

One new species of *Micronephthys* Friedrich, 1939 and one new species of *Nephtys* Cuvier, 1817 (Polychaeta: Phyllodocida: Nephtyidae) from eastern Australia with notes on *Aglaophamus australiensis* (Fauchald, 1965) and a key to all Australian species.

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Abstract

There are currently over 130 described species of Nephtyidae worldwide, with 18 species known from Australian waters belonging to four genera. Two new species are described, *Micronephthys derupeli* n.sp., and *Nephtys triangula* n.sp., from Eastern Australia. Descriptions are provided for all species examined. Comments are given about the recent transfer of *Nephtys australiensis* to *Aglaophamus*. A key to all Australian species of nephtyids is provided.

Key Words

Polychaeta, New South Wales, Taxonomy, *Nephtys*, *Micronephthys*

Introduction

Nephtyidae is a common family of benthic polychaetes (Wilson 2000; Ravara *et al.* 2010a, b). This family occurs worldwide and is recorded at all depths, although more species have been recorded from shallow waters with sandy and muddy bottoms than other habitats. There are currently five accepted genera found worldwide: *Aglaophamus*, *Inermonephtys*, *Micronephtys*, *Nephtys* and *Bipalponephtys* with over 130 described species (Ravara *et al.* 2010b). The most diverse genera both worldwide and in Australia are *Aglaophamus* and *Nephtys*, with eight and seven species now known in Australia respectively. The genus *Inermonephtys* also occurs in Australia with two described species but was not found in this study. The validity of the new genus *Bipalponephtys* erected by Ravara *et al.* (2010a) has been questioned by Jirkov and Dnestrovskaya (in conversation and in a publication in 2012), but their criticism rejected by Ravara (2011) and while beyond the scope of this paper, the types of some species placed in this new genus certainly need to be re-examined to confirm these relocations. However none of the Australian species possess bifid palps.

A recent phylogenetic study by Ravara *et al.* (2010a) using both molecular and morphological characters found two well supported clades, corresponding mainly to the genera *Aglaophamus* and *Nephtys*. *Nephtys australiensis*, a very common species in sheltered marine habitats in Eastern Australia was transferred to *Aglaophamus*. The genus *Dentinephtys*, which is known only from a single species in Japan and California, U.S.A., was transferred to *Nephtys*. They also found that *Micronephtys* was a sister group to *Nephtys*, and the position of *Inermonephtys* was unresolved.

Nephtyids were first recorded from Australia by Stimpson (1856) who described *Nephtys longipes* from Botany Bay, New South Wales (NSW). Subsequent studies by Augener (1913, 1922), Benham (1915, 1916), Fauchald (1965), Rullier (1965), Knox and Cameron (1971), and Paxton (1974) described additional Australian species. Rainer and Hutchings (1977) undertook a comprehensive survey of the Australian fauna and increased the number of known species to thirteen, describing five new species. Subsequently Rainer and Kaly (1988) described an additional four new species from the North West Shelf, and recorded the presence of

another species of *Micronephthys*, bringing the Australian nephtyid fauna to 18 species belonging to four genera.

All these studies facilitated the recognition of undescribed species collected during benthic studies by Dixon-Bridges *et al.* (2013), Jones *et al.* (1986), a project undertaken from 1992–1995 by the Australian Museum for the Federal Airports Commission, and various other Australian Museum fieldwork trips. This paper describes one new species of *Micronephthys* and one of *Nephtys* occurring along the east coast of Australia, and increasing the number of species known from Australian waters to 19. A brief note is also given re the transfer of *Nephtys australiensis* Fauchald, 1965 to *Aglaophamus*.

Materials and methods

The majority of specimens were collected from Port Stephens, New South Wales, in May 2009, February and October 2011, using a Van-Veen grab of 0.25 m³. Sediment was retained in bags of 1 mm mesh and fixed in a 5% formalin-seawater solution containing Rose Bengal. After a week the sediment was washed and sorted to extract all polychaetes which were then sorted to family and transferred to 70% ethanol. Specimens collected by the Australian Museum in the 1980s from the Hawkesbury River, and in 1994 from Pittwater, were similarly fixed in 5% formalin-seawater solution and subsequently transferred to 70% ethanol. Some of the specimens collected in 2004 from Pittwater, New South Wales, were fixed and preserved in 95% ethanol. Material has been deposited at the Australian Museum (AM), Natural History Museum, London UK (NHM) and the United States Natural History Museum, Washington D.C., USA (USNM). Some specimens of each species were also prepared for examination under a Scanning Electron Microscope (SEM). Specimens were dried via critical point, coated in gold, and observed under a Zeiss EVO LS15 SEM with a Robinson Backscatter detector (AM).

Types of each species were photographed using a Leica MZ16 microscope and Spot flex 15.2 camera attached and images of the entire animal were generated using a montage program. In some cases material was stained with methylene blue to increase the resolution. For each species, maximum width was recorded which includes parapodia, but excludes chaetae, and maximum body length which excludes anal cirrus.

Taxonomy

Family Nephtyidae Grube, 1850

Nephtyidae Grube, 1850: 249–364. —Fauchald, 1977: 96–97. —Ravara *et al.*, 2010b: 5.

Diagnosis. Elongate compact bodies with an eversible pharynx, prostomium with pair of antennae and simple palps and nuchal organs present at base. Pharynx with terminal papillae and many longitudinal rows of subterminal papillae, proximal surface may be smooth or covered with small verrucae, pair of subterminal jaws.

Parapodia biramous, typically with well separated rami, with acicular, pre- and post chaetal lobes, ventral and dorsal cirrus. Chaetae simple, often barred or spinose, lyrate chaetae present or absent, aciculae thick. Except for some species of *Micronephthys*, branchiae are typically present on ventral margin of notopodia below dorsal cirrus occupying the interramal space. Terminal anus with single cirrus.

Comments: The above definition is largely derived from the description of the family given by Ravara *et al.* (2010b). Ohwada (1985) suggested that the morphology of the prostomium was a useful criterion in the identification of the nephtyids and that the shape of the antennae and palps and their point of insertion was useful, however the figures he provides are very schematic. Using this data he divides up the genus *Nephtys* into two groups although one of his species *N. australiensis* Fauchald, 1965, has now been transferred to *Aglaophamus* by Ravara *et al.* (2010b). While accepting these are useful characters, in fixed material they are highly dependent on whether the pharynx is everted or not and we have not used his classification as the Australian species of *Nephtys* can be easily separated using other characters. For the new species described here we have provided this information although often it is not provided in other species descriptions which are listed in Tables 4 & 5. A recent paper by Dnestrovskaya and Jirkov (2010) has followed Ohwada (1985) classification for species of *Micronephthys*. We have also followed the chaetal terminology of Dnestrovskaya and Jirkov (2010, 2011) who recognise four main types: capillary, barred, chaetae with spines which we divide into two and lyrate. The development of chaetal spines varies considerably and in the most ornate

cases (called spinose) the spines form regular transverse rows or combs of spines which we refer to as spinose and those with spines arranged in a single longitudinal row as serrated. We have not distinguished between those having fine and coarse spines, i.e spinose and spinulose as several earlier authors have (Rainer and Hutchings 1977; Rainer and Kaly 1988, for example) as this can be subjective. The detailed structure of the chaetae is only revealed with the use of the scanning electron microscope.

Key to Australian species of Nephtyids

1. Parapodia with branchiae 2
 - Parapodia without branchiae or if present reduced in size and straight *Micronephthys*.4
2. (1). Prostomium without antennae, palps only; pharynx without papillae *Inermonephthys*.19
 - Prostomium with antennae and palps; pharynx with papillae 3
3. (2). Acicular lobes acutely pointed, neuropodial postacicular lobes may be present; pharynx with subterminal longitudinal rows of papillae, each row with 10 or more papillae, proximal region smooth; branchiae involuted or recurved *Aglaophamus*.12
 - Acicular lobes conical, rounded or bilobed, neuropodial postacicular lobes absent; pharynx with subterminal longitudinal rows of papillae, each row with less than 10 papillae (usually 5–7), proximal region may be smooth or covered with verrucae; branchiae recurved *Nephtys*. 6
4. (1). Notopodia of chaetiger 1 with specialised dentate (teeth fused to form knobs along margin) chaetae; eyespots between chaetigers 2 and 3 *M. cf. stammeri*
 - Notopodia of chaetiger 1 without specialised dentate chaetae 5
5. (4). Reduced branchiae present from chaetigers 7–8 (10–20 pairs); lyrate chaetae absent *M. derupeli* n.sp.
 - Branchiae completely absent; lyrate chaetae present; eyespots present.....*M. cf. sphaerocirrata*
6. (3). Prostomium produced anteriorly; long flowing chaetae 7
 - Prostomium not produced anteriorly; long flowing chaetae absent 8

7. (6). Prostomium elongate, triangular with antennae at apex
..... *N. triangula* n.sp.
– Prostomium oval with thin preantennal lobe with antennae at base
.....*N. longipes*
8. (6). Branchiae from chaetigers 3–5 9
– Branchiae from chaetigers 7–10 11
9. (8). Branchiae from chaetigers 3 or 4; spinose chaetae present among post
acicular chaetae of middle and posterior chaetigers; pharynx with or without
median dorsal papilla 10
– Branchiae from chaetiger 5, spinose chaetae absent among postacicular
chaetae of middle and posterior chaetigers; pharynx lacking median
dorsal papilla *N. inornata*
10. (9). Branchiae from chaetiger 3; pharynx with verrucae over entire surface of
basal region, median dorsal papilla absent *N. gravieri*
– Branchiae from chaetiger 4; pharynx with verrucae only on proximal
portion of basal region, median dorsal papilla absent
..... *N. semiverrucosa*
11. (8). Branchiae from chaetigers 7–8, absent from chaetiger 24 onwards
..... *N. mesobranchia*
– Branchiae from chaetiger from 8–10, initially small, fully developed by
25–27th chaetiger often with two lateral foliaceous lobes, subsequently
becoming smaller *N. paradoxa**
12. (3). Branchiae from chaetiger 2; prostomium with pair of eyespots situated
near midline of its posterior border; parapodial lobes and cirri foliose
..... *A. foliocirrata*
– Branchiae start from chaetiger 3 to 8; prostomium with or without
eyespsots; parapodial lobes and cirri conical or cirriform 13
13. (12). Lyrate chaetae absent 14
– Lyrate chaetae present 16
14. (13). Branchiae from chaetiger 4 *A. australiensis*
– Branchiae from chaetiger 3 15
15. (14). Pharynx with median dorsal subterminal papillae and with verrucae, 14
longitudinal rows of subterminal papillae, each row with 3-4
..... *A. hedlandensis*

- Pharynx without median dorsal subterminal papillae, without verrucae, 14 longitudinal rows of subterminal papillae, each row with 12-15 *A. gippslandicus*
- 16. (13). Postacicular chaetae of middle and posterior chaetigers include lyrate chaetae; pharynx with 14 or 22 rows of subterminal papillae..... 17
 - Parapodia without lyrate chaetae; pharynx with 22 rows of subterminal papillae *A. profundus*
- 17. (16). Pharynx with 14 rows of subterminal papilla, median dorsal papilla present (presence of verrucae unknown) *A. dibranchis*
 - Pharynx with 22 rows of subterminal papilla, median dorsal papilla present, verrucae present 18
- 18. (17). Branchiae from chaetiger 3; prostomium with a pair of eyespots *A. victoriae*
 - Branchiae from chaetiger 7–8; prostomium with two pairs of eyespots *A. verrilli*
- 19. (2). Barred chaetae present in preacicular fascicles; two aciculae with caps per parapodial ramus; prostomium without eyes *I. palpata*
 - Barred chaetae absent; variable number of aciculae in parapodial rami (up to 4), without caps; prostomium with 2 pairs of eyes *I. tetrophthalmos*

**N. paradoxa* Malm 1874, this species has been reported as occurring in Australian waters by Paxton (1974) and has been recorded widely southern Chile as well as Northern European waters and the Australian material needs to be compared with material from the type locality.

