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Lumbriclymene interstricta comb. nov. with a taxonomic key and a catalogue for all species of *Lumbriclymene* (Maldanidae, Polychaeta)

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ABSTRACT. In this paper, we transfer *Nicomache interstricta* Ehlers, 1908 to *Lumbriclymene* Sars, 1872 based on a redescription of the type-specimen. We provide new illustrations for the species and new diagnostic features for the genus. *Lumbriclymene interstricta* (Ehlers, 1908) **comb. nov.** has 19 chaetigerous segments and four pre-anal achaetous segments; a prostomium rounded anteriorly, forming a slightly arched dorsal keel; semi-circular nuchal grooves; one acicular spine on chaetigers 1-4; and a small pygidium, with the anal pore bearing many small papillae. In addition, we compare the species with other subfamilies and genera of Maldanidae. We also provide a taxonomic key for all species presently included in *Lumbriclymene*. Finally, we provide a world catalogue for *Lumbriclymene*, containing synonyms and main references.

KEY WORDS. Maldanid polychaetes; redescription; new combination; world catalogue.

Maldanidae includes sedentary polychaetes known as bamboo worms. They occur from the intertidal region to the deep sea (Arwidsson 1906, Chamberlin 1919). They construct their tubes either horizontally, with sand and mucous under rocks, or vertically, on sand or mud bottoms (Jiménez-Cueto & Salazar-Vallejo 1997, De Assis *et al*. 2010). Their bodies are cylindrical, with a relatively small number of elongated, fragile segments (18-24) (Imajima & Shiraki 1982, De Assis *et al*. 2007a, 2010).

Lumbriclymeninae Malmgren, 1867 contains four valid genera: *Lumbriclymene* Sars, 1872, *Praxillura* Verrill, 1880, *Clymenopsis* Verrill, 1900 and *Lumbriclynenella* Arwidsson, 1911.

Characters used to identify species of *Lumbriclymene* are the shape of the prostomium, the shape of the nuchal grooves, the number of spines per bundle on the anterior chaetigers, the shape of the chaetae, the shape and number of achaetous pre-anal segments, and the structure of the anal funnel.

At present, 10 species of *Lumbriclymene* are known, including the new combination proposed herein: *Lumbriclymene interstricta* (Ehlers, 1908), **comb. nov.**; *L. cylindricauda* Sars, 1872; *L. japonica* (McIntosh, 1885); *L. minor* Arwidsson, 1906; *L. nasuta* Wesenberg-Lund, 1948; *L. lineus* Hartman, 1960; *L. noemia* Lana, 1983; *L. fusca* Detinova, 1984, *L. campanulata* Detinova, 1984; and *L. australis* Wang & Wu, 1988.

In this study we redescribe *Nicomache interstricta* Ehlers, 1908, transfer it to *Lumbriclymene* under the new combination *Lumbriclymene interstricta* (Ehlers, 1908), provide a taxonomic key for *Lumbriclymene*, and discuss the species-complexes established previously. We also provide a world catalogue for all known species.

MATERIAL AND METHODS

The type material that we examined was obtained from Museum für Naturkunde aus Berlin – *Nicomache interstricta* Ehlers, 1908 (Holotype 4535, Deutsche Tiefsee-Expedition Valdivia Station 203). We redescribed the type species using a Zeiss stereomicroscope. Chaetae, uncini, and acicular spines were observed with an Olympus BX41 compound microscope. All illustrations were drawn using a camera lucida. Measurements are in millimeters.

We provide a catalogue of all species of *Lumbriclymene* previously described in the literature (Appendix 1). The following information is included: species names (in alphabetical order), authority for each name, publication year, number of pages and figures (when available), type locality (including coordinates when available), and geographical distribution. In some cases, we have included remarks on possible taxonomic issues. Synonyms (when present) are listed below the original name, including as many references for each as possible. The references contain complete citations, including all authors who have described new taxa.

TAXONOMY

Lumbriclymene is diagnosed by the absence of cephalic and anal plates; presence of 19 chaetigerous segments; chaetigers 1-4 with acicular spines; pygidium cylindrical, with elliptical or tapered distal end, sometimes ventrally flattened, with many transversal striae; anus terminal, subterminal, or dorsal, with short anal papillae (Arwidsson 1906, Day 1967, Imajima & Shiraki 1982, Lana 1983).

