

# First Record of *Desmoscolex* Nematoda (Desmoscolecida: Desmoscolecidae) from Korea

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**Abstract:** As a result of the faunistic survey of the free-living marine nematodes from coastal algal beds and sublittoral sands in South Korea, we report a meiobenthic species, *Desmoscolex cosmopolites* Timm, 1970, for the first time from the western Pacific as well as Korean waters. Among 17-ring *Desmoscolex* species, *D. cosmopolites* is represented by the following combination of characters: absence of subventral setae on 10th and 14th main rings and the presence of subdorsal setae with large angular lance-shaped tip. A detailed morphological redescription is provided using a scanning electron microscope and a differential interference contrast microscope. Character comparison between *D. cosmopolites* and its allied congeneric species is also analysed.

**Key words:** Free-living, marine Nematoda, Desmoscolecida, *Desmoscolex cosmopolites*, SEM, Korea

The order Desmoscolecida, a group of marine interstitial nematodes, is unique in having the serial concretion rings and somatic setae. To date, 311 species of 21 genera in two families have been recorded (cf. Decraemer, 1998). Of these, *Desmoscolex* is the most representative genus, and comprises 136 nominal species, accounting for 43% of total number of species currently known in the order. This genus is known as distributed worldwide, ranging from deep sea to beach or salt marshes. Nevertheless, the taxonomic study on the *Desmoscolex* nematodes was very scanty in the western Pacific area, and still entirely lacking in Korean waters.

In the course of the faunistic studies on the free-living marine nematodes during last four years, we have collected many specimens of *D. cosmopolites* from the coastal algal beds and sublittoral sands in South Korea. It is one of the

most abundant and frequent desmoscolecid nematode species in Korean waters. In the present paper, we provide the redescription and differential diagnoses of the species with detailed illustrations and photomicrographs, using a scanning electron microscope (SEM) and a differential interference contrast (DIC) microscope, in addition to the character comparisons among related congeneric species.

## MATERIALS AND METHODS

Materials have been collected from 14 locations around sea coasts of South Korea since May 1995. Samplings were made by washing the algae from algal beds in the rocky shore or by scraping sublittoral bottom sands into polyethylene vinyl bag by skin divers. Nematodes were filtered through nylon net (64 µm in pore diameter) after rinsing with freshwater for less than a minute for osmotic shock (Kristensen, 1989), and were fixed with 5% buffered formalin or 95% ethyl-alcohol.

Specimens were mounted in glycerine on H-S slide (Shirayama et al., 1993), a modification of the Cobb's slide after placing in a solution of 5% glycerin in distilled water for 1-2 days, and observed under a differential interference contrast (DIC) microscope (Olympus BX-51) equipped with Nomarski optics. After examination, slides were sealed with nail polish. All drawings were prepared using a camera lucida.

Scanning electron microscopic pictures were taken from formalin fixed specimens. After an ultrasonic treatment (10-30 sec) to remove detritus attached to the body, and prefixed overnight at 4°C in a 2.5% buffered glutaraldehyde, then followed by postfixation with 1% cold buffered osmium tetroxide. After dehydration through a graded ethanol series (50, 60, 70, 80, 90, 100, 100%) for 30 minutes each and t-butyl alcohol for 1 hour, the material was freezing-dried, coated with platinum-palladium in a high evaporator, and then examined in a Hitachi S-4300

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operated at 15KV.

Terminology mostly follows Decraemer (1974, 1985). Abbreviations used in the text are as follows: L = body length; hd = maximum head dimensions (length by width); cs = length of cephalic setae;  $sd_n$  = length of subdorsal somatic setae on main ring n;  $sv_n$  = length of subventral somatic setae on main ring n; t = tail length; tnr = length of terminal ring; tnrw = width of terminal ring; (mbd) = maximum body diameter, external material not included; mbd = maximum body width; oes = length of oesopharynx; spic = length of spicules measured along the median line; gub = length of gubernaculum; V = distance of vulva from anterior end as percentage of total body length. Scale bar in figures are indicated in  $\mu\text{m}$ .

### SYSTEMATIC ACCOUNTS

Family Desmoscolecidae Schepotieff, 1907

Subfamily Desmoscolecinae Shipley, 1896

Genus *Desmoscolex* Claparède, 1863

*Desmoscolex (Desmoscolex) cosmopolites* Timm, 1970  
(Figs. 1, 2)

*Desmoscolex cosmopolites* Timm, 1970, p. 20, figs. 8-10.

