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ORIGINAL ARTICLE

Prochaetosoma dokdoense sp. nov. (Nematoda: Draconematidae) from Dokdo, Korea: First record of the genus *Prochaetosoma* from a shallow subtidal zone in the northwest Pacific Ocean

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Abstract

A draconematid nematode *Prochaetosoma dokdoense* sp. nov., first discovered in December 2006 at a subtidal zone of Dokdo, Korea, the northwest Pacific Ocean, is described. This new species was obtained from coarse detritus and shell gravels. *Prochaetosoma dokdoense* sp. nov. differs from all the species hitherto described by the following combination of characteristics: longer slender body (910–1175 μm), elongate loop-shaped amphidial fovea in male (distal end of ventral arm slightly curved anteriorly), eight cephalic adhesion tubes in both sexes positioned just anterior to swollen pharyngeal region, number of posterior sublateral adhesion tubes (6 in male and 6–10 in female) and posterior subventral adhesion tubes (7–8 in male and 8–9 in female), longer spicule length (78–86 μm), long cylindro-conoid tail (114–131 μm in male and 116–131 μm in female) and higher ratio c′ (6.5–7.5 in male and 7.4–9 in female). A table comparing the major differential diagnostic characteristics of the species of the genus *Prochaetosoma* Micoletzky, 1922 is presented. For a reliable understanding of the geographic distribution and species identification of the genus *Prochaetosoma*, a pictorial key showing the relative length of non-annulated tail terminus to total tail length in both sexes is included, together with a dichotomous species identification key based on adults and fourth-stage juvenile as far as known. This is the first record of the genus *Prochaetosoma* in the northwest Pacific Ocean.

Key words: *DIC photomicrographs, key, morphology, morphometrics, taxonomy*

Introduction

The genus *Prochaetosoma* was created by Micoletzky (1922) based on *Chaetosoma primitivum* Steiner, 1916 and classified within the family Draconematidae Filipjev, 1918 based on the following combination of characteristics: moderately developed buccal cavity armed with conspicuous dorsal tooth, tiny ventrosublateral teeth and endbulb of pharynx with a well cuticularized lumen wall.

The genus *Prochaetosoma* has been reported from the intertidal and shallow subtidal environments in oceans all over the world except for the northern part of the Pacific Ocean (overview in Table I based on Steiner 1916; Allgén 1932; Gerlach 1957; Kreis 1963; Allen & Noffsinger 1978; Jensen 1986; Decraemer 1989). Ten species within the genus *Prochaetosoma* have been described previously (Allen & Noffsinger 1978; Decraemer et al. 1997). Of these, three species have been described from the southwest Pacific Ocean, i.e. *P. campbelli* (Allgén, 1932) and *P. longicapitatum* (Allgén, 1932) from New Zealand and *P. martensi* Decraemer, 1989 from Papua New Guinea. However, no biodiversity studies from the northwest Pacific Ocean with respect to the genus *Prochaetosoma* have been carried out so far.

During a continuous ecological investigation on an annual fluctuation of the free-living marine

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Table I. Biogeography of the species of the genus *Prochaetosoma* including *P. dokdoense* sp. nov.

Taxa	Geographic distribution	Habitat
P. arcticum (Kreis, 1963)	Along banks of Eyjafjörõur Fjord, Iceland	Marine
P. brighti Jensen, 1986	the East Flower Garden in the north-western Gulf of Mexico	Marine; sandy sediments of downstream Gollum's Canyon and outside the influence of the sulphide-rich brine seep (72 m depth)
P. campbelli (Allgén, 1932)	Persev. Harbor, Campbell Island, New Zealand	Marine; associated with red algae (40 m depth)
P. cayense Allen & Noffsinger, 1978	Coral Key, Florida, USA	Marine; associated with *Halimeda* sp., a calcareous algae
P. dokdoense sp. nov.	Dokdo, Korea in the northwest Pacific Ocean	Marine; shallow subtidal detritus and shell gravels (72 m depth)
P. longicapitatum (Allgén, 1932)	Persev. Harbor, Campbell Island, New Zealand	Marine; associated with red algae (40 m depth)
P. lugubre (Gerlach, 1957)	Beach in front of City of Ilha Bela, São Sebastião Island, State of São Paulo, Brazil	Marine; medium coarse sand and bottom debris (1.8 m depth)
P. martensi Decraemer, 1989	Madang Province, Papua New Guinea	Marine; coral sand from a shallow tide pool
P. mediterranicum Allen & Noffsinger, 1978	Calangue de Port Miou near Marseille, France	Marine; medium coarse sand (18 m depth)
P. primitivum (Steiner, 1916)	Barents Sea	Marine
P. vitielloi Allen & Noffsinger, 1978	Calangue de Port Miou near Marseille, France	Marine; medium coarse sand (18 m depth)

nematofauna around Dokdo Islands, Korea, one draconematid nematode species was obtained from the washings of coarse detritus and shell gravels from a subtidal benthic environment. Morphological study of males, females and juveniles using a differential interference contrast (DIC) microscope indicated that this species is new to science.

In this paper, we propose and describe a new *Prochaetosoma* species, *P. dokdoense* sp. nov., using illustrations and DIC photomicrographs, and discuss its relationships with other members of the genus. A pictorial identification key using the relative length of non-annulated tail terminus to total tail length and dichotomous keys to species level, respectively, for adults and fourth-stage juveniles are given. A world distribution map for the species of *Prochaetosoma* is also provided. This is the first taxonomic report on the genus *Prochaetosoma* from the northwest Pacific Ocean.

Materials and methods

The draconematid species dealt with in the present paper is part of an extensive sampling of meiobenthic animals during the KORDI (Korea Ocean Research and Development Institute) cruise of the research vessel RV *Eardo* within the framework of the research project on the sustainable development of Dokdo. Marine benthic sediments, yielding specimens for the present study, were taken by means of the Smith-McIntyre Grab from a shallow subtidal zone of Dokdo Islands, the East Sea in the northwest Pacific Ocean, approximately 216.8 km east of the Korean Peninsula (Figure 1). Composition of the sediments was mostly shell gravels such as dead molluscs, brachiopods and bryozoan particles. Sediment grain size was analysed with a Sedigraph 5000D Particle Size Analyzer, after sieving the coarse fraction through a 1000 μm screen. Median grain size was calculated. The composition of the sediments was as follows: 97.72% shell gravel, 1.85% sand, 0.21% silt and 0.22% clay. Samples were filtered through a 63 μm mesh sieve in the field after freshwater rinsing for less than a

Figure 1. Map showing the type locality of *Prochaetosoma dokdoense* sp. nov. (●: Dokdo).

minute to release the attachment from the substrates (Kristensen 1989), and then fixed in 4% buffered formalin in seawater for morphological study and/or stored in 99% molecular grade ethanol for future molecular analysis. Coarse detritus and tiny shell gravels were removed from the sample by decantation, and the meiobenthos was roughly extracted by flotation in Ludox® (DuPont) HS 40 (Burgess 2001). The draconematid specimens were picked out from the mixed meiobenthos under a high magnification of LEICA MZ 8 stereomicroscope with differential interference contrast. Specimens for morphological observation were transferred to anhydrous glycerin according to Seinhorst (1959) and mounted in anhydrous glycerin between two cover slips on a HS-slide (Shirayama et al. 1993). Adults and various juvenile stages of *Prochaetosoma dokdoense* sp. nov. were examined using an Olympus BX51 microscope equipped with Nomarski differential interference contrast. All drawings and measurements were made with a drawing tube. The photographs were taken with a Nikon Coolpix 990 digital camera, and quality enhanced with Adobe Photoshop V7.0 software.

Terminology and abbreviations

The terminology of the description and measurements were conducted following Decraemer (1989). Abbreviations used in the text are as follows: L: total body length; CAT: cephalic adhesion tubes; CATn: number of cephalic adhesion tubes; mbd: maximum body diameter at mid-body level; (mbd): minimum body diameter; mbd Ph: maximum body diameter in pharyngeal region; ph: length of pharynx, measured from anterior end of head capsule up to posterior border of pharyngeal bulb; lips and cardia not included; PAT: posterior adhesion tubes; SlATl: length of anteriormost sublateral posterior adhesion tube; SlATn: number of sublateral posterior adhesion tubes; SvATl: length of anteriormost subventral posterior adhesion tube; SvATn: number of subventral posterior adhesion tubes; VAT: ventral adhesion tube; VATn: number of ventral adhesion tubes; t: tail length including non-annulated tail terminus; tmr: length of non-annulated tail terminus; tmr/t: proportion of non-annulated tail terminus to total tail length; abd: anal body diameter; spic: spicule or length of spicule measured along the median line; gub: gubernaculum or length of gubernaculums; V: position of the vulva as a percentage of the total body length from the anterior end; a, b, c, c′: proportions of de Man (1880); a: body length divided by maximum body width; b: body length divided by pharynx length; c: body length divided by tail length; c′: tail length divided by anal body diameter.

Taxonomy

Phylum Nematoda Potts, 1932
Class Chromadorea Inglis, 1983
Subclass Chromadoria Pearse, 1942
Order Desmodorida De Coninck, 1965
Family Draconematidae Filipjev, 1918
Genus *Prochaetosoma* Micoletzky, 1922

Diagnosis

Emended after Decraemer et al. (1997). Prochaetosomatinae. Swollen anterior body region 9–20% of total body length. Cuticle thin, with spiny ornamentation or granulation. Head capsule round. Amphidial fovea modified spiral, C-shaped or elongate loop-shaped. CAT variable in number (4, 6, 8, 9 and 14), with enlarged base and located less than one diameter posterior to head capsule. Buccal cavity moderately developed, armed with three teeth (one larger dorsal tooth and two tiny ventrosublateral teeth). Endbulb of pharynx with a well thickened lumen wall. PAT with bell-shaped tip, all anterior to cloacal opening/anus. Paravulval setae usually present. Tail cylindro-conoid with numerous annules. Non-annulated tail terminus short conical or narrow cylindro-conoid.