Micronephthys Friedrich, 1939

Micronephthys.—Hartman, 1950: 130. —Fauchald, 1977: 96–97. —Paxton, 1974: 204. —Rainer and Kaly, 1988: 696. —Ravara *et al.*, 2010b: 23–24.

Type species: *Micronephthys minuta* (Théele, 1879), by monotypy.

Diagnosis: Body of small size. Branchiae absent or present, if present, reduced, nearly straight and present on few chaetigers only; pre- and postchaetal lobes rudimentary (Hartman 1950). Acicular lobes conical, neuropodial postacicular lobes absent. First chaetiger not reduced, similar to remaining ones. Barred chaetae may be present; if so, restricted to anterior chaetigers. Lyrate chaetae may be present or absent. Aciculae of median and posterior parapodia with curved tips. Antennae and palps present. Pharynx with subterminal papillae, middorsal papilla present or absent, proximal region smooth or with verrucae. Nuchal organs rounded.

Comments: This genus is now not easily distinguished from small specimens of *Nephtys* as they share many characters, but from the recent literature it appears the only distinguishing features are its small body size together with poorly developed parapodial lobes. Mature adults are required for correct identification to genus level. One character typically used to define the genus - "branchiae absent or poorly developed" requires some clarification by defining exactly what "poorly developed" means, as some species possess branchiae that occupy almost $\frac{1}{2}$ to $\frac{2}{3}$ rds of the interramal space, a feature which some species of *Nephtys* possess also. The estimation of the size of the branchiae is also relative to the size of the interramal space, which can range from a wide V-shape, to a narrow U-shape. We have expanded the definition to include the presence or absence of verrucae on the proximal region of the pharynx as occur in several species (see Table 4). Ravara *et al.* (2010a) found that the genus *Micronephthys* was well supported and sister taxon to the genus *Nephtys*, however they suggest that it is heterogeneous and in need of revision. We agree, but this is beyond the scope of this study.

***Micronephthys derupeli* n. sp.**

Figures 1a-c, 2a-c, 3a-d, 4a-f, 5a-e, Table 1

Material examined. HOLOTYPE: AM W41508, Australia, **New South Wales**, Port Stephens, Big Swan Bay South, 32° 43' 22" S, 151° 58' 1" E, Apr 2009. PARATYPES: AM W41509 (1 gravid, 22 mm in length, 2 mm in width), AM W41510 (1), AM W41732, (1 on SEM), AM W43573 (2), all from same location as holotype; USNM 1220304 (1), Port Stephens, Big Swan Bay South, 32° 43' 37.3" S, 151° 58' 02.3 "E, Apr-May 2009; USNM 1220305 (1), Port Stephens, just west of Soldiers Point, muddy/sand site, 32° 41' 58" S, 152° 03' 16" E, June 2009; BMNH 2013.442-443 (2), Port Stephens, 32° 42' 49.0" S, 152° 01' 22.1" E, Apr 2009.

Additional material examined. New South Wales. Port Stephens, 32° 41' 35" S, 152° 3' 9" E, Apr 2009, 1, AM W41581; Big Swan Bay South, 32° 43' 22" S, 151° 58' 1" E, Apr 2009, 1, AM W41548, 1, AM W41550, 1, AM W41552, 7, AM W41553; N of Soldiers Point, 32° 41' 22" S, 152° 3' 32" E, Apr 2009, Oct 2011, 1, AM W41547; Lemon Tree Passage, 32° 44' 30" S, 152° 2' E, Apr 2009, 1, AM W41551, 1, AM W41549 (parapodia 4, 8, 20, 35 mounted for SEM). Hawkesbury River, 1 km S of eastern end of Spectacle Island, 33° 32' S, 151° 7' 30" E, May 1984, 2, AM W41566, Aug 1984, 2, AM W41567; 300 m NE of Green Point, 33° 34' S, 151° 13' 30" E, Aug 1979, 1, AM W41562, May 1982, Aug 1972, 2, AM W41568, May 1983, 1, AM W41569, Nov 1983, 1, AM W41570; 50 m NE of Green Point, 33° 34'S, 151° 13' 30" E, Aug 1983, 1, AM W41563, 1, AM W24728, Nov 1983, 1, AM W41564, May 1984, 1, AM W41572, 1, AM W41573; near Juno Head, 33° 34' S, 151° 16' E, Feb 1984, 1, AM W41571; near Hungry Beach, 33° 35' S, 151° 17' E, May 1983, 1, AM W41565; 200 m S of eastern end of Spectacle Island, 33° 32' S, 151° 12' 30" E, May 1984, 2, AM W41561. Pittwater, W of Sand Point, 33° 35' 51" S, 151° 18' 25" E, Sep 2004, 1, AM W41555, 3, AM W41558, 1, AM W41559, Dec 2004, 1, AM W41560; Pittwater, 33° 35' 56" S, 151° 18' 38" E, Apr 1994, 1, AM W23958; Pittwater, 33° 35' 50" S, 151° 18' 39" E, Apr 1994, 1, AM W23959; Pittwater, 33° 35' 57" S, 151° 18' 43" E, May 1994, 1, AM W23960; 33° 35' 50" S, 151° 18' 39" E, Apr 1994, 1, AM W23959; Pittwater, 33° 35' 51" S, 151° 18' 21" E, Jun 1994, 2, AM W23961; 33° 35' 55" S, 151° 18' 40" E, Oct 1994, 1, AM W23963; 33° 35' 50" S, 151° 18' 43" E, Oct 1994, 1, AM W23962; Pittwater, west of Sand Point, 33° 35' 48" S, 151° 18' 39" E, Dec 2004, 1, AM W32539; 33° 35' 51" S , 151° 18' 38" E, May 1995, 2, AM W23965; 33° 35' 52" S, 151° 18' 37" E, Jan 1995, 1, AM W23964; Pittwater, W of Sand Point, 33° 35' 49" S, 151° 18' 50" E, Sep 2004,

1, AM W41557. Botany Bay, E of end of airport runway, 33° 58' 21" S, 151° 12' 1" E, Dec 2004, 2, AM W41556.

Description. Holotype entire, 48 chaetigers, pharynx not everted (examined by dissection of paratype material); length 18 mm, maximum width 2 mm. Paratype material ranges from 13–22 mm in length, 1.5–2.5 mm width with 30–50 chaetigers. Body robust, rectangular in cross-section, preserved animal without pigmentation, chaetae golden-coloured with orange-coloured bases, eyespots absent.

Prostomium approximately square and slightly convex anteriorly (Fig. 1a, b) with one pair of simple short antennae and one pair of palps, all similar in length and conical in shape basally (Fig. 1c). Nuchal organs round, situated dorsolaterally at margin of prostomium adjacent to chaetiger 1 (Fig. 1a). Pharynx (based on paratypes) divided into muscular terminal region with 18 bifid terminal papillae, and subterminal region with 22 longitudinal rows each with 7–9 papillae which commence just below terminal papillae. Single elongate median dorsal papilla present, up to 4 times longer than other subterminal papillae. Base of pharynx smooth without verrucae (Fig. 1b). Jaws paired and brown in colour. Parapodia biramous with noto- and neuropodia widely divergent (Fig. 2b, c). Preacicular and postacicular lobes low and not foliaceous, absent posteriorly. Parapodia of 1st chaetiger projecting anteriorly, adjacent to prostomium (Fig. 1a). Chaetiger 1 notopodia with conical acicular lobe and short rectangular postacicular lobe, dorsal cirrus visible on posterior face as small sphaerical papilla; neuropodia with conical acicular lobe, low rectangular postacicular lobe and small digitiform ventral cirrus. Aciculae on all chaetigers thick, colourless except for tips which are strongly chitinised, dark reddish brown, and knob shaped with straight tips, conspicuous on anterior chaetigers (see Fig. 1c, on paratype AM W41509). Chaetiger 4 notopodia with pointed conical acicular lobe longer than rounded postacicular lobe, notopodial cirrus small, pyriform, neuropodia with pointed conical acicular lobe, rectangular postacicular lobe and small digitiform ventral cirrus (see Figs 1c, 3a of paratypes AM W41509, AM W43573). Chaetiger 8 notopodia with pointed conical acicular lobe, and shorter rectangular pre- and postacicular lobes of similar size, small dorsal pyriform cirrus; neuropodia with pointed conical acicular lobe and shorter rectangular pre- and postacicular lobes and small digitiform ventral cirrus (see Figs 1c, 2a, 3b, from paratype AM W43573). Chaetiger 21 notopodia with elongate pointed conical acicular lobe, and low rounded pre- and postacicular lobes, small

conical dorsal cirrus, neuropodia with pointed conical acicular and postacicular lobes, former slightly longer, small digitiform ventral cirrus (Fig. 2b, AM W41581 shown). Chaetiger 40 notopodia with elongate pointed acicular lobe and rounded short postacicular lobe, small globular dorsal cirrus, neuropodia with elongate pointed acicular lobe and short postacicular, with small conical ventral cirrus (Figs 2c, 3d from paratypes AM W41509, AM W43573). Dorsal cirri small and spherical on postbranchial chaetigers, ventral cirri also reduced and digitiform. Two types of chaetae present: barred chaetae present in preacicular notopodial fascicle and neuropodial fascicle of anterior chaetigers only (Table 1), (Fig 5a) absent from mid and posterior chaetigers (Table 1); broad-bladed asymmetrical capillaries with finely serrated margins tapering to fine tips (Fig. 5c) present throughout body (Fig. 5b-e, Table 1). Bases of all chaetae heavily chitinised. Lyrate and spinose chaetae absent. Fifteen pairs of branchiae present on chaetigers 8–22, increasing in size up to chaetiger 20, foliaceous with ciliated margins and occupying from $\frac{1}{3}$ – $\frac{1}{2}$ of the interramal space, mostly straight, then last 2 pairs of branchiae smaller (Figs 2a-b, 4a-c, paratype AM W41732). Up to 10 raised ciliated patches also present on branchial and postbranchial chaetigers (Fig. 4a, d).

Variation. Paratypes possess branchiae from chaetiger 7–8 through to chaetiger 22 (15–16 pairs). One of the more posterior branchiae (C20) on several paratypes is somewhat involute, and a few non-type specimens also exhibit a few curved branchiae (e.g. AM W41549). Large non-type specimens may also possess more branchial pairs, from chaetiger 8 through to chaetiger 24–27, i.e. 17–20 pairs (e.g. AM W23962, with 19 pairs, body 26 mm in length, 3 mm max. width, 51 chaetigers). Some of these larger specimens also have different numbers of branchiae on each side of the body e.g. AM W23959 has 14 pairs on one side and 20 pairs on the other. Other non-paratype material of much smaller body size (AM W41553, 7 specimens of 5–12 mm length, for complete specimens of 25–37 segments) display branchiae that range from chaetigers 7–8 through to chaetigers 16–17 (10–11 pairs), and which extend into $\frac{1}{2}$ – $\frac{2}{3}$ of the interramal space. In summary, specimens of this species thus exhibit 10–20 pairs of (mostly) straight foliaceous branchiae, starting from chaetigers 7–8, and the number of pairs increases with the size (age) of the specimen. The subdermal eyes within the body at the level of chaetiger 2 of small specimens (less than 13 mm in length) are also much more prominent and may be seen without manipulation of the specimen.

