

# Marine Tubificidae (Oligochaeta) of the Dampier area, Western Australia

Christer Erséus

Department of Invertebrate Zoology, Swedish Museum of Natural History  
Box 50007, SE-104 05 Stockholm, Sweden; email christer.erseus@nrm.se

and

Hongzhu Wang

State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology,  
Chinese Academy of Sciences, Wuhan 430072, China; email wanghz@ihb.ac.cn

**Abstract** – Twenty-two species of Tubificidae are reported from intertidal and shallow-water subtidal habitats in the area near Dampier, on the northern coast of Western Australia. Five species are new to science, *Ainudrilus vallus* sp. n., *Heterodrilus carinatus* sp. n. (both Rhyacodrilinae), *Albanidrilus pulcher* sp. n., *Bathydrilus paramunitus* sp. n. (both Phallo-drilinae), and *Tectidrilus borioides* sp. n. (Limnodriloidinae), while six others (*Ainudrilus gibsoni*, *Heronidrilus* cf. *gravidus*, *Limnodriloides tenuiductus*, *Limnodriloides tarutensis*, *Smithsonidrilus ludmillae*, and *Smithsonidrilus grandiculus*) are recorded from Western Australia for the first time. Based on the new material, taxonomic notes are given also for *Heterodrilus devexus*, *Pectinodrilus multiplex*, *Duridrilus piger* and *Smithsonidrilus edgari*. With the additions of taxa from the Dampier area, a total of 90 species of marine Tubificidae have now been recorded from Western Australia. The results corroborate the position of the northern coast of the Australian continent as a hotspot for this oligochaete group.

**Key words:** Marine Oligochaeta, Tubificidae, taxonomy, new species, biogeography

## INTRODUCTION

The marine tubificid oligochaetes of Western Australia have been investigated in a number of previous taxonomic studies, with a geographical coverage that includes the south-western (Michaelsen, 1907; Erséus, 1990a, 1998), western (Erséus, 1993, 1997a) and north-western coasts of the state (Erséus, 1997a). The corresponding fauna in the Darwin region of the Northern Territory has also been scrutinized (Erséus, 1997b), and it was shown to have a considerable overlap with the Tubificidae of the tropical parts of Western Australia. This means that species described from Darwin, but yet not recorded from Western Australia, can be predicted to occur there too. The previous works have already revealed an astonishing diversity of marine Tubificidae in Western Australia. A total of 79 species have been recorded, and some species complexes (particularly, within the genera *Heterodrilus* and *Olavius*) appear to have undergone a radiation in this region (Erséus, 1997a). Nevertheless, we were provided with a valuable opportunity to supplement our knowledge by the second author's participation at the "Woodside Dampier Marine Biological Workshop", arranged in Dampier and its environs, north-western Western Australia, by the Australian Marine Sciences Association (see this volume). In this paper, we report on the tubificid material collected on this occasion.

Enchytraeidae, also collected at the Dampier workshop, are treated separately (Rota et al., 2003).

### MATERIAL AND METHODS

A range of intertidal and shallow-water subtidal sites in the Dampier area were visited by the second author; in one case by Dr. Ilse Bartsch. At each station, a sediment sample of a few litres was collected by hand. Each sample was repeatedly (four times or more) stirred in seawater in a bucket, and the suspensions of organic material thus obtained were decanted into a 0.25 mm sieve, after which the sieved material was brought live into the laboratory for further examination. One-hundred and eighty-three sexually mature tubificids, present in 25 of the samples, were sorted out under a dissecting microscope. The worms were fixed in Bouin's fluid for one or two days and then transferred into 80% ethanol. Two additional tubificid specimens were sorted from subtidal sediment samples (included in list below) collected by a SCUBA diver (Mr. Clay Bryce) and preserved in toto in alcohol or in formalin.

Later, the individuals were all stained in alcoholic paracarmine, dehydrated through an ethanol/xylene series and mounted whole in Canada balsam. All morphological studies reported herein were performed on these mounted specimens under a light microscope. In the descriptions, specific segments are referred to by Roman numerals. Types and other reference material are deposited in the Western Australian Museum (WAM), Perth, and in the Swedish Museum of Natural History (SMNH), Stockholm.

### LIST OF STATIONS

All stations in the vicinity of Dampier, Western Australia. Oligochaete species found at each station are listed too; these include species of Enchytraeidae (in parenthesis) reported separately by Rota et al. (2003).

DP00-2. Burrup Peninsula, Withnell Bay, SW of mangroves; medium sand, lower intertidal; 20°35'S, 116°47'E; 3 August 2000. *Heterodrilus devexus*, *Olavius clavatus*. (*Grania ocarina*.)