Type species

Prochaetosoma primitivum (Steiner, 1916) Micoletzky 1922

Other valid species

P. arcticum (Kreis, 1963) Allen & Noffsinger 1978
P. brighti Jensen, 1986
P. campbelli (Allgén, 1932) Allen & Noffsinger 1978
P. cayense Allen & Noffsinger, 1978
P. dokdoense sp. nov.
P. longicapitatum (Allgén, 1932) Allen & Noffsinger 1978
P. lugubre (Gerlach, 1957) Allen & Noffsinger 1978
P. martensi Decraemer, 1989
P. mediterranicum Allen & Noffsinger, 1978
P. vitielloi Allen & Noffsinger, 1978

Prochaetosoma dokdoense sp. nov.
(Figures 2–13)

Material examined

Holotype. Male, slide (RIT 757) deposited in the nematode collection of the Royal Belgian Institute of Natural Sciences, Brussels, Belgium.

Paratypes. Five paratypes, one male (RIT 758), one female (RIT 759), one fourth-stage juvenile (RIT 760), one third-stage juvenile (RIT 761) and one second-stage juvenile (RIT 762), deposited in the nematode collection of the Royal Belgian Institute of Natural Sciences, Brussels, Belgium. Five paratypes, one male (NIBRIV0000108692), one female (NIBRIV0000108693), one fourth-stage juvenile (NIBRIV0000108694), one third-stage juvenile (NIBRIV0000108695) and one second-stage juvenile (NIBRIV0000108696), deposited in the nematode collection of the National Institute of Biological Resources, Incheon, Korea. Five paratypes, one male (IRBK107), one female (IRBK108),

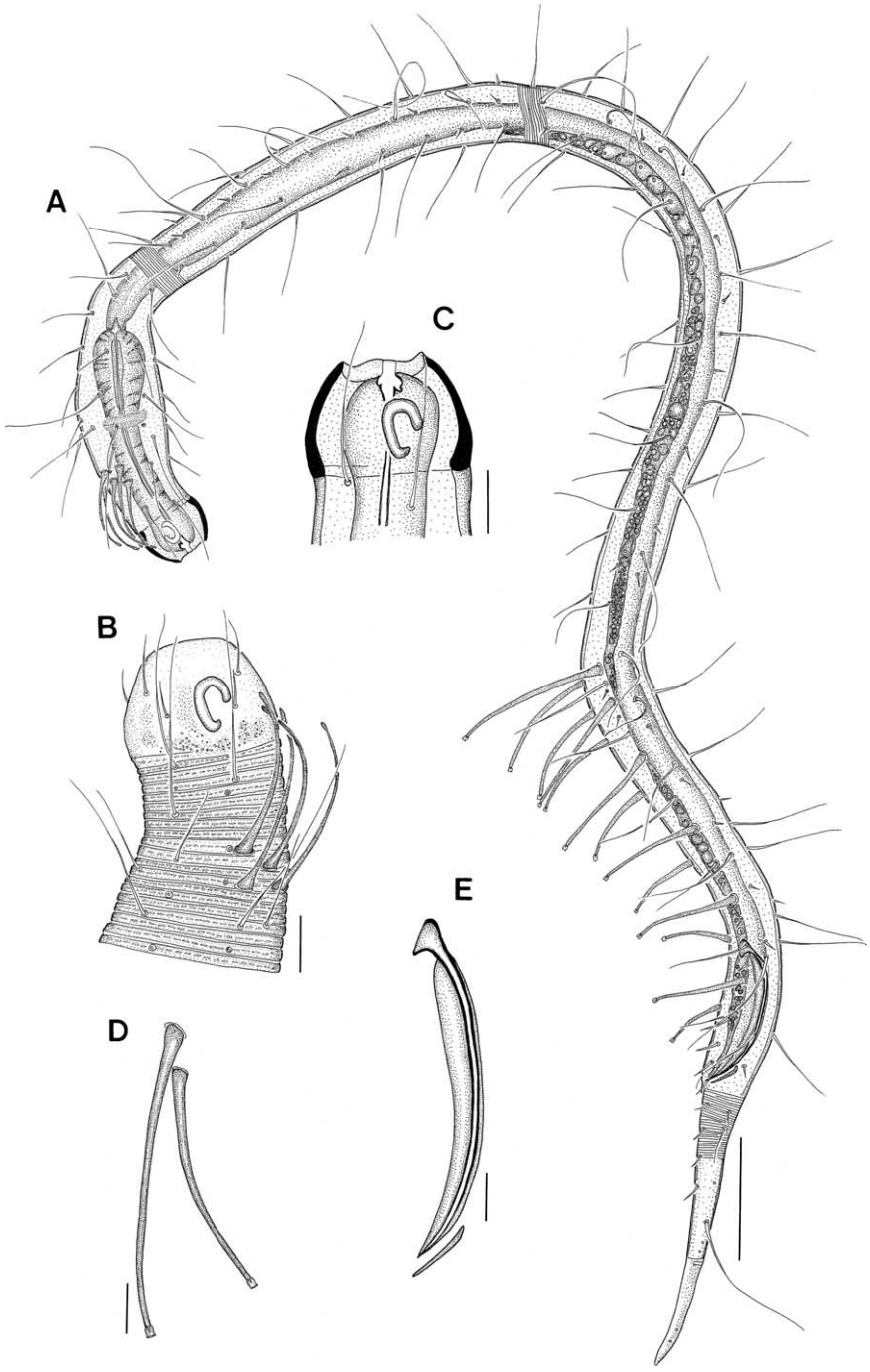

Figure 2. *Prochaetosoma dokdoense* sp. nov., holotype male. (A) Habitus, lateral view; (B) anterior body region showing amphidial fovea and cephalic adhesion tubes, lateral surface view; (C) buccal cavity, optical section and amphidial fovea, surface view; (D) posterior sublateral (left side) and subventral adhesion tubes (right side), lateral view; (E) copulatory apparatus, lateral view. Scale bars: A = 50 μm; B–E = 10 μm.

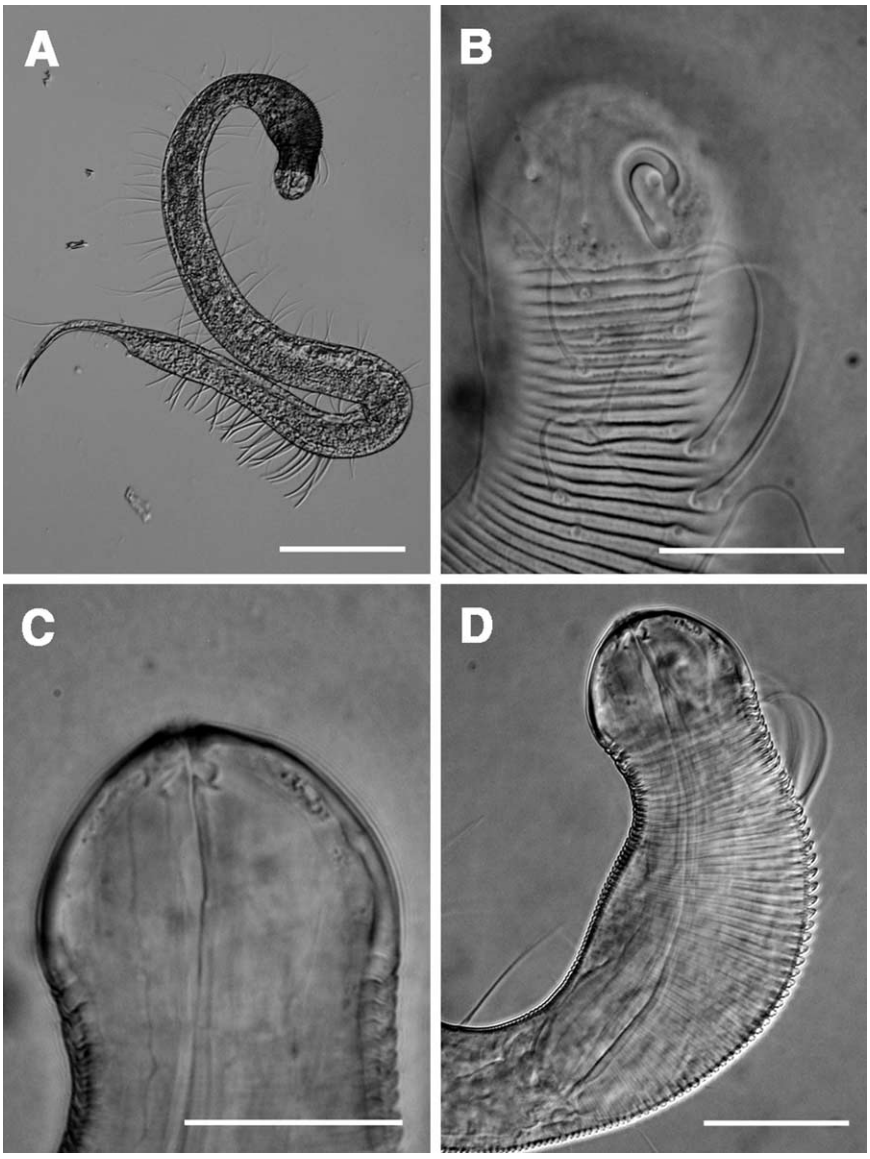

Figure 3. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of paratype male. (A) Habitus, lateral view; (B) anterior body region showing amphidial fovea and some cephalic adhesion tubes, lateral surface view; (C) buccal cavity showing the dorsal tooth, optical section; (D) anterior body region showing pharynx with well-developed cuticularized lumen wall, partial optical section. Scale bars: A = 100 μm; B,C = 20 μm; D = 30 μm.

one fourth-stage juvenile (IRBK109), one third-stage juvenile (IRBK110) and one second-stage juvenile (IRBK111), deposited in the Invertebrate Resources Bank of Korea (IRBK), Seoul National University. Twenty-eight paratypes, six males (KORDI023-KORDI028), six females (KORDI029-KORDI034), six fourth-stage juveniles (KORDI035-KORDI040), five third-stage juveniles (KORDI041-KORDI045) and five second-stage juveniles (KORDI046-KORDI 050), deposited in the collection at the specimen conservation room of the Marine Living Resources Research Department, Korea Ocean Research and Development Institute.

