



## Records of *Notospermus tricuspидatus* (Quoy & Gaimard, 1833) (Nemertea: Pilidiophora) in Japanese waters, with a review of warm-water green-bodied heteronemerteans from the Indo–West-Pacific

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**Abstract.** The heteronemertean *Notospermus tricuspидatus* (Quoy & Gaimard, 1833) [new Japanese name: mitsuyari-midori-himomushi] is known to be distributed in the tropical Indo–West-Pacific, but has not been formally reported from Japanese waters based on voucher material. We summarize records of the species based on recently collected specimens in the Nansei Islands. A specimen collected on Yakushima Island (ca. 30°N) represents the northern limit of the species' distribution. For facilitating future studies, a synonym list for the species is compiled based on primary literature; nominal species of heteronemerteans with green body originally described from the temperate to tropical Indo–West-Pacific regions and their surrounding seas are listed and tentatively classified into 11 forms.

### Introduction

The tropical heteronemertean *Notospermus tricuspидatus* (Quoy & Gaimard, 1833) is conspicuous in having a uniformly dark-green body with a characteristic zigzag-shaped white marking on the head. It is one of the most common heteronemertean species distributed in warmer waters in the Indo–West-Pacific, sometimes annoying marine-aquarium fanciers by voraciously eating up other creatures (e.g., gastropods) when it is unintentionally introduced into the tank via live rocks, in which it can hide itself between narrow crevices.

A similar, but rare form, *Lineus albovittatus* (Stimpson, 1855), was described from Okinawa (Stimpson 1855, 1857). It also has a uniformly green body colour, but differs from *N. tricuspидatus* in that the white transverse line on the head is straight, instead of a zigzag. Because these two forms had been confused for a long time (Bürger 1890; Riser 1991), *N. tricuspидatus* was once believed to be distributed in Japanese waters (Gibson 1995).

Actually, however, no nemertean with a zigzag marking has ever been reported from Japanese waters, meaning that there is no formal record of *N. tricuspидatus* in Japan if it is a different species from *L. albovittatus* (Kajihara 2007). Whether or not these two forms belong to a single biological entity should be tested in future molecular studies, but we tentatively regard *N. tricuspидatus* s.str. as represented by individuals with a zigzag marking, while *L. albovittatus* as having a straight band. Indeed, the latter species has been transferred to *Notospermus* by Chernyshev (2016) as *N. albovittatus*.

We provide records of heteronemerteans with a zigzag marking, referable to 'true' *N. tricuspидatus* in the sense of this paper, for the first time from Japanese waters based on voucher specimens. To facilitate future studies, we furnish a revised synonymy for *N. tricuspидatus*, as well as a list of nominal species of heteronemerteans from the Indo–West-Pacific that have a more-or-less similar body coloration as *N. tricuspидatus*, having uniformly greenish body either with or without white markings.

### Material and methods

Ribbon worms were collected intertidally and photographed alive. Voucher specimens, preserved in 99% EtOH, were deposited in the Invertebrate Collection of the Hokkaido University Museum (ICHUM), Sapporo, and the Ryukyu University Museum, Fujukan (RUMF), Nishihara.

### Results

#### *Notospermus* Huschke, 1830

#### *Notospermus tricuspидatus* (Quoy & Gaimard, 1833)

[New Japanese name: mitsuyari-midori-himomushi]

[English name: king ribbonworm]

(Fig. 1)