DP00-4. Dampier, W of Hamersley Cottages and Western Australian Laboratory of Australian Institute of Marine Science, rocky area; medium to coarse sand, lower intertidal; 20°39'S, 116°43'E; 4 August 2000. *Heterodrilus devexus*. (*Grania darwinensis*.)

DP00-5A. E part of Nickol Bay, E of Cleaverville, rocky platform, intertidal pool; medium to coarse sands, lower intertidal; 20°40'S, 117°03'E; 5 August 2000. *Heterodrilus decipiens*, *H. devexus*., *H. carinatus* sp. n. (*Grania ocarina*.)

DP00-6A. E part of Nickol Bay, a cove E of Cleaverville, but W of DP00-5A; medium to coarse sand, lower intertidal; 20°40'S, 117°02'E; 5 August 2000. *Heterodrilus devexus*.

DP00-8A. W end of Dampier Archipelago, near Cape Preston, N of Sand Pit, rocky area; medium to coarse sand, barely subtidal, 0.5 m; 20°56'S; 116°19'E; 6 August 2000. *Heterodrilus devexus*.

DP00-8B. W end of Dampier Archipelago, near Cape Preston, N of Sand Pit, rocky area; medium to coarse sand with black silt, lower intertidal; 20°56'S, 116°19'E; 6 August 2000. *Heterodrilus devexus*, *Limnodriloides armatus*, *Smithsonidrilus grandiculus*.

- DP00-8C. W end of Dampier Archipelago, near Cape Preston, N of Sand Pit, rocky area; medium to coarse sand with black silt among or underneath rocks, lower intertidal; 20°56'S, 116°19'E; 6 August 2000. *Heterodrilus devexus*, *Limnodriloides armatus*, *Smithsonidrilus grandiculus*, *S. edgari*. (*Grania darwinensis*.)
- DP00-8E. W end of Dampier Archipelago, near Cape Preston, N of Sand Pit, rocky area; medium to coarse sand with black silt, upper intertidal pool; 20°56'S, 116°19'E; 6 August 2000. *Smithsonidrilus ludmillae*.
- DP00-10. Dampier Archipelago, W of Angel Island; fine to medium sand, 12 m; 20°29.77'S, 116°47.48'E; 4 August 2000; sediment collected by C. Bryce. *Limnodriloides armatus*.
- DP00-11B. Nickol Bay, Karratha Beach, rocky area; black silt, lower intertidal; 20°44'S, 116°54'E; 7 August 2000. *Limnodriloides armatus*.
- DP00-11C. Nickol Bay, Karratha Beach, rocky area; clay with medium to coarse sand, lower intertidal; 20°44'S, 116°54'E; 7 August 2000. *Duridrilus piger*, *Heronidrilus cf. gravidus*, *Limnodriloides armatus*. (*Grania darwinensis*.)
- DP00-12B. Nickol Bay, Karratha Beach, rocky area; medium to coarse sand with silt, upper intertidal pool; 20°44'S, 116°54'E; 7 August 2000. *Heronidrilus cf. gravidus*, *Tectidrilus borioides* sp.n., *Limnodriloides armatus*.
- DP00-13. Dampier, NW of shopping center; medium sand, intertidal; 20°39'S, 116°43'E; 7 August 2000; sediment collected by I. Bartsch. *Limnodriloides lateroporus*.
- DP00-14B. Nickol Bay, E side of Burrup Peninsula, Watering Cove, N rocky platform; heterogeneous sand with silt, lower intertidal pool; 20°36'S, 116°48'E; 8 August 2000. *Heronidrilus cf. gravidus*. (*Grania integra*.)
- DP00-14D. Nickol Bay, E side of Burrup Peninsula, Watering Cove, N of middle platform; fine sand, black silt covered with heterogenous sand, lower intertidal pools; 20°36'S, 116°48'E; 8 August 2000. *Limnodriloides armatus*.
- DP00-14E. Nickol Bay, E side of Burrup Peninsula, Watering Cove, E mouth of creek inside mangroves; black silt covered with heterogenous sand, upper intertidal; 20°36'S, 116°48'E; 8 August 2000. *Doliidrilus diverticulatus*, *Limnodriloides rubicundus*.
- DP00-14F. Nickol Bay, E side of Burrup Peninsula, Watering Cove; black silt with fine to medium sand, upper intertidal pool inside mangroves, underneath mangrove roots; 20°36'S, 116°48'E; 8 August 2000. *Limnodriloides rubicundus*, *L. tarutensis*.
- DP00-14G. Nickol Bay, E side of Burrup Peninsula, Watering Cove, W edge of mangroves; clay covered with medium sand, uppermost intertidal; 20°36'S, 116°48'E; 8 August 2000. *Ainudrilus gibsoni*, *A. vallus* sp. n., *Pectinodrilus multiplex*.
- DP00-15A. Dampier, NW of shopping center, rocky area; medium to coarse sand, barely subtidal, 0.5 m; 20°39'S, 116°43'E; 9 August 2000. *Limnodriloides armatus*, *Smithsonidrilus grandiculus*, *S. edgari*.
- DP00-15B. Dampier, NW of shopping center, rocky area; medium to coarse sand, lower intertidal; 20°39'S, 116°43'E; 9 August 2000. *Heterodrilus devexus*, *Limnodriloides armatus*.
- DP00-15C. Dampier, NW of shopping center, rocky area; medium sand with black silt, upper intertidal pool; 20°39'S, 116°43'E; 9 August 2000. *Smithsonidrilus grandiculus*.