Key for described species of *Lumbriclymene*

1a. With terminal anus (Species complex one) 2

1b. With sub-terminal dorsal anus (Species complex two) ... 5

1c. With dorsal anus (Species complex three) 6

2a. Pygidium cylindrical, with elliptical distal end 3

2b. Pygidium cylindrical, with tapered distal end 4

3a. Anus with one short ventral papilla; with 4-5 achaetous pre-anal segments; prostomium broadly rounded anteriorly; keel rises abruptly; nuchal grooves short, slightly curved outwards ..... *L. japonica*

3b. Anus with numerous short papillae; with four short achaetous pre-anal segments; prostomium rounded anteriorly, forming a slightly arched keel; nuchal grooves short with deep, semi-circular, furrows curved outwards . ..... *L. interstricta* **comb. nov.**

4a. Anus short, without papillae; with five achaetous pre-anal segments; prostomium pointed anteriorly, nuchal grooves slightly curved outwards ..... *L. campanulata*

4b. Anus with a long papilla, and numerous smaller papillae surrounding pygidium; with four achaetous pre-anal segments; prostomium distinctly set off and broad; nuchal grooves deep, wide, curved, forming almost half of an ellipsis ..... *L. nasuta*

5a. Pygidium cylindrical, with elliptical distal end, with a single, long, papilla; without achaetous pre-anal segments; prostomium pointed anteriorly, with well-developed keel; nuchal grooves slightly curved outwards ..... *L. fusca*

5b. Pygidium cylindrical, with tapered distal end, with numerous papillae; with 4-6 achaetous pre-anal segments decreasing in length; prostomium broad above median keel, nuchal grooves markedly curved, almost semi-circular .... *L. cylindricauda*

6a. Anus without papillae 7

6b. Anus with papillae 8

7a. Pygidium cylindrical, with tapered distal end; with three achaetous pre-anal segments; prostomium rounded anteriorly, with a well-developed keel; nuchal grooves poorly marked, curved, almost semi-circular ..... *L. minor*

7b. Pygidium cylindrical, with tapered distal end; without achaetous pre-anal segments; prostomium tapering anteriorly, with arched keel; nuchal grooves V-shaped .... *L. australis*

8a. Pygidium cylindrical, with tapered distal end; with one medio-ventral papilla; with a short achaetous pre-anal segment; prostomium rounded anteriorly, with arched keel; nuchal grooves J-shaped and curved outwards .... *L. lineus*

8b. Pygidium cylindrical, with distal end tapered; with one medio-ventral papilla; with 4-5 achaetous pre-anal segments; prostomium broadly rounded in front, keel rises abruptly; nuchal grooves short and slightly curved outwards ..... *L. noemia*

Lumbriclymeninae Malmgren, 1867

Lumbriclymene Sars, 1872

Lumbriclymene interstricta (Ehlers, 1908) **comb. nov.**

Nicomache interstricta Ehlers, 1908: 135, figs 1-4a-b.

Redescription. The type-specimen is fragmented into three pieces: an anterior region measuring 45 mm in length and 1 mm in width, having seven very long chaetigerous segments, a median portion with a length of 5 mm and a width of 1 mm, with three short chaetigerous segments, and a posterior portion measuring 46 mm in length and 1 mm in width, having nine long chaetigerous segments. Specimen with 96 mm in total length, with 19 chaetigerous segments, and four achaetous pre-anal segments. Head with 0.6 mm in length; posterior end with four achaetous pre-anal segments, and a pygidium without an anal cup, with 0.2 mm in length. The body is basically cylindrical, with elongate segments.

Prostomium fused with peristomium, forming a well-defined head. Prostomium rounded anteriorly, bent upwards, forming a slightly arched dorsal keel (Figs 1 and 2). Nuchal grooves form deep and short depressions, semi-circular, curved outwards (Fig. 2). Mouth located ventrally, with well-developed lips, only slightly wrinkled.