Remarks. We were initially unsure with which genus this species is aligned — *Micronephthys* or *Nephtys*, or *Aglaophamus*. These three genera are difficult to distinguish if specimens possess the shared generic characters such as simple palps and antennae, round nuchal organs, 22 rows of subterminal pharyngeal papillae, conical or pointed acicular lobes, the absence of lyrata chaetae, the presence of barred preacicular chaetae, finely spinulated postacicular chaetae, and presence of branchiae. According to Dnestrovskaya and Jirkov (2010), the genus *Micronephthys* can only be characterised by a reduction in branchial size and a reduced number of segments, features which are often possessed by juveniles of the other two genera. As most of our specimens are mature adults, we are confident that the poor development of parapodial lobes or lamellae and the low number of segments are characteristic enough features to place the specimens within *Micronephthys*; however the branchiae are not quite “poorly developed”, or always straight, as, on some of our specimens, they may occupy almost $\frac{2}{3}$ of the interramal gap, a few may be somewhat involute, and are of a similar size to those possessed by some small specimens of *Nephtys* spp, that we have observed. But based on current diagnoses of the three genera we are conservatively placing this new species in *Micronephthys*.

Micronephthys derupeli n.sp., is characterised by having 10–20 pairs of branchiae starting on chaetiger 7–8, pharynx with an elongated middorsal subterminal papilla, verrucae absent, barred chaetae present on chaetigers 1–9, serrated capillary chaetae present in all other chaetigers, and lyrata chaetae absent. This combination of characters distinguishes this species from all other twelve species of *Micronephthys*. Of the other species, the majority lack branchiae completely (Table 3). Rainer and Hutchings (1977) recorded *M. sphaerocirrata* (Wesenberg-Lund, 1949) from Queensland, however Ravara *et al.* (2010b) cast some doubt on this identification but did not examine this material. Given that this species was originally described from the Gulf of Iran we have listed it as *M. cf. sphaerocirrata* in the key, but it lacks branchiae and therefore cannot be confused with *M. derupeli* n.sp.

Of the four other species which possess branchiae, *M. hartmannschroederiae* Jirkov and Dnestrovskaya in Jirkov, 2001 has branchiae from chaetigers 5–6 continuing to chaetiger 19 and possesses four types of chaetae; *M. maryae* (San

Martin, 1982) has poorly developed branchiae although this has been synonymised with *M. stammeri* (Augener, 1932) *vide* Ravara *et al.* (2010b), which has no branchiae, and possesses lyrate chaetae; *M. minuta* (Théel, 1879) has 10 pairs branchiae from chaetiger 6 continuing to 13–16 (as reported for syntypes by Ravara *et al.*, 2010b, p. 25) as well as three types of chaetae; and *M. neotena* (Noyes, 1980) has fewer pairs of branchiae from chaetiger 5–7 continuing to chaetiger 12–18, as well as possessing three types of chaetae. These characters distinguish them all from *M. derupeli* n.sp, which has branchiae from chaetigers 7–8, continuing to chaetigers 17–27, as well as only two types of chaetae. For this reason this species is described as new.

Etymology. The new species is named from a combination of initials of close family members of the first author; Dean Bridges, Ruth Dixon, Peter Dixon and Lisa Dixon.

Habitat. Specimens were found in sites containing mud, muddy/sand and *Zostera*, in depths from 1.6–3.6 m.

Distribution. Occurs from Port Stephens to Botany Bay, NSW, in shallow protected areas.

Nephtys Cuvier, 1817 (sensu Hartman, 1959)

Nephtys. —Hartman, 1950: 89; 1959: 282. —Ravara *et al.*, 2010b: 30.

Diagnosis. The genus *Nephtys* currently includes species with conical, rounded or bilobed acicular lobes and well developed parapodial lobes. Branchiae recurved. Lyrate chaetae present or absent. Aciculae of median and posterior parapodia with curved tips. Pair of antennae and palps present. Pharynx usually with rows of less than 10 subterminal papillae (usually up to 5–7); long, median dorsal papilla may be present; proximal region smooth or covered with small verrucae. Jaws conical, hook-like. Nuchal organ rounded.

Type species. *Nephtys hombergii* Savigny in Lamarck, 1818.

Comments. A recent phylogenetic study utilising both morphological and molecular techniques has confirmed the monophyly of the genus (Ravara *et al.* 2010a). We have modified the generic diagnosis provided by Ravara *et al.* (2010b), to include the presence or absence of lyrate chaetae.

Nephtys triangula n. sp

Figures 6a-c, 7a-c, 8a-d, 9a-f, 10a-f, Table 2

Material examined. HOLOTYPE: AM W24763 (chaetigers 3, 20, 40, posterior parapodia removed and mounted for SEM), **New South Wales:** Arrawarra Beach, 30° 4' S, 153° 12' E, June 1994, intertidal, just above low water mark. PARATYPES: Arrawarra Beach, 30° 4' S, 153° 12' E, Jan 1994, 1, AM W24719; Sawtell Headland, 30° 22' 32" S, 153° 6' E, May 2005, 1 AM W41471. **Queensland:** Gold Coast, beach at Tugun, 28° 08' 36" S, 153° 29' 50" E, May 2008, USNM 1220303, 2, BMNH 2013.438-439, AM W36903, AM W36905 (parapodia 3, 20, 40, 80, removed), AM W43573.

Additional material examined. Queensland: Gold Coast, beach at Tugun, 28° 8' 36" S, 153° 29' 50" E, Dec 2007, 1, AM W36903, Oct 2007, 5, AM W36902, 3, AM W36904, May 2008, 5, AM W36905; beach at Currumbin, 28° 7' 43" S, 153° 29' 15" E, May 2008, 3, AM W36900, Oct 2007, 7, AM W36899; beach at Palm Beach, 28° 7' 9" S, 153° 28' 24" E, Oct 2007, 6, AM W36901. **New South Wales:** Sawtell Headland, 30° 22' 32" S, 153° 06' E, May 2005, 1, AM W41471; Angourie Beach, 29° 28' 42" S, 153° 21' 44" E, Feb 2003, 1, AM W33123.

Description: Holotype entire, pharynx everted, length 80 mm for 148 chaetigers (not including pharynx), maximum width at 6th chaetiger 5 mm, excluding chaetae. Paratype material ranges from 5–45 mm length, 9–15 mm wide, and 46–126 chaetigers. Body without pigmentation. Prostomium pentagonal with anterior triangular extension (Fig. 6a) and distinct brown pigmentation (Fig. 6a-c). One pair of antennae and one pair of palps present. Antennae at distal end of anterior extension of prostomium uniform in width, palps slightly longer with bulbous bases inserted at the basal lateral margins of prostomium. Eyespots absent. Body compact with conical parapodia which become more erect posteriorly as body width decreases. Pharynx with 12 pairs of bifid terminal papillae, 22 longitudinal rows of subterminal papillae; each with 7-9. Distinct gap between terminal and longitudinal rows (Fig. 6b). Median dorsal papilla absent, slightly raised verrucae present proximally (Fig. 6c). Parapodia biramous with long flowing chaetae which become progressively longer posteriorly (Figs 7a-c, 8a-d, 9e, f) exceeding body width. Chaetiger 3 (AM W43573, Figs 8a, 9a, b) notopodia with elongate digitate postacicular lobe, and small rounded acicular and preacicular lobes; dorsal cirrus

elongate (Fig. 7b). Neuropodia with two rounded conical preacicular and acicular lobes, divergent, postacicular lobe slightly longer, small ventral digitiform cirrus. Chaetiger 20 (AM W43573, Figs 8b, 9c): notopodia with elongate postacicular digitiform lobe, acicular lobe rounded, shorter preacicular lobes; neuropodia with two equal-sized pre and postacicular lobes divergent, smaller acicular lobe, with well developed ventral cirrus (Fig. 9c). Chaetiger 40 (AM W36905, Figs 8c, 9d, e): notopodia with elongate digitiform postacicular lobe and rounded acicular and preacicular lobes, small digitiform dorsal cirrus; neuropodia with two conical pre and post acicular lobes and small acicular lobe, well developed ventral cirrus. Chaetiger 70 and posterior chaetigers (AM W24763 Figs 8d, 9f): notopodia with elongate preacicular digitiform lobe smaller in length than anterior ones, rounded acicular lobe, expanded postacicular lobe; neuropodia with two divergent conical pre and post acicular lobes with rounded margins, smaller in size than anterior ones, small acicular lobe, small digitiform ventral cirrus. Three types of chaetae are present, barred chaetae (Fig. 10c), broad bladed capillaries with serrated margins and with longitudinal striations along blades which may be twisted (Fig. 15b) and broad bladed spinose (Fig. 10d, e, f). Chaetal counts along the body are provided in Table 2 but are approximate as capillaries very long and twisted especially in posterior chaetigers (see Fig. 9c-f). Lyrate chaetae absent. Aciculae colourless with rounded tips in anterior chaetigers, becoming darker in posterior ones.

Branchiae present from chaetiger 3 and continue to posterior end, curved outwardly with dorsal lobe (Figs 7a, c, 9a-f, 8a-b, f) increase in size and by chaetiger 40 (Fig. 9d) occupied two thirds of the interramal space, decreasing in size posteriorly, small dorsal ligule present (Fig. 9a). Dorsal ciliated patches visible on some mid body chaetigers (Fig. 9d). Single long pygidial cirrus present as long as last 5 chaetigers.

Remarks: *Nephtys triangula* n. sp., is characterised by the distinctive triangular prostomium and pigmentation, branchiae beginning on chaetiger 3 and continuing posteriorly, and long flowing chaetae. This combination of characters allows it to be easily distinguished from all other species known from the region (See Table 4). The only other species with branchiae beginning on chaetiger 3 is *N. gravieri* Augener, 1913, but this species lacks the triangular prostomium and both the antennae and palps are inserted on the dorsoectal margins whereas in *N. triangula* n.sp., the palps are inserted basally on the prostomium. *Nephtys longipes*

Stimpson, 1856, which has a similar pattern of branchial distribution and long flowing chaetae similar to *N. triangula* n. sp, also appears to have an expanded prostomium, however in this species it consists of an oval prostomium, with a thin preantennal lobe which is a triangular translucent lobe, marked by an intricate pattern of slightly thicker tissue (see Fig. 6.8 in Paxton 1974); whereas in *N. triangula* n. sp., it is the entire prostomium which is extended. Also in *N. longipes* the antennae are situated at the base of the preantennal lobe whereas in *N. triangula* n. sp., they are on the anterior margins of the prostomium (Fig. 6a, c). Ecologically these two species differ in that *N. triangula* n. sp., is found on more exposed oceanic beaches whereas *N. longipes* is found in slightly more protected areas, although both are intertidal species occurring in clean sandy sediments.

Etymology: The new species *N. triangula* was named in reference to its distinctive triangular prostomium (Fig. 6a).

Habitat: Intertidally on exposed sandy beaches.

Distribution: Occurs along the east coast of Australia from southern Queensland to northern New South Wales.

***Aglaophamus* Kinberg, 1866 (sensu Hartman, 1950)**

Aglaophamus.—Fauchald, 1977: 97.—Rainer and Kaly, 1988: 686.—Ravara *et al.*, 2010a: 402.—Ravara *et al.*, 2010b: 7.

Type species. *Aglaophamus lyratus* Kinberg 1866, by monotypy.

Diagnosis. Branchiae involute or recurved. Lyrate chaetae present or absent. Barred chaetae present. Acicular lobes acutely pointed, aciculae curved at tip. Antennae and palps present. Pharynx with variable number of subterminal papillae in 14–22 longitudinal rows, proximal region of pharynx smooth.

***Aglaophamus australiensis* (Fauchald, 1965)**

Nephtys australiensis Fauchald, 1965: 334–335, figs 6.1–2.—Hutchings, 1974: 180.—Hutchings and Recher, 1974: 105, 108.

Nephtys gravieri.—Augener, 1927: 116.—Rullier, 1965: 18 (*non* Augener, 1913).

Aglaophamus australiensis.—Ravara *et al.*, 2010a: 401–402.

