58.5-63.8); V' = 95.6 (94.8-96.5).

Holotype female: L = 2.34 mm; width = 214 μ m; oesophagus = 361 μ m; tail = 867 μ m; head to vulva = 1.40 mm; stoma = 67 μ m; a = 10.9; b = 6.5; c = 2.7; V = 60.0; V' = 95.4.

Female. Body flanges mirroring the pseudolabial quartiles contain two recurved spines directed posteriorly, i. e. a total of 8 spines on the posterior subdorsal and subventral margins (Fig. 1. C). Prominent cervical collar present bearing numerous (about 38-40) small, 11-15 μ m long, spines with fused bases on their posterior edge. Collar continuous except laterally where it is extended posteriorly to form pairs of cuticular lappets, the outer margin of each strongly serrated with the spines continuing along the inner margin for some distance (Fig. 1. A, G). Inner margins of the lappets attached to the body only for about 40% of their length. Numerous spines on the lappets and with bifurcate tips. Two pairs of large, smooth spines on each side of the body posterior to the collar with separate and not contiguous bases. Anterior spines about 50 (45-52) μ m long and posterior spines about 60 (58-67) μ m long. Bases of anteriormost pair of spines overlapped by the lappets. Cuticle in cervical region minutely punctate (Fig. 2. A). Eight cuticular ridges - two subdorsal, two dorsolateral, two ventrolateral, two subventral (Fig. 1. A, I) present at the point of attachment of the posterior pair of spines

and extending to the level of the vulva. Ridges about 17 μ m high and 13 μ m wide. Body pores disposed regularly along each ridge. Lateral alae absent, but an internal invagination of the cuticle can be seen laterally in transverse section (Fig. 1. I). Tail subulate, attenuating to a fine point.

Male. Not attributable, but probably either male A or B as described later in this paper.

Differential diagnosis. Characterized by possessing a continuous cervical collar formed from numerous small spines with fused bases, serrate lateral lappets, two pairs of lateral spines and eight somatic ridges. Other species with females which have serrate lateral lappets and a continuous cervical collar formed from numerous small spines with their bases fused into a band are *H. juli*, *H. dimorphum*, *H. hamatus*, *H. insularis* and also *H. ortonwilliamsi* sp. n., *H. xaniophora* sp. n. and *H. sutherlandi* sp. n. *Heth costata* sp. n. can be distinguished from all of these species by its having eight longitudinal cuticular ridges and by the size and configuration of the lateral spines.

Type host and locality. Hind gut of unidentified black and gold banded diplopod collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Type material. Holotype female and nine paratype females in the collection of the International Institute of Parasitology, St. Albans, UK and three paratype females in the nematode collection at Rothamsted Experimental Station, Harpenden, Herts., UK.

Etymology. Derived from the Latin *costatus*, meaning ribbed and referring to the longitudinal ridges on the cuticle.

Heth ortonwilliamsi sp. n. (Figs. 2. C, D & 3)

Female (n=12): L=2.47 (1.97-2.63) mm; width = 159 (94-179) μ m; oesophagus = 362 (315-390) μ m; tail = 700 (620-754) μ m; head to vulva = 1.70 (1.29-1.84) mm; stoma = 60 (55-70) μ m; a = 15.6 (14.3-20.9); b = 6.8 (6.2-7.2); c = 3.5 (3.2-3.7); V = 68.9

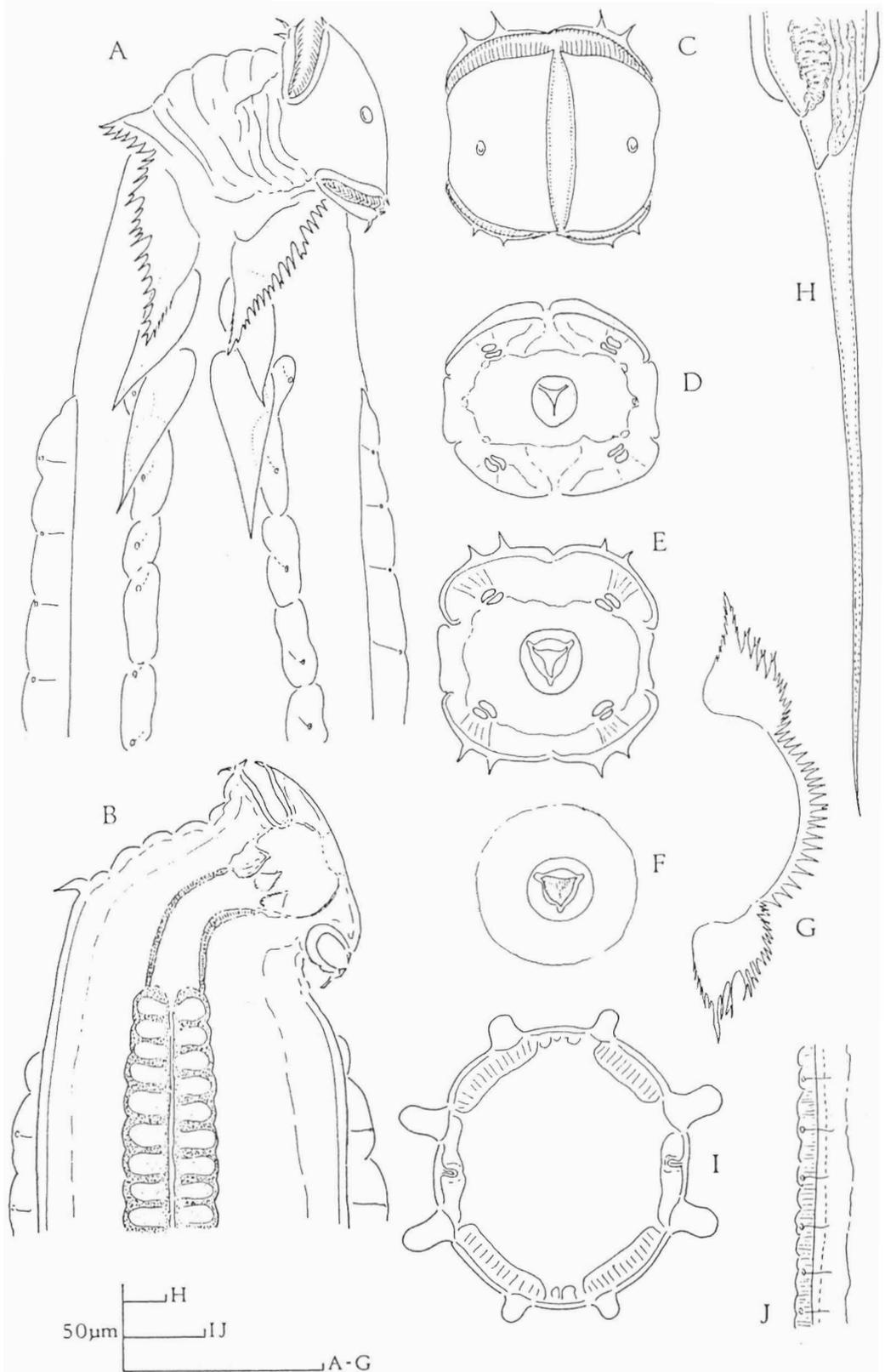


Fig. 1. *Heth costata* sp. n. Female. A: Cervical region; B: Buccal region; C-F. *En face* and progressively deeper optical sections through the buccal cavity; G: Cervical collar and serrate lateral lappets; H: Posterior region; I: Transverse section showing somatic ridges; J: Somatic ridge in profile.