**Materials examined:** 26 inds., Samcheok, Hosan, 9 May 2001, C.Y. Chang; 26 inds., Masan, 1 Oct. 2004, H.W. Lim & C.Y. Chang; 3 ind., Pohang, Samjung-ri, 30 Dec. 2003, H.W. Lim, J.M. Jeon & C.Y. Chang; 9 inds., Pohang, Sinchang-ri, 29 May 1999, C.Y. Chang; 3 inds., Gyeongju, Bonggil-ri, 14 Sep. 1996, C.Y. Chang; 40 inds., Busan, Gijang, 27 Oct. 2004, H.W. Lim; 4 inds., Jindo Is., Gagye, 1 Jul. 2004, H.W. Lim & J.M. Jeon; 2 inds., Jindo Is., Mosari, 1 Jul. 2004, H.W. Lim & J.M. Jeon; 20 inds., Jindo Is., Geumgab, 20 Oct. 2004, H.W. Lim & J.M. Jeon; 3 inds., Jindo, Jodo Is., 19 Oct. 2004, H.W. Lim & J.M. Jeon; 20 inds., Jeju Is., Jangheung, 19 Nov. 2004, H.W. Lim & J.M. Jeon; 7 inds., Udo Is., Yeongil, 3 Mar. 2003, J.M. Lee & C.Y. Chang; 2 inds., JeJu Is., Hyeobjae, 23 Aug. 1998, C.Y. Chang.

**Diagnosis:** Body short, 313-350  $\mu\text{m}$  long in male, 343-359  $\mu\text{m}$  in female; head pyriform, with rather round amphid; with 17 main rings; interzones somewhat broad and equal sized, each with 2-4 distinct annuli; amphid oval or pyriform, hind margin not reaching posterior end of head; cephalic setae slender, slightly longer than head length; with 9 subdorsal setae (on main rings 1, 3, 5, 7, 9, 11, 13, 16, 17) and 6 subventral setae (on main rings 2, 4, 6, 8, 12, 15); subdorsal setae with large angular lance-shaped tip; tails not elongated, ending with small spinneret.

**Male:** Body (Figs. 1A, 2A) somewhat stout, widest between

main rings 8 and 10, tapering toward extremities. Cuticle with 17 well developed main rings, covered with small, scattered concretion particles. Main rings separated from each other by broad interzone, composed of mostly 3 (sometimes 4 at posterior part of body) secondary annules (Fig. 1A). Secondary rings bearing transverse row of fine, short spines (1.5-2  $\mu\text{m}$ ).

Head (Fig. 2B) subspherical to pyriform (rounded in lateral view, due to slight lateral flattening), 1.4 times wider than long, tapering anteriorly toward truncate end. Lip region more or less offset, covered by layer of fine concretion particles; 4 dots present at base of lip region in lateral view. In frontal view (Fig. 2C), at anterior end of head, circular arrangement of projections bearing fine, obscure pegs; posterior to circle of projections, 1 small trigonal stoma surrounded with 6 distinct lips; each lip bearing 1 small labial papilla in the center.

Cephalic setae (Figs. 1A, 2B) of 4 submedian setae, situated just anterior to level of maximum head-width, slightly longer than head length, about two-thirds the head width; all cephalic setae jointed, proximal half swollen, covered with numerous spinules when examined under SEM, and distal half naked, slender.

Amphid oval or pyriform, a little narrowing anteriorly; anterior margin extending to near anterior base of mouth, posterior margin not reaching hind of head. Amphidial pore faintly visible as a groove in lateral view, in connection with elevated strongly sclerotized structure, broadly "U" shaped, along posterior part of amphid (Fig. 2B).

Oesophagus of general type of *Desmoscolex*, surrounded by nerve-ring at level of 2nd main ring. Oesophago-intestinal junction occurring at end of 2nd main ring or in the following interzone. Cloacal tube protruding from middle of conically expanded ventral side of 15th main ring.

Ocelli lightly coloured, oval, situated at level of 4th or in the following interzone.