Remarks: Ravara *et al.* (2010a) undertook a phylogenetic analysis of the family Nephtyidae using both morphological and molecular data. They found that *Nephtys australiensis* was embedded within *Aglaophamus* and formally transferred this species to *Aglaophamus*. The branchiae in *A. australiensis* are poorly developed but slightly recurved which explains why Fauchald (1965) originally described this species, common in estuarine and shallow protected bays in eastern Australia, as belonging to the genus *Nephtys*. The shape of branchiae and their development has until Ravara *et al.* (2010a) been the main character used to separate genera; involute (*Aglaophamus*, *Inermonephtys*), recurved (*Nephtys*, *Dentinephtys*) or absent or poorly developed (*Micronephtys*), although other characters have also been used. The inclusion of *N. australiensis* in the *Aglaophamus* clade indicates the homoplasy in the shape and development of branchiae. They found the only morphological apomorphies for the genus *Aglaophamus* were acutely pointed acicular lobes and finely spinulated postacicular chaetae although Dnestrovskaya and Jirkov (2011) have recorded the presence of spinose chaetae (same as spinulated of Ravara *et al.* 2010a) in *A. malmgreni* (Théel, 1879) so this apomorphy needs to be revisited and

shows the need to examine nephtyid chaetae under the SEM to clarify the ornamentation of the capillary blades. Ravara *et al.* (2010a) also suggest that other characters such as the presence or absence of lyrate chaetae, arrangement of papillae on the pharynx and shape of nuchal organs should also be taken into account. Ravara *et al.* (2010a) also provides a table of the diagnostic characters for the five genera which they accept as valid for the family.

We have included notes on this new placement of *A. australiensis* (Fauchald, 1965) as this study provides a key to all species of Australian nephtyids, and we suggest that the transfer in Ravara *et al.*'s (2010a) is somewhat hidden within a phylogenetic revision of this family.

This species is widespread in estuarine sites in eastern Australia, which are fully marine except after heavy rain (see comments in Hutchings 1999). While *N. longipes* may occur in the same estuary this species occurs closer to the seaward entrance than *A. australiensis*.

Discussion

Four known genera of nephtyids are represented in Australian waters by 17 species (Rainer and Kaly 1988 plus the two new species described in this paper) with seven of these species belonging to *Nephtys*. It is most likely these numbers will increase and additional records will be found in areas of Australia where almost no collection has occurred. These include areas such as north-western Australia and offshore around the coast of Australia (Rainer and Hutchings 1977). One of the species described here were found in the Port Stephens—Great Lakes Marine Park, NSW which was declared on the 1st December 2005 because of its diverse marine life (Breen *et al.* 2004) and the other one *Nephtys triangula* n. sp., occurs in northern New South Wales and southern Queensland.

The nephtyid fauna has a strong degree of endemism, with only one species of Australian *Nephtys* recorded from outside Australia; *N. paradoxa* Malm, which appears cosmopolitan in its distribution, and two species of *Micronephthys*: *M. sphaerocirrata* (Wesenberg-Lund, 1949) which has been recorded from the Gulf of Iran and S. Africa and also the ambiguity regarding the presence of *M. stammeri* (Augener, 1932) in Australian waters, although it seems likely that the material identified by Rainer and Kaly (1988) as *M. maryae* (which has been synonymised with *M. stammeri* by Ravara *et al.* 2010b) from North West Australia represents another undescribed species. This can only be resolved with additional material being collected. The true identity of *M. sphaerocirrata* recorded from Queensland also needs to be verified. The majority of Australian records of nephtyids are from intertidal or shallow subtidal areas. *Nephtys longipes* and *N. inornata* live in sheltered but fully marine environments, *N. longipes* in clean sand and *N. inornata* in sandy mud; both species occur in intertidal and shallow subtidal areas. Both of these species were also present within Port Stephens, NSW, Australia. *Micronephthys derupeli* n.sp., was found in mud, muddy/sand and *Zostera* habitats of Port Stephens and the Hawkesbury River. It is suggested that with additional sampling in shallow protected habitats along the east coast of Australia, the distribution of this species will be extended. *Nephtys triangula* n.sp., has only been recorded from exposed sandy beaches. Several of the above species co-occur and therefore careful examination of material from intertidal estuarine and sandy beaches is required to

accurately identify species. We have included tables listing the major characteristics of all species of *Micronephthys* and species of *Nephtys* occurring in Australia and the Indo-Pacific to facilitate the identification of the Australian fauna as we suspect that more undescribed species occur in Australian waters especially in deeper water and in northern Australia. However it is worth noting that both the new species were collected from New South Wales where extensive collecting has occurred (Rainer and Hutchings 1977).

In Tables 4 and 5 we have used the data provided in the original description but in many cases we have supplemented the information by using additional references and figures which are listed in the tables. We have only provided the original type locality, rather than the entire reported range for the species as this would have required us to check all these other records which was not feasible in this study. We suspect that in some cases the reported range extensions may not be valid. We accept that nephtyids have one pair of antennae and one pair of palps (Ravara *et al.* 2010a) so in descriptions which state two pairs of antennae we have accepted that the first pair are antennae and the more basal pair are palps.

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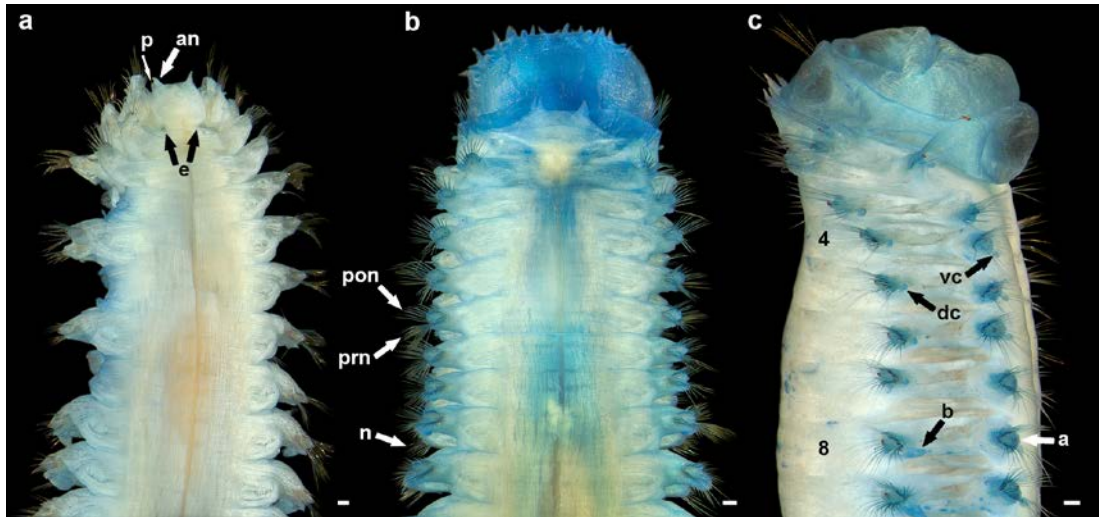


FIGURE 1. *Micronephthys derupeli* n. sp. a. anterior dorsal view (paratype AM W43573), b. anterior dorsal view with pharynx partially everted (AM W41581), c. lateral anterior view (paratype AM W41509). All scale bars 0.1 mm. a=aciculum, an=antenna, b= branchia, e=nuchal organs, dc =dorsal cirrus, n= neurochaetae, p=palp, pon=postacicular notochaetae, prn= preacicular notochaetae, vc=ventral cirrus.

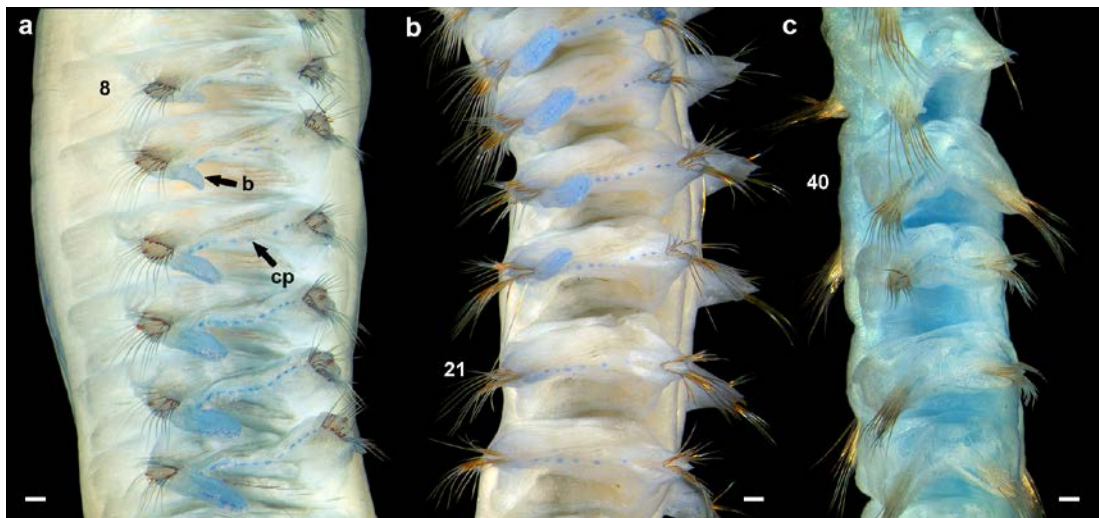


FIGURE 2. *Micronephthys derupeli* n. sp. a. lateral view of anterior chaetigers (paratype AM W43573), b. mid chaetigers (AM W41581), c. posterior chaetigers (paratype AM W41509). b=branchia, cp=ciliated patches. All scale bars 0.1 mm.

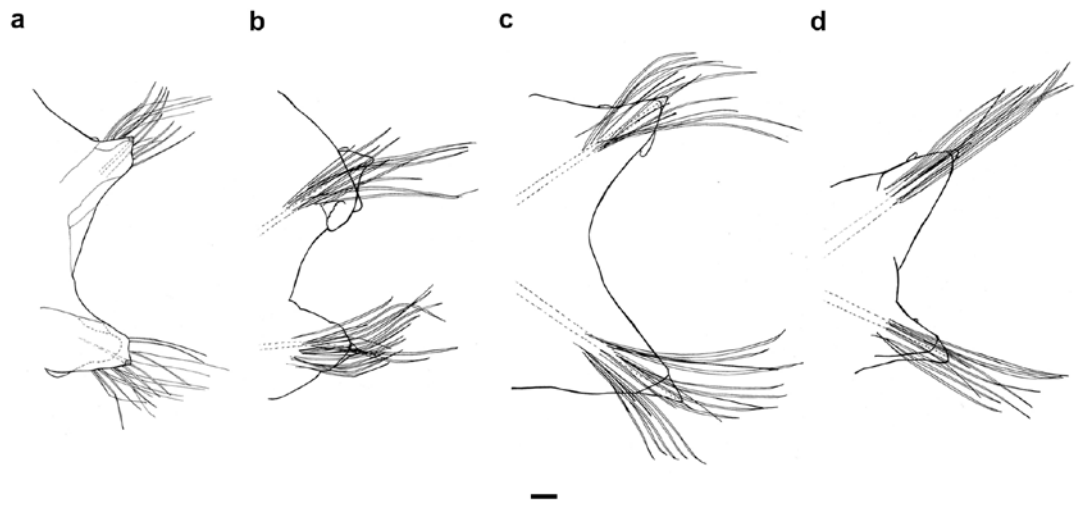


FIGURE 3. *Micronephthys derupeli* n. sp. Line drawings of parapodia (anteroposterior view). a. chaetiger 4, b. chaetiger 8, c. chaetiger 23 d. chaetiger 40 (all from paratype AM W43573). All scale bars 0.1 mm.