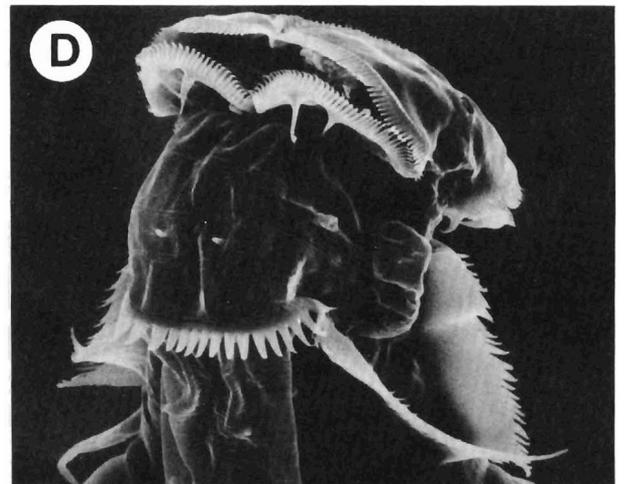
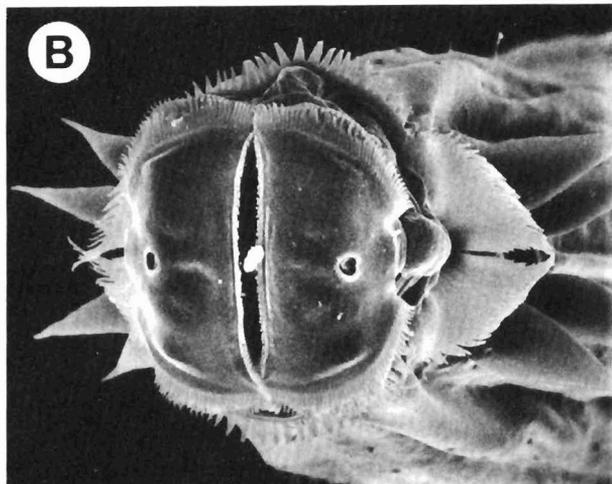
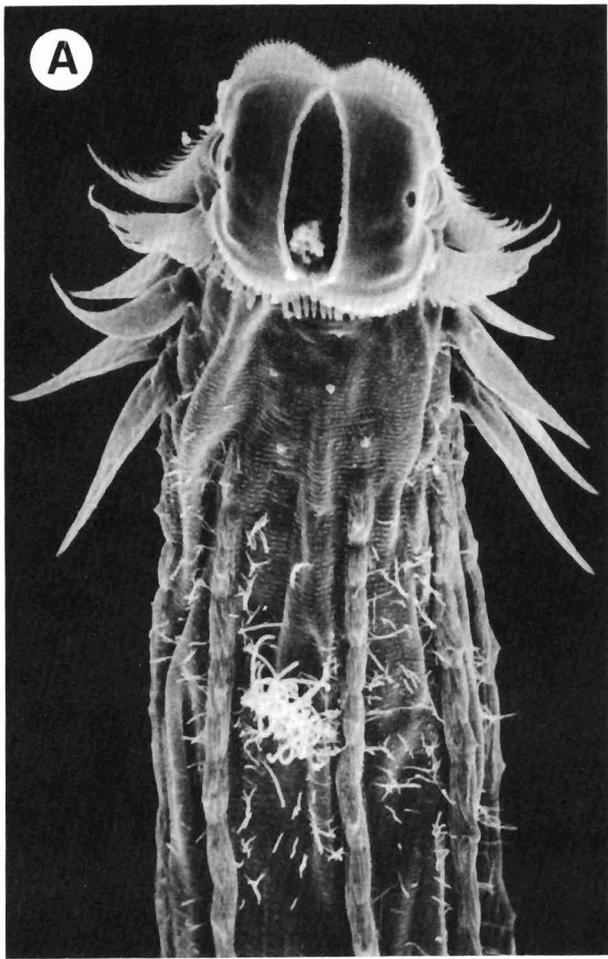


Fig. 2. *Heth costata* sp. n. Female. A: Cervical region showing somatic ridges; B: En face. *H. ortonwilliamsi* sp. n. Female. C: Cervical region; D: Cephalic region.