Other material. We are also preserving the fresh raw samples of the coarse detritus and shell gravels collected from the type locality of *Prochaetosoma dokdoense* sp. nov. in a −80°C refrigerator for future genetic analysis.

Measurements

See Table II.

Etymology

The specific name is taken from Dokdo, the type locality.

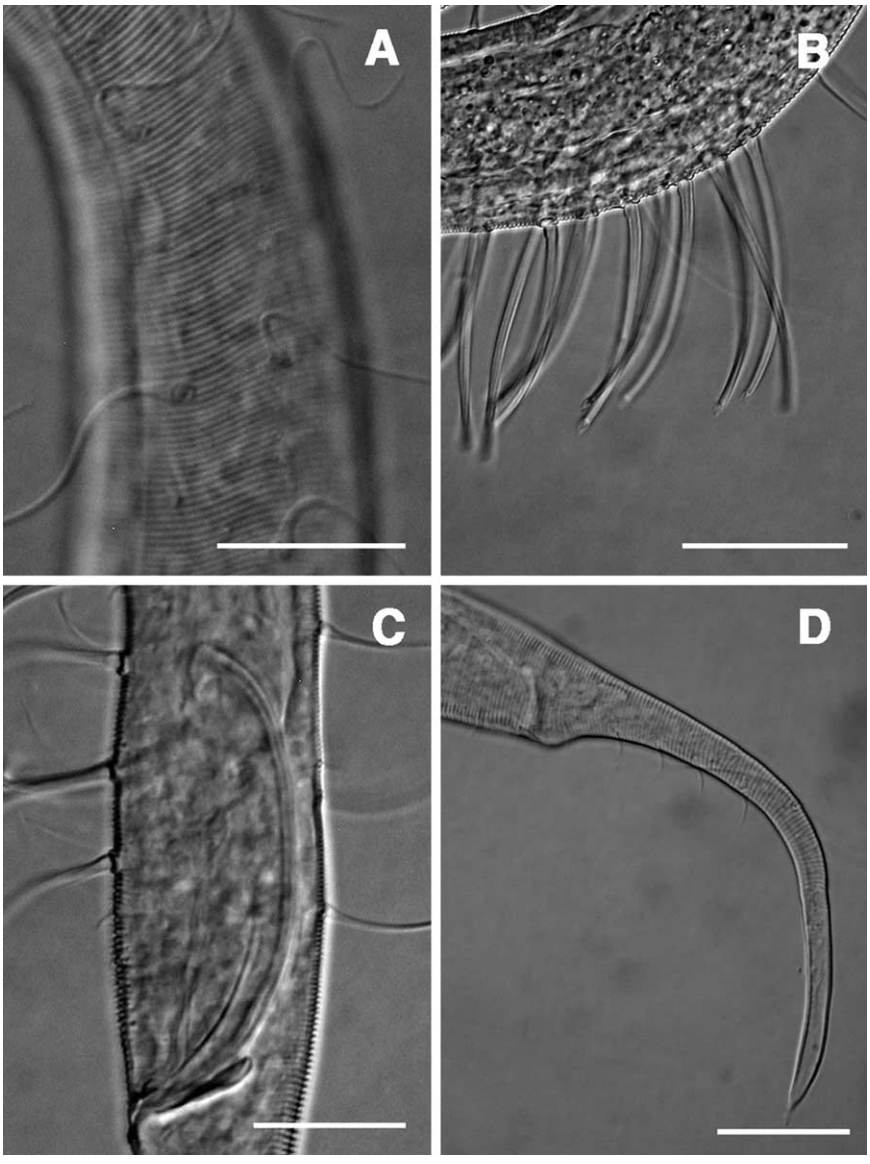

Figure 4. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of paratype male. (A) Surface cuticle of mid-body region, lateral view; (B) posterior adhesion tubes, lateral view; (C) copulatory apparatus, lateral view; (D) tail region, lateral view. Scale bars: A,C = 20 μm; B,D = 30 μm.

Type locality

A subtidal zone of Dokdo Islands, Korea (37°14′93″N, 131°52′31″E), 72 m depth, collected on 2 December 2006 by H. S. Rho and T. Kang.

Habitat and species associations

Subtidal detritus and shell gravels (72 m depth). Shell gravels contained dead molluscs, brachiopods and bryozoan particles. *Prochaetosoma dokdoense* sp. nov. co-occurred with other nematodes (*Paradraconema* sp., *Desmoscolex* sp., *Tricoma* sp., *T.* (*Quadricoma*) sp., *Epsilonema* sp., *Leptepsilonema* sp., *Metepsilonema* sp. *Bathyepsilonema* sp. and unidentified nematodes), kinorhynchs (*Echinoderes* sp.), amphipods, isopods, tanaidaceans, harpacticoids and halacarids.

Description

Males. Body long, slender, shallow sigmoid, anterior body region often strongly curved ventrally in fixed specimens (Figures 2A and 3A). Pharyngeal region comprising 10–12% of total body length, slightly swollen, about as wide as mid-body region. Tail long, gradually tapered posteriorly and ending in cylindroconoid portion. Body cuticle finely annulated except for head capsule and tail terminus; cuticular annules broader in pharyngeal and tail regions; no lateral differentiation. Annules in pharyngeal region

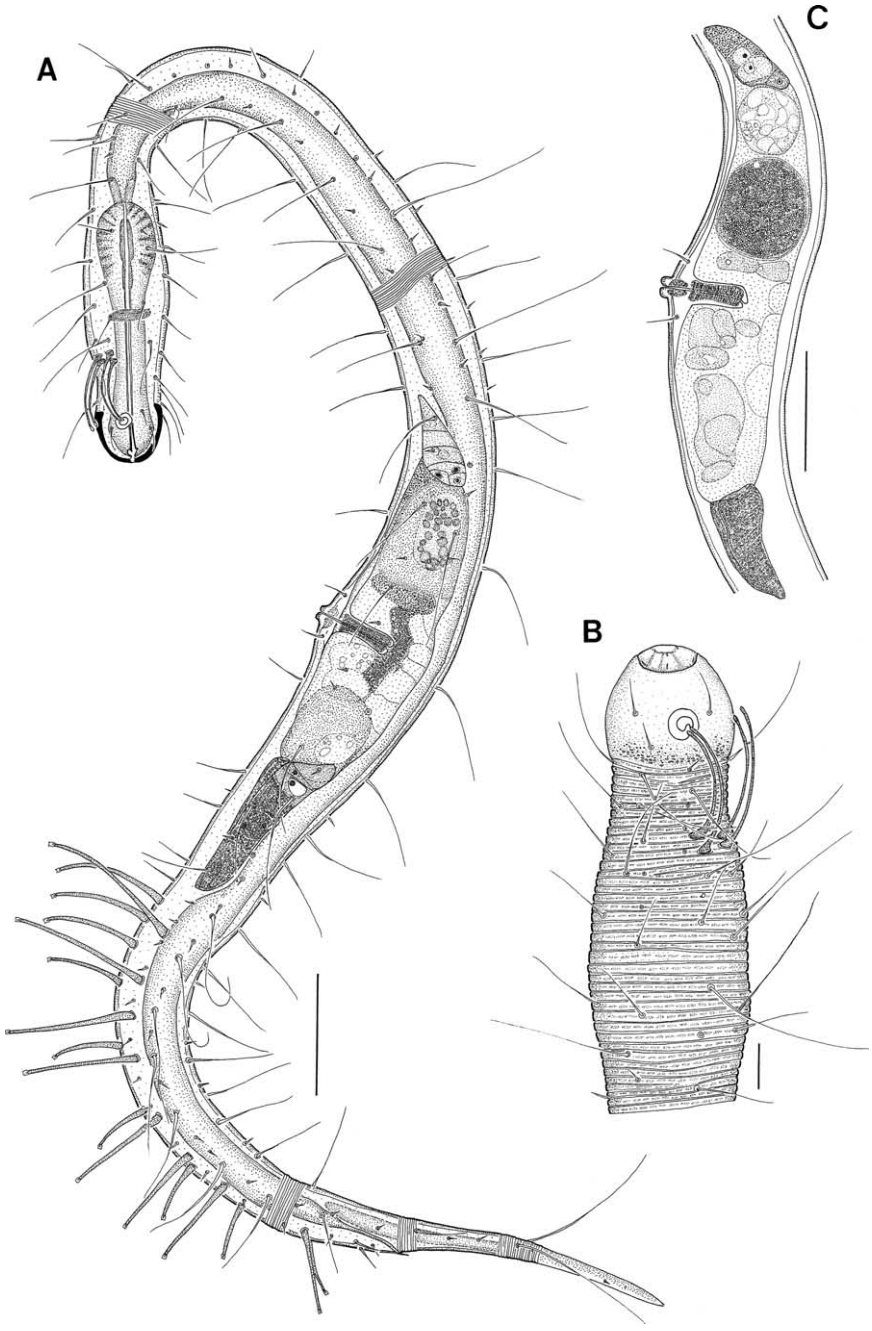

Figure 5. *Prochaetosoma dokdoense* sp. nov., paratype female. (A) Habitus of female allotype, total view, optical section; (B) neck of allotype showing amphidial fovea on head capsule and cephalic adhesion tubes, lateral surface view; (C) female reproductive system, paratype, optical section. Scale bars: A,C = 50 μm; B = 10 μm.

ornamented with fine granulation; annules smooth in mid-body region (Figure 4A).