Neuropodia of first four chaetigers have a simple acicular spine, which is strong, pointed, and honey-colored (Fig. 3). Chaetiger five with a short collar. From chaetiger five towards posterior region, the neuropodia have tori, which are present up to chaetiger 19. Each uncinus has 2-4 teeth on the main fringe, and 5-6 smaller teeth slightly below this fringe. Below the rostrum arise five thin long barbules (Fig. 4). Each hook is perpendicular to the body wall, with a long and curved posterior shaft, and a prominent manubrium on the posterior half. Notopodia of chaetigers 1-19 with tufts of long and fine capillary chaetae, which are limbate, with base ruffled (Fig. 5).

There are four achaetous pre-anal segments, which are thin and only slightly inflated. Pygidium cylindrical, short, with numerous transversal striae, positioned very close to each other. Anus terminal, with many small and thick papillae (Fig. 6).

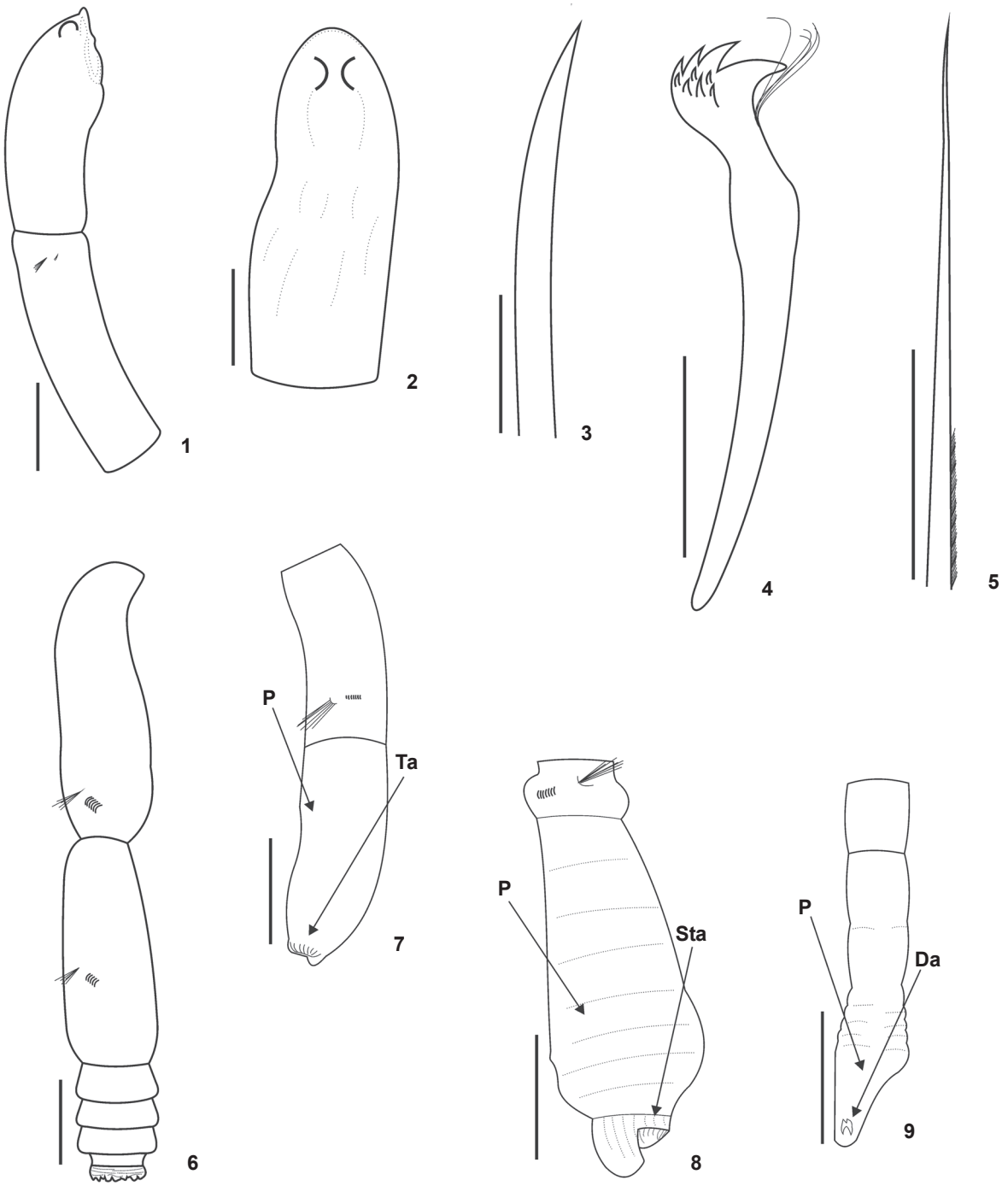
Tube. Tube fragments composed of fine sand grains and clay.

