Three new species of free-living nematodes from freshwater bodies of Vietnam (Nematoda: Araeolaimida)

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Paraplectonema vietnamicum sp. n. (Plectidae), *Paraphanolaimus asiaticus* sp. n. (Halaphonolaimidae) and *Parodontophora obscurus* sp. n. (Axonolaimidae) from freshwater bodies of Vietnam are described and illustrated.

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Introduction

It is the first record of the freshwater free-living nematode species from Vietnam. Samples were collected by junior authors from two water bodies near Hanoi: the Nhue River and West Lake. Nematodes were fixed in 4% formalin, then processed and mounted in glycerin. The descriptions and drawings are made from permanent slides.

Paraplectonema vietnamicum sp. n. (Figs 1-9)

Holotype.♀, **Vietnam**, Nhue River, about 10 km NW of Hanoi, depth 1 m, silt, 26.VIII.1999, slide no. 39/1 (I.7), deposited at the Institute for Biology of Inland Waters, Borok.

Paratypes. 12 ♀, 5 ♂, collected with holotype. 3 ♀ and 2 ♂ deposited with holotype (slide no. 40/1); 9 ♀ and 3 ♂ deposited at the Institute of Ecology and Biological Resources, Hanoi.

Measurements. See Table 1.

Description. Female. Body straight and slender, tail curved ventrally. Cuticle annulate; annuli 1.1-1.5 µm wide at midbody. Lateral fields with two incisures extending from middle of oesophagus length to middle of tail. Cuticle in vulva region about 1 µm thick. Somatic setae about 1 µm long, rare. Two setae at level of oesophagus, two setae in region between oesophagus end and vulva, three setae in region from vulva to anus and two setae on tail.

Labial region 10-12 µm wide, slightly flattened, with six lips. Lip papillae small, hardly visible. Cephalic setae four in number, about 2 µm long. Amphidial fovea 3 µm in diameter, situated at 3-4 µm from anterior end of body. Stoma 18-23 µm long, tubular. Cheilostoma short, weakly developed. Border between cheilostoma and protostoma with three small teeth. Protostoma 4.5-5.0 µm long (23-27% of stoma length), strongly culicularised and distinctly visible. Telostoma slightly widened, with three small denticles at base. Oesophagus slender, muscular. Lumen of oesophagus narrow, cuticularised. "Pharynx structure" situated in lumen of oesophagus at 12-20 µm from anterior end. Tissues of oesophagus cover the whole stoma. Basal bulb well developed, 20-24 µm long, 19-22 µm wide, divided into two sections. Inner line bulb with thick sclerotisations. Cardia 12-16 µm long, elongate, muscular. Renetta situated at level of cardia and anterior part of intestine. Excretory pore posterior to nerve ring, 30-35 µm from posterior end of oesophagus. Elongate oval coelomocyte 65-90 µm long situated ventrally, posterior to cardia. Rectum divided into two parts. Proximal part of rectum widened, bulb-shaped. Distal part of rectum narrow, cuticularised. Rectal glands present.

Female didelphic, amphidelphic. Ovaries antidromous. Ovaries long, reaching vulva. Q_1 = 170-215 µm, Q_2 = 145-205 µm. Vulva preequatorial, transverse, slit-shaped. Vulvar lips cuticularised,

Table 1. Measurements of *Paraplectonema vietnamicum* sp. n.

Characteristics	Females			Males	
	holotype	12 paratypes		5 paratypes	
		range	mean	range	mean
L, μm	895	695-920	793	630-916	781
a	26	18-29	23	20-30	24
b	6.5	6.0-7.1	6.7	5.5-6.8	6.2
c	6.4	5.2-6.6	5.8	5.7-7.4	6.6
c'	7.1	5.5-7.5	6.5	4.7-6.1	5.5
V	47.1	43.0-47.3	45.2	–	–
Labial region width, μm	11	10-12	11	10-11	11
Cephalic setae length, μm	2	2	2	2	2
Stoma length, μm	21	18-23	20	18-21	19
Stoma posterior end - pharynx structure, μm	20	12-20	16	15-19	17
Oesophagus length, μm	137	105-137	119	112-134	125
Posterior end of oesophagus – vulva, μm	284	217-290	241	–	–
Vulva – anus, μm	332	238-346	295	–	–
Posterior end of oesophagus – cloaca, μm	–	–	–	420-652	539
Tail length, μm	140	115-158	138	98-130	117
Spicula length, μm	–	–	–	29-35	31
Gubernaculum length, μm	–	–	–	15-17	16
Ventromedial supplements	–	–	–	11-13	12

Table 2. Measurements of *Paraphanolaimus asiaticus* sp. n.