- Borlasia tricuspadata* Quoy & Gaimard, 1833, p. 289, pl. 24, figs. 12–14, Guam.
- Cerebratulus albo-vittatus* [sic]: Bürger (1890), p. 11, pl. 1, fig. 1, Indonesia (Ambon Island). [non *Meckelia albovittata* Stimpson, 1855 from Okinawa, Japan, nec *Lineus albovittatus* sensu Iwata (1954) from Nakanoshima Island, Tokara Islands, Kagoshima, Japan]
- Lineus albovittatus*: Bürger (1895), p. 31, pl. 2, fig. 5a, b, Indonesia (Atapupu, Timor), Fiji (Matuku), Mauritius; Punnett (1900c), p. 826, Torres Strait; Punnett (1903), p. 111, Maldives (Hulule, Male Atoll); Punnett & Cooper (1909), p. 7, British Indian Ocean Territory (Chagos Archipelago, Salomon Islands), Kenya (Wasini Island).
- Lineus albo-vittatus* [sic]: Punnett (1900a), p. 578, pl. 61, figs. 46, 47, New Caledonia (Lifou Island); Staub (1900), p. 79, Indonesia (Ambon Island).
- Lineus tricuspatus*: Gibson (1981), p. 206, figs. 21–25, Australia (Pelorus Island, Palm Island Group; Michaelmas Reef, north of Cairns).
- Notospermus tricuspatus*: Riser (1991), p. 435 (based on literature); Gibson & Sundberg (2002), p. 1788, fig. 2, Solomon Islands (Honiara, north of Guadalcanal); Paulay (2003), appendix 1, Guam; Schwartz (2009), Federated States of Micronesia (Kosrae), Australia (Pelorus Island); Chernyshev (2011), p. 22, fig. 1A, Vietnam (Cù Lao Thu Island).
- ?*Notospermus* cf. *tricuspatus*: Norenburg (2009), p. 557, Gulf of Mexico.

**Material examined.** Two specimens: ICHUM 5080, intertidal under stone on sandy beach, 30°18'3"N, 130°39'10"E, Harutahama, Yakushima Island, Japan, 3 August 2015, I. Hosokawa & K. Hosokawa leg., posterior portion (few centimeters) preserved in 99% EtOH, anterior body released; RUMF-ZN-00002, among dead corals in reef area, 0–1 m depth, Hoshizuna Beach, Sumiyoshi, Iriomote Island, Japan, 23 October 2014, R. Yoshida leg., preserved in 99% EtOH.

**Description.** The specimen from Yakushima (ICHUM 5080) was 0.6–1.0 cm in width and exceeded 50 cm in length when stretched (Fig. 1A); when contracted, the body can shrink to about 15 cm long (Fig. 1B). The other specimen from Iriomote (RUMF-ZN-00002) lacked the posterior portion when collected; it was 7 cm long and 3 mm wide. In both specimens, the body is uniformly dark green. The characteristic cephalic marking is comprised of a white, transverse, zigzag line forming three wedges (two longer lateral ones and a short middle one) with the acute angle directed anteriorly on both dorsal and

ventral surface of the head, situated half way between the anterior tip of the head and the level of the posterior end of the horizontal lateral cephalic slits. There is a short, white, longitudinal line near the tip of the head on the middle line in ICHUM 5080 (Fig. 1C). In RUMF-ZN-00002, this is connected to the middle wedge (Fig. 1D). In the normal creeping mode, the head is wider than the succeeding body, isosceles-trapezoid in shape (shorter base anteriorly) viewed dorsally, with its anterior edge conspicuously notched. The edges of the cephalic slits are white. There are numerous, small, black ocelli distributed on the dorso-lateral edges of the head (Fig. 1E). The posterior portion is bluntly pointed, without caudal cirrus.

**Remarks.** ICHUM 5080 from Yakushima (ca. 30°N), being ~50 cm in length, extends previous records of the species in terms of the body size and northern limit of distribution. One of the specimens reported by Bürger (1895), from Mauritius, measuring 30–40 cm long in the living state, was the longest previously recorded length. Another specimen reported by Chernyshev (2011) from Cù Lao Thu Island (ca. 10°N), Vietnam, represented the hitherto-confirmed northern-most record of the species in the sense of this paper.

Although no voucher specimens remain, the occurrence of the species in Japanese waters has been witnessed in Yakushima Island on 31 July 2009 (by K. Hosokawa, movie available at <http://yaplog.jp/yakushima/archive/19>) and in the Kerama Islands on 19 December 2011 (Atsushi Ono, pers. comm., image available at <http://ononini.exblog.jp/16968525/>).

### Green heteronemerteans from the Indo–West-Pacific and its surrounding seas

From the temperate to tropical Indo–West-Pacific and surrounding seas, two nominal species of valenciniids—*Eupolia multiporata* Punnett, 1900a (type locality: Rakaiya, Papua New Guinea) and *Baseodiscus sordidus* Punnett & Cooper, 1909 (type locality: Praslin, Seychelles)—are known to have a uniformly green body colour, although they can be distinguished from *Notospermus tricuspatus* and related forms by lacking horizontal lateral cephalic slits.