Type material examined. *Nicomache interstricta* (Museum für Naturkunde aus Berlin – Holotype 4535, Deutsche Tiefsee-Expedition Valdivia Station 203).

Distribution. *Lumbriclymene interstricta* **comb. nov.** was originally described from Bangka, Indonesia.

DISCUSSION

Nicomache interstricta does not have an anal plate, which is a diagnostic character for the subfamilies of Nicomachinae Malmgren, 1867 [according to ICZN (1999), art. 36.1; 36.2], Euclymeninae Malmgren, 1867 [according to ICZN (1999), art. 36.1; 36.2], Notoproctinae Malmgren, 1867 [according to ICZN



Figures 1-9. (1-6) *Lumbriclymene interstricta* **comb. nov.**: (1) anterior end of holotype, lateral view; (2) head, in dorsal view; (3) acicular spines from chaetiger 3; (4) rostrate uncinus from chaetiger 17; (5) capillary chaetae, with base ruffled, from chaetiger 17; (6) posterior end holotype, showing four achaetigers pre-anal segments and pygidium. (7-9) Position of the anus in *Lumbriclymene*, according to the species complex: (7) terminal anus (complex one), from *Lumbriclymene nasuta* modified from Treadwell (1948); (8) sub-terminal dorsal anus (complex two), from *Lumbriclymene fusca* modified from Detinova (1984); (9) dorsal anus (complex three), from *Lumbriclymene minor* modified from Day (1967). (P) Pygidium, (Ta) terminal anus, (Sta) sub-terminal anus, (Da) dorsal anus. Scale bars: 1-2, 6-9 = 1 mm, 3-5 = 0.5 mm.

(1999), art. 36.1; 36.2], and Maldaninae Malmgren, 1867 [according to ICZN (1999), art. 36.1; 36.2] (Arwidsson 1906, Day 1967, Fauchald 1977, Imajima & Shiraki 1982, Detinova 1984, De Assis *et al*. 2010). Besides, it cannot be grouped with the subfamilies Rhodininae Malmgren, 1867 [according to ICZN (1999), art. 36.1; 36.2], and Bogueinae Malmgren, 1867 [according to ICZN (1999), art. 36.1; 36.2], as it does not have a double row of uncini (Wolf 1983, 1984). Lumbriclymeninae has four valid genera, namely *Clymenopsis* (Ehlers, 1887), *Praxillura* Verrill, 1880, *Lumbriclymenella* Arwidsson, 1911, and *Lumbriclymene*. However, this species cannot be part of genera *Clymenopsis* or *Praxillura*, because these are characterized by having a top-shaped pygidium, with numerous rings, and a hook-shaped anus. Neurospines appear in the last segments of *Praxillura*, which do not have notochaetae (Imajima & Shiraki 1982: 29, figs 11a-m), while *Clymenopsis* has acicular spines in the first three chaetigers, and a triangular collar.

Lumbriclymenella has two described species, *Lumbriclymenella robusta* Arwidsson, 1911, and *Lumbriclymenella brevis* Detinova, 1984, which are very similar to the species of *Lumbriclymene*, but differ from those by having a pygidium strongly curved upwards (Arwidsson 1911, Detinova 1984).

Lana (1983) suggested to transfer *Lumbriclymene constricta* Wesenberg-Lund, 1948 to *Clymenopsis constricta* (Wesenberg-Lund, 1948), based on the presence of a collar on chaetiger four, and due to the restriction of the acicular spines to the first three chaetigers.

The position of the anus and the shape of the pre-anal structures provide the main diagnostic characters for the distinction of the species of *Lumbriclymene*. The number of chaetigerous is constant for all species of this genus (Lana 1983). The number of achaetous pre-anal segments, the shape of the prostomium, the shape of the nuchal grooves, and the number of acicular spines vary only slightly within this taxon.