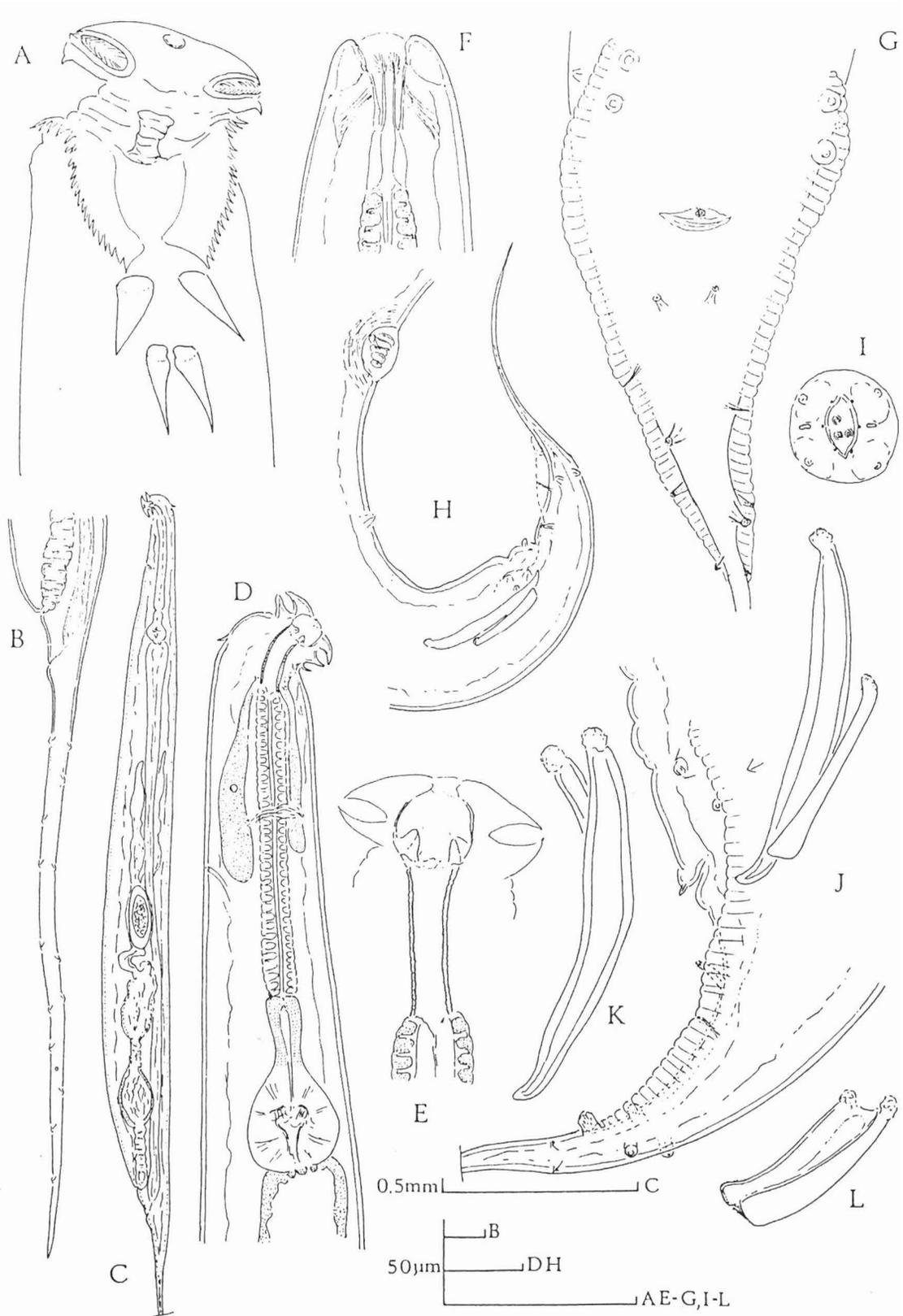


Fig. 3. *Heth ortonwilliamsi* sp. n. Female A-E. A: Cervical region; B: Posterior region; C: Entire; D: Oesophagus; E: Buccal cavity. Male F-L. F: Buccal cavity; G: Tail region, ventral; H, J: Tail region, lateral; I: En face; K: Spicule; L: Gubernaculum.

(67.1-70.4); $V' = 96.1$ (95.4-96.7).

Holotype female: L = 2.50 mm; width = 172 μm ; oesophagus = 362 μm ; tail = 700 μm ; head to vulva = 1.76 mm; stoma = 57 μm ; a = 14.5; b = 7.1; c = 3.7; V = 70.4; $V' = 95.5$.

Male (n = 5): L = 1.51 (1.25-1.66) mm; width = 95 (88-104) μm ; oesophagus = 391 (351-439) μm ; tail = 173 (155-192) μm ; spicule = 96 (94-100) μm ; a = 15.9 (14.1-17.4); b = 3.9 (3.5-4.4); c = 8.7 (6.5-9.9).

Female. Each somatic subdorsal and subventral flange mirroring the pseudolabia with one, posteriorly directed, recurved spine, making four in total. Cervical collar spined, continuous, except laterally where it is extended to form pairs of serrate cuticular lappets, the outer margins having small spines (Fig. 3. A). A pair of smooth spines with separate bases posterior to the cervical collar followed by a pair of spines with almost contiguous bases. Body cuticle from the cervical region to the vulva ornamented with transverse rows of minute suboval platelets, each platelet in the midbody region being about 0.7 μm long and separated transversely from its neighbour by about 1.2 μm . Lateral alae absent.

Male. Buccal cavity with three cuticular processes, one dorsal, two subventral, bearing lamellae (Fig. 3. F). Spicules slightly cephalated, fused for most of their length and ventrally concave distally; gubernaculum broad, trough-like; fifteen copulatory papillae arranged as illustrated (Fig. 3. G, H, J) and a pre-cloacal ventral sucker surrounded by muscle fibres. A pair of prominent body pores present posterior to the last pair of copulatory papillae. Body cuticle forming a low, crenate, bursa-like extension extending from the first pair of copulatory papillae to where the tail narrows to form a subulate tip (Fig. 3. G). Tail anteriorly dorsally convex-conoid, narrowing to a slender, subulate appendage.

Differential diagnosis. Characterized by possessing a continuous cervical collar formed from numerous small spines with fused bases, serrate lateral lappets and two pairs of lateral spines, the second pair being smaller, closer together and with

almost contiguous bases. *H. ortonwilliamsi* sp. n. is closest to three of the other species described here. It can be distinguished from *H. costata* sp. n. in lacking somatic ridges and by the configuration of the lateral spines; from *H. xaniophora* sp. n. in lacking the broad lateral alae and in the configuration of the much smaller lateral spines and from *H. sutherlandi* sp. n. in the configuration of the lateral spines, particularly the second pair where the bases are almost contiguous.

Type host and locality. Hind gut of unidentified large grey diplopod, probably *Polyconoceras* sp., collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Type material. Holotype female, eight paratype females and three paratype males in the collection of the International Institute of Parasitology, St. Albans, UK and three paratype females and two paratype males in the nematode collection at Rothamsted Experimental Station, Harpenden, Herts., UK.

Etymology. Named in honour of the late Ken Orton Williams, a friend and former colleague at the Institute, who died in 1992.

Heth xaniophora sp. n. (Figs. 4 - 6)

Female (n = 11): L = 2.71 (2.40-2.96) mm; width = 167 (143-195) μm ; oesophagus = 461 (397-500) μm ; tail = 1087 (867-1230) μm ; head to vulva = 1.55 (1.44-1.65) mm; stoma = 85 (75-98) μm ; a = 16.2 (15.0-17.9); b = 5.9 (5.1-6.5); c = 2.5 (2.2-3.0); V = 57.4 (52.2-63.9); $V' = 96.0$ (94.1-96.8).

Holotype female: L = 2.65 mm; width = 143 μm ; oesophagus = 520 μm ; tail = 1180 μm ; head to vulva = 1.38 mm; stoma = 98 μm ; a = 18.5; b = 5.1; c = 2.2; V = 52.2; $V' = 94.1$.

Male (n = 5): L = 2.36 (2.06-2.92) mm; width = 138 (124-156) μm ; oesophagus = 632 (530-705) μm ; tail = 393 (335-458) μm ; spicules = 146 (130-162) μm ; a = 16.4 (13.7-18.9); b = 3.7 (3.2-4.7); c = 6.0 (4.9-7.5). (Note: some of the paratype males are in poor condition, so only those relatively undistorted specimens were measured).