- DP00-16A. Dampier, NW of shopping center, rocky area; medium to coarse sand, barely subtidal, 0.5 m; 20°39'S, 116°43'E; 9 August 2000. *Heterodrilus devexus*. (*Grania darwinensis*.)
- DP00-16B. Dampier, NW of shopping center, rocky area; medium sand, lower intertidal; 20°39'S, 116°43'E; 9 August 2000. *Coralliodrilus bidentatus*, *Limnodriloides tenuiductus*, *Smithsonidrilus grandiculus*.
- DP00-16E. Dampier, NW of shopping center, rocky area; medium to coarse sand, barely subtidal, 0.5 m; 20°39'S, 116°43'E; 9 August 2000. *Heterodrilus devexus*, *Pectinodrilus multiplex*, *Bathydrius paramunitus* sp.n., *Smithsonidrilus grandiculus*, *S. edgari*. (*Grania darwinensis*, *G. ocarina*.)
- DP00-18A. Dampier, W of Hamersley Cottages and Western Australian Laboratory of Australian Institute of Marine Science, rocky area; heterogeneous sand, lower intertidal; 20°39'S, 116°43'E; 10 August 2000. *Heterodrilus devexus*, *Smithsonidrilus grandiculus*, *S. edgari*.
- DP00-18B. Dampier, W of Hamersley Cottages and Western Australian Laboratory of Australian Institute of Marine Science, rocky area; medium sand, lower intertidal; 20°39'S, 116°43'E; 10 August 2000. *Heterodrilus devexus*.
- DP00-20. Dampier Archipelago, NW of Enderby Island, near Bare Rock; subtidal sediment, 13.2 m; 20°32.10'S, 116°26.72'E; 3 August 2000; sediment collected by C. Bryce. *Albanidrilus pulcher* sp. n.

#### ABBREVIATIONS USED IN THE FIGURES

a, atrium; aa, atrial ampulla; ad, atrial duct; am, amorphous mass (in spermatheca); cg, copulatory gland; cs, copulatory sac; e, egg; es, epidermal slit; fp, female pore; m, muscle; mt, mesodermal tissue; o, ovary; pc, penial chaeta; pco, penial chaeta of other side of worm; pp, pseudopenis; ppa, prostatic pad; pr, prostate gland; pr 1, anterior prostate gland; pr 2, posterior prostate gland; ra, rudimentary atrium; s, spermatheca; sf, sperm funnel; so, spermatheca of other side of worm; sp, spermathecal pore; sz, spermatzeugma; vd, vas deferens.

#### LIST OF SPECIES

(All family TUBIFICIDAE)

##### Subfamily RHYACODRILINAE

- Ainudrilus gibsoni* Erséus, 1990  
*Ainudrilus vallus* sp. n.  
*Heronidrilus* cf. *gravidus* Erséus, 1990  
*Heterodrilus decipiens* Erséus, 1997  
*Heterodrilus devexus* Erséus, 1997  
*Heterodrilus carinatus* sp. n.

##### Subfamily PHALLODRILINAE

- Albanidrilus pulcher* sp. n.  
*Pectinodrilus multiplex* (Erséus, 1990)  
*Bathydrius paramunitus* sp. n.