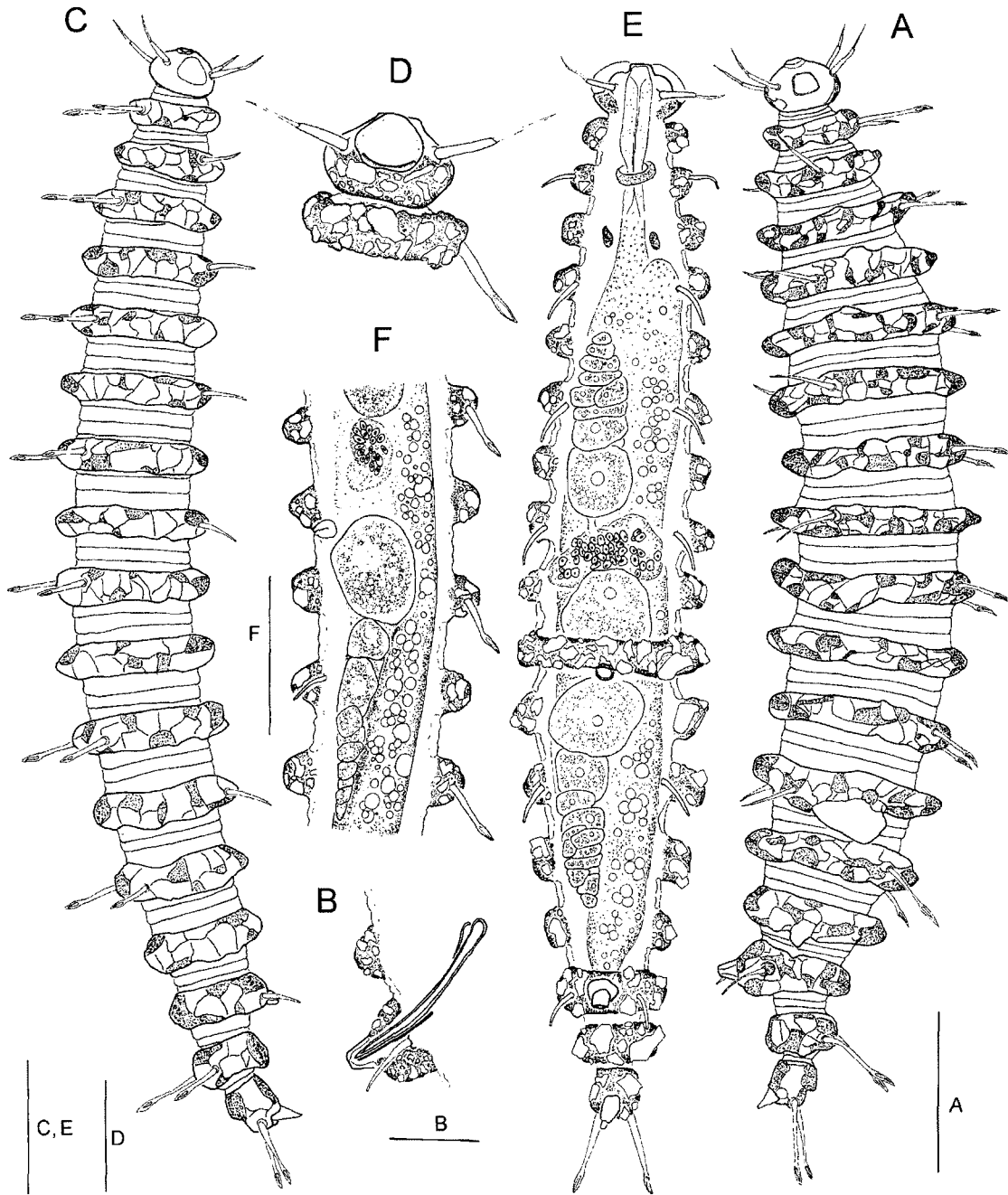
Somatic setae (Figs. 1A, 2A) arranged as follow:

subdorsal	right	1, 3, 5, 7, 9, 11, 13, 16, 17 = 9
	left	1, 3, 5, 7, 9, 11, 13, 16, 17 = 9

subdorsal	right	2, 4, 6, 8, 12, 15 = 6
	left	2, 4, 6, 8, 12, 15 = 6

with pairs 2 and 15 in sublateral position.