Head capsule truncated dome-shaped with thickened cuticle; gradually tapering anteriorly (Figure 2B). Head capsule, excluding lip region, 21 μm long, with slightly granulated ornamentation posteriorly and four subcephalic setae (7 μm long); greatest width subterminally (28 μm in diameter). Lip region partially to completely retracted in most fixed specimens. External labial sensillae setiform. Four cephalic setae (11 μm long) located on anterior third of thickened head capsule. Amphidial fovea large (10 μm long), elongate loop-shaped, lying dorsosublateral on head capsule; ventral arm longer than dorsal one and distal end slightly curved anteriorly (Figure 2B,C and 3B). Length of amphidial fovea 47.6% of head capsule length. Eight CAT, all posterior to head capsule, located subdorsally and more or less arranged in four longitudinal pairs; with anterior row inserted on the ninth or tenth

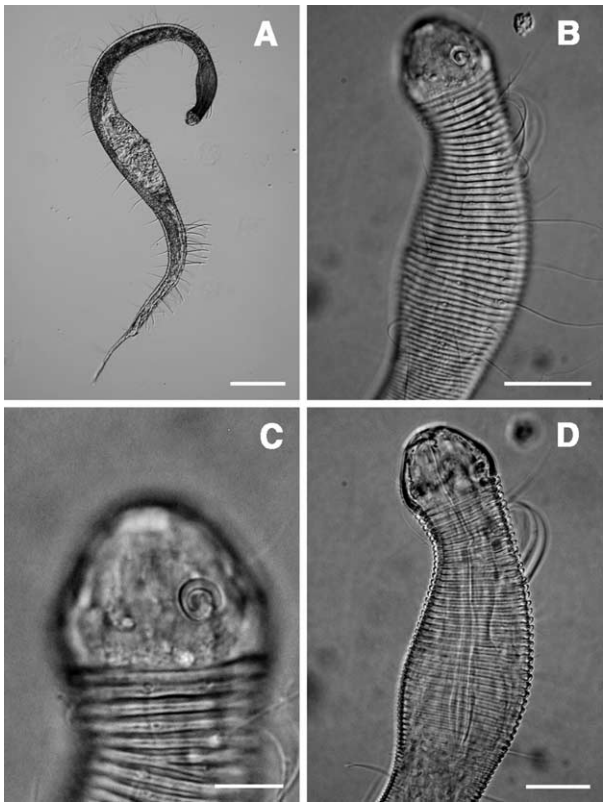

Figure 6. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of paratype female. (A) Habitus, lateral view; (B) anterior body region showing amphidial fovea and some cephalic adhesion tubes, lateral view; (C) detail of head capsule showing amphidial fovea, lateral surface view; (D) anterior body region showing pharynx with well-developed cuticularized lumen wall, optical section. Scale bars: A = 100 μm; B = 30 μm; C = 10 μm; D = 20 μm.

complete body annule and posterior row inserted on twelfth body annule in holotype; position of CAT on body annules somewhat variable in paratypes. Setae enlarged at insertion base and slightly swollen at tip (Figures 2B and 3B); CAT bent ventrally, 32–37 μm long (mean value 35 μm) with posterior tubes slightly longer than anterior ones.

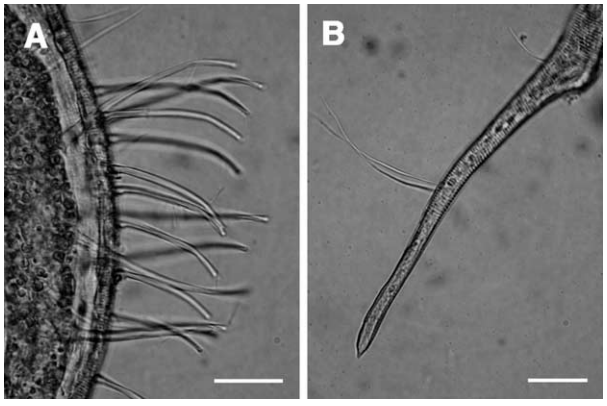

Figure 7. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of paratype female. (A) Posterior adhesion tubes, lateral view; (B) tail region, lateral view. Scale bars: A,B = 20 μm.

Buccal cavity narrow, armed with a moderately developed dorsal tooth and two tiny ventrosublateral teeth (Figures 2C and 3C). Pharynx largely cylindrical, with terminal bulb with well-developed cuticularized lumen wall, slightly thickened posteriorly (Figure 3D); nerve ring located just in front of terminal bulb (Figure 2A). Cardia well developed, 5.3 μm long. Intestine narrow, mostly cylindrical, gradually widening posteriorly and lying dorsally to genital system. Secretory–excretory system not observed.

Somatic setae, hair-like with broadened base, varying in length from mainly long (36–43 μm) to short (15–17 μm); setae arranged in 14 longitudinal rows in pharyngeal region: 4 subdorsal rows, 2 laterodorsal rows, 2 mediolateral rows, 2 lateroventral rows and 4 subventral rows. Slender region between pharyngo-intestinal junction and pre-PAT region with eight longitudinal rows: two subdorsal rows, two laterodorsal rows, two lateroventral rows and two subventral rows of somatic setae (Figure 2A). Longest somatic setae (79 μm) located on mid-body region. Four pairs of pericloacal setae with three pre-cloacal and one post-cloacal. Three pairs of pre-cloacal setae composed of two long anterior setae (10 μm) and one short posterior seta (7 μm). Single post-cloacal seta 6 μm long.

Posterior adhesion tubes (PAT) with well marked bell-shaped tip containing tongue-like valve (Figure 2D and 4B); all PAT located anterior to cloacal opening and arranged in 4 longitudinal rows: 2 sublateral rows each with 6 adhesion tubes intermingled with 5 somatic setae, and two subventral rows consisting of 7–8 adhesion tubes without intermingling somatic setae. PAT becoming slightly shorter caudally. First SlAT and SvAT located at 67.1% and 67.7% of body length, respectively. Distance between anteriormost and posteriormost SlAT 15.2% of total body length.

Reproductive system with a single, outstretched anterior testis (monorchic), extending far anteriorly (testis tip reaching up to 36.7% of total body length from anterior end) and located ventrally to intestine. Spicules 78–86 μm long, slightly arcuate; blade very slender, with well-developed ventral velum; capitulum offset, usually sharp beak-shaped (Figures 2E and 4C). Capitulum of retracted spicule reaching up to fifth or sixth sublateral adhesion tubes, spicule length up to 8.4% of total body length in holotype. Gubernaculum thin, parallel to spicules. Short, smooth anal flap present.

Tail gradually tapering posteriorly to a very slender cylindro-conoid non-annulated tail terminus constituting 38–41% of total tail length (Figure 4D).

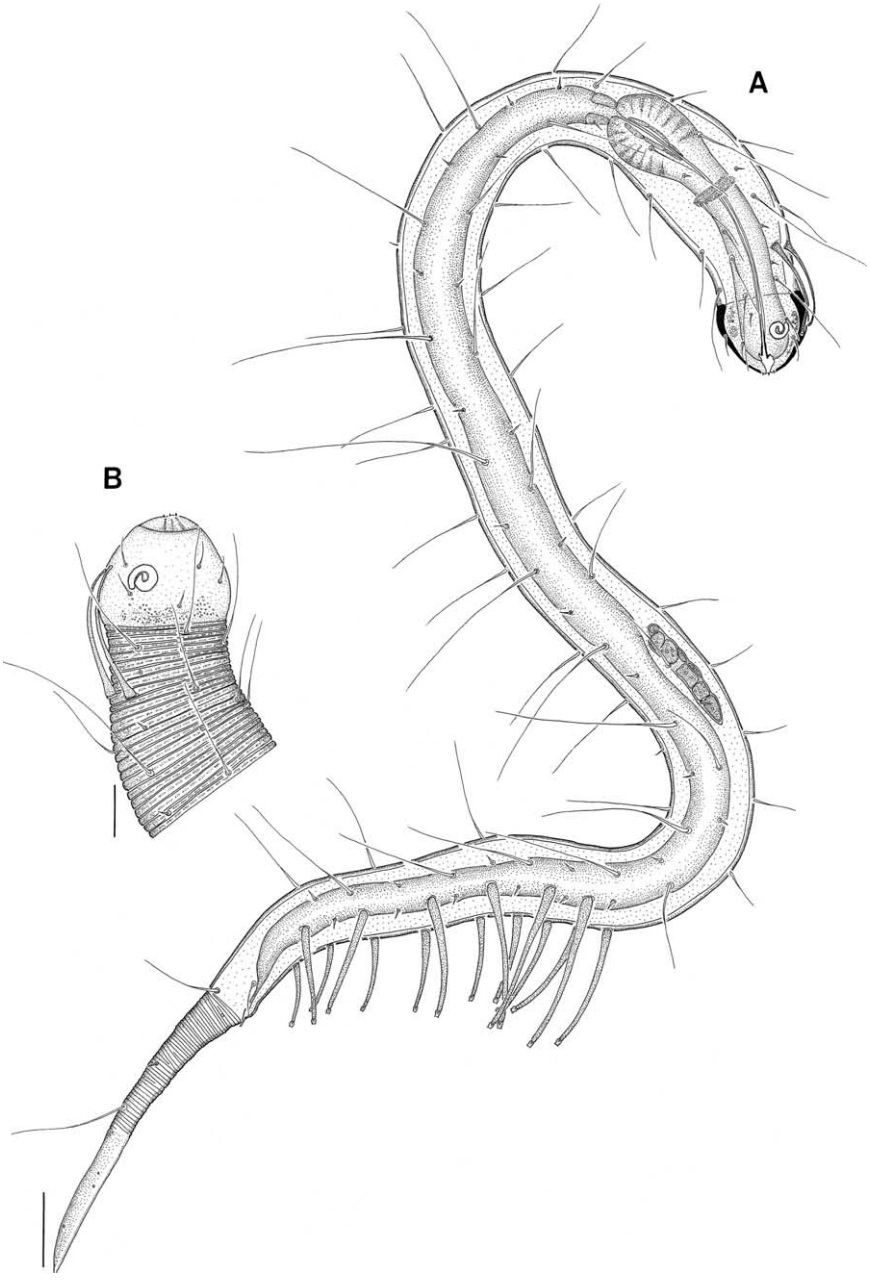

Figure 8. *Prochaetosoma dokdoense* sp. nov., fourth-stage juvenile paratype. (A) Habitus, lateral view; (B) anterior body region showing amphidial fovea and cephalic adhesion tubes, lateral surface view. Scale bars: A = 20 μm; B = 10 μm.