Characteristics	Females			Males	
	holotype	16 paratypes		7 paratypes	
		range	mean	range	mean
L, μm	1053	913-1172	1061	688-900	801
a	26	18-32	24	23-33	27
b	5.8	5.3-6.7	6.0	4.1-5.8	5.0
c	6.4	6.0-7.0	6.5	5.4-6.9	6.3
c'	10.6	7.3-11.1	9.4	4.5-7.2	5.8
V	54.5	52.8-59.3	55.7	–	–
Labial region width, μm	5.5	5.0-5.5	5.3	5.0-5.5	5.3
Cephalic setae length, μm	5.0	4.0-5.0	4.5	4.0-5.0	4.5
Stoma length, μm	5.5	4.5-5.5	5.0	5.0-5.5	5.2
Oesophagus length, μm	182	147-217	177	144-175	162
Posterior end of oesophagus – vulva, μm	392	364-462	412	–	–
Vulva – anus, μm	315	240-364	310	–	–
Posterior end of oesophagus – cloaca, μm	–	–	–	420-616	511
Tail length, μm	164	136-189	162	100-161	128
Spicula length, μm	–	–	–	75-91	84
Gubernaculum length, μm	–	–	–	20-25	22
Ventromedial supplements	–	–	–	14-18	16

often protruded. Vagina short. Uterus elongate, chamber-shaped. Tail slender, gradually narrowing, strongly curved ventrally, 5.5-6.5 times longer than anal body diameter. Caudal glands and spinneret well developed.

Male. Similar to female in general appearance. Labial region 10-11 µm wide, stoma 18-21 µm long, cephalic setae 2 µm long. Border between cheilostoma and protostoma with three small teeth. Telostoma also with three small denticles. Pharynx distinct. Oesophagus with well developed basal bulb. Cardia elongate, muscular. Excretory pore situated at anterior end of basal bulb of oesophagus. Testis simple, straight. Spicules 29-35 µm long (along arch), slightly curved, with large rounded capituli. Gubernaculum small, with large dorsal appendix. The latter with short base and two elongate projections. Ventromedian supplements 11-13 in number, 11-13 µm long, consisting of two curved tubular parts. Supplement which is closest to cloaca situated near capitulum of spicula. Between anus and first supplement, one somatic seta. Tail slender, gradually narrowing, curved ventrally, with five pairs of setae, of which three anterior pairs longest, 4-5 µm long. Glandular structure with large cuticular opening situated at mid-tail ventrally. Caudal glands and spinneret distinct.

Comparison. The new species is close to *P. multitubiferum* (Imamura, 1931). It differs from the latter in the presence of three teeth at the border between cheilostoma and protostoma (in *P. multitubiferum*, teeth are absent), presence of large coelomocyte near the anterior end of middle intestine (in *P. multitubiferum*, coelomocyte is absent), and presence of glandular structure in the middle part of male tail (in *P. multitubiferum* male, tail glandular structure is absent).

Key to the species of *Paraplectonema*

1(2). Body length less than 920 µm; male with 15-17 supplements . . . . . **P. vietnamicum** sp. n.
2(1). Body length 920 µm or more; male with 9-13 supplements.
3(4). Tail length 270 µm or more; *c* = 4 or less . . . . . **P. canadianum** Hopper, 1983
4(3). Tail length 200 µm or less; *c* more than 5.
5(6). Spicule 22 µm or shorter; male with 9 supplements . . . . . **P. pedunculatum** (Hofmanner, 1913)
6(5). Spicule 31µm or longer; male with 13 supplements . . . . . **P. multitubiferum** (Imamura, 1931)

Paraphanolaimus asiaticus sp. n.
(Figs 10-17)

Holotype.♀, **Vietnam**, Nhue River, about 10 km NW of Hanoi, depth 1.5 m, silt, 26.VIII.1999, slide no. 41/1 (VI.3), deposited at the Institute for Biology of Inland Waters, Borok.