Ornamentation of somatic setae differing from typical pattern of 17-ring species by absence of subventral setae on 10th and 14th main rings. Subdorsal setae stout, with spatulate or lance-shaped tip distally; setae on 1st main ring a little longer than next ones up to 11th main ring; the latter about equal in length to each other; setae on 16th ring a little longer than proceedings, nearly same as that on 1st ring; setae on last tail ring longest. Subventral setae slender with blunt and opened tip; subventral setae all about the



**Fig. 1.** *Desmoscolex (Desmoscolex) cosmopolites*. A-B, Male. A, Habitus, lateral. B, Spicule. C-F, Females. C, Habitus, lateral. D, Head and 1st main ring, lateral. E, Habitus, ventral, showing internal organs. F, Reproductive organs, lateral (a different specimen). Scale bars = 50  $\mu$ m (A, C, E, F) and 20  $\mu$ m (B, D).

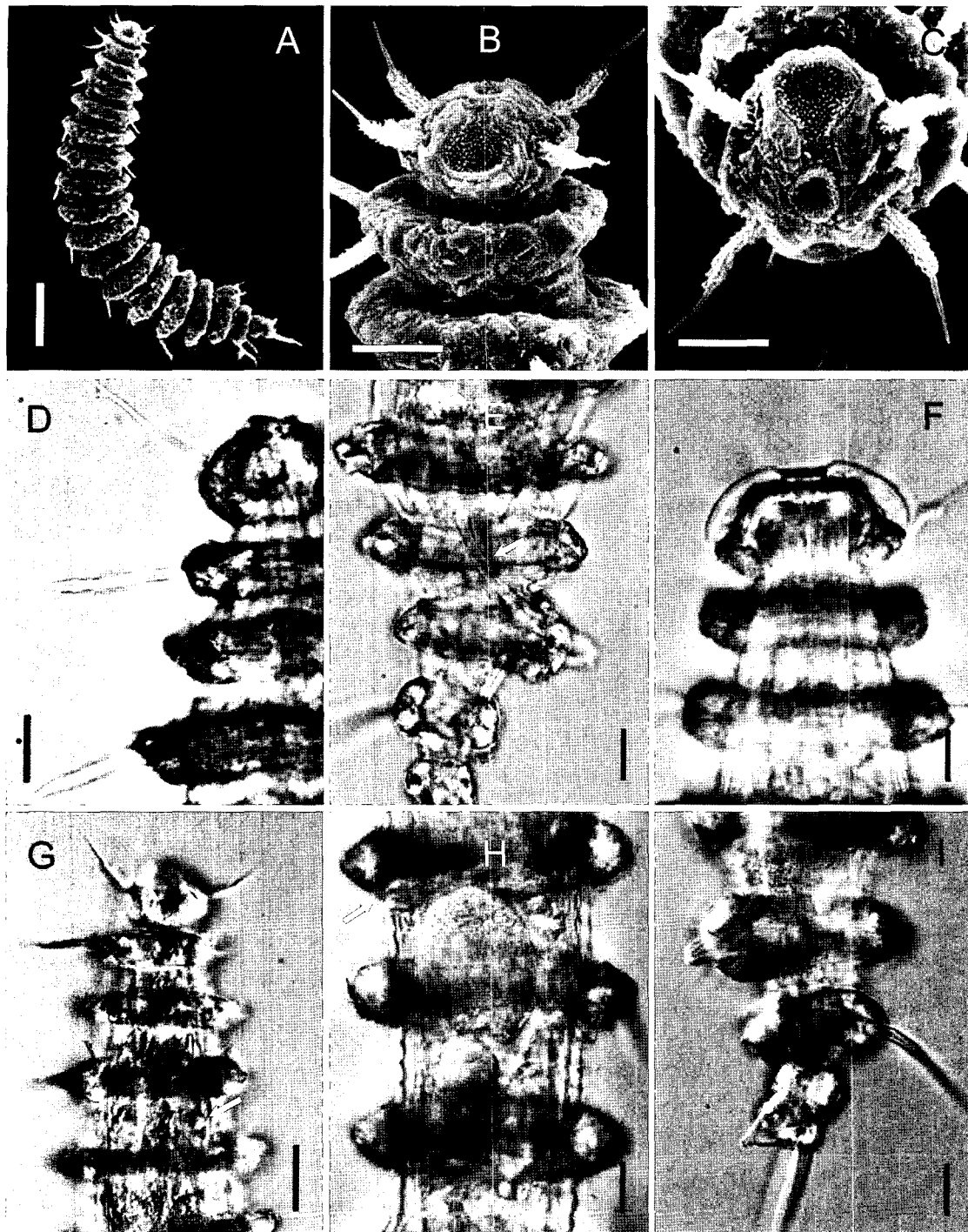
same length to each other, shorter and a little slenderer than subdorsal setae; subventral pair on 2nd main ring situated a little laterally.