*Duridrilus piger* Erséus, 1984  
*Coralliodrilus bidentatus* Erséus, 1993  
*Olavius clavatus* (Erséus, 1981)

Subfamily LIMNODRILOIDINAE

*Doliodrilus diverticulatus* Erséus, 1985  
*Tectidrilus borioides* sp. n.  
*Limnodriloides lateroporus* Erséus, 1997  
*Limnodriloides tenuiductus* Erséus, 1982  
*Limnodriloides armatus* Erséus, 1982  
*Limnodriloides rubicundus* Erséus, 1982  
*Limnodriloides tarutensis* Erséus, 1986  
*Smithsonidrilus ludmillae* Erséus, 1997  
*Smithsonidrilus grandiculus* (Erséus, 1983)  
*Smithsonidrilus edgari* Erséus, 1993

SYSTEMATIC ACCOUNT

Family TUBIFICIDAE

Subfamily RHYACODRILINAE

Genus *Ainudrilus* Finogenova, 1982

*Ainudrilus gibsoni* Erséus, 1990

*Ainudrilus gibsoni* Erséus, 1990b: 267, figure 1D–G, table 1.

**New material**

WAM V 4287, and SMNH Main Coll. 43902: two specimens from Station DP00-14G.

**Description of new material**

Length 5.2–5.9 mm, both specimens with 31 segments. Width at XI, 0.39–0.43 mm. Prostomium triangular, about as long as wide. Clitellum extending over ½X–XII. Somatic chaetae bifid, with upper tooth barely longer than lower. Bifids 40–55 µm long, 1.5–2.5 µm thick, three to five per bundle in preclitellar region, one to two per bundle in postclitellar bundles. Penial chaetae 35–65 µm long, 3–4 µm thick, basically straight, with distinct nodes and single-pointed, curved tips, two per bundle; within bundle, chaetae arranged to form a "V", i.e., with tips close together ventrally. Male pores in line with ventral chaetae, in posterior part of segment X. Spermathecal pores in line with ventral chaetae, in anteriormost part of segment IX.

Pharyngeal glands in (III)IV–VI. Coelomocytes spherical, granulated with central nucleus, abundant. Male genitalia paired. Vas deferens not observed, but appears to enter atrium subapically. Atrium more or less erect, with round to oval ampulla, 55–75 µm long, about 50 µm wide, and simple, narrow, ectal duct; copulatory sac poorly developed. Spermathecae with simple, somewhat hollow duct, about 50 µm long, 20–28 µm wide, and oval ampulla, 95–115 µm long, about 65 µm wide. Sperm few and scattered in spermathecal ampullae.

**Remarks**

This species was originally described from an intertidal mangrove site in Hong Kong (Erséus, 1990b), but never before recorded from Australia. The new material differs from the type specimens by its more numerous anterior somatic chaetae (up to five per bundle, as opposed to two or three per bundle), and slightly smaller male ducts and spermathecae. Moreover, all of the penial chaetae of the Dampier worms appear single-pointed, whereas a few such chaetae were bifid (possessing a small upper tooth) in the Hong Kong material (see Erséus, 1990b: figure 1E). For the time being, these differences are regarded as intra-specific.

**Distribution and habitat**

Northern coast of Western Australia (new record) and Hong Kong. Intertidal sandy substrate near mangroves.

*Ainudrilus vallus* sp. n.

## Figure 1

**Holotype**

WAM V 4288, whole-mounted specimen.

**Type locality**

Western Australia, Nickol Bay, near Dampier, mangroves (Station DP00-14G).