Paratypes. **Vietnam**: 6 ♀, 2 ♂, collected with holotype; 10 ♀, 5 ♂, West Lake, 2 km N of Hanoi, depth 3 m, silt and gravel, 23.V.2001. 4 ♀ and 2 ♂ deposited with holotype; 12 ♀ and 5 ♂ (slide no. 42/1) deposited at the Institute of Ecology and Biological Resources, Hanoi.

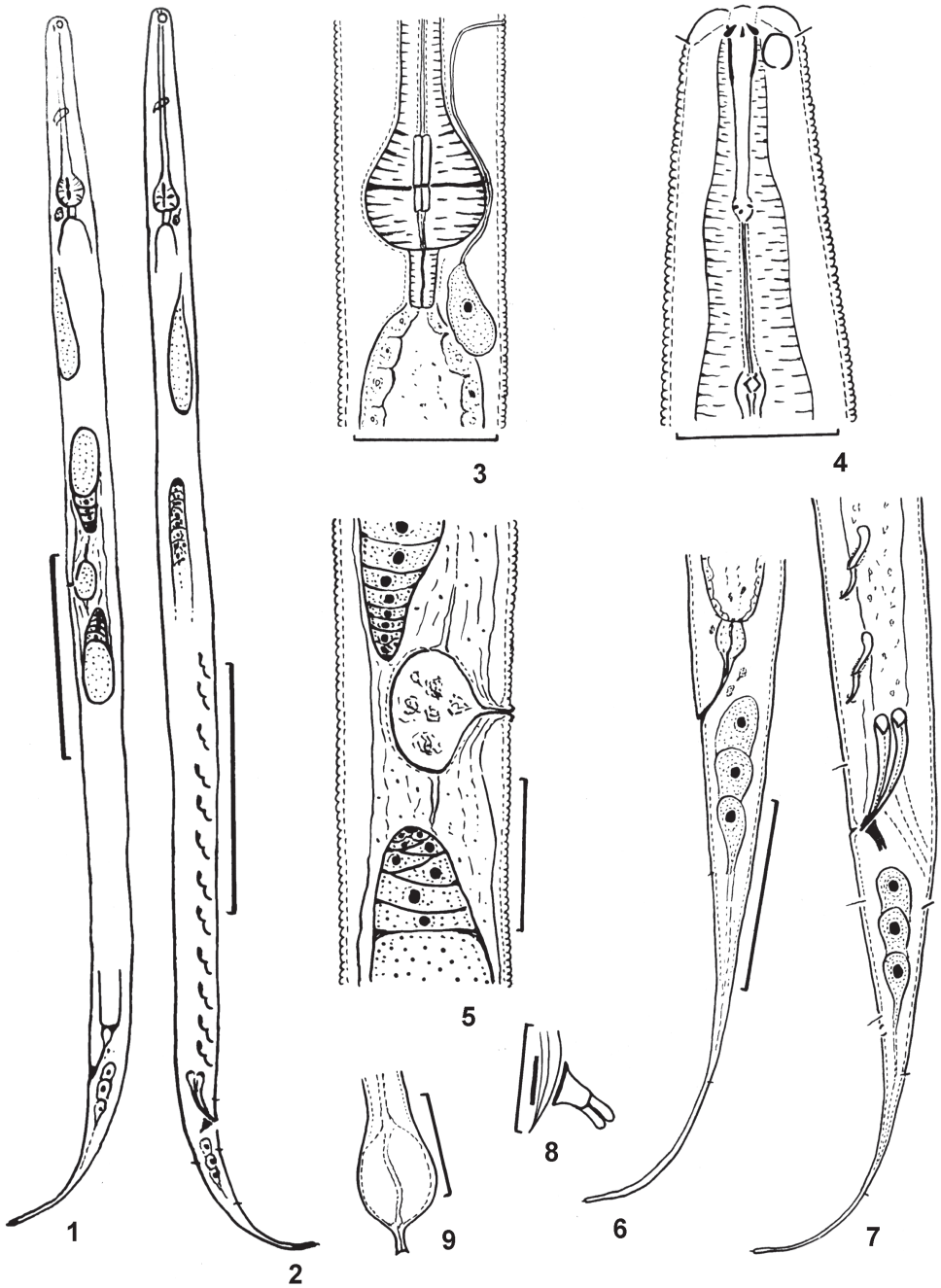
Measurements. See Table 2.