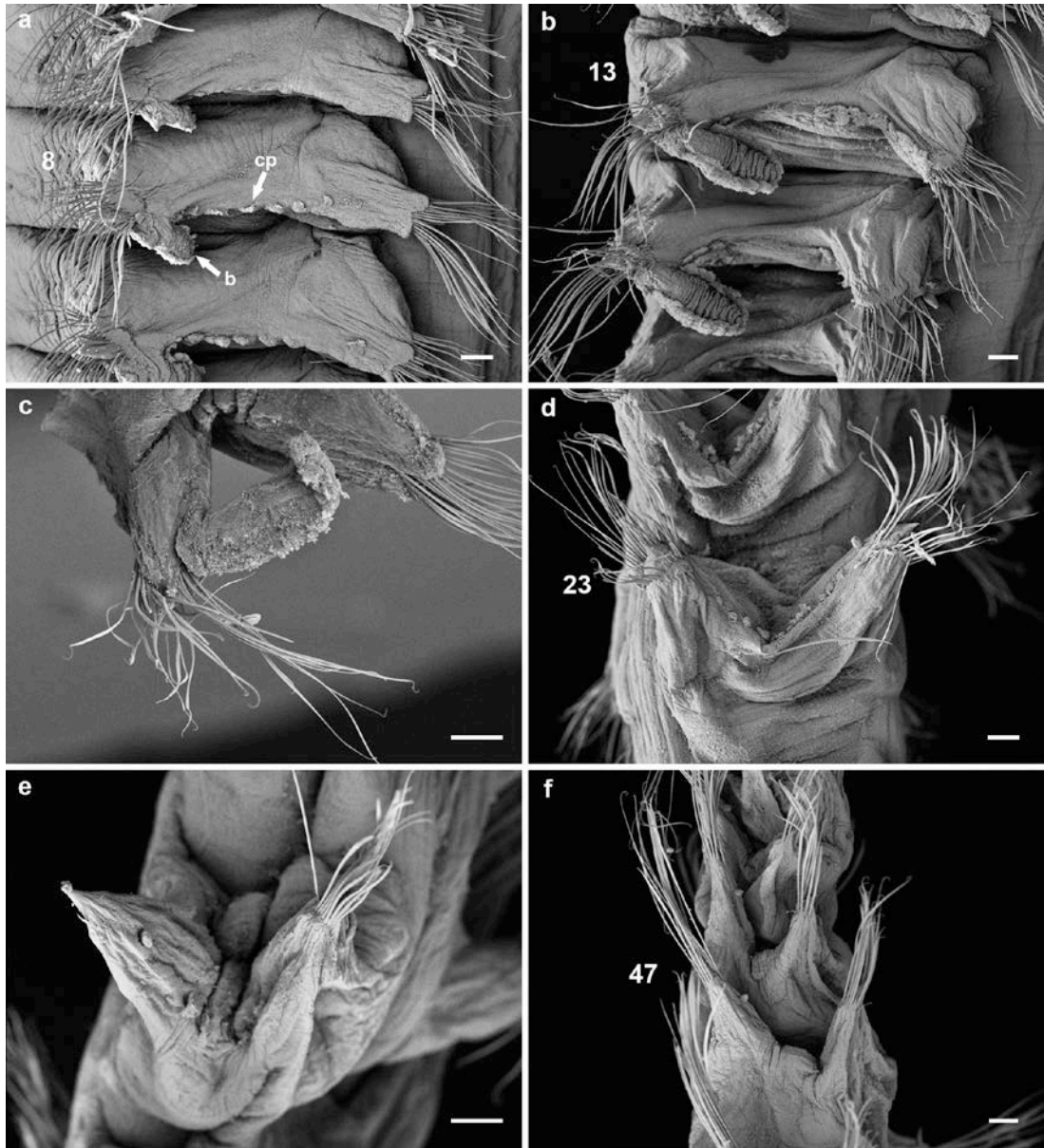


FIGURE 4. *Micronephthys derupeli* n. sp. SEM a. chaetiger 8, b. chaetiger 13, c. chaetiger 20, d. chaetiger 23, e. chaetiger 43, f. chaetiger 47. b=branchia, cp=ciliated patches. (paratype AM W41732). All scale bars 0.1 mm.

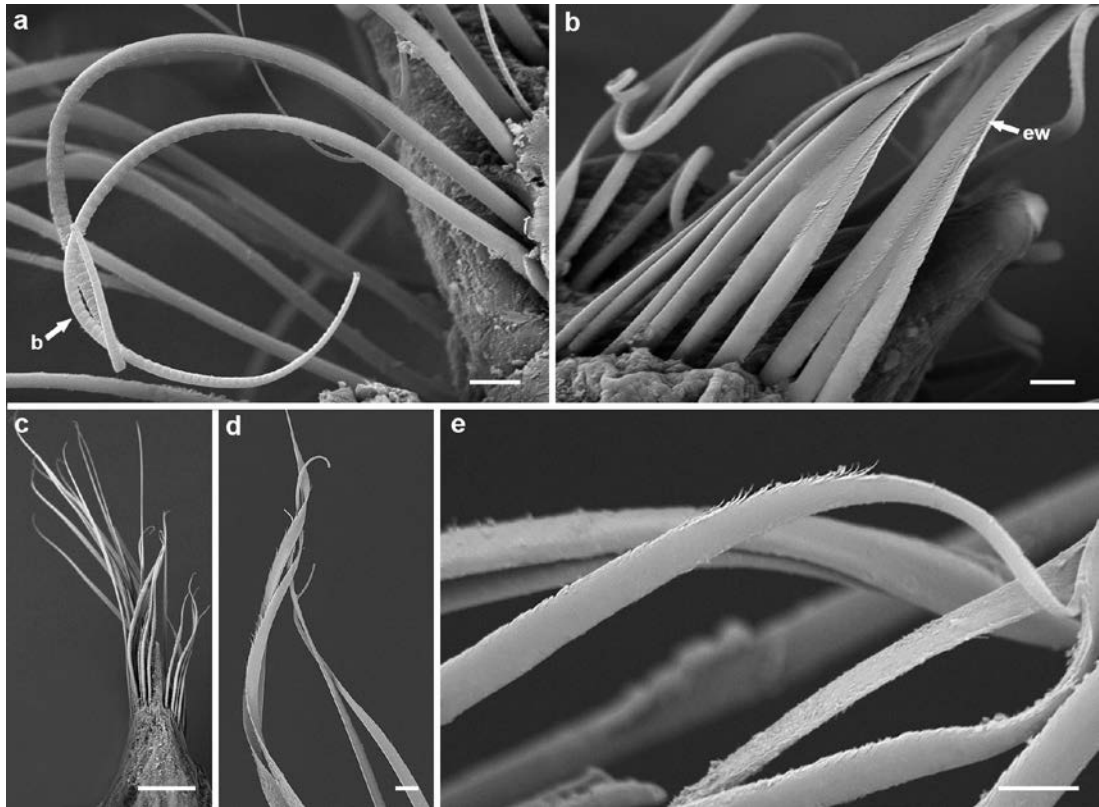


FIGURE 5. *Micronephthys derupeli* n. sp. a. barred chaeta from chaetiger 6, b. broad bladed serrated capillary from chaetiger 8, c. chaetiger 20, d. broad bladed serrated from chaetiger 35, e. close up of broad bladed serrated from chaetiger 20. b=barred chaeta, ew= broad bladed serrated. Scale bars a,b,d,e 10 μm , c=100 μm . All from AM W41549.

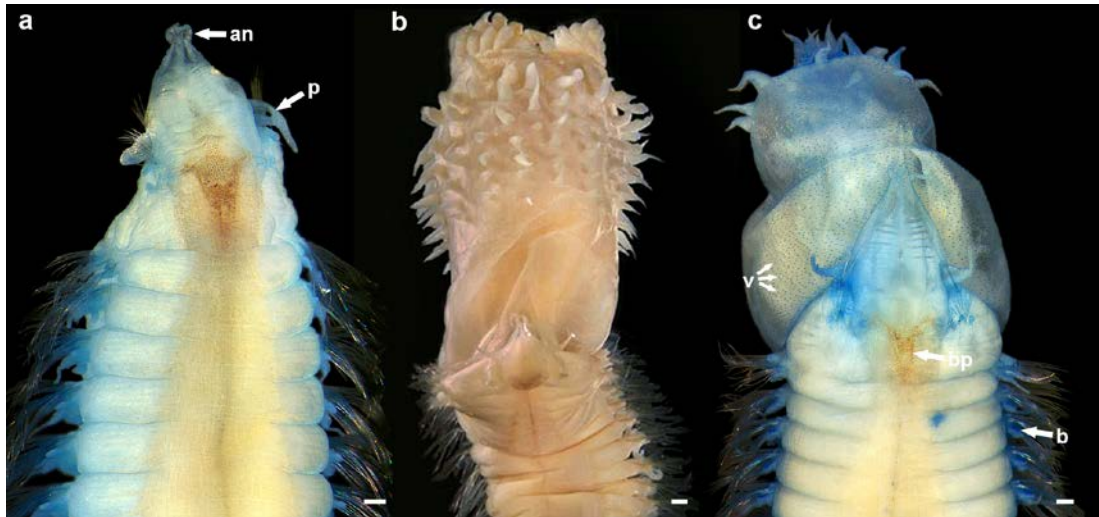


FIGURE 6. *Nephtys triangula* n. sp. a. anterior view of prostomium (AM W36899), b. with completely everted pharynx (AM W24763), c. partially everted pharynx (AM W41471). an= antenna, p=palp, v=verrucae, b= branchia, bp= brown pigment. All scale bars 0.1 mm.

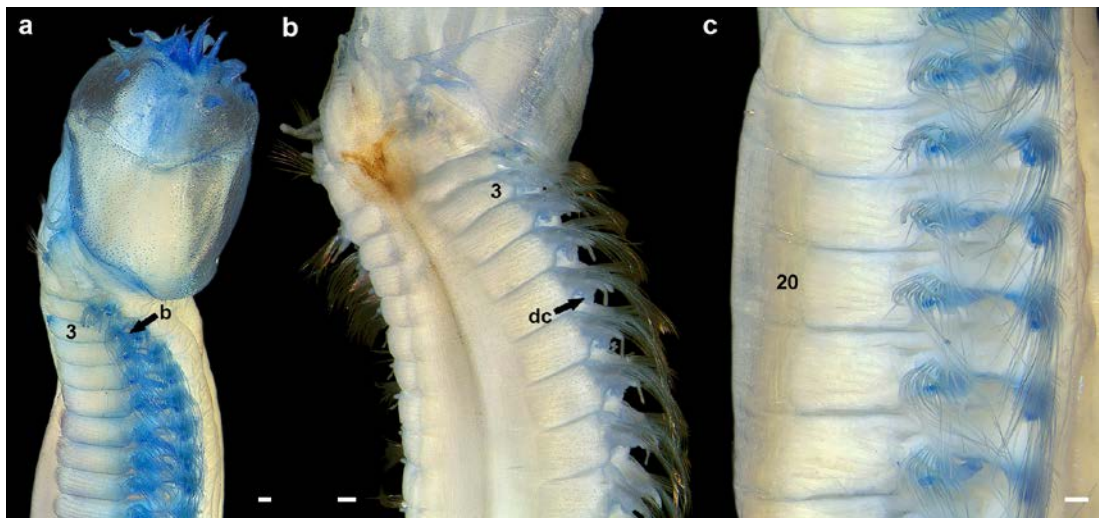


FIGURE 7. *Nephtys triangula* n.sp. a: lateral view of anterior end (AM W41471b, close up of anterior chaetigers (AM W36902), c. mid chaetigers (AM W41471). b= first branchia, dc= dorsal cirrus, numbers refer to chaetiger. Scale bars 0.1 mm.