Tail with nine pairs of somatic setae: six subdorsal and three subventral; longest somatic setae located subdorsally, 60 μm long. Non-annulated tail terminus with two pairs of somatic setae; cuticle finely vacuolated on dorsal region. Well-developed spinneret present. Caudal glands obscure.

Females. Similar to male in most respects (Figure 5A,B, 6A,B,D and 7B). Body with slightly swollen pharyngeal region, 9–12% of total body length; greatest body width at level of vulva; anterior body region strongly curved ventrally. Amphidial fovea circular unispiral (7 μm in diameter) (Figures 5B and 6C). Amphidial fovea 26.3% of head capsule length. Eight CAT, all posterior to head capsule, located subdorsally and more or less arranged in four longitudinal pairs of tubular setae with enlarged insertion base and slightly swollen tip (Figures 5B and 6B). Digestive system as in male. Short anal flap present, not crenate (Figure 5A).

All PAT with same structure as in male (Figures 5A and 7A); all located anterior to anal opening and arranged in four longitudinal rows: two sublateral rows each consisting of 6–10 adhesion tubes, and two subventral rows of 8–9 adhesion tubes, respectively; PAT without intermingling somatic

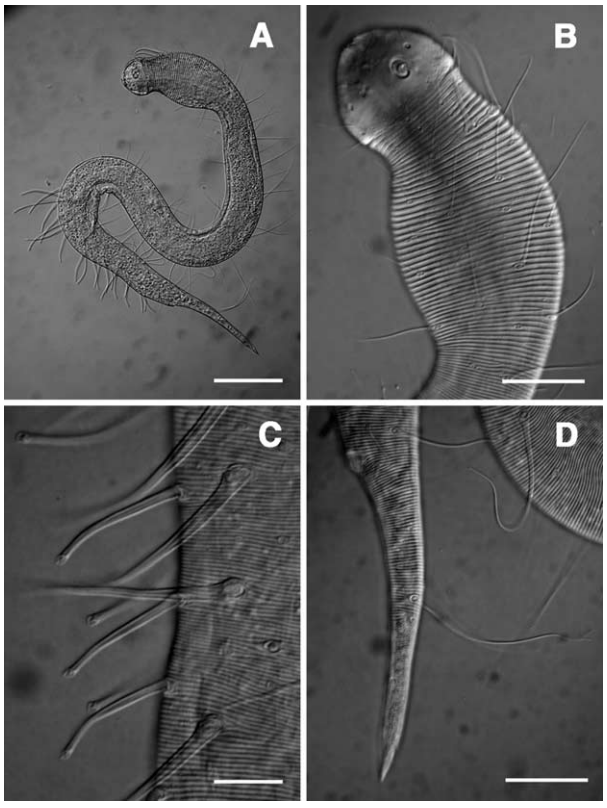

Figure 9. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of fourth-stage juvenile paratype. (A) Habitus, lateral view; (B) neck region showing amphidial fovea and cephalic adhesion tubes, lateral surface view; (C) posterior adhesion tubes, lateral view; (D) tail region, lateral view. Scale bars: A = 50 μm; B–D = 20 μm.

setae. PAT becoming slightly shorter caudally. Anteriormost SlAT and SvAT located at 71.8% and 70.9% of body length, respectively. Distance between anterior and posterior SlAT 15.5% of total body length.

Reproductive system typical of Draconematidae, didelphic–amphidelphic and ovaries reflexed both to left side; spermathecae not observed; vagina long, *pars vaginae proximalis* surrounded by well-developed constrictor muscle; vulval lips slightly protruding (Figure 5A,C). Two pairs of paravulval setae present (11 μm long).

Tail long, gradually tapering to cylindro-conoid smooth tail terminus, 45–51% of total tail length (Figure 7B). Tail with five pairs of laterodorsal somatic setae on annulated part and two pairs of mediolateral somatic setae on smooth terminal part. Cuticle of non-annulated tail end finely vacuolated dorsally. Caudal glands well-developed and extending up to posteriomost sublateral adhesion tube; well-developed spinneret present.

Juveniles. Three developmental juvenile stages (J2, J3, J4) observed. Developmental stages mainly differentiated by the number of CAT and the arrangement (number of longitudinal rows) and number of PAT.

Fourth-stage juveniles. Habitus similar to adult except for absence of mid-body swelling (Figures 8A and 9A). Body with slightly swollen pharyngeal region, 9–13% of total body length. Head capsule as in adult and ornamented with granulation posteriorly (Figure 8B). Body cuticular annules broader in pharyngeal and tail regions. Annules in pharyngeal region ornamented with fine granulation (Figure 9B). Amphidial fovea similar to female (5 μm in diameter). Amphidial fovea 25% of head capsule length. Four CAT, all posterior to head capsule, located dorsally and arranged in one transverse row of tubular setae with enlarged insertion base and slightly swollen tip. Digestive system as in adult. Feature of PAT similar to adult (Figure 9C), all located anterior to anal opening and arranged in 3 longitudinal rows: 2 sublateral rows each consisting of 6 adhesion tubes, and one row of VAT with 9 adhesion tubes. No intermingling somatic setae. PAT becoming slightly shorter caudally. Anteriormost SlAT and VAT located at 65.2% and 63.7% of body length, respectively. Distance between anteriormost and posteriormost SlAT 13.6% of total body length. Reproductive system with genital primordium, 33 μm long. Short anal flap present, not crenate. Tail gradually tapering to cylindro-conoid non-annulated tail terminus; finely vacuolated end 45–51% of total tail length (Figure 9D). Tail with four pairs of somatic setae: three pairs of subdorsal and one pair of lateroventral setae on annulated part and smooth part with four pairs of somatic setae; spinneret well-developed.

Third-stage juveniles. Habitus similar to adult except for absence of mid-body swelling (Figures 10A and 11A). Body slightly swollen pharyngeal region, 11–15% of total body length. Head capsule similar to fourth-stage juvenile (Figure 10B). Body cuticular annules broader in pharyngeal and tail regions. Annules in pharyngeal region ornamented with fine granulation (Figure 10B). Amphidial fovea located about mid-way in head capsule, 4 μm in diameter, similar to fourth stage juvenile (Figures 10B and 11B); amphidial fovea 26.3% of thickened head capsule. Three CAT, all posterior to head capsule; located dorsally. Pharynx with well-developed cuticularized lumen wall, slightly widening posteriorly (Figure 10A and 11C). Digestive system as in adult.

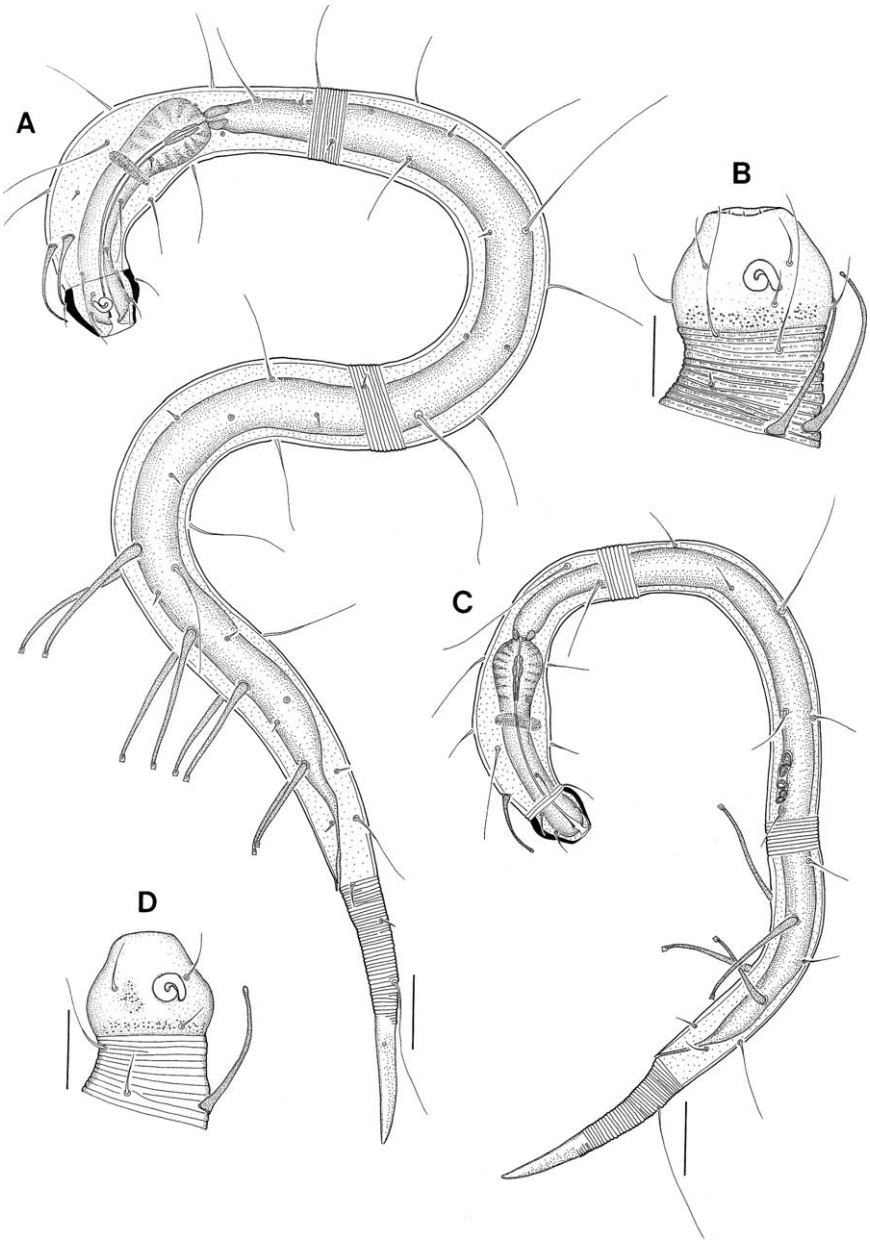

Figure 10. *Prochaetosoma dokdoense* sp. nov., third and second-stage juvenile paratypes. (A) Third-stage juvenile *in toto*, lateral view; (B) head capsule showing amphidial fovea and cephalic adhesion tubes of third-stage juvenile, lateral suface view; (C) second-stage juvenile *in toto*, lateral view; (D) head capsule showing amphidial fovea and cephalic adhesion tubes of second-stage juvenile, lateral surface view. Scale bars: A,C = 20 μm; B,D = 10 μm.