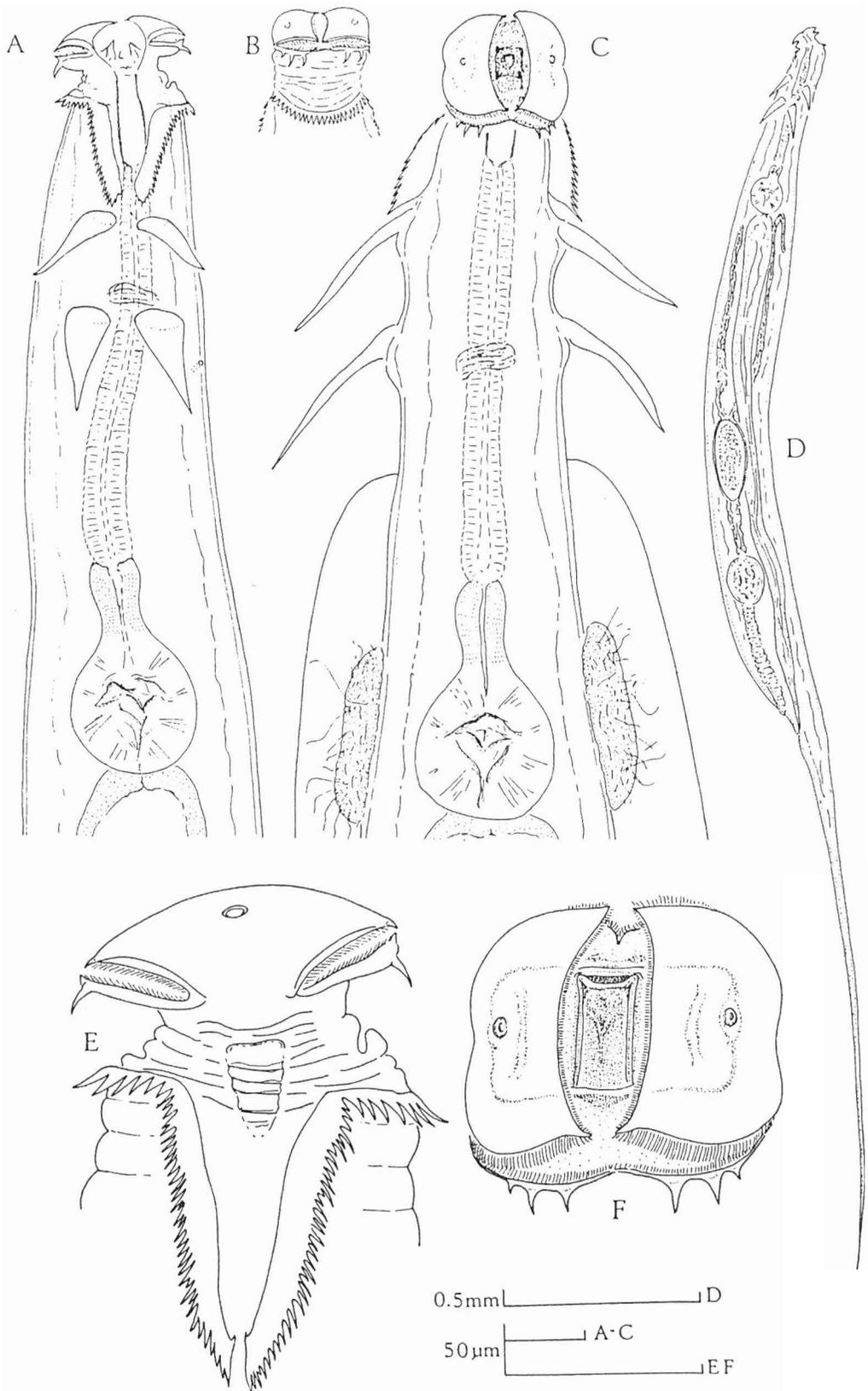


Fig. 4. *Heth xaniophora* sp. n. Female. A: Cervical region, lateral; B: Cephalic region; C: Cervical region, ventral; D: Entire; E: Cephalic region, lateral. F: Pseudolabia.