In this sea area, apart from *Borlasia tricuspadata*, there are 20 nominal species of green-coloured heteronemerteans having horizontal lateral cephalic slits, either with or without white markings. For the purpose of facilitating taxon-name application in

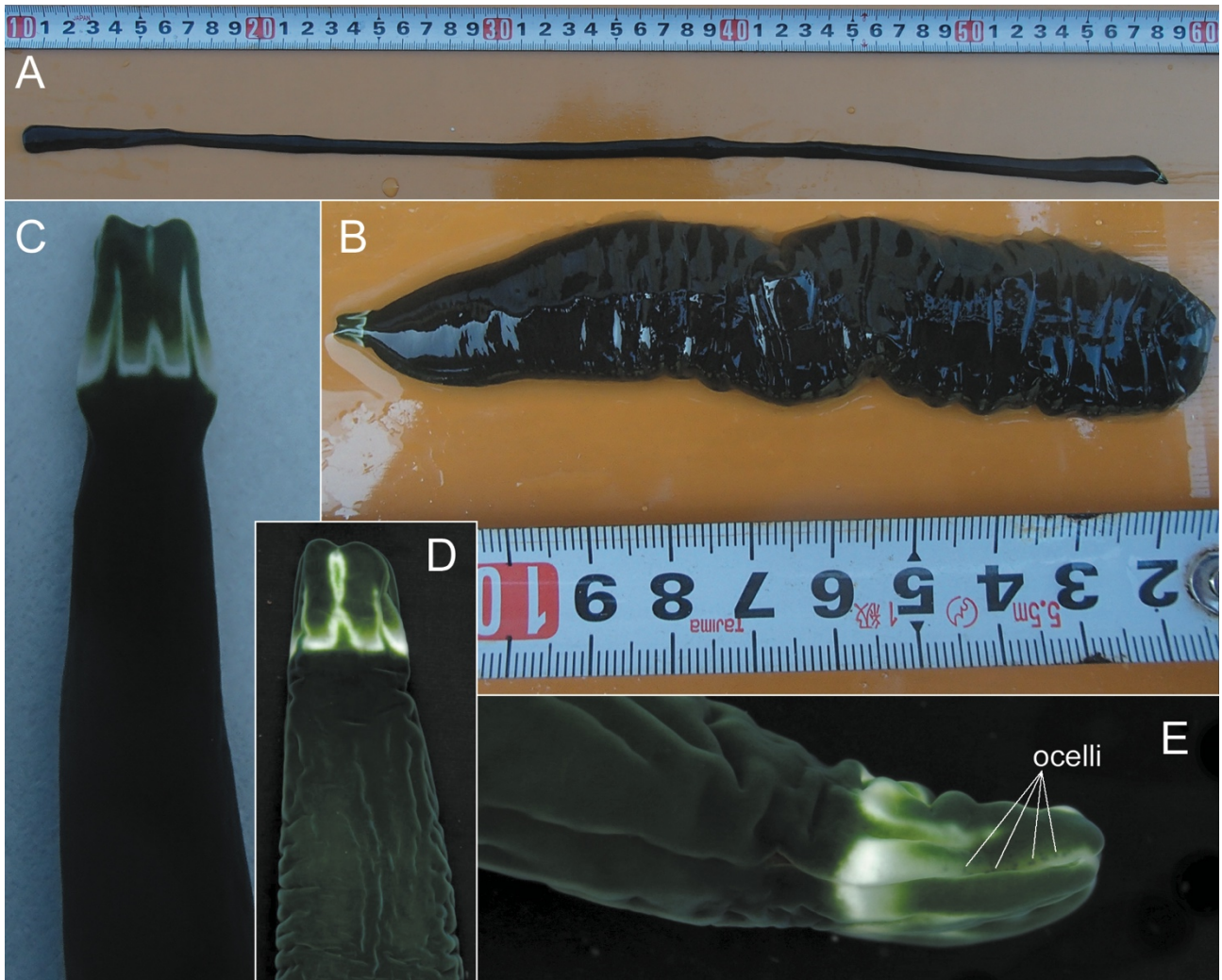


Fig. 1. *Notospermus tricuspoidatus* (Quoy & Gaimard, 1833). A–C, ICHUM 5080; D, E, RUMF-ZN-00002. A, Entire animal (lacking a posterior portion of ~10 cm long) when extended; B, contracted state; C, head, dorsal view, in normal creeping mode; D, head, dorsal view, in anaesthetized state; E, head, lateral view, showing black ocelli.