Description. Female. Body small, slender. Cuticle annulate; annuli about 1 µm wide at mid-body. In mature female, a total of 750-1000 annuli. Cuticle about 1.5 µm thick. Lateral fields with two incisures being 1.0-1.2 µm wide, extending from mid-oesophagus to mid-tail. Two rows (17-20 pairs) of hypodermic glands along the entire body length. Glands open by round cuticular pores, situated near edge of lateral field: 3-4 pairs at level of oesophagus, 7-9 pairs from posterior end of oesophagus to vulva, 3-4 pairs from vulva to anus, 2-3 pairs on tail. Somatic setae absent. Anterior body end strongly narrowed.

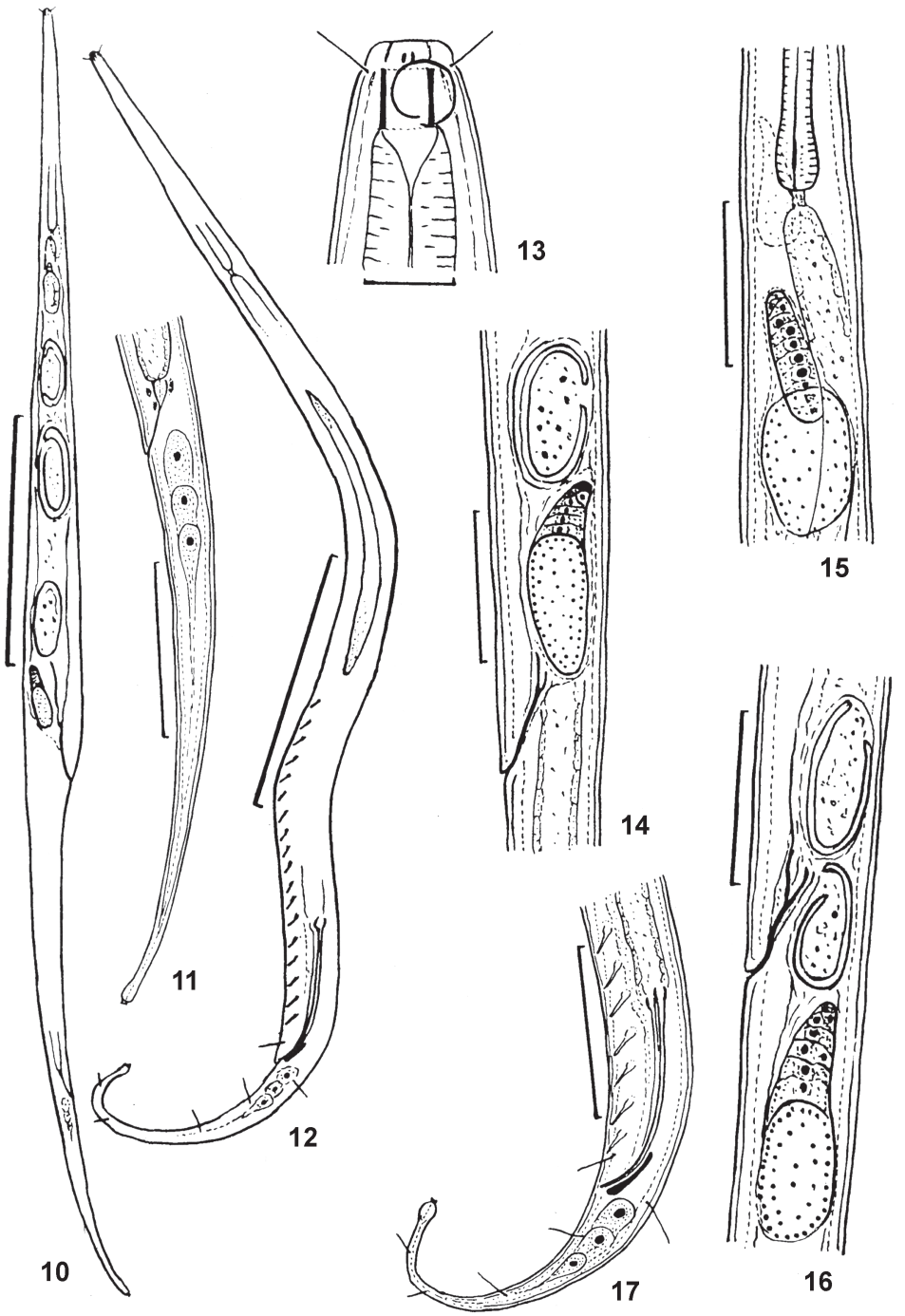
Labial region 5.0-5.5 µm wide; cephalic setae four in number, 4.0-4.5 µm long; lip papillae not observed. Amphidial fovea spiral-shaped, with one coil 4.0-4.5 µm in diameter, situated at level of stoma. Stoma cylindrical, its size 4.5-5.5 × 3.0-3.5 µm. Cheilostoma short. Three small denticles situated at level of protostoma. Anterior section of oesophagus narrow, weakly muscular; posterior section of oesophagus wider and with musculature more developed. Renetta small, situated at level of cardia. Length of rectum equal to or slightly greater than anal diameter of body. Proximal part of rectum bulb-shaped. Rectal glands present.