Reproductive system with single, outstretched testis. Spicules (Figs. 1B, 2D) slightly bent at proximal third, at level of 14th main ring; capitulum located at interzone between 13th and 14th main rings; spicule lengths ranging from 32 to 40  $\mu$ m according to individuals. Gubernaculum trough-shaped, parallel to spicules, 12-15  $\mu$ m long.

Tail bearing 2 concretion rings. Terminal main ring twice as long as former ring, bent a little ventrally, ending into short spinneret. Phasmata distinct, situated at base of terminal cone, slightly elevated, surrounded by foreign particles.

**Female:** Similar to male for most characteristics including setal pattern (Fig. 1C), cephalic setae and amphid (Figs. 1D, E, 2F), tail (Figs. 1C, 2I), etc.

Oesophago-intestinal junction (Fig. 1E) occurring in



**Fig. 2.** *Desmoscolex (Desmoscolex) cosmopolites*. A-E, Male. A, Habitus, lateral (SEM). B, Head to 2nd main ring, lateral (SEM). C, Head region, frontal (SEM). D, Head to 3rd main ring with two subdorsal setae, lateral. E, Spicule (DIC microscope). F-I, Female (DIC microscope). F, Head, ventral. G, Head to 4th main ring, lateral (arrow indicating ocellus). H, Genital organs (arrow indicating vulva). I, Tail region, lateral. Scale bars = 50 μm (A) and 10 μm (B-I).

interzone between main rings 2 and 3. Ocelli (Figs. 1E, 2G) lightly coloured, lying at level of 3rd main ring or between 3rd ring and following interzone. Reproductive system (Figs. 1E, F, 2H) didelphic-amphidelphic, with outstretched ovaries; each branch with several immature and matured oocytes. Vulva (Figs. 1E, F, 2H) situated at posterior end of

10th main ring. Spermatheca represented by 2 rounded nucleated sacs near vulva. Uteri well defined. Anal tube variable in length, protruded from posterior border of 15th concretion ring, relatively weak proximally but rather protuberant distally than in male.

**Measurements:**

**Male:** L = 340  $\mu$ m, hd = 17  $\times$  24  $\mu$ m, cs = 18  $\mu$ m, sd<sub>1</sub> = 24  $\mu$ m, sd<sub>3</sub> = 21  $\mu$ m, sd<sub>5</sub> = 20  $\mu$ m, sd<sub>7</sub> = 20  $\mu$ m, sd<sub>9</sub> = 19  $\mu$ m, sd<sub>11</sub> = 19  $\mu$ m, sd<sub>13</sub> = 20  $\mu$ m, sd<sub>16</sub> = 27  $\mu$ m, sd<sub>17</sub> = 27  $\mu$ m, sv<sub>2</sub> = 19  $\mu$ m, sv<sub>4</sub> = 21  $\mu$ m, sv<sub>6</sub> = 21  $\mu$ m, sv<sub>8</sub> = 21  $\mu$ m, sv<sub>12</sub> = 16  $\mu$ m, sv<sub>15</sub> = 16  $\mu$ m, t = 40  $\mu$ m, tnr = 20  $\mu$ m, tnrw = 15  $\mu$ m, (mbd) = 49  $\mu$ m, mbd = 65  $\mu$ m, oes = 46  $\mu$ m, spic = 45  $\mu$ m, gub = 19  $\mu$ m.

**Female:** L = 410  $\mu$ m, hd = 17  $\times$  24  $\mu$ m, cs = 19  $\mu$ m, sd<sub>1</sub> = 23  $\mu$ m, sd<sub>3</sub> = 19  $\mu$ m, sd<sub>5</sub> = 17  $\mu$ m, sd<sub>7</sub> = 17  $\mu$ m, sd<sub>9</sub> = 19  $\mu$ m, sd<sub>11</sub> = 19  $\mu$ m, sd<sub>13</sub> = 19  $\mu$ m, sd<sub>16</sub> = 25  $\mu$ m, sd<sub>17</sub> = 25  $\mu$ m, sv<sub>2</sub> = 19  $\mu$ m, sv<sub>4</sub> = 18  $\mu$ m, sv<sub>6</sub> = 18  $\mu$ m, sv<sub>8</sub> = 16  $\mu$ m, sv<sub>12</sub> = 19  $\mu$ m, sv<sub>15</sub> = 16  $\mu$ m, t = 45  $\mu$ m, tnr = 23  $\mu$ m, tnrw = 18  $\mu$ m, (mbd) = 43  $\mu$ m, mbd = 68  $\mu$ m, oes = 57  $\mu$ m, V = 57%.