図1. ミツヤリミドリヒモムシ (新称). A–C, ICHUM 5080; D, E, RUMF-ZN-00002. A, 伸びた状態の全体図 (体後端は約 10 cm にわたって欠落); B, 収縮した状態; C, 通常の這い回っている状態での頭部背面図; D, 麻酔した状態での頭部背面図; E, 頭部側面図, 眼点を示す.

future species-delimitation studies based on molecular data, they are listed below.

1. *Borlasia viridis* Quoy & Gaimard, 1833 (type locality: Port Jackson, Australia): body green; head with white band, anteriorly twisted on mid line both dorsally and ventrally; synonymized with *Borlasia tricuspoidata* Quoy & Gaimard, 1833 by Gibson (1981: 206), listed as *Notospermus tricuspoidatus* (Quoy & Gaimard, 1833) by Gibson (1995: 312).

2. *Cerebratulus albocirculus* Iwata, 1957 (type locality: Sagami Bay, Japan): in preserved state, body yellowish green; head dark green, with white transverse ring; listed as valid name in Gibson (1995: 328).

3. *Cerebratulus bicornis* Joubin & François, 1892

(type locality: Îlot Maître, near Nouméa, New Caledonia): body greenish yellow; a single, black pigment spot at tip of head; antero-lateral corners of head slightly protruded so that they look like a pair of ‘tentacles’; edges of head, including peripheries of black spot, white; no caudal cirrus; listed as *Cerebratulus bicornis* by Gibson (1995: 330) as a valid name.

4. *Cerebratulus boutani* Joubin, 1893 (type locality: Red Sea): body olive green, ventrally yellowish; with numerous white rings, the anterior-most one situated in middle of head; after the eighth white ring, there are three, blue stripes on ventral surface of body; listed as *Lineus boutani* (Joubin, 1893) by Gibson (1995: 393) as a valid name. A

similar form, *Cerebratulus anas* Joubin & François, 1892 (type locality: Nouméa, New Caledonia), has a black background body colour; this taxon has been synonymised with *Notospermus geniculatus* (Delle Chiaje, 1828) by Riser (1991: 427).

5. *Cerebratulus glaucus* Bürger, 1890 (type locality: Sebira Island, Thousand Islands, Indonesia): body dark green; head with yellowish (maybe whitish in living state) transverse dorsal band; eyes numerous, arranged dorso-laterally on head; listed as *Lineus glaucus* (Bürger, 1890) by Gibson (1995: 396) as a valid name.

6. *Cerebratulus insignis* Punnett, 1900b (type locality: Singapore): body olive green, ventrally paler; broad white transverse band near tip of head, latter being nearly black; no eyes; caudal cirrus present; listed as a valid species name in Gibson (1995: 336).

7. *Cerebratulus psittacinus* Bürger, 1890 (type locality: Ambon Island, Indonesia): body variously yellowish to brownish green, with numerous white rings arranged at intervals on body; head with transverse white line that is mid-dorsally projected forward forming an inversed V shape; listed as *Lineus psittacinus* (Bürger, 1890) by Gibson (1995: 342) as a valid name.

8. *Cerebratulus tigrinus* Bürger, 1890 (type locality: Ambon Island, Indonesia): basement body colour yellowish; except head, dorsally mottled with green to brown spots; no eyes; listed as a valid name by Gibson (1995: 345).

9. *Lineus fuscoviridis* Takakura, 1898 (type locality: Misaki, Japan): body variously pale green to purplish dark green, without markings; brain reddish; numerous, small, black eyes found in cephalic slits and dorsal edges of tip of head; proboscis pale red in colour; listed as a valid species by Gibson (1995: 396).