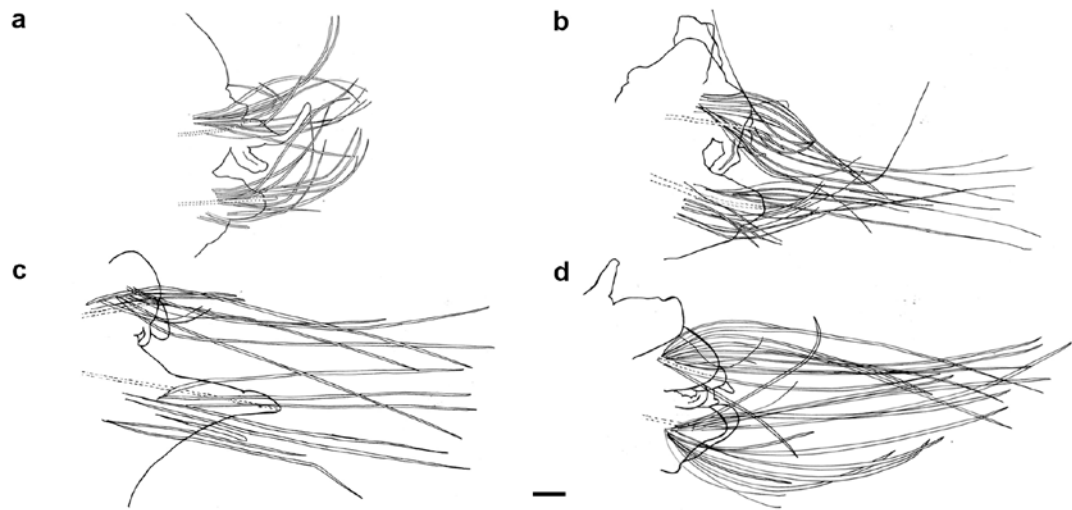


FIGURE 8. *Nephtys triangula* n. sp. Line drawings of parapodia (anteroposterior view) (AM W43573), a. chaetiger 3, b. chaetiger 20, c. chaetiger 40, d. chaetiger 70. Scale bar 0.1 mm.

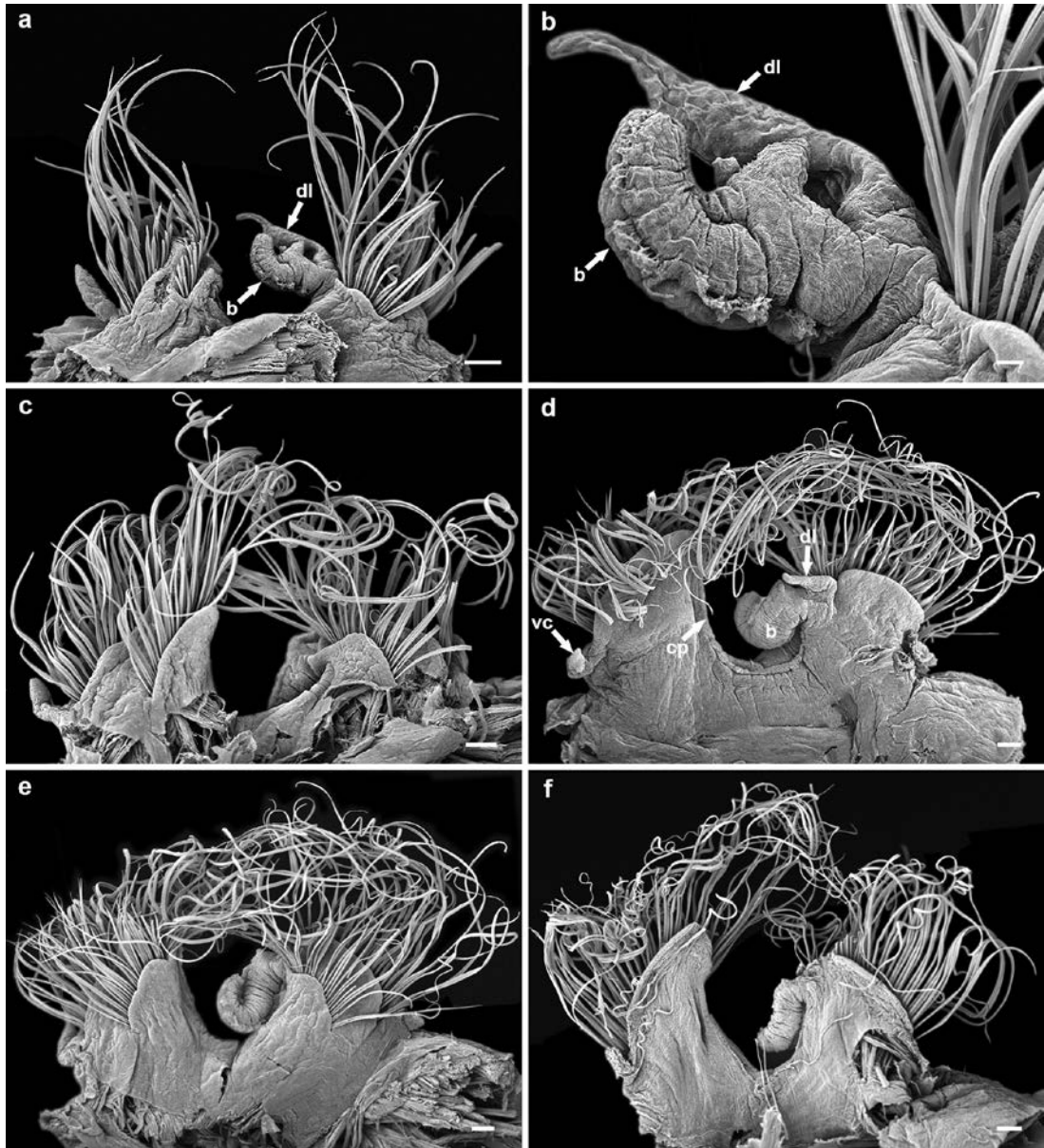


FIGURE 9. *Nephtys triangula* n. sp. (AM W24763) SEM a: chaetiger 3, b. close up of branchia of chaetiger 3 with dorsal ligule, c. chaetiger 20, d. chaetiger 40 showing fully developed branchia, posterior lateral view, e. chaetiger 40, anterior lateral view, f, posterior chaetiger. b=branchia, cp=ciliated patches, dl= dorsal ligule, vc=ventral cirrus. Scale bars 0.1mm except b= 20 μ m.

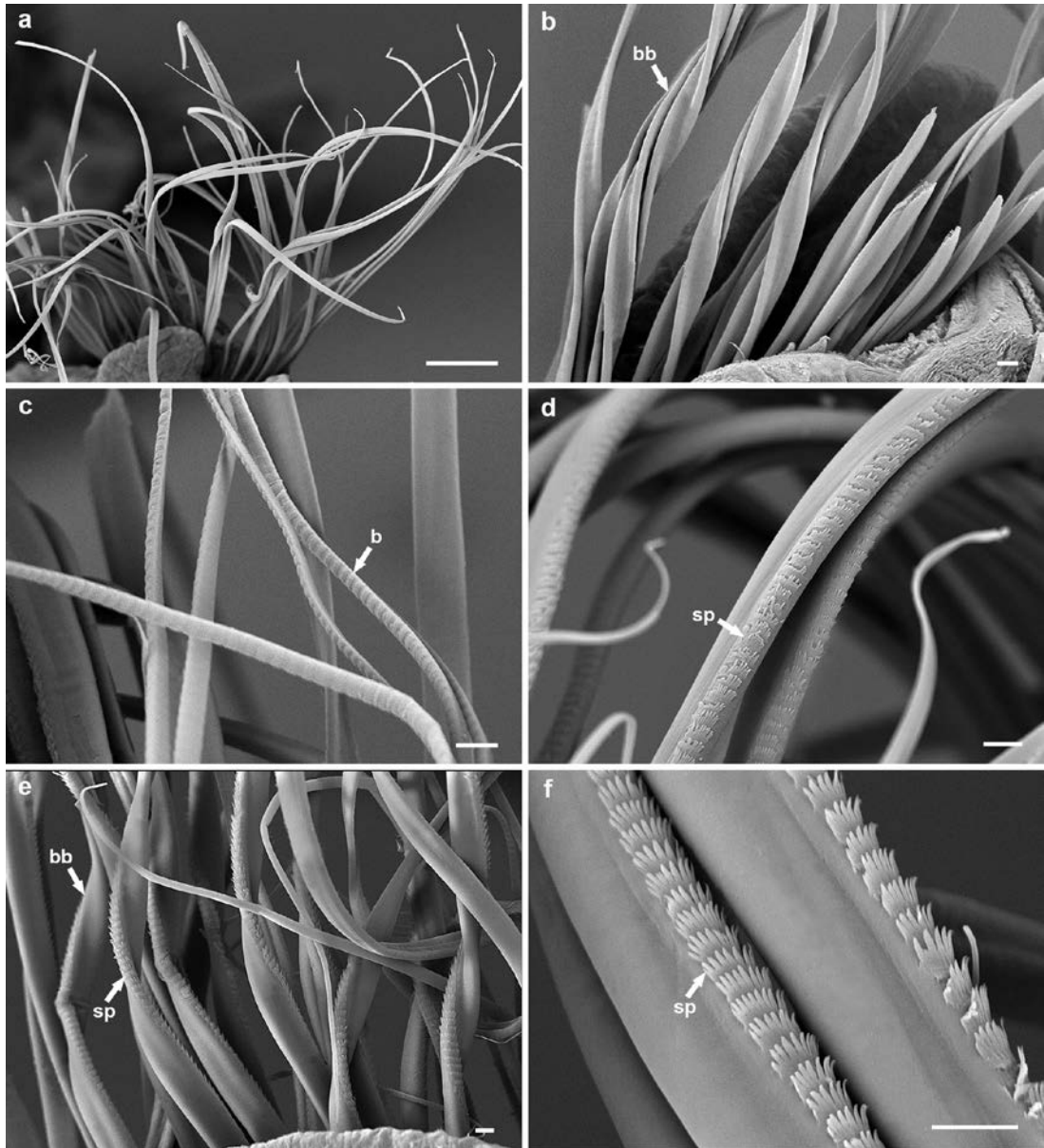


FIGURE 10. *Nephtys triangula* n. sp. (AM W24763) SEM a. chaetiger 3 showing broad bladed serrated capillaries, b. close up of same, c. barred chaetae of chaetiger 3, d. broad bladed spinose of chaetiger 20, e. broad bladed spinose and serrated from chaetiger 40, f. close up of broad bladed spinose from posterior chaetiger. bb=broad bladed serrated, b= barred, sp= broad bladed serrated, sp broad bladed spinose. Scale bars 10 μm except for a =100 μm .

Table 1. Chaetal counts for *Micronephthys derupeli* n.sp.