All PAT located anterior to anal opening and arranged in two longitudinal rows: two sublateral rows consisting of four adhesion tubes each. No intermingling somatic setae. PAT becoming slightly shorter caudally. Anteriormost SlAT located at 67.6% of body length. Distance between anteriormost and posteriormost SlAT 13.2% of total body length. Genital primordium obscure. Tail 70–88 μm long, with numerous fine transverse striae and well-developed spinneret; terminal region non-annulated but finely vacuolated, 43–52% of total tail length (Figure 11D). Short anal flap present and not crenate.

Second-stage juveniles. Habitus similar to adult except for absence of mid-body swelling (Figure 10C and 12A). Anterior body region strongly curved ventrally. Body with slightly swollen pharyngeal region, 14–15% of total body length. Head capsule similar to third-stage juvenile (Figure 10D). Amphidial fovea, 4 μm in diameter, similar to fourth stage juvenile (Figure 10D); amphidial fovea 27.1% of

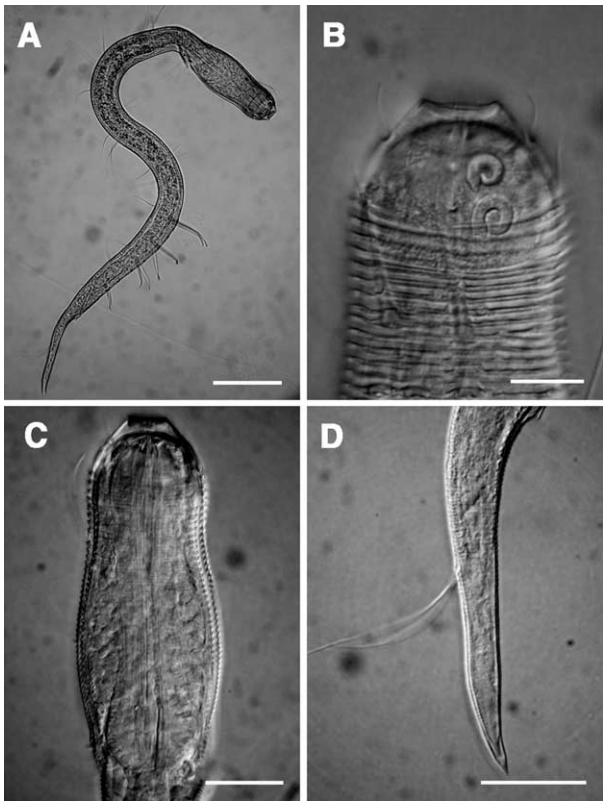

Figure 11. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of moulting third-stage juvenile paratype. (A) Habitus, lateral view; (B) head capsule showing amphidial fovea, lateral view; (C) anterior body region showing pharynx, optical section; (D) tail region, lateral view. Scale bars: A = 50 μm; B–D = 20 μm.

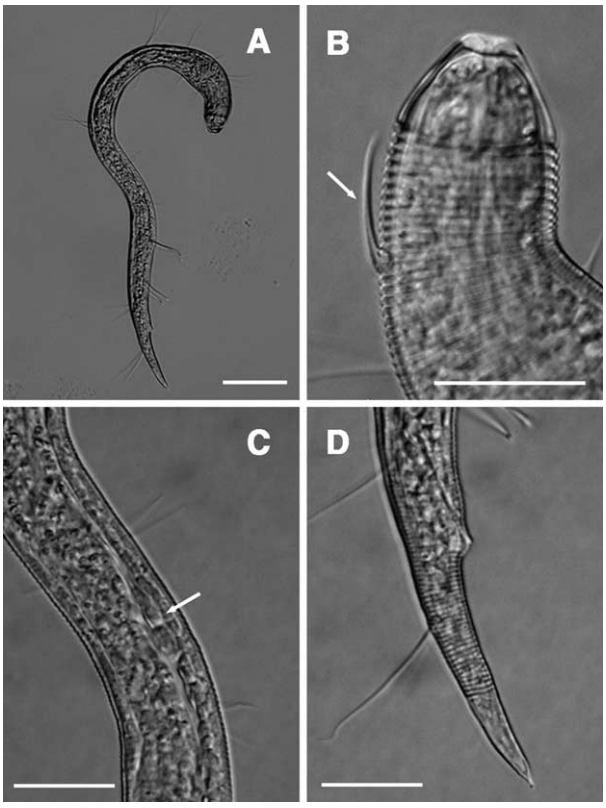

Figure 12. *Prochaetosoma dokdoense* sp. nov., DIC photomicrographs of second-stage juvenile paratype. (A) Habitus, lateral view; (B) anterior body region showing a cephalic adhesion tube (white arrow), lateral view; (C) mid-body region showing genital primordium (white arrow), optical section; (D) tail region, lateral view. Scale bars: A = 50 μm; B–D = 20 μm.

thickened head capsule. One CAT posterior to head capsule, located dorsally (Figure 12B). Digestive system as in more developed stages. All PAT located anterior to anal opening and arranged in two longitudinal rows: two sublateral rows each with two adhesion tubes; no intermingling somatic setae. Anterior SlAT (33 μm long) longer than posterior one (24 μm long). Anterior SlAT located at 68.5% of body length from anterior end. Distance between anterior and posterior SlAT 6.5% of total body length. Genital primordium, 15 μm long (Figure 12C). Tail 58–77 μm long, with numerous fine transverse striae and well-developed spinneret; terminal region non-annulated but finely vacuolated, 36–46% of total tail length (Figure 12D). Short anal flap present and not crenate.

Sexual dimorphisms and variations

Males and females differ in width of the mid-body region, the number of PAT and shape of tail region as shown in Table II. Female vulval region is mostly enlarged because of well-developed female reproductive system (mbd: 39–45 μm in males vs. 46–61 μm in females). Males and females have an almost similar number of SvAT (7–8 in males vs. 8–9 in females), although females have a higher and more variable number of SlAT (6 in males vs. 6–10 in females). Moreover, males and females have almost similar tail length (114–131 μm in males vs. 116–131 μm in females), but females possess a longer non-annulated terminal part than males. This characteristic is easily explained by the proportion of non-annulated tail terminus to total tail length, that is, 38–41% in males vs. 45–51% in females.

Diagnosis and relationships

Prochaetosoma dokdoense sp. nov. is characterized by the following combination of characteristics: (1) longer slender body (910–1175 μm; ratio a = 22–35 in male and 16–22 in female) with swollen pharyngeal region 9–12% of total body length; (2) amphidial fovea elongate loop-shaped in male (distal end of the ventral arm slightly curved anteriorly) and amphidial fovea circular unispiral in female; (3) eight cephalic adhesion tubes with widened base and blister-shaped tip positioned just anterior to swollen pharyngeal region in both sexes; (4) number of

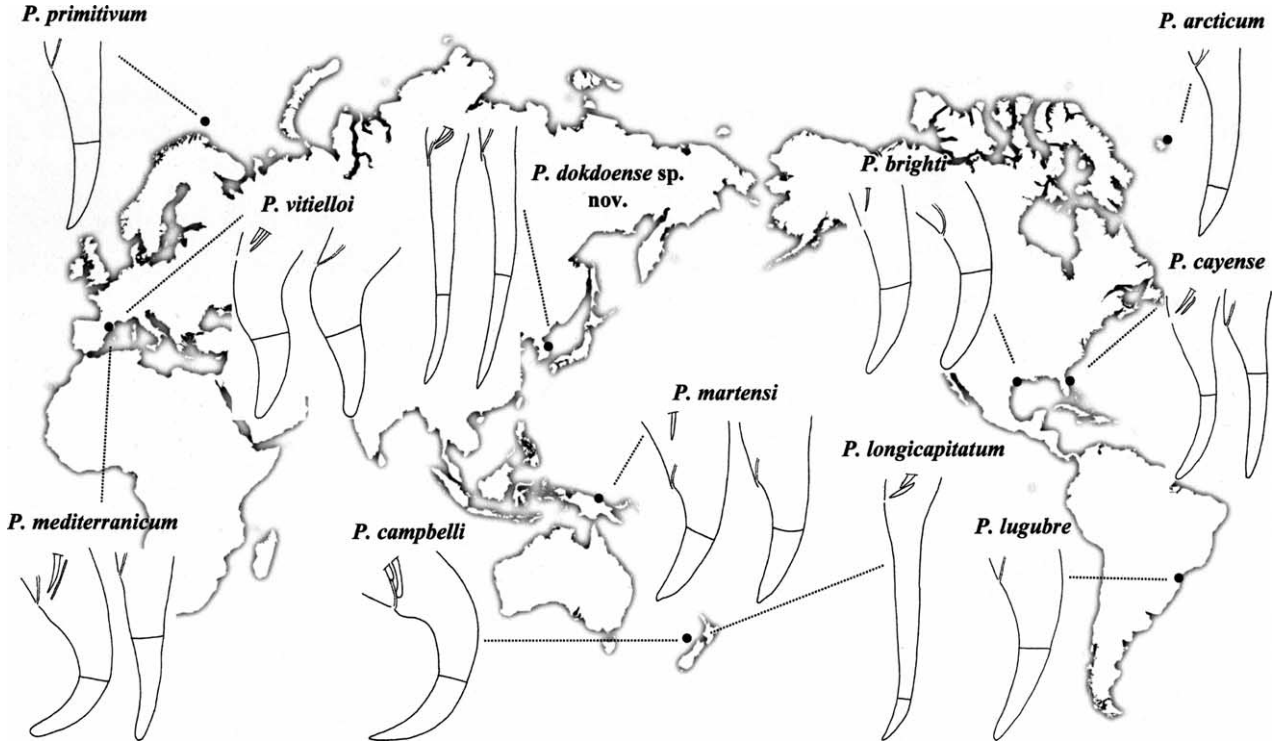

Figure 13. Biogeographic distribution and diagnostic pictorial key showing the relative length of non-annulated tail terminus to total tail length for the species of the genus *Prochaetosoma*. Both sexes presented when available; male with part of copulatory apparatus.

posterior sublateral adhesion tubes (6 in male and 6–10 in female) and posterior subventral adhesion tubes (7–8 in male and 8–9 in female); (5) spicules long (78–86 μm), relatively slender and with a well-developed ventral velum; (6) long, slender cylindro-conoid tail (114–131 μm in male and 116–131 μm in female); and (7) higher ratio c′ (6.5–7.5 in male and 7.4–9 in female). Of these characters, the ratio c′ is the most remarkable diagnostic feature together with the other morphological characteristics mentioned in Table III to differentiate the new species from all the other species within the genus *Prochaetosoma*. Currently, 10 valid species within the genus *Prochaetosoma* have been described based on the morphological characters shown in Table III.