Female didelphic, amphidelphic. Ovarial bends short. Posterior bend of ovary shortened. Q_1 = 358-490 µm; Q_2 = 50-137 µm. Vulva post-equatorial, transverse, slit-shaped. Vagina length about 1/3 of the corresponding diameter of body, curved to anterior end of body. Uterus filled with sperm. Numerous eggs with developed larvae inside, located only in anterior bend of ovary. Tail long, gradually narrowing, 7.3-11.1 times as long as anal body diameter. Terminal end of tail swollen. Caudal glands present; spinneret short and wide.

Male. Similar to female in general appearance. Cuticle annulated, with narrow lateral fields. 17-19 pairs of hypodermic glands, including three pairs at level of oesophagus. Walls of two anterior gland pores with setae 8-10 µm long. Anterior end of body strongly narrowing. Cephalic setae 4-5 µm long. Stoma cylindrical. Amphidial fovea spiral-shaped, situated at level of stoma. Three small denticles at level of protostoma. Oesophagus narrow, weakly muscular. Renetta small, bag-shaped. Testes paired. Spicules 75-91 µm long, narrow, transversely striate, slightly curved ventrally. Capitulum of spicula elongate. Gubernaculum 20-25 µm long, boat-shaped. Ven-



Figs 1-9. *Paraplectonema vietnamicum* sp. n.: **1**, female, general view; **2**, male, general view; **3**, cardia region; **4**, head of female; **5**, vulva region; **6**, tail of female; **7**, tail of male; **8**, gubernaculum; **9**, terminus of tail. Scales: 150 μm (1, 2), 50 μm (6, 7), 30 μm (3, 5), 20 μm (8), 15 μm (4), 4 μm (9).



Figs 10-17. *Paraphanolaimus asiaticus* sp. n.: **10**, female, general view; **11**, tail of female; **12**, male, general view; **13**, head of female; **14, 16**, vulva region; **15**, cardia region; **17**, posterior end of male. Scales: 200 µm (10), 150 µm (12), 50 µm (11, 14-16), 40 µm (17), 5µm (13).

Table 3. Measurements of *Parodontophora obscurus* sp. n.

Characteristics	Holotype (male)	Paratypes	
		2 males	1 female
L, μm	1320	1093, 1134	1336
a	37	27, 26	29
b	6.9	6.2, 6.8	6.9
c	8.1	7.4, 7.6	8.5
c'	5.8	5.6, 5.5	5.6
V	–	–	51.6
Labial region width, μm	12	11, 12	12
Cephalic setae length, μm	5.5	5.0, 5.5	5.5
Stoma length, μm	28	27, 28	28
Amphideal fovea length, μm	18	17, 18	18
Renetta length, μm	122	95, 105	100
Oesophagus length, μm	192	175, 168	203
Posterior end of oesophagus – vulva, μm	–	–	486
Vulva – anus, μm	–	–	490
Posterior end of oesophagus – cloaca, μm	966	770, 812	–
Tail length, μm	162	148, 154	157
Spicula length, μm	33	35, 32	–
Gubernaculum length, μm	18	17, 18	–

tromedian supplements14-18 in number, tubular, their proximal ends swollen. Anterior supplement at 25-30 μm from anus; next supplements spaced at intervals of 15-20 μm; 4-5 supplements situated near spicules. Two setae 13-15 μm long situated anterior to cloaca. Tail long, gradually narrowing, curved ventrally, with swollen terminal end. Tail with two subventral pairs and two subdorsal pairs of setae 8-14 μm long. Gaudal glands and spinneret present.