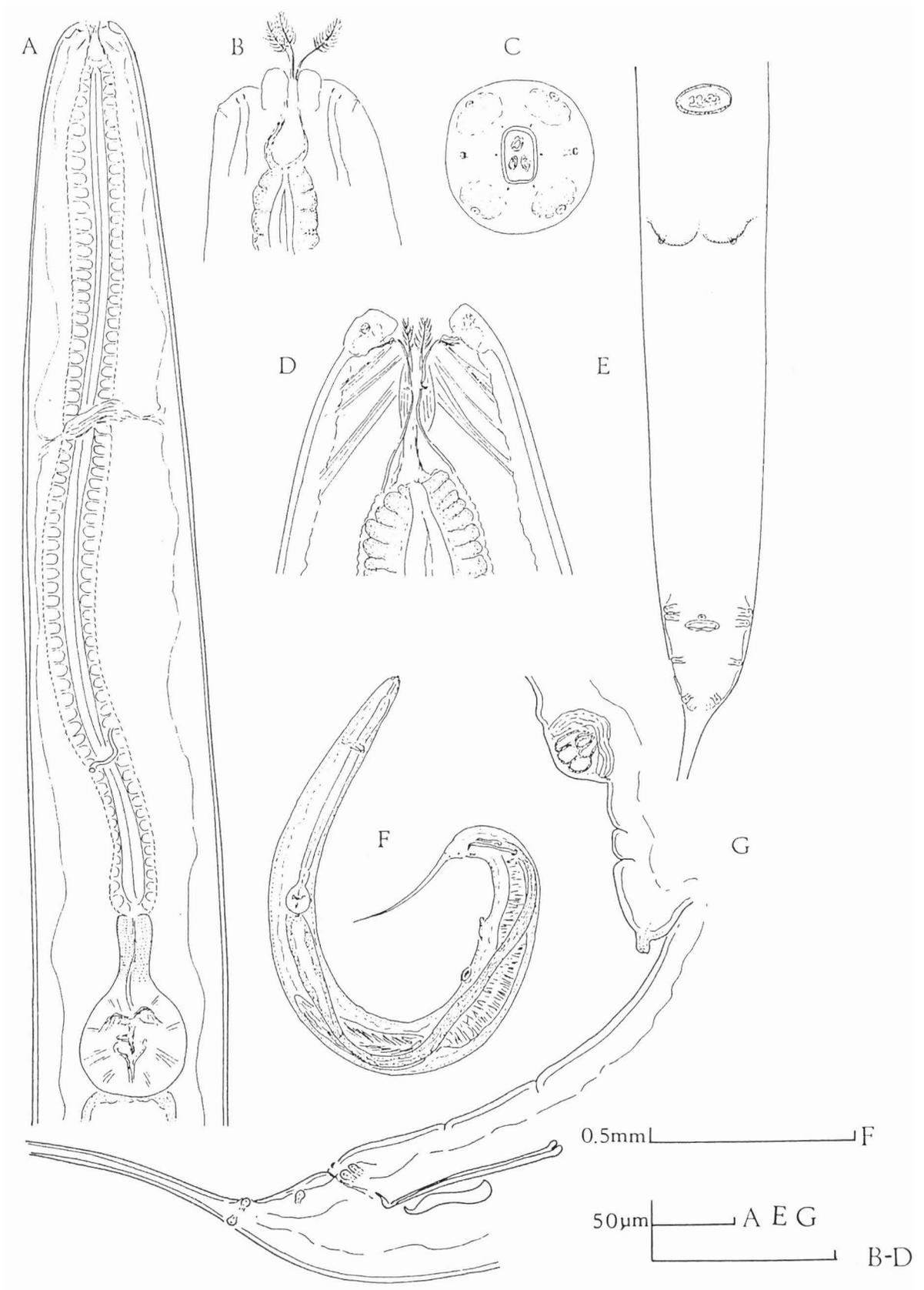


Fig. 5. *Heth xaniophora* sp. n. Male. A: Oesophagus; B, D: Buccal region; C: En face; E: Posterior region, ventral; F: Entire; G: Posterior region, lateral.

Female. Each somatic subdorsal and subventral flange mirroring the pseudolabia possessing three, posteriorly directed, recurved spines (the four most lateral being shorter than the others, i.e. about $8\text{--}9\ \mu\text{m}$ as compared to $20\text{--}25\ \mu\text{m}$), thus making a total of 12 spines (Fig. 4. F). Cervical collar comprising about 48 small spines ($18\text{--}20\ \mu\text{m}$) long with fused bases and continuous except laterally where it is extended to form pairs of serrate cuticular lappets, the outer margins of which are spined (Fig. 4. E). Inner margins of the lappets mostly fused with the body cuticle. Two pairs of large spines on each side posterior to the cervical collar, the bases of which are separate superficially, although the subcuticular roots of each pair are fused to form a large sub-oval plate. Anterior spines about $90\ (80\text{--}95)\ \mu\text{m}$ long, posterior spines about $95\ (84\text{--}107)\ \mu\text{m}$ long. The broad lateral alae, which rise to about $50\ \mu\text{m}$, commence just posterior to the last pair of spines and continue along the body to about the level of the vulval aperture. Tail long, anteriorly conoid and then subulate, attenuating to a fine point.

Male. Buccal cavity with three cuticular processes, one dorsal, two subventral, bearing lamellae (Fig. 5. B, C). Spicules slightly cephalated, slender; fused for most of their length and with the distal tip sharply bent at 90° to the axis. Thirteen copulatory papillae present, including a subventral pair of very prominent hypertrophied mammiform papillae about $130\ \mu\text{m}$ posterior to the ventral sucker. A low, bursa-like extension of the cuticle present, extending from just prior to the cloacal lip to the point where the tail narrows. Tail anteriorly dorsally convex-conoid, rapidly attenuating to a subulate/filiform tip.

Differential diagnosis. Characterized by possessing a continuous cervical collar formed from numerous small spines with fused bases, serrate lateral lappets, two pairs of very long lateral spines and broad lateral alae. *H. xaniophora* sp. n. is closest to three of the other species described here. It can be distinguished from all three by the presence of broad lateral alae; from *H. costata* sp. n. in lacking somatic ridges and by the configuration of the lateral spines;

from *H. ortonwilliamsi* sp. n. in the configuration of the much longer lateral spines and from *H. sutherlandi* sp. n. in the size and configuration of the lateral spines.

Type host and locality. Hind gut of unidentified large grey diplopod, probably *Polyconoceras* sp., collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Type material. Holotype female, seven paratype females and seven paratype males in the collection of the International Institute of Parasitology, St. Albans, UK and three paratype females and three paratype males in the nematode collection at Rothamsted Experimental Station, Harpenden, Herts., UK.

Etymology. Derived from the Greek *xanios* and *phorein*, meaning comb-bearer and referring to the spined cervical collar.

Heth sutherlandi sp. n. (Fig. 7. A-D)

Female (n=11): L=2.18 (2.01–2.36) mm; width = 150 (120–180) μm ; oesophagus = 350 (324–373) μm ; tail = 670 (513–767) μm ; head to vulva = 1.43 (1.26–1.57) mm; stoma = 59 (53–65) μm ; a = 14.5 (12.9–18.0); b = 6.2 (5.6–7.0); c = 3.2 (2.7–4.0); V = 66.0 (60.9–72.3); V' = 95.3 (94.0–96.5).

Holotype female: L = 2.18 mm; width = 120 μm ; oesophagus = 328 μm ; tail = 580 μm ; head to vulva = 1.35 mm; stoma = 58 μm ; a = 16.8; b = 6.1; c = 3.5; V = 67.2; V' = 94.4.

Female. Each subdorsal and subventral somatic flange mirroring the pseudolabia with two, posteriorly directed, recurved spines, making eight in total. Cervical collar containing about 48 small spines and continuous, except laterally where it is extended to form pairs of serrate cuticular lappets which are spined on their outer margins and attached to the body near their distal tips (Fig. 7. A, B). Posterior to the cervical collar are two pairs of lateral spines with non-contiguous bases, the posteriormost pair being closer together than the anterior spines (Fig. 7. A, B). The anterior spines, when seen in profile, about $50\ \mu\text{m}$ long, the posterior spines being $55\ \mu\text{m}$. Eight