Nicomache interstricta cannot belong to any of these subfamilies, neither to *Nicomache* Malmgren, 1866, of Nicomachinae, whose species have a truncate anal plate inserted into an anal cup (De Assis *et al*. 2007a, b). Therefore, based on the shape of the anal plate, we transfer *N. interstricta* to *Lumbriclymene*, which belongs to Lumbriclymeninae, under the new combination *Lumbriclymene interstricta* **comb. nov.**.

Lana (1983) recognized three species complexes within *Lumbriclymene*. The first complex includes species with a terminal anus (Fig. 7): *L. nasuta*, which has a cylindrical pygidium with a tapered end, and an anal pore covered by one large, short, ventral papilla, which is larger than the dorsal papilla; *L. campanulata*, which has a pygidium with tapered end, and no papillae covering the anal pore; *L. japonica,* with a cylindrical pygidium with an elliptical end, and with an anal pore covered by many small papillae; and *L. interstricta* **comb. nov.**, which has a cylindrical pygidium with an elliptical end, and an anal pore covered by numerous short papillae (Arwidsson 1906, Hartman 1960, 1965, Wesenberg-Lund 1948, Lana 1983).

The second complex includes species with a sub-terminal dorsal anus (Fig. 8): *L. cylindricauda* and *L. fusca*, which have a cylindrical pygidium with a narrow end, and an anal pore covered by a single ventral papilla (Sars 1872, Arwidsson 1906, Day 1967, Lana 1983).

The third complex includes species with a dorsal anus (Fig. 9): *L. australis* and *L. minor*, both with a pygidium which tapers to a distal end, but without papillae covering the anal pore; and *L. lineus* and *L. noemia*, both with a pygidium with a pointed distal end, and with an anal pore covered by a medioventral small papilla (Arwidsson 1906, Hartman 1960, Wesenberg-Lund 1948, Lana 1983).

Most species are only known from their type localities, whereas only *L. minor* and *L. cylindricauda* have a broad geographical distribution (Fig. 10).

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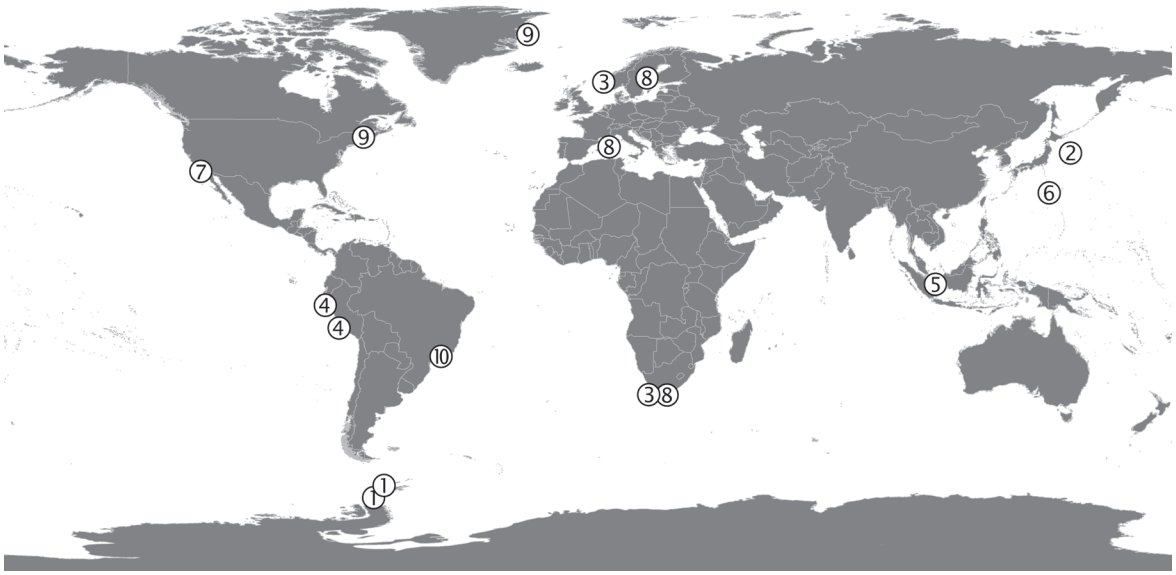

Figure 10. Known distribution of species of *Lumbriclymene*: (1) *L. australis*; (2) *L. campanulata*; (3) *L. cylindricauda*; (4) *L. fusca*; (5) *L. interstricta*; (6) *L. japonica*; (7); *L. lineus*; (8) *L. minor*; (9) *L. nasuta*; (10) *L. noemia*.