10. *Lineus hancocki* Punnett & Cooper, 1909 (type locality: Saint Brandon [Cargados Carajos], Mauritius): body pale yellow green in preserved state; although not mentioned in the text, a transverse band is depicted in a figure (Punnett & Cooper 1909, pl. 1, fig. 6b); listed as a valid name in Gibson (1995: 397).

11. *Lineus indicus* Punnett & Cooper, 1909 (type locality: Amirante Islands, Seychelles): body pale green in preserved state; it is stated in the text that on the dorsal surface of the head, “there is a thin white collar running across the brain-region” (Punnett & Cooper 1909: 9), although the “collar” is not illustrated on the figure (Punnett & Cooper, 1909, pl. 1, fig. 2, the only illustration of the species included in the original description is a ventro-lateral view);

listed as a valid name in Gibson (1995: 397).

12. *Lineus mitellatus* Takakura, 1898 (type locality: Misaki, Japan): body variously pale green to dark purple; with numerous white rings [Note: Takakura (1898) gave a distinction between *N. geniculatus* (Delle Chiaje, 1828) from the Mediterranean in that the white rings are dorsally continuous in *L. mitellatus*, whereas these are mid-dorsally interrupted in *N. geniculatus*]; synonymised with *Notospermus geniculatus* (Delle Chiaje, 1828) by Riser (1991: 427).

13. *Lineus orientalis* Punnett & Cooper, 1909 (type locality: Coëtivy Island, Seychelles): body brown-green, paler ventrally, without markings; no eyes; listed as a valid name by Gibson (1995: 400).

14. *Meckelia albovittata* Stimpson, 1855 (type locality: Okinawa, Japan): body slender, “grass-green; head truncated, a little narrower than the body, margined with white and crossed by a white band at a point about the middle of the lateral fissures” (Stimpson 1855: 382); synonymized with *Notospermus tricuspidatus* (Quoy & Gaimard, 1833) by Riser (1991: 435).

15. *Meckelia ceylanica* Schmarda, 1859 (type locality: Sri Lanka): body dirty brownish green; no white markings; no caudal cirrus; horizontal lateral cephalic slits reddish; listed as *Micrura ceylanica* (Schmarda, 1859) by Gibson (1995: 416) as a valid name.

16. *Meckelia macrostoma* Schmarda, 1859 (type locality: Auckland, New Zealand): body greenish dark blue, without markings; no caudal cirrus; listed as *Cerebratulus macrostomus* (Schmarda, 1859) by Gibson (1995: 339) as a valid name.

17. *Meckelia trigonocephala* Schmarda, 1859 (type locality: Sri Lanka): body olive green; no white markings; no caudal cirrus; horizontal lateral cephalic slits rose red; listed as *Micrura trigonocephala* (Schmarda, 1859) by Gibson (1995: 420) as a valid name.

18. *Micrura tridacnae* Gibson, 1981 (type locality: Townsville, Australia): body dorsally bright pea-green, ventrally pale blue-green, with numerous white rings; a broader white band situated anterior to brain, mid-dorsally shifted forward; numerous eyes arranged above and below cephalic slits; small caudal cirrus present; synonymised with *Notospermus geniculatus* (Delle Chiaje, 1828) by Riser (1991: 427).

19. *Nemertes collaris* Schmarda, 1859 (type locality: Sri Lanka): body dark green; head separated from body by a white line [Note: The line does not appear to be continuous on the dorsal surface, according to the illustration (Schmarda 1859, pl. 9,



fig. 98)]; numerous eyes on dorsal side of head; listed as *Lineus collaris* (Schmarda, 1859) by Gibson (1995: 394) as a valid name.

20. *Uricholemma nigricans* Sundberg & Gibson, 1995 (type locality: Little Armstrong Bay, Rottnest Island, Western Australia): body variably black with greenish-blue tinge or deep green, both with clear white margin on anterior tip of head; no eyes; no caudal cirrus (Sundberg & Gibson 1995).

These green-bodied forms from the Indo–West-Pacific can be classified into the following 11 forms.

**Form 1.** Without marking—*Meckelia ceylanica* Schmarda, 1859; *Meckelia macrostoma* Schmarda, 1859; *Meckelia trigonocephala* Schmarda, 1859; *Lineus fuscoviridis* Takakura, 1898; *Lineus orientalis* Punnett & Cooper, 1909.