Comparison. The new species is close to *P. behningi* Micoletzky, 1923, but differs in the longer cephalic setae (which are approximately equal to the labial region width in *P. asiaticus* sp. n. and only to 1/3-1/2 of the labial region width in *P. behningi*), presence of three small denticles at the level of prostoma (in *P. behningi*, denticles are absent), presence of shortened posterior bend of ovary (in females of *P. behningi*, both ovarial bends are well developed and long) and postequatorial vulva (in females of *P. behningi*, vulva is preequatorial) (Micoletzky, 1923; Alekseev, 1980).

Paradontophora obscura sp.n.
(Figs 18-22)

Holotype. ♂, **Vietnam**, Nhue River, about 10 km NW of Hanoi, depth 1.5 m, silt, 26.VIII.1999, slide No. 43/1 (IV.5), deposited at the Institute for Biology of Inland Waters, Borok.

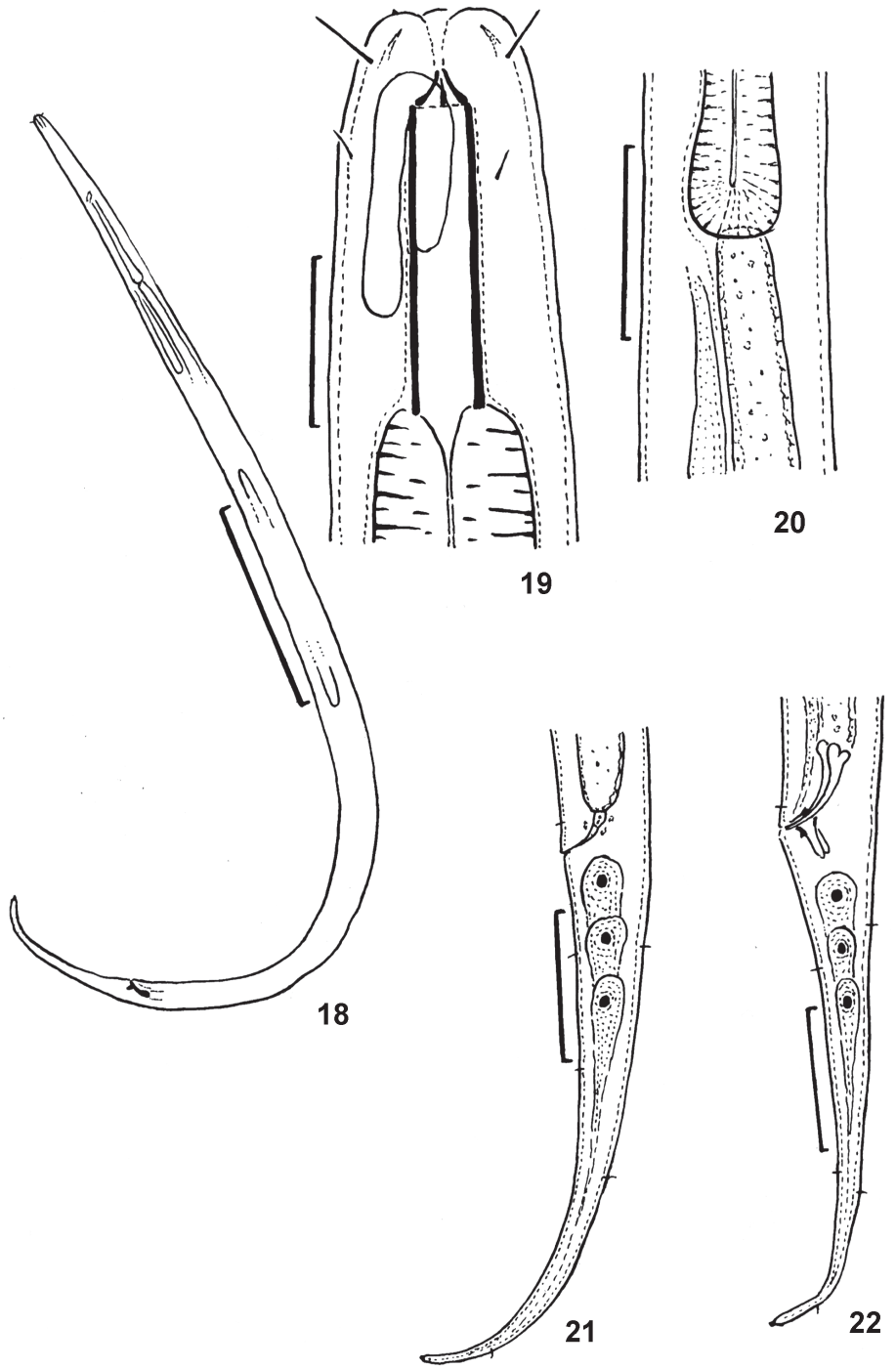
Paratypes. 2 ♂, 1 ♀, collected with holotype, deposited at the Institute of Ecology and Biological Resources, Hanoi.