**Remarks:** The genus *Desmoscolex* Claparède, 1863 is characterized by the prominent cuticular annules (main rings), separated by the interzones with secondary annules, and by the presence of subdorsal and subventral setae, and a pair of stout setae on a terminal ring. In the genus *Desmoscolex*, the basic scheme of classification has been based on the characters of the number of main body rings as a primarily diagnostic one, the arrangement of the somatic setae (Timm, 1970; Freudenhammer, 1975), internal structures such as location of esophago-intestinal junction and shape of genital organs (Decraemer, 1974a, b, c), and ultrastructure of labial region (Shirayama and Hope, 1992; Decraemer, 1996).

The number of main rings is known as rather consistent, especially in the 17-ring species (Decraemer, 1979). *Desmoscolex cosmopolites* has 17 main rings, but shows the different setal pattern from the so-called "typical pattern of the 17 rings with 9 pairs of subdorsal (on main rings 1, 3, 5, 7, 9, 11, 13, 16, 17) and 8 pairs of subventral (on main rings 2, 4, 6, 8, 10, 12, 14, 15) somatic setae" (Timm, 1970) by lacking subventral setae on main rings 10 and 14. In having 17 main rings with the different setal pattern lacking subventral setae on rings 10 or 14, or both, *D. cosmopolites* resembles *D. rudolphi* Steiner, 1916, *D. leptus* Steiner, 1916, *D. laevis* Kreis, 1926, *D. longisetosus* Timm, 1970, *D. timmi* Decraemer, 1974, *D. dimorphus* Decraemer, 1974, *D. sieverti* Freudenhammer, 1975 and *D. membranifer* Soetaert, 1989.

*Desmoscolex rudolphi* is similar to *D. cosmopolites* in having the lance-tipped subdorsal setae and large size (350–400  $\mu$ m), but different by having subventral setae on 10th ring (Steiner, 1916). *Desmoscolex laevis*, which is closely related with *D. rudolphi* as mentioned by Decraemer (1984), is distinguished from *D. cosmopolites* by the strikingly elongate pair of subventral setae on 8th main ring in female (cf. Table 1).

*Desmoscolex leptus* differs from *D. cosmopolites* by small body size (155  $\mu$ m long) bearing the subventral setae

on 10th main ring and the cephalic setae locating at the extremity of head (Steiner, 1916).

*Desmoscolex dimorphus*, *D. timmi* and *D. sieverti* show the sexual dimorphism in the somatic setal pattern, that is, the former two species have the typical setal arrangement in male but lack the subventral setae on 14th main ring (in *D. dimorphus*) or both 10th and 14th ring (in *D. timmi*) in female. In *D. sieverti*, male lacks subventral setae on 10th and 14th main ring as in *D. cosmopolites*, but female lacks subventral setae on 4th and 8th main ring in addition. Besides the sexual dimorphism, *D. dimorphus* is easily discernible from *D. cosmopolites* by relatively small (185–260  $\mu$ m long, while generally over 300  $\mu$ m in *D. cosmopolites*) and ventrally curved body, slender and open-tipped subdorsal setae (against stout and lance-tipped subdorsal setae in *D. cosmopolites*), and strikingly elongated subdorsal setae on 13th main ring and tail (Decraemer, 1974b). *Desmoscolex timmi* is different by much smaller body (usually less than 200  $\mu$ m long), the elongated amphid (far exceeding the posterior margin of head), the shape of subdorsal setae with slightly expanded tip (against lance-tipped in *D. cosmopolites*), ventrally located subventral setae on 15th main ring (lateroventrally in *D. cosmopolites*), and the elongate shape of tail (Decraemer, 1974c). *Desmoscolex sieverti* is different from *D. cosmopolites* by the elongated amphid (far exceeding the posterior margin of head) and cephalic setae (nearly twice longer than head length, while nearly as long as head length in *D. cosmopolites*).