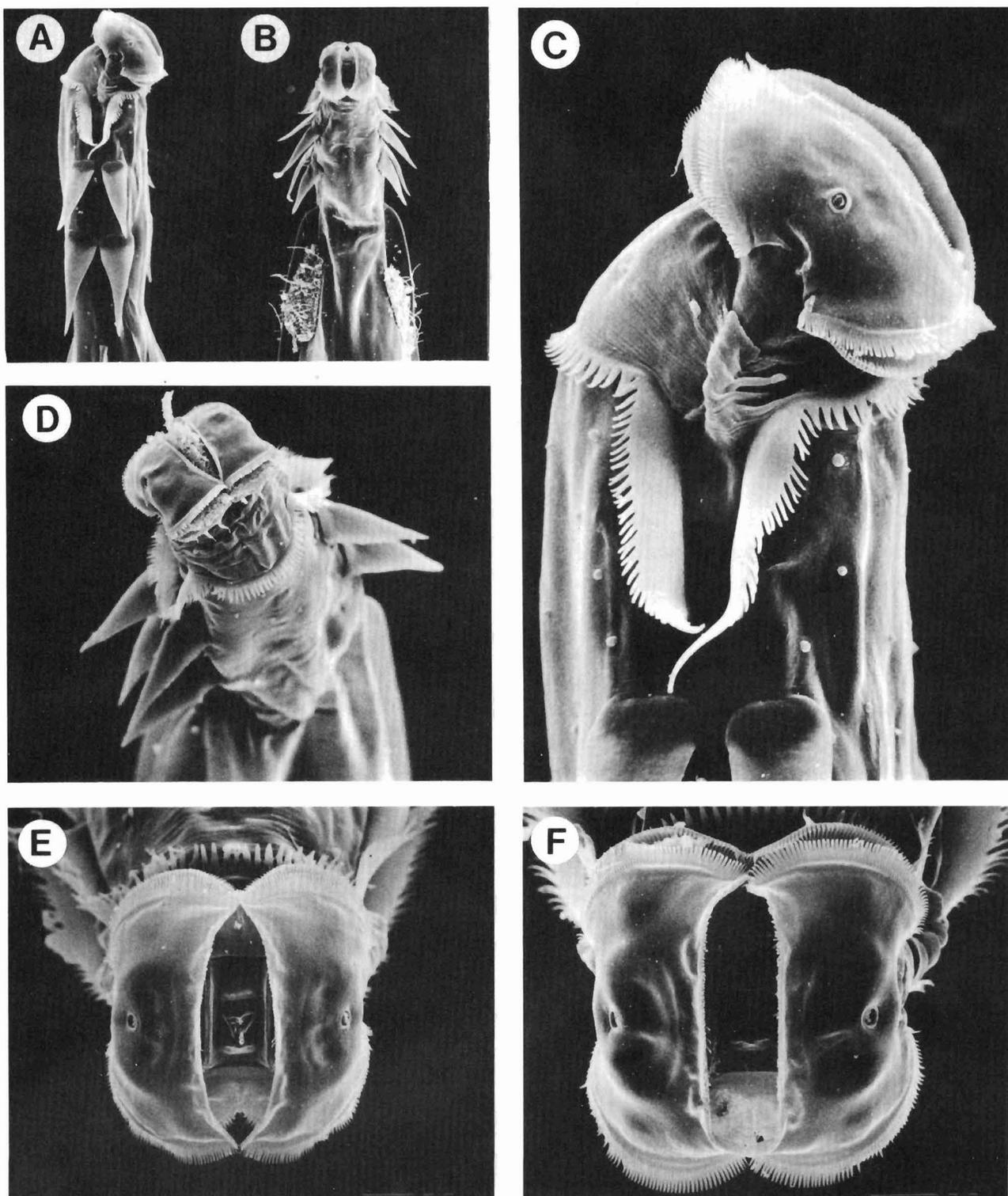


Fig. 6. *Heth xaniophora* sp. n. Female. A, B, C, D: Cervical region; E, F: Pseudolabia.

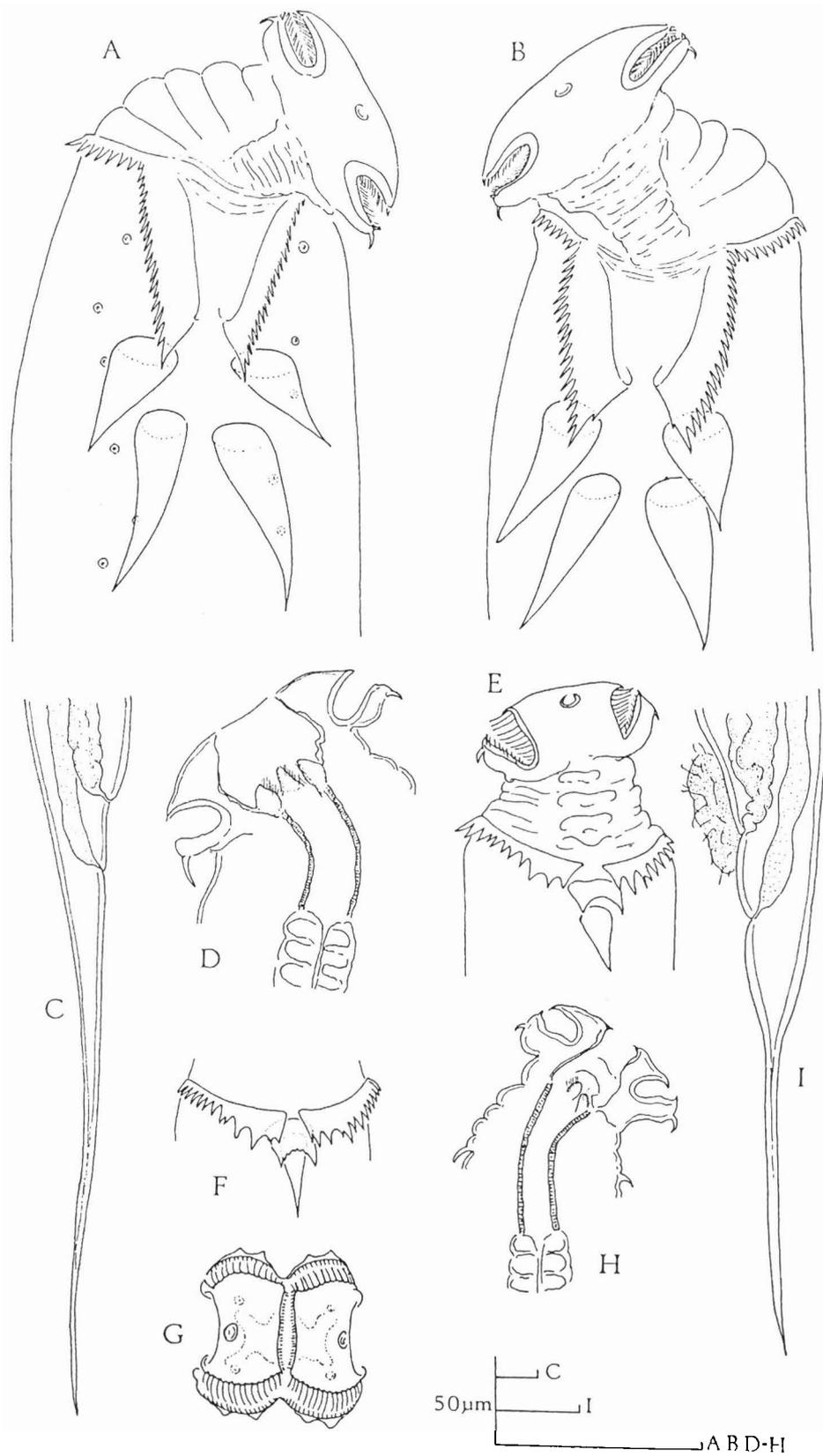


Fig. 7. *Heth sutherlandi* sp. n. Female A-D. A, B: Cervical region; C: Posterior region; D: Buccal region. *H. zeuglocantha* sp. n. Female E-I. E: Cervical region; F: Cervical collar and lateral spines; G: Pseudolabia; H: Buccal region; I: Posterior region.

longitudinal rows of somatic pores present. Lateral alae absent. Tail subulate, tapering evenly to a fine point.