The new species, *P. dokdoense* sp. nov., is most like *P. longicapitatum* (Allgén, 1932) by possessing a similar general body length and shape, and mainly cylindrically elongated slender tail. However, *P. dokdoense* sp. nov. differs from *P. longicapitatum* by: (1) the number of CAT in male (eight vs. six); (2) the shape of amphidial fovea in male (elongate loop-shaped with distal end of ventral arm slightly curved anteriorly vs. loop-shaped); (3) the number of SlAT and SvAT in male (6 SlAT and 7–8 SvAT vs. 18 and 4–5); (4) the relative length of non-annulated tail terminus to total tail length in male (45–51% vs. 18%); (5) the length of spicule (78–86 μm vs. 45 μm); and (6) the ratio c′ in the male (6.5–7.5 vs. 5.6).

Prochaetosoma dokdoense sp. nov. is similar to *P. arcticum* (Kreis, 1963), reported from Eyjafjörõur Fjord, Iceland and based on a single female and second-stage juvenile, in having a long body reaching 1000 μm, 8 CAT and relatively long tail, but it can be easily distinguished from *P. arcticum* by the number of PAT in female (6–10 SlAT and 8–9 SvAT in *P. dokdoense* sp. nov. vs. 12 and 12 in *P. arcticum*), the shape and relative length of non-annulated tail terminus to total tail length (cylindro-conoid, 45–51% of total tail length vs. short conical, 17%).

Prochaetosoma dokdoense sp. nov. is also similar to *Prochaetosoma vitielloi* Allen and Noffsinger, 1978, described from Marseille, France, in having the same number of CAT (eight); however, it differs from *P. vitielloi* by the following distinctive characters: body size in both sexes (long body, 910–1175 μm vs. relatively short body, 500–700 μm), the shape of the amphidial fovea in male (elongate loop-shaped with distal end of ventral arm slightly curved anteriorly vs. modified loop-shaped appearing circular shape), number of PAT (6 SlAT and 7–8 SvAT in male and 6–10 and 8–9 in female vs. 5 and 2–3 and 5–8 and 3), presence or absence of VAT in both sexes (absence vs. presence), length of spicule (78–86 μm vs. 47–56 μm), shape of non-annulated tail terminus (cylindro-conoid vs. conical) and ratio

Table II. Morphometrics of *Prochaetosoma dokdoense* sp. nov. All measurements are in μm and in the form: mean ± standard deviation (range). Abbreviations are explained in the Materials and methods section.

	Male		Female	J4	J3	J2
	Holotype	Paratypes	Paratypes	Paratypes	Paratypes	Paratypes
n	1	6	7	7	6	4
L	940	987 ± 96 (910–1090)	1023 ± 73.9 (940–1175)	847 ± 151 (605–990)	587 ± 63.9 (515–660)	398 ± 19.9 (390–430)
a	35.3	24.3 ± 2.6 (22–28)	18.4 ± 2.3 (16–22)	27.3 ± 1.8 (25.4–29.8)	27.3 ± 3.3 (24.3–33.2)	24.5 ± 2.7 (20.8–27.2)
b	9.5	9.5 ± 0.7 (8.4–10.3)	9.1 ± 0.8 (8.1–10.8)	9.4 ± 1.5 (7–10.9)	7.9 ± 0.9 (6.7–9)	6.6 ± 0.2 (6.5–6.9)
c	8	8 ± 1.1 (6.6–9.5)	8.2 ± 0.4 (7.8–8.9)	8 ± 0.8 (6.6–8.9)	7.4 ± 0.5 (6.6–8)	6.1 ± 0.5 (5.6–6.6)
c′	7.3	6.9 ± 0.4 (6.5–7.5)	8.1 ± 0.5 (7.4–9)	7.2 ± 0.6 (6.2–7.7)	6.4 ± 0.3 (6–6.9)	6 ± 0.5 (5.4–6.1)
V	–	–	56.5 ± 1.6 (54.2–59)	–	–	–
mbd	27	41 ± 2.2 (39–45)	56.3 ± 7.9 (46–61)	31.1 ± 5.1 (23.8–36.7)	21.7 ± 2.5 (18.8–25)	16.5 ± 2 (14.2–18.8)
(mbd)	23	24 ± 2.4 (20–26)	24.6 ± 0.8 (23.4–25.8)	22.6 ± 1.7 (20–24.2)	17.8 ± 1.6 (15.6–20.3)	14.3 ± 1.2 (12.8–15.6)
mbd ph	36	37 ± 1.1 (36–38)	36.3 ± 1.3 (34.4–38.3)	34.1 ± 3.5 (29.2–39.1)	27.4 ± 1.7 (25–29.7)	21.3 ± 1.2 (19.5–21.9)
ph	99	103 ± 6 (95–111)	112.3 ± 7.6 (104–125)	90.2 ± 4 (85.8–95.3)	74.1 ± 1.6 (71.9–76.6)	60 ± 1.1 (59.3–61.7)
abd	16	18 ± 0.9 (17–19)	15.5 ± 0.9 (14.1–16.9)	14.9 ± 1.7 (12.1–17.2)	12.5 ± 1.2 (10.8–14.1)	11.1 ± 1 (10.2–12.5)
t	117	125 ± 6.1 (114–131)	125.4 ± 4.8 (116–131.3)	106.1 ± 12.1 (91.4–118.8)	79.4 ± 6.5 (70.3–87.5)	66.2 ± 7.9 (58.3–76.6)
tmr	48	50 ± 2.5 (47–53)	60 ± 3.5 (55.3–64.1)	49.6 ± 3.2 (45.3–53.1)	36.8 ± 0.8 (35.9–37.5)	26.8 ± 0.3 (26.6–27.3)
tmr/t	41	40 ± 1.3 (38–41)	48 ± 2.1 (45–51)	47 ± 2.6 (44.7–50.9)	46.6 ± 3.7 (42.9–52.2)	40.9 ± 4.3 (35.6–45.8)
spic	79	82 ± 208 (78–86)	–	–	–	–
gub	15	15 ± 1.3 (13–16)	–	–	–	–
CATn	8	8 ± 0 (8–8)	8 ± 0 (8–8)	4 ± 0 (4–4)	3 ± 0 (3–3)	1 ± 0 (1–1)
SlATl	65	68 ± 2.7 (64–72)	65.7 ± 4 (61–71.9)	51.3 ± 3.6 (45–55.5)	43.7 ± 1.9 (41.7–46.9)	35.3 ± 1.7 (33.3–37.5)
SlATn	6	6 ± 0 (6–6)	7.6 ± 1.3 (6–10)	6 ± 0 (6–6)	4 ± 0 (4–4)	2 ± 0 (2–2)
VATl	–	–	–	40.9 ± 3.8 (35.8–46.9)	–	–
VATn	–	–	–	9 ± 0 (9–9)	–	–
SvATl	52	51 ± 4.4 (45–56)	50.9 ± 3.2 (47–57)	–	–	–
SvATn	7	8 ± 0 (8–8)	8.7 ± 0.5 (8–9)	–	–	–

Table III. Character comparisons of *Prochaetosoma dokdoense* sp. nov. with its congeners (M: male; F: female; 4th: fourth-stage juvenile; –: unknown).