**Form 2.** With single, straight cephalic band; no white rings on the body—*Meckelia albovittata* Stimpson, 1855; *Nemertes collaris* Schmarda, 1859; *Cerebratulus glaucus* Bürger, 1890; *Lineus hancocki* Punnett & Cooper, 1909; *Lineus indicus* Punnett & Cooper, 1909; *Cerebratulus arbocirculus* Iwata, 1957. Some specimens corresponding to this form have been collected in Vietnam, which should be referred to as *Notospermus albovittatus* (Chernyshev 2016).

**Form 3.** With single cephalic band twisted anteriorly on midline; no white rings on the body—*Borlasia viridis* Quoy & Gaimard, 1833. [Takakura (1898) mentioned a variety of *Lineus mitellatus* that conforms to this form]

**Form 4.** With single cephalic band twisted anteriorly three times; no white rings on the body—*Borlasia tricuspидatus* Quoy & Gaimard, 1833. This form corresponds to *Notospermus tricuspидatus*.

**Form 5.** With numerous white rings; anterior-most ring straight—*Cerebratulus boutani* Joubin, 1893 [*Cerebratulus anas* Joubin & François, 1892]. A green variety, possibly referable to *Cerebratulus boutani*, has been collected in Japanese waters (Kajihara & Yoshida pers. obs.). An orange variety has been found in China (S. Sun pers. comm.).

**Form 6.** With numerous white rings; anterior-most ring twisted forward on midline—*Cerebratulus psittacinus* Bürger, 1890; *Lineus mitellatus* Takakura, 1898; *Micrura tridacnae* Gibson, 1981. *Notospermus geniculatus* as currently diagnosed corresponds to this form, but it appears to be a complex of multiple cryptic species (M. Schwartz pers. comm.). Since the type locality is Naples, Italy (Delle Chiaje 1828), the name *geniculatus* (-a, -um) will be applied only to the population within the Mediterranean.

**Form 7.** With black pigment spot at tip of head—

*Cerebratulus bicornis* Joubin & François, 1892.

**Form 8.** Head with white band; caudal cirrus present—*Cerebratulus insignis* Punnett, 1900.

**Form 9.** Body yellowish, dorsally with green/brown mottles—*Cerebratulus tigrinus* Bürger, 1890.

**Form 10.** Body white, with green cephalic patch and broad mid-dorsal stripe, corresponding to '*Lineus albovittatus*' sensu Iwata (1954). No nominal species is currently assigned for this form. Some specimens have recently been found in Vietnam (Chernyshev 2016).

**Form 11.** Body variously deep green or black with greenish-blue tinge, with clear white margin on anterior tip of head—*Uricholemma nigricans* Sundberg & Gibson, 1995.

*Notospermus tricuspидatus* (Form 4) may be either closely related to, or even conspecific with, Forms 2 and/or 3, whereas Forms 7–11 are unlikely to belong to *Notospermus*. Future studies should elucidate the actual species diversity of these forms based on DNA sequence data and high-quality digital images of specimens from wide zoogeographic ranges.

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**ミツヤリミドリヒモムシ (新称)  
*Notospermus tricuspидatus* (Quoy & Gaimard, 1833) (紐形動物: 担帽類) の日本からの記録, 及びインド西太平洋産暖海性緑色異紐虫類に関する論評**

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**要旨.** 異紐虫類ミツヤリミドリヒモムシ (新称) *Notospermus tricuspидatus* (Quoy & Gaimard, 1833) はインド西太平洋熱帯域に分布する事が知られているが, 日本の海域からは証拠標本に基づいた正式な記録が無かった. 本論文では南西諸島 (本誌における「琉球列島」) から近年得られた標本に基づく本種の記録を報告する. 屋久島 (北緯約 30 度) で得られた標本は本種の分布の北限記録となる. 将来の研究に資するため一次文献に基づいて本種の異名表を作成した. またインド西太平洋の温・熱帯域およびその周辺海域において原記載された異紐虫類の名義種 20 種をリストし, それらを暫定的に 11 の型に分類した.

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