Chaetiger 4	Noto	Pre-acicular	15 barred
		Post-acicular	9 broad bladed serrated
	Neuro	Pre-acicular	12 barred, 12 broad bladed serrated
Chaetiger 8	Noto	Pre-acicular	4 barred
		Post-acicular	7 broad bladed serrated
	Neuro	Pre-acicular	9 barred, 20 broad bladed serrated
Chaetiger 21	Noto	Pre-acicular	20 broad bladed serrated
		Post-acicular	9 broad bladed serrated
	Neuro	Pre-acicular	14 broad bladed serrated
Chaetiger 40	Noto	Pre-acicular	14 broad bladed serrated
		Post-acicular	8 broad bladed serrated
	Neuro	Pre-acicular	12 broad bladed serrated

Table 2. Chaetal counts for *Nephtys triangula* n.sp. (posterior chaetiger, chaetal counts all approximate given the long coiled nature of chaetae- see Fig. 14d-f, also distinguishing between serrated and spinose under light microscopy difficult, but obvious under SEM- Fig. 15b, e, f))

Chaetiger 3	Noto	Pre-acicular	8 barred
		Post-acicular	9 broad bladed serrated,
	Neuro	Pre-acicular	10 broad bladed serrated
		Post-acicular	4 barred, 6 broad bladed serrated
Chaetiger 20	Noto	Pre-acicular	12 barred, 5 broad bladed serrated
		Post-acicular	15 short barred, 10 broad bladed serrated
	Neuro	Pre-acicular	20 barred, 5 broad bladed spinose
		Post-acicular	10 broad bladed

			spinose
Chaetiger 40	Noto	Pre- acicular	15 barred
		Post- acicular	16 broad bladed spinose
	Neuro	Pre- acicular	20 barred
		Post- acicular	20 broad bladed spinose, 5 serrated
Chaetiger 70	Noto	Pre- acicular	8 short barred
		Post- acicular	18 broad bladed spinose, 8 serrated
	Neuro	Pre- acicular	8 short barred
		Post -acicular	12 broad bladed serrated

Table 3: All accepted world species of the genus *Micronephthys* (following Ravara et al 2010b)

Species	Type locality	Data source	Body length, body width (max) in mm, nos of chaetigers of type material	Body pigmentation, eyespots & position	Prostomium with nos of prs of antennae	Pharynx, nos of prs terminal bifid papillae	Pharyngeal subterminal papillae, nos of rows,	1st chaetiger	Notopodia of well developed chaetigers; presence or absence of branchiae	Neuropodia of well developed chaetigers;	Types of chaetae
<i>M. abbranchiata</i> (Ehlers, 1913)	Antarctic Seas, 385 m	based on original description & Hartman 1964	6, n/a, 28	colourless, absent	almost rectangular. 1 pr on anterior margins, thin, ½ length of prostomium, 1 pr larger palps	10 (original description says simple conical papillae)	20 rows each with 4-5 papillae per row; cone shaped, reducing in size towards base of pharynx	1 st chaetiger not described	lobes rounded, poorly developed decrease in size posteriorly, dorsal cirrus present; branchiae absent	lobes rounded poorly developed decrease in size posteriorly, ventral cirrus present	barred and serrated capillaries present, no further details given
<i>M. ambrizettana</i> (Augener, 1918)	Ambrizette, Angola, West Africa	based on original description, & Day, 1967	6.5, n/a, 42	colourless, 1 pr large brown eyespots behind prostomium	pentagonal broad as long, 1 pr slender antennae, 1 pr of palps both inserted anteriorly	n/a	n/a	ventral cirrus longer than chaetigerous lobe; dorsal cirrus similar,...	noto poorly developed lobes, dorsal cirri absent; branchiae absent	neuro poorly developed lobes, ventral cirri present t;	anterior chaetigers with barred chaetae, middle & posterior chaetigers with long chaetae 3x3 body width, broad bladed with serrated margins

<i>M. derupeli n. sp.</i>	Port Stephens, NSW, Australia, 1.6 – 3.6 m	based on description in this paper	18, 2, 48	colourless, eyespots absent	square and slightly convex anteriorly, pr of antennae & palps inserted anteriorly	9	22 each row with 7 papillae, median papilla & verrucae absent	parapodia projecting anteriorly, lying adjacent to prostomium	noto with conical acicular & postacicular lobes; branchiae from chaetigers 8-22, straight	neuro with conical acicular & postacicular lobes, small conical ventral cirrus	barred chaetae present in preacicular fascicles of chaetigers 1-9, broad-bladed serrated capillaries
<i>M. hartmannschroederæ</i> Jirkov & Dnestrovskaya in Jirkov, 2001	Kieler Bucht, Atlantic	based on original description, & Dnestrovskaya & Jirkov 2010	3, n/a, 33	colourless, eyespots absent	broader anteriorly than posteriorly, 1 pr of antennae & palps near anterolateral corners, conical; posterior margin	10	20 each row with 2 to 5-6 papillae, median dorsal & ventral papilla absent	noto with low conical acicular lobe, neuro 2x as long as noto, acute, conical	parapodial lobes well separated from each other; ventral & notopodial cirri starting from chaetiger 2, similar in size along body; . branchiae occupying 1/4 of interramal space; present from chaetiger 5 or 6 to chaetiger 19		4 types: barred, serrated, spinose & smooth capillaries
<i>M. maryae</i> (San Martin, 1982) accepted as <i>M. stammeri</i>	Sas Caló des Morro, Ibiza, Spain, 4 m	based on original description, & Ravara et al. 2010b, Rainer & Kaly, 1988	7, 0.4, 51	colourless, 2 prs of eyespots on chaetiger 3, almost fused together	quadrangular, longer than wide and fused dorsally with chaetiger 1, 1 pr of thick smooth antenna on anterior margin, 1 pr of basal palps	10	20-22 each row with 8 long papillae; below verrucae present for 2/3 length; proximal region smooth	same size as subsequent ones, directed anteriorly; not- acicular lobes conical others poorly developed; neuro pre & postacicular lobes encircling acicular lobes; dorsal cirrus small, ventral cirriform	noto- poorly developed, with conical acicular lobes, other lobes poorly developed; branchiae absent	neuro poorly developed, with conical acicular lobes, other lobes poorly developed, ventral cirrus subspherical	5 types: barred, capillary, dentate, spinulose & unequal lyrate

								with swollen tips			
<i>M. minuta</i> (Théel, 1879)	Arctic Ocean 72°53'N, 52°53'E, 7-17 m	based on original description, & Dnestrovskaya & Jirkov 2010, Ravara et al. 2010b	14, n/a, 34	colourless, eyespots not seen	subsquare, 1 pr of antennae & palps arising from antero-lateral margins, swollen bases, similar in size, antennae with cirriform tip, palps with small basal papilla	9	18-20 each row with 4-6 papillae, single mid-dorsal papilla, proximal region smooth	anteriorly directed, noto & neuro acicular conical lobes, other lobes poorly developed, dorsal cirrus v. small, ventral well developed cirriform	noto- with conical acicular lobes, pre & post acicular lobes poorly developed, dorsal cirrus small; branchiae straight, ciliated occupying 1/3 of interramal space; from chaetiger 6-8 to 10-14	neuro with conical acicular lobes, pre & post acicular lobes poorly developed, ventral cirrus small.	3 types, barred restricted to 1 st 20 chaetigers in preacicular fascicle, finely spinulated in postacicular fascicle, capillaries present in 1 st chaetiger and preacicular fascicle
<i>M. neotena</i> (Noyes, 1980)	Maine, USA	based on original description, & Ohwada, 1985; Dnestrovskaya & Jirkov 2010,	11, n/a, 33	live – white to pink, 1pr dark red on chaetiger 3	almost rectangular, 1 pr of antennae & palps constricted at base inserted close together on anterior margins	9, radially flattened	20 each row with 1-2 or 6 papillae, mid-dorsal long papilla present, verrucae absent	directed forward at 45°, reduced compared to following	branchiae present on chaetigers 5-9, straight, more on larger individuals		3 types, smooth capillaries, serrated & barred only in preacicular

<i>M. oculifera</i> Mackie, 2000	Hong Kong, harbour 5 m	based on original description	19, 1.35, 59 (2 fragments - posterior two chaetigers possibly regenerated)	yellowish white, 2 prs of large reddish brown eyes, almost fused, inserted on prostomium	subtrapezoidal, 1 pr smooth antennae on anterior margin, 1 pr palps arise ventro-laterally to antennae,	10	22 each row with 6-10 papillae, mid-dorsal papilla absent; proximal base with verrucae arranged in longitudinal bands	same size as subsequent ones, neuro & noto with cylindrical lobes, those of noto smaller; dorsal cirrus smaller than ventral, with swollen tips	noto with pointed acicular lobes, preacicular lobes less developed than post; dorsal cirrus larger than ventral, with inflated bases; branchiae absent but walls of interramal region with 6 tufts of cilia	neuro with pointed acicular lobes, preacicular lobes less developed than post; ventral cirrus with inflated bases	preacicular chaetae all straight barred, except for 1 st neuro, postacicular chaetae all finely spinose capillaries, lyrate with unequal forks from chaetiger 3 or 4
<i>M. sphaerocirrata</i> (Wesenberg-Lund, 1949)	Off Kharg, Persian Gulf, 13 m	based on original description & Ravara et al. 2010b	19,1,75	light salmon, 1 pr of eyespots inserted at level of chaetiger 3	subpentagonal, anterior margin straight, posterior V shaped extending over 1 st chaetiger, 1 pr of long terminal antennae, 1 pr of long basally inserted palps	10	22 each row with 7-10 papillae per row, mid-dorsal & ventral papilla absent, proximal base covered in verrucae,	directed forwards to lie parallel to prostomium; noto with conical acicular lobe, pre & post acicular lobes rudimentary; neuro pre & post acicular lobes encircling acicular	noto with acicular lobes conical, all pre & post acicular lobes poorly developed, dorsal cirri with spherical base & pointed tip, branchiae absent	neuro with acicular lobes conical, all pre & post acicular lobes poorly developed., ventral cirrus initially subspherical becoming elongated posteriorly;	4 kinds, barred in preacicular, post acicular with finely spinulated & lyriform with unequal branches, capillaries in 1 st chaetiger neuro, all chaetae long.
<i>M. sphaerocirrata orientalis</i> Lee & Jae, 1983	Korea, Yellow Sea, 20 m	based on original description & Imajima & Takeda, 1985	15, 0.7, 54	colourless, 1 pr of eyespots on chaetiger 3	broad & depressed; 1 pr of antennae on anterior margin, 1 pr palps inserted basally.	11	22 each row with 12-15 (mainly 14-15) papillae median dorsal papilla & verrucae absent	directed forwards to lie parallel to prostomium, dorsal cirri absent, ventral cirrus same shape as palps, all lobes poorly developed	noto with conical acicular lobes, preacicular lobe rounded, postacicular lobe low & rounded; dorsal cirrus almost spherical ; branchiae absent	neuro with conical acicular lobes, preacicular lobe rounded, postacicular lobe low & rounded; ventral cirrus almost spherical	3 types, most in postacicular fascicles with v. long serrated capillaries, barred in preacicular, lyrate chaetae with equal forks

<i>M. stammeri</i> (Augener, 1932)	Istra, off Rovinj, Geviet region), Croatia, 18 m	based on original description, & Ravara et al. 2010b., although type specimen lost, Banse (1959)	6, n/a, 49 (based on Ravara et al 2010b)	fixed colourless; chaetae and acicula amber, two pairs of large coalescent eyes visible at level of chaetiger 3	subpentagonal, anterior margin slightly convex; . antennae & palps subequal in length, cirriform with swollen tips	absent (at least according to Ravara et al 2010b)	20-22 rows each with 8 long and conical subterminal papillae subterminal papillae are followed by several minute papillae, extending over 2/3 length of pharynx; proximal region smooth	parapodia similar in size to subsequent chaetigers, anteriorly directed, parallel to prostomium. dorsal cirri small & spherical; ventral cirri cirriform with swollen tips	noto with conical acicular lobe, pre & post chaetal poorly developed rounded, dorsal cirrus subsphaerical; branchiae absent	Neuro with conical acicular lobe, pre & post chaetal poorly developed rounded, ventral cirrus subsphaerica l	5 types: barred, smooth capillaries, serrated, spinose capillaries & unequal lyrate
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n/a indicates data not provided

Table 4:

All Australian and Indo-pacific species of the genus *Nephtys*.