	Characters								
Taxa	Body length (μm)	CATn	Amphidial fovea	SlATn	SvATn	VATn	tmr/t (%)	Spicule/ gubernaculum	ratio c′
P. arcticum (Kreis, 1963)	F: 700–1000	F: 8	F: loop-shaped, appearing unispiral	F: 12	F: 12	absent in adult	F: 17	–	F: 4.2
P. brighti Jensen, 1986	M: 632 F: 612–622	M: 8 F: 4	M: loop-shaped F: modified loop, appearing circular	M: 3 F: 6–7	M: 5 F: 5–7	absent in adult	–	40/–	M: 3.3 F: 3–3.5
P. campbelli (Allgén, 1932)	M: 800 F: 800 4th: 600	M: 4 F: 4 4th: –	M: circular unispiral F: similar to males 4th: circular unispiral	M: 5 F: 9 4th: 5	M: 7–8 F: 10–11	absent in adult 4th: 9	M: 50 F: – 4th: –	71/29	M: 2.8 F: – 4th: –
P. cayense Allen & Noffsinger, 1978	M: 800–1000 F: 600–1000 4th: 500–800	M: 14 F: 14 4th: 8	M: loop-shaped, F: double spiral 4th: double spiral	M: 7–8 F: 10–12 4th: 5	M: 14–17 F: 14–18	absent in adult 4th: 9	M: 49–60 F: 61–68 4th: 54–71	54–63/11–19	M: 4.1–5 F: 4.5–7.2 4th: 4.5–5.1
P. dokdoense sp. nov.	M: 910–1090 F: 940–1175 4th: 605–990	M: 8 F: 8 4th: 4	M: elongate loop-shaped F: circular unispiral 4th: circular unispiral	M: 6 F: 6–10 4th: 6	M: 7–8 F: 8–9	absent in adult 4th: 9	M: 38–41 F: 45–51 4th: 45–51	78–86/13–16	M: 6.5–7.5 F: 7.4–9 4th: 6.2–7.7
P. longicapitatum (Allgén, 1932)	M: 900	M: 6	M: loop-shaped, horseshoe-shaped	M: 18	M: 4–5	absent in adult	M: 18	45/10	M: 5.6
P. lugubre (Gerlach, 1957)	F: 700	–	F: unispiral	F: 15	F: 4–5	absent in adult	F: 57	–	F: 2.8
P. martensi Decraemer, 1989	M: 550–800 F: 475–695 4th: 360–470	M: 9 F: 9 4th: 4	M: elongate loop-shaped F: spiral to slightly shepherd's crook shaped 4th: as in female	M: 10–11 F: 12–13 4th: 6–7	M: 10–12 F: 10–14	absent in adult 4th: 9	M: 59	37–49/12–14	M: 2.4–3.1 F: 2.4–3.2 4th: 2.2–3.2
P. mediterranicum Allen & Noffsinger, 1978	M: 600–900 F: 600–800 4th: 500–600	M: 6 F: 6 4th: 4	M: elongate loop-shaped F: modified loop appearing circular 4th: similar to adults	M: 6–8 F: 8–9 4th: 5	M: 2–3 F: 2–3	absent in adult 4th: 2	M: 46–56 F: 61–68 4th: 59–67	62–68/18–22	M: 2.1–3.2 F: 2.7–3.2 4th: 2.5–3.1
P. primitivum (Steiner, 1916)	4th: 500	4th: 4	4th: unispiral, about 1/8 spiral doubled	4th: 6	–	4th: 13	4th: 51	–	4th: 3.5
P. vitielloi Allen & Noffsinger, 1978	M: 500–700 F: 500–700 4th: 400–500	M: 8 F: 8 4th: 4	M: modified loop appearing circular F: similar to males 4th: similar to adults	M: 5 F: 5–8 4th: 5	M: 2–3 F: 3	present M: 3–4 F: 3–5 4th: 3	M: 37–59 F: 55–75 4th: 57–61	47–56/11–16	M: 2.5–3.2 F: 2.3–2.9 4th: 2.8–2.9

c′ (6.5–7.5 in male and 7.4–9 in female vs. 2.5–3.2 and 2.3–2.9).

Prochaetsoma primitivum (Steiner, 1916) was described based on a single fourth-stage juvenile having the following characteristics: 4 CAT, 6 SlAT, 13 VAT, 51% of relative length of non-annulated tail terminus to total tail length and ratio c′ of 3.5. We compared the fourth-stage juvenile of *P. dokdoense* sp. nov. with the one of *P. primitivum*, and these two species were easily discriminated from each other by the number of VAT (9 in *P. dokdoense* sp. nov. vs. 13 in *P. primitivum*) and the ratio c′ (6.2–7.7 vs. 3.5).

Prochaetosoma dokdoense sp. nov. can furthermore be easily discerned from the other *Prochaetosoma* spp. by using the comparative characters listed in Table III and the pictorial key showing the relative length of non-annulated tail terminus to total tail length of Figure 15. Further, an updated dichotomous key for species identification is also given for adults and an additional key for fourth-stage juveniles.

Biogeography

The discovery of *Prochaetosoma dokdoense* sp. nov. in shallow subtidal coarse detritus and shell gravels collected from Dokdo, the East Sea expands the range of hitherto known biogeography for the genus *Prochaetosoma*, from the Atlantic Ocean (*P. arcticum*, *P. brighti*, *P. cayense*, *P. lugubre* and *P. primitivum*), the Mediterranean Sea (*P. mediterranicum* and *P. vitielloi*) and the southwest Pacific Ocean (*P. campbelli*, *P. longicapitatum* and *P. martensi*) to the northwest Pacific Ocean (this report).

Dichotomous key based on males and females to species of the genus *Prochaetosoma* Micoletzky, 1922

1. PAT with four longitudinal rows, two sublaterals and two subventrals 2
– PAT with four anterior longitudinal rows (two sublaterals and two subventrals) and three posterior rows (two sublaterals and one ventral) . . . . . *P. vitielloi* Allen & Noffsinger, 1978
2. Female with 15 SlAT or males with 18 SvAT 3
– Females with <13 SlAT and/or males with <11 SlAT 4
3. Females with 15 SlAT and 4–5 SvAT; non-annulated tail terminus 57% of total tail length . . . . . *P. lugubre* (Gerlach, 1957)
– Males with 18 SlAT and 4–5 SvAT; non-annulated tail terminus 18% of total tail length . . . . . *P. longicapitatum* (Allgén, 1932)
4. Number of CAT less than 6 5
– Number of CAT higher than 8 6
5. Six CAT in both sexes; male with 6–8 SlAT and 2–3 SvAT . . . . . *P. mediterranicum* Allen & Noffsinger, 1978
– Four CAT in both sexes; male with 5 SlAT and 7–8 SvAT . . . . . *P. campbelli* (Allgén, 1932)
6. Females with >8 CAT and >8 SvAT. 7
– Females with 4 CAT and 5–7 SvAT . . . . . *P. brighti* Jensen, 1986
7. Females with 8 CAT 8
– Females with >8 CAT 9
8. Female with 12 SlAT and 12 SvAT; non-annulated tail terminus short conical, 17% of total tail length . . . . . *P. arcticum* (Kreis, 1963)
– Female with 6–10 SlAT and 8–9 SvAT; non-annulated tail terminus narrow cylindro-conoid, 45v51% of total tail length . . . . . *P. dokdoense* sp. nov.
9. Nine CAT in both sexes; male with 10–11 SlAT and 10–12 SvAT; spicules short (37–49 μm) . . . . . *P. martensi* Decraemer, 1989
– Fourteen CAT in both sexes; male with 7–8 SlAT and 14–17 SvAT; spicules long (54–63 μm) . . . . . *P. cayense* Allen & Noffsinger, 1978

Dichotomous key to fourth-stage juveniles known in 7 out of 10 species of the genus *Prochaetosoma* Micoletzky, 1922

1. Five pairs of SlAT 2
– Six to 7 pairs of SlAT 5
2. Nine VAT 3
– Two to 3 VAT 4
3. Amphidial fovea double spiral . . . . . *P. caysense* Allen & Noffsinger, 1978
– Amphidial fovea unispiral . . . . . *P. campbelli* (Allgén, 1932)
4. Three VAT . . . . . .*P. vitielloi* Allen & Noffsinger, 1978
– Two VAT . . . . . *P. mediterranicum* Allen & Noffsinger, 1978
5. Nine VAT 6
– Thirteen VAT . . . . . *P. primitivum* (Steiner, 1916)
6. Body short (360–470 μm); tail short (38–45 μm); non-annulated tail terminus short conical (22–26 μm) . . . . . *P. martensi* Decraemer, 1989
– Body long (600–990 μm); tail long (70–88 μm); non-annulated tail terminus long cylindro-conoid (45–53 μm) . . . . . *P. dokdoense* sp. nov.

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References

Allen MW, Noffsinger EM. 1978. A revision of the marine nematodes of the superfamily Draconematoidea Filipjev, 1918 (Nematoda: Draconematina). University of California Publications in Zoology 109:1–133.

Allgén C. 1932. Weitere Beiträge zur Kenntnis der marinen Nematodenfauna der Campbellinsel. Nytt Magazin for Naturvidenskabene 70:97–198.

Burgess R. 2001. An improved protocol for separating meiofauna from sediments using colloidal silica sols. Marine Ecology Progress Series 214:161–65.

Decraemer W. 1989. Three new draconematid species from Papua New Guinea. Bulletin de l'Institut Royal des Sciences Naturelles de Belgique. Biologie 59:5–24.

Decraemer W, Gourbault N, Backeljau T. 1997. Marine nematodes of the family Draconematidae (Nemata): A synthesis with phylogenetic relationships. Hydrobiologia 357:185–202.

de Man JG. 1880. Die Einheimischen, frei in der reinen Erde und im süssen Wasser lebenden Nematoden. Vorlaufiger Bericht und descriptiv-systematischer Theil. Tijdschrift Nederlandsche Dierkundige Vereeniging 5:1–104.

Gerlach SA. 1957. Die Nematodenfauna des Sandstrandes an der Küste von Mittelbrasilien. (Brasilianische Meeres-Nematoden IV). Mitteilungen aus dem Zoologischen Museum in Berlin 33(2):411–59.

Jensen P. 1986. The nematode fauna in the sulphide-rich brine seep and adjacent bottoms of the East Flower Garden, NW Gulf of Mexico. I. Chromadorida. Zoologica Scripta 14(4):247–63.

Kreis H. 1963. Marine Nematoda. The Zoology of Iceland 2(14):1–68.

Kristensen RM. 1989. Marine Tardigrada from the southeastern United States coastal waters I. *Paradoxipus orzeliscoides* n. gen., n. sp. (Arthrotardigrada: Halechiniscidae). Transactions of the American Microscopical Society 108:262–82.

Micoletzky H. 1922. Die freilebenden Erd-Nematoden mit besonderer Berücksichtigung der Steiermark und der Bukowina, zugleich mit einer Revision sämtlicher nicht mariner, freilebender Nematoden in Form von Genus-Beschreibungen und Bestimmungsschlüsseln. Archiv für Naturgeschichte 87A(8–9):1–650.

Seinhorst JW. 1959. A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. Nematologica 4:67–69.

Shirayama Y, Kaku T, Higgins RP. 1993. Double-slided microscopic observation of meiofauna using an HS-slide. Benthos Research 44:41–44.

Steiner G. 1916. Freilebende, Nematoden aus der Barentssee. Zoologische Jahrbücher Abteilung für Systematic Ökologie und Geographie der Tiere 39(5–6):511–676.

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