Male. Not attributable, but probably either Male A or B as described at the end of this section (see also *H. costata*).

Differential diagnosis. Characterized by possessing a continuous cervical collar formed from numerous small spines with fused bases, serrate lateral lappets and two pairs of equally developed lateral spines. *H. sutherlandi* sp. n. is closest to three of the other species described here. It can be distinguished from *H. costata* sp. n. by lacking somatic ridges and the configuration of the lateral spines; from *H. xaniophora* sp. n. in lacking the broad lateral alae and in having smaller lateral spines and from *H. ortonwilliamsi* sp. n. in the configuration of the lateral spines, particularly the second pair where the bases are well separated and not almost contiguous.

Type host and locality. Hind gut of unidentified black and gold banded diplopod collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Type material. Holotype female and six paratype females in the collection of the International Institute of Parasitology, St. Albans, UK and four paratype females in the nematode collection at Rothamsted Experimental Station, Harpenden, Herts., UK.

Etymology. Named in honour of Dr. J. A. Sutherland, who collected the diplopod material.

Heth zeuglocantha sp. n. (Fig. 7. E-I)

Female (n=10): L = 1.55 (1.32-1.92) mm; width = 103 (86-120) μ m; oesophagus = 318 (301-345) μ m; tail = 351 (248-478) μ m; head to vulva = 1.13 (0.98-1.42) mm; a = 15.1 (12.5-17.3); b = 4.9 (4.3-5.6); c = 4.4 (3.6-5.5); V = 72.7 (66.6-77.1); V' = 93.9 (92.3-95.3).

Holotype female: L = 1.68 mm; width = 111 μ m; oesophagus = 300 μ m; tail = 468 μ m; head to vulva =

1.12 mm; a = 15.1; b = 5.6; c = 3.6; V = 72.7; V' = 92.3.

Female. Pseudolabia less extensive distally than in the other species described here so that much more of the proximal somatic flanges are visible in *en face* view (Fig. 7. G). Pectinae on the pseudolabia are noticeably longer than those on the somatic flanges. Each subdorsal and subventral body flange mirroring the pseudolabia with two, posteriorly directed, recurved spines each, thus making eight in total. Cervical collar continuous except laterally containing about 32 fine, attenuate spines which become longer, with a tendency to bifurcate, towards the lateral region. Lateral cuticular lappets absent. The first pair of lateral spines posterior to the cervical collar relatively short with completely fused bases, in some specimens a number of small marginal spinelets are present on the inner edge of each spine (Fig. 7 F). A single midlateral spine present posteriorly to the duplex spines. Lateral alae absent. Tail anteriorly conoid narrowing to a subulate tip (Fig. 7. I).

Male. Unknown. Unlikely, on a relative size basis, to be either of the two males described herein as Male sp. A and Male sp. B.

Differential diagnosis. Characterized by markedly smaller pseudolabia, continuous cervical collar formed from numerous small spines, absence of serrate lateral lappets and the lateral spines comprising a first pair with fused bases followed by a single midlateral spine. *H. zeuglocantha* sp. n. differs from all the other species described here and also *H. juli*, *H. dimorphum*, *H. hamatus* and *H. insularis* in lacking serrate lateral lappets. In lacking such lappets, but possessing a continuous cervical collar formed from numerous small spines, it resembles *H. amazonensis*, *H. bifidispiculum*, *H. duvidosum*, *H. mauriesi*, *H. perarmatum*, and *H. spinosum*, from which it can be distinguished by possessing neither anterior cervical combs nor spined cervical studs. *Heth zeuglocantha* sp. n. is the only species from the Australasian area which lacks serrate lateral lappets. In this feature it is more similar to Central and South American species, although *H. insularis* Kloss, 1965, from Brazil, is

illustrated as having apparently similar lappets.

Type host and locality. Hind gut of unidentified black and gold banded diplopod collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Type material. Holotype female and six paratype females in the collection of the International Institute of Parasitology, St. Albans, UK and three paratype females in the nematode collection at Rothamsted Experimental Station, Harpenden, Herts., UK.

Etymology. Derived from the Greek *zeuglo*, meaning joined, or yoked, and *akanthus*, meaning spine or thorn and referring to the pairs of lateral spines with fused bases.

Heth sp. (Male A) (Fig. 8. A-I)

Male (n=4): L = 1.24 (1.21-1.27) mm; width = 92 (87-97) μm ; oesophagus = 353 (334-384) μm ; tail (n = 3) = 143 (139-149) μm ; spicule = 65 (58-72) μm ; a = 13.4 (13.0-14.1); b = 3.5 (3.2-3.8); c = 8.7 (8.2-9.1).

Buccal cavity with three cuticular processes, one dorsal, two subventral, lacking lamellae (Fig. 8. A). Spicules slightly cephalated, slender; fused for most of their length and with the distal tip slightly curved ventrally (Fig. 8. E, G). Gubernaculum trough-shaped (Fig. 8. F). Fifteen copulatory papillae present and a midventral sucker about 220 μm anterior to the cloaca. A low, bursa-like extension of the cuticle present, extending from about the level of the second pair of preanal papillae to the point where the tail narrows. Tail anteriorly dorsally convex-conoid, rapidly attenuating to a subulate/filiform tip.

Host and locality. Hind gut of unidentified black and gold banded diplopod collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Relationships. *Heth* sp. A is characterized by lacking lamellae on the buccal processes, shape of the spicules and the disposition of the copulatory papillae. This species is possibly the male of either *H. costata* sp. n. or *H. sutherlandi* sp. n., as it is considered too

long in comparison to the body length of females of *H. zeuglocantha* sp. n. to be ascribed to that species.

Voucher specimens. Deposited in the collection of the International Institute of Parasitology, St. Albans, UK.