Measurements. See Table 3.

Description. Female. Cuticle 1.5 μm thick, annuli not very distinct, 1-1.5 μm wide. Lateral fields not observed. Somatic setae 3-4 μm long, small, rare. Hypodermic glands absent. Anterior body end narrowed. Body at posterior end of oesophagus 3.3-3.6 times as wide as diameter of labial region. Lips high; labial papillae small. Four cephalic setae 5.0 μm long.

Stoma 21 μm long, 5.0 μm wide, tubular, narrowing, with 6 stick-shaped teeth 5 μm long at anterior end. At level of stoma, two pairs of cervical setae 5.0 μm long. Amphidial fovea tubular, folded in two, both bends close to each other; ventral bend (18 μm long) always longer than dorsal one (12 μm long). Oesophagus narrowly tubular, widened at base. Walls of oesophagus weakly muscular. Cardia and cardial glands not observed. Renetta about 100 μm long, situated ventrally at anterior end of middle intestine. Rectum 18 μm long, 0.5 times as long as anal diameter. Rectal glands present.

Female didelphic, amphidelphic. Ovaries homodrous, comparatively long. Q_1=164 μm, Q_2=157 μm. Vulva transverse, slit-shaped, its lips not protruded. Vagina short, 1/4 times as long as corresponding body diameter. Tail elongate, conical, gradually narrowing, with five pairs of setae



Figs 18-22. *Paradontophora obscurus* sp. n.: **18**, male, general view; **19**, head of male; **20**, cardia region; **21**, tail of female; **22**, tail of male. Scales: 200 μm (18), 40 μm (20-22), 10 μm (19).

5.0-5.5 µm long. Caudal glands and spinneret well developed.

Male. Similar to female in general appearance. Labial region 11-12 µm wide. Stoma 21-23 µm long, 5.0-5.5 µm wide, narrow, tubular, with 6 teeth 5.0-5.5 µm at anterior end. Cardial setae 5.0-5.5 µm long. Amphidial fovea tubular, folded in two. Ventral bend 18-19 µm long, dorsal bend 12-13 µm long. Oesophagus narrow, weakly muscular. Renetta 95-123 µm long, situated ventrally at anterior end of middle intestine. Two testes present. Supplements absent. Spicules 32-35 µm long, ventrally curved, with bifurcate heads. Gubernaculum with wide pyramidal base, two elongate projections and large dorsal process 17-18 µm long. Tail elongate, conical, gradually narrowing, with five pairs of setae 5.0-5.5 µm long. Caudal glands and spinneret well developed.

Comparison. The new species is close to *P. brevamphida* (Timm, 1952) and *P. quadristicha* (Schuurmans Stekhoven, 1950). It differs from both the species in the smaller number of cervical setae (in *P. brevamphida* and *P. quadristicha*, cervical setae form 4 groups of 10-12 setae), shorter cephalic setae (in *P. brevamphida* and *P. quadristicha*, cephalic setae are 8.4-8.6 µm long, that is 70-80% of the labial region width), and in the differently-shaped gubernaculum. *P. obscurus* differs from *P. brevamphida* also in the longer gubernaculum (in males of *P. brevamphida*, gubernaculum is 8-10 µm long) and renetta (in *P. brevamphida*, it is 32-65 µm long) (Timm, 1962; Wieser & Hopper, 1967). *P. obscurus* differs from *P. quadristicha* also in the shorter stoma (which is 40 µm long in *P. quadristicha*), longer amphidial fovea (which is 17-18 µm long in *P. quadristicha*) and longer spicules (which are 32-35 µm long in *P. quadristicha*) (Schuurmans Stekhoven, 1950; Wieser & Hopper, 1967).

Etymology. The species name means "vague", "unknown", "hidden".

Acknowledgements

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