*Desmoscolex membranifer* shows the same setal pattern (lacking subventral setae on 10th and 14th main rings) with *D. cosmopolites*, however, apparently distinguished from it by the cephalic setae bearing a thin flag-like membrane, smaller body (less than 200  $\mu$ m long), and very elongated tail ring (Soetaert, 1989).

*Desmoscolex cosmopolites* most resembles *D. longisetosus* in sharing the same setal pattern of lacking subventral setae on 10th and 14th main rings and the subdorsal setae with large angular lance-shaped tip (cf. Table 1). However, *D. longisetosus* differs from *D. cosmopolites* by smaller body (generally around 200  $\mu$ m long), elongated amphid (far exceeding the posterior margin of head), not-jointed and slender cephalic setae (nearly 2 times longer than head length, while jointed and slightly longer than head length in *D. cosmopolites*), jointed subventral setae, and well developed spinneret of tail ring.

*Desmoscolex vanoyei* De Conink, 1943 is similar to *D. cosmopolites* in the general appearances and stout, lance-tipped subdorsal setae, but different by having 18 main rings (sometimes 17 rings), small body (usually less than 200  $\mu$ m long, while up to 350  $\mu$ m in *D. cosmopolites*), long cephalic setae (nearly twice longer than head length, while slightly longer in *D. cosmopolites*), and big tail cone (cf. Table 1).

**Table 1.** Character comparison among *Desmoscolex cosmopolites* and its allied congeneric species

Parameter	Species			
	<i>D. cosmopolites</i>	<i>D. laevis</i>	<i>D. longisetosus</i>	<i>D. vanoyei</i>
Body length ( $\mu\text{m}$ )	♂: 215-350 ♀: 255-375	♂: 295-525 ♀: 314-537	♂: 160-286 ♀: 150-310	150-230
Number of main rings	17	17	17	17-18
Interzone	3-4 annules	2-3 annules	2-3 annules	2-3 annules
Head	pyriform, rounded	oval-shaped	oval-shaped	rounded
Cephalic setae	jointed	jointed	not jointed	long, thin
Amphid	pyriform, not elongate	oval, not elongate	oval, elongate	oval, not elongate
Ocelli location	rings 4-5 (♂) rings 3-4 (♀)	rings 3-5	rings 4 (♂) rings 3 (♀)	rings 3
Subventral setae (sv) deviating from typical pattern	10th, 14th sv	10th, 14th sv	(8th), 10th, 14th sv	♂: 10th, 14th sv ♀: 4th, 8th, 10th, 14th sv
Subdorsal setae	lance-tipped	lance-tipped	lance-tipped	lance-tipped
Subventral setae	not jointed	8th seta of female very elongate	jointed	not jointed
Spicule	slightly bent	short, broad	slightly arcuate	slightly bent
Phasmata	circular, at tail cone	at base of tail cone	small, circular, at tail cone	-
Tail	not elongate with short spinneret	short with elongate spinneret	not elongate with long spinneret	short tail cone with small spinneret
Habitat	algal bed on rocky shore; subtidal sands	beach	sand beach	tide pool at rocky shore; salt marshes
Locality	Galapagos Isl., Australia, Italia (Timm, 1970); Korea (present study)	North Sea, Atlantic coasts (Europe, America), Mediterranean (Kreis, 1926; Timm, 1970); The Great Barrier Reef (Decraemer, 1974a)	Galapagos Isl., Australia, Italia (Timm, 1970); The Great Barrier Reef (Decraemer, 1974c); Portugal (Freudenhammer, 1975); English Channel (Decraemer, 1979)	Iceland (De Conink, 1943); North Sea (Lorenzen, 1969)

The specimens from Korea fit well with Timm's (1970) original description and figures although they were insufficiently prepared, except for the head shape (nearly as long as wide in the original description, while 1.4 times wider than long in the present specimens from Korea). The somatic setae are a little variable in length according to individuals, but they have a similar arrangement in length to one another. A female among 164 specimens examined showed an abnormality in the setal arrangement: 2nd ring does not bear subventral but subdorsal pair. In Korea, most specimens of *D. cosmopolites* were collected by rinsing the various algae, especially coralline algae on the rocky shore.

**Distribution:** Korea, Galapagos Isl. (Santa Cruz Isl.), Australia (Christie's Beach), Italy.

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