Species	Type locality	Data source	Body length, body width (max) in mm, no. of chaetigers, holotype/neotype	Body pigmentation	Eyespots	Prostomium shape; no. of prs of antennae & palps**	Pharynx, arrangement, no. of prs bifid terminal papillae	Pharyngeal subterminal papillae, no. of rows, ornamentation	1st chaetiger	Noto- & neuropodia of well developed chaetigers	Branchiae	Chaetae
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<i>N.brachycephala</i> Moore, 1903	Sagami Bay, Japan, 320-347 m	based on original description, & Imajima & Hartman 1964, o illustrations;	64, 4, 60 (incomplete)	n/a	absent	2x as wide as long, 2 prs antennae	n/a	22, no other details available	n/a	noto- & neuro widely separated ; distally truncate; noto lack postacicular lamellae	from 5 th to at least chaetiger 35; base of notopodial cirrus continuous with external base of branchiae	original description indicates all damaged
<i>N. bruuni</i> Kirkegaard, 1995	W. of New Zealand in 610 m	based on original description	11, 3, 24 (incomplete)	n/a	n/a	trapezoidal, 1 pr antennae & palps	n/a	n/a	dorsal cirri absent, conical ventral cirri	noto-conical, reduced preacicular & large oval postacicular lobes, neuro-conical with large pre & post acicular lobes, dorsal cirrus absent, ventral digitate	7 th . to chaetiger ?,	short barred preacicular & long capillary postacicular chaetae, faintly dentate
<i>N. chemulpoensis</i> Jung & Hong, 1997	Eastern Yellow Sea, Korea, intertidal	based on original description	43, 2.4, 71	n/a	absent	rounded with convex anterior margin, 1 pr antennae & palps	10	22, each with 1-4 papillae, mid-dorsal papillae present, verrucae absent	noto-& neuro with rounded acicular lobes; dorsal & ventral cirri well developed, digitiform	dorsal cirrus rounded, ventral cirrus digitiform	9 th . to chaetiger ?	preacicular fascicle with barred, postacicular fascicle with spinulose margins

<i>N. danida</i> Nateewathana & Hylleberg, 1986	Bang Tao Bay, Phuket Is, Thailand, 10 m	based on original description	9.5, n/a, 47	colourless	present, although may not be visible except by dissection	rounded, quadrangula r; 1 pr antennae & palps.	10	18 (16?), each with 6-8 per row, median dorsal papillae & verrucae absent	parapodia reduced, directed forward	noto- with conical acicular & postacicular lobes increasing in size posteriorly, neuro with conical acicular, & digitiform pre acicular, & large post acicular lobes.	from 5 th to last chaetiger	barred present to chaetiger 13, broad- bladed capillaries
<i>N. gravieri</i> Augener, 1913	Freemantle, West Australia	based on Rainer & Hutchings, 1977, largely on type of <i>N.</i> <i>mirocirrus</i> Fauchald synon by Rainer & Hutchings, 1977 with <i>N. gravieri</i>	49, 2.2, 87 (based on <i>N.</i> <i>mirocirrus</i> Fauchald)	cream, becoming brown posteriorly,	absent	flattened, quadrate, slightly concave anteriorly with 1 pr short tapering antennae & 1 pr palps dorsal margins	10	22, each with 6-10 conical papillae per row, median papilla absent, verrucae numerous	parapodium reduced, directed anteriorly, adjacent to prostomium	noto-with pre- postacicular & acicular lobes, & dorsal cirrus; neuro- with pre- & postacicular lobes	from 3 rd to posterior	four types: barred, spinose, spinulose & capillaries

<i>N. inornata</i> Rainer & Hutchings, 1977	Port Hacking, NSW Australia, 4-6 m	based on original description	1, 0.93, 51	colourless,	1 pr inserted on posterior chaetiger 2, brown	flattened, rounded & as long as wide, 1 pr short antennae & palps	9	20, each row with 4-7 papillae, median subterminal papilla absent, verrucae absent	reduced, anteriorly directed	both noto- & neuro with rounded pre- & postacicular lobes & acicular lobes dorsal & ventral cirri;	from 5 th to posterior	barred from chaetiger 1-16, plus spinulose & capillaries in all chaetigers
<i>N. longipes</i> Stimpson, 1856	Bateman's Bay, NSW, Australia, intertidal	based on redescription from Rainer & Hutchings 1977, Paxton, 1974 (<i>N. vikingensis</i>)	82, 3, 143	anteriorly with dorsal brown pigmentation, absent by 10 th chaetiger	absent	oval, with triangular translucent preantennal lobe, 1 pr of antennae & palps	10	22, each row with 5-7 papillae, 1 mid-dorsal & mid-ventral papillae, verrucae present	greatly prolonged, anteriorly directed	noto- & neuro with rounded acicular, pre & post acicular lobes, all cirri digitate,	from chaetiger 3 to last 8-10 chaetiger ss	long, flowing & golden, includes barred, spinose & spinulose

<i>N. mesobranhia</i> Rainer & Hutchings, 1977	Calliope River Gladstone Qld Australia, estuarine	based on original description	23, 2.2, 49	colourless	present on anterior margin of chaetiger 3, black	almost square, slightly convex anteriorly, 1 pr of antennae & palps	10	18, each row with 10-12 papillae, median subterminal papilla present, verrucae absent	reduced dorsally, almost obscured by 2 nd chaetiger, both forwardly directed	acicular lobes & pre- & postacicular lobes in both rami, dorsal & ventral cirri present.	from 7 th to 24 th	3 types: barred, spinulose & capillaries
<i>N. neopolybranchia</i> Imajima & Takeda, 1987	Usurjiri Bay, Hokkaido, Japan, 22 m	based on original description, Jung & Hong, 1997	20, 1, 61	dark pigmented diamond in median part of prostomium	1 pr on 3 rd chaetiger	rectangular, slightly convex anterior, elongate, 1 pr of antennae & palps	10	22, each row with 5-7 papillae, mid-dorsal papilla absent, verrucae present	biramous, small, directed anteriorly	noto- & neuro with rounded acicular lobes, noto preacicular conical, postacicular lobe rounded, neuro with rounded preacicular & post acicular	from 3 rd to posterior chaetigers	preacicular chaetae barred, postacicular chaetae spinulose
<i>N. oligobranhia</i> Southern, 1921	Chilka Lake, India, brackish waters, intertidal to 5 m	based on original description, & Imajima & Takeda, 1987 (& refs therein)	17, n/a, 51	colourless	1 pr on 2 nd chaetiger	rounded, pentagonal, 1 pr of antennae & palps	11	22, each row with 6-9 papillae, slender mid-dorsal papilla, verrucae absent	biramous, directed forward. dorsal & ventral cirri poorly developed	acicular lobes conical longer than pre & postacicular rounded lobes, dorsal cirrus conical ventral cirrus digitate	from 5 th / 8 th to 20 th to 27 th , decrease in size posteriorly, foliate	barred restricted to anterior 13 th -15 th chaetigers, (preacicular) & spinulose in postacicular.

<i>Nephtys paradoxa</i> Malm, 1874**	Koster, Bohuslän, Sweden, 50-860 m	based on Fauchald, 1963 & Ravara et al. 2010b	179, n/a, 91	brown with darker brown pigment on prostomium & anterior segments	absent	pentagonal, anterior margin slightly concave, 1 pr antennae & palps	10	22, each row with (3) 4-6 papillae, mid dorsal papilla & verrucae present	parapodia equal in size to subsequent parapodia, directed anteriorly, parallel to prostomium .	pre & postacicular lobes poorly developed, surrounding acicular lobes, dorsal cirri small, lamelliform & concave dorsally, ventral cirri conical, small	from 9 th fully developed by 25 th -27 th continue to 60-65 th	barred preacicular & spinose in postacicular position & capillary restricted to 1 st chaetiger
<i>Nephtys phasuki</i> Nateewathana & Hylleberg, 1986	Patong Bay, Phuket Is, Thailand, 20 m	based on original description	8.5, n/a, 30 (anterior fragment)	n/a	absent	slightly longer than wide, slightly notched at front margin. 1 pr of antennae & palps	n/a	present but not counted, verrucae absent .	anteriorly directed adjacent to prostomium ; noto with long, conical acicular lobe, neuro acicular lobe much shorter	noto with conical acicular lobe, preacicular low, postacicular rounded, neuro with slender conical acicular lobe, inflated preacicular & conical postacicular lobe; noto cirrus conical & ventral short & oblong	from 5 th . to ?.	barred & broad bladed capillaries, barred restricted to anterior chaetigers, absent from 17 th , capillaries throughout plus geniculate chaetae

<i>N. polybranchia</i> Southern, 1921	Chilka Lake, India, brackish waters	based on original description , & Imajima & Takeda, 1987 (refs therein)	22, n/a, 52	colourless	1 pr base of prostomiu m	rectangular, 1 pr of antennae & palps	11	22, each row with 6-7 papillae, , median dorsal papilla & verrucae absent	1 st parapodia directly obliquely, acicular lobes conical with small ventral & dorsal cirri	noto & neuro acicular lobes conical, preacicular lobes rounded, postacicular longer than acicular lobes, widely separated	from 5 th to near posterior end, digitate & flattened (some variation within literature)	barred restricted to chaetigers 1-16, broad- bladed capillaries, neuro all fine capillaries
<i>N. semiverrucosa</i> Rainer & Hutchings, 1977	Fannie Bay, Darwin, NT Australia, intertidal	based on original description	18, 0.8, 63	colourless	absent	pentagonal, slightly extended anteriorly, 1 pr of antennae & palps	10	22, each row with 4-7 papillae, median dorsal subterminal papilla absent , verrucae present restricted to basal region of pharynx	displaced forwards but not adjacent to prostomium , with small acicular lobe & postacicular lamella	noto with small acicular & preacicular lobes, postacicular divided into 2 unequal lobes, neuro with unequally divided preacicular lobe, acicular lobe, postacicular lobe & ventral cirrus large lamellate	from 4 th almost to pygidium	4 types: narrow- winged, smooth- tipped capillaries, barred (absent from 28 th), plus spinose & spinulose
<i>N. serrata</i> Imajima & Takeda, 1987	Nemuro Peninsula, Japan, 3 m	based on original description	325, 11.5, 190	n/a	Absent	trapezoidal, tapers posteriorly, 1 pr of antennae & palps	11	22, each row with 3-4 papillae, median dorsal papilla absent, verrucae small abundant on proximal surface	not erect, noto with conical acicular lobe, pre & postacicular lobes small, dorsal & ventral cirri long & digitate	noto better developed than neuro, acicular lobes bilobed distally, preacicular low & rounded, postacicular ; dorsal cirrus with foliaceous base	from 5 th to near end of body, well developed & involute	2 kinds, barred in preacicular & long spinulose with postacicula r fascicles

<i>N. sukumoensis</i> Kitamori, 1960	Sukumo Bay, Kochi Prefecture, Japan from stomach of fish	based on original description, & Imajima & Hartman 1964	14, 1, 52	n/a	present, 2 prs	suboval, straight frontal margin, 1 pr antennae & palps	n/a	20, each with 4-7 papillae, no mid-dorsal papilla present	n/a	parapodial lobes slightly incised at distal ends	from 2 nd almost to pygidium, foliaceous thick, with small cirrus, absent on last 5 segments	barred limited to chaetigers 1-8, replaced with long smooth capillaries on subsequent chaetigers, plus some with flattened serrated blades
<i>Nephtys triangula n. sp.</i>	Arwarra Beach, NSW, Australia, intertidal	based on the description in this paper	80, 5, 148	colourless, except for brown pigment on anterior extension of prostomium	absent	pentagonal with anterior triangular extension, 1 pair of antennae at distal margin, 1 pair of basal palps	12	22, each row with 7 papillae, median dorsal papilla absent, verrucae present proximally	directed forward, lying adjacent to prostomium	noto with elongate postacicular lobe, acicular lobe rounded, neuro with 2 equal sized lobes, well developed ventral cirrus	from 3 rd (4 in small specimens), continue to posterior, by chaetiger 20 fully occupying interramal space	barred extend to posterior chaetigers, broad-bladed long flowing capillaries with serrated margins,

* for discussion re palps and antennae see Discussion of this paper

** *Nephtys paradoxa* was originally described from Sweden but has been described from Australia and many other locations in the world, and certainly needs to be re-examined as almost certainly represents a suite of species see Ravara et al. 2010b.