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Appendix 1. Catalogue of all described species of *Lumbriclymene*.

Lumbriclymeninae Malmgren, 1867

Lumbriclymene Sars, 1872

Type specie: *Lumbriclymene cylindricauda* Sars, 1872: 146-148, pl. 6, figs 1-4.

Lumbriclymene australis Wang & Wu, 1988
Reference: Wang & Wu (1988): 229-231, fig. 1a-d.
Occurrence: South Atlantic, Bransfield Strait, Antarctic (180-478 m).

Lumbriclymene campanulata Detinova, 1984
Reference: Detinova (1984): 79-80, fig. 2g-h.
Occurrence: North Pacific, abyssal and bathyal zones (3042 m).

Lumbriclymene cylindricauda Sars, 1872
References: Sars (1872): 146-148, pl. 6, figs 1-4; Müller (1780): 49, pl. 75, fig. 3; Danielsen (1859): 122; Arwidsson (1906): 41-44, pl. 1, figs 19-24; pl. 7, figs 219-221; Friedrick (1938): 152; Day (1963a): 432; (1967): 625, fig. 30.2j-m; Hartmann-Schröder (1971): 411; Amourex (1982): 199, 5A; Lana (1983): 57-58.
Occurrence: North Atlantic in the Norway; South Atlantic in the Cape region, South Africa (90-360 m).

Lumbriclymene fusca Detinova, 1984
Reference: Detinova (1984): 77-79, fig. 2a-f.
Occurrence: South Pacific, abyssal and bathyal (2400 m).

Lumbriclymene interstricta (Ehlers, 1908) **comb. nov.**
Synonym: *Nicomache interstricta* Ehlers, 1908: 135, 1-4a-b.
Reference: Ehlers (1908): 135, 1-4a-b.
Occurrence: Indic Ocean, 15 miles south of Bangka, Indonesia (660 m).

Lumbriclymene japonica (McIntosh, 1885)
References: McIntosh (1885): 399-400, pl. 24, fig. 20; pl. 46, fig. 5: Imajima & Shiraki (1982): 26-28, figs 9a-m and 10a-d; Lee & Paik (1986): 16, fig. 3a-g.
Occurrence: North Pacific, Sea of Japan (360-1650 m).
Remarks: this species was described originally as *Nicomache japonica* McIntosh, 1885. However, with the revision of the maldanids from Japan, Imajima & Shiraki (1982) redescribed and transferred the species to *Lumbriclymene japonica* (McIntosh, 1885), based on the holotype and additional specimens from other localities. The authors also provided new illustrations.

Lumbriclymene lineus Hartman, 1960
References: Hartman (1960): 142-143, pl. 15, figs 2-3; Lana (1983): 57-58.
Occurrence: Santa Catalina basin, California, USA (up 2000 m).

Lumbriclymene minor Arwidsson, 1906
References: Arwidsson (1906): pl. 1, fig. 26; pl. 7, figs 223-225a, 226; Wesenberg-Lund (1948): 15-17, fig. 5a-d; Fauvel (1927): 196-197, fig. 86k-q; Friedrick (1938): 152; Uschakovi (1955): 338, fig. 124e; Eliason (1962): 230; Hartman (1965): 201-202; Day (1963b): 336; (1967): 626, fig. 30.2n-p; Hartmann-Schröder (1971): 411; Imajima & Shiraki (1982): 39, fig. 16a-m; Lana (1983): 57-58.
Occurrence: North Atlantic, Sweden, Mediterranean (30-200 m), and South Africa (from abyssal zones up to 1,000 m from surface).

Lumbriclymene nasuta Wesenberg-Lund, 1948
References: Wesenberg-Lund (1948): 10-12, figs 2-3; Hartman (1965): 202; Lana (1983): 57-58.
Occurrence: Off New England, in abyssal depths; Davis Strait, Greenland (up to 1000 m).

Lumbriclymene noemia Lana, 1983
Reference: Lana (1983): 51-59, figs 1-2.
Occurrence: Ilha Anchieta, Ubatuba, State of São Paulo, Brazil (20-30 m).

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