Heth sp. (Male B) (Fig. 8. J-P)

Male (n=3): L = 1.53 (1.38-1.79) mm; width = 101 (88-111) μm ; oesophagus = 421 (397-439) μm ; tail = 212 (198-228) μm ; spicule = 108 (95-115) μm ; a = 15.2 (13.3-16.2); b = 3.6 (3.2-4.1); c = 7.2 (6.5-7.9).

Buccal cavity with three cuticular processes, one dorsal, two subventral, bearing prominent lamellae (Fig. 8. J). Spicules slightly cephalated, slender; fused for most of their length and with the distal tip conspicuously hamate (Fig. 8. M). Gubernaculum broadening and deepening distally (Fig. 8. N). Thirteen copulatory papillae and a midventral sucker present. A low, bursa-like extension of the cuticle present, extending from the level of the second pair of preanal papillae to the point where the tail narrows (Fig. 8. K). Tail anteriorly dorsally convex-conoid, rapidly attenuating to a subulate/filiform tip.

Host and locality. Hind gut of unidentified black and gold banded diplopod collected in Morobe Province, Bubia ARC, Lae, Papua New Guinea.

Relationships. *Heth* sp. B differs from all the other males described here in possessing a conspicuously hamate tip to the spicules. This species is possibly the male of either *H. costata* sp. n. or *H. sutherlandi* sp. n., as it is considered too large in comparison to the body length of females of *H. zeuglocantha* sp. n. to belong to that species.

Voucher specimens. Deposited in the collection of the International Institute of Parasitology, St. Albans, UK.

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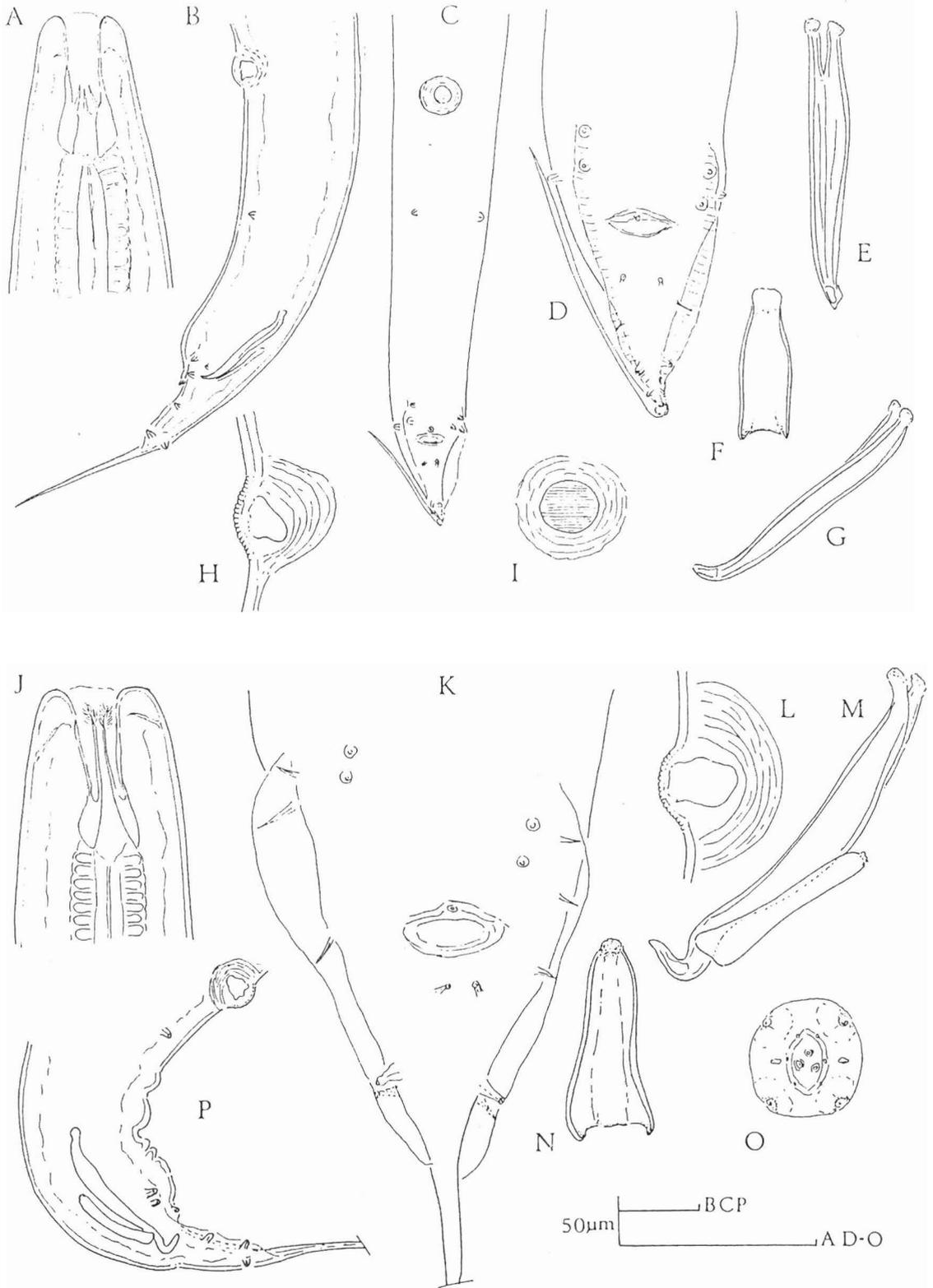


Fig. 8. *Heth* males. Species A. A-I. A: Buccal region; B: Posterior region, lateral; C, D: Posterior region, ventral; E: Spicule, ventral; F: Gubernaculum, ventral; G: Spicule, lateral; H: Ventral sucker, lateral; I: Ventral sucker, ventral. Species B. J-P. J: Buccal region; K: Posterior region, ventral; L: Ventral sucker, lateral; M: Spicule and gubernaculum, lateral; N: Gubernaculum, ventral; O: *En face*; P: Posterior region, lateral.

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Hunt D.J. Анализ Hethidae (Nematoda: Rhigonematida) с описанием пяти новых видов *Heth* Cobb, 1898 от диплопод Папуа-Новой Гвинеи.

Резюме. Пять новых видов рода *Heth* Cobb, 1898: *H. costata* sp. n., *H. ortonwilliamsi* sp. n., *H. xaniophora* sp. n., *H. sutherlandi* sp. n. и *H. zeugloantha* sp. n. обнаружены в двух видах диплопод из Папуа-Новой Гвинеи. Новые виды дифференцируются, главным образом, по форме и расположению латеральных шипов на цервикальном отделе тела самок и наличию или отсутствию латеральных крыльев. С помощью СЭМ изучено строение поверхности головного и цервикального отделов тела трех из описанных видов. Анализируется состав Hethidae, предлагается диагноз рода *Heth* и библиография по этому роду.