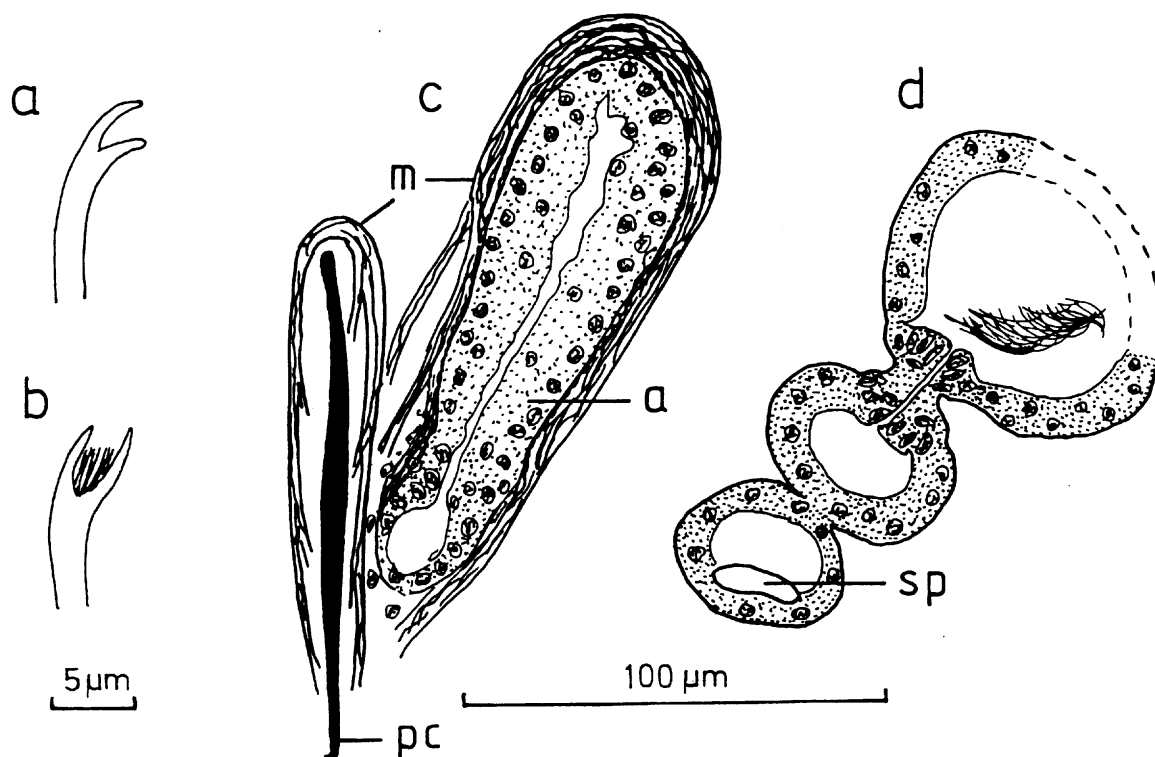
**Paratypes**

WAM V 4289, and SMNH Type Coll. 5501: two specimens from type locality.

**Description**

Single complete specimen (WAM paratype) 5.2 mm long, with 42 segments. Other two worms incomplete; holotype 5.2 mm long, but missing posterior end broken off at segment XXXIX. Width at IX, 0.40–0.53 mm, but widest specimen (holotype) partly squashed in this region. In WAM paratype, prostomium small, shorter than wide; in other two worms, prostomium damaged or lost. Clitellum extending over ½X–XII. Ventral somatic chaetae (Figure 1a) bifid, with upper tooth distinctly longer than lower, three to four per bundle anteriorly, two to three (occasionally only one) per bundle in postclitellar segments. Bifid chaetae 55–70 µm long, 2–2.5 µm thick. Dorsal bundles generally with one to three pectinate chaetae (Figure 1b) and one to three rather small hair chaetae; in available material, however, tips of some of these chaetae broken off, even some whole chaetae or bundles missing. Pectinate chaetae somewhat shorter than ventral bifid chaetae, with marginal teeth more or less equal in length, intermediate teeth indistinct and numerous (Figure 1b). Hair chaetae thinner than pectinates. Penial chaetae, one at each male pore, straight, single-pointed with slightly curved tips, 105–125 µm long, about 5 µm thick at node. Male pores paired, in line with ventral chaetae, in about middle of segment XI. Spermathecal pores paired, in line with ventral chaetae, anteriorly in X.

Pharyngeal glands in (III)IV–VI. Coelomocytes spherical, granulated, mostly abundant. Male genitalia (Figure 1c) paired. Vas deferens not observed, but probably entering base (ectal part) of atrium. Atrium elongate, erect, with rounded apex (inner end), about 120–180 µm long, 35–75 µm wide, consisting of heavily muscular ampulla and short, less muscular, ectal duct; details



**Figure 1** *Ainudrilus vallus* sp. n., a: ventral bifid chaeta; b: dorsal pectinate chaeta; c: penial chaeta and atrium (holotype); d: spermatheca (SMNH paratype).

of latter not clear, but it appears to open directly to exterior through simple pore. Prostate glands absent. In SMNH paratype, atrial lumen containing sperm. Spermathecae poorly visible in holotype and WAM paratype; in SMNH paratype (Figure 1d) consisting of bipartite vestibule, a short narrow duct, and innermost, a more or less spherical ampulla, about 80  $\mu\text{m}$  wide. Sperm as small random mass in each spermathecal ampulla.

### Etymology

Named *vallus*, which is Latin for 'stake', 'pole', alluding to the single, straight penial chaetae characterizing this species.

### Remarks

Among the marine species of *Ainudrilus*, there are three additional taxa with dorsal hair chaetae: *A. taitamensis* Erséus, 1990(b), *A. brendae* Erséus, 1997(b) and *A. piliferus* Erséus, 1997(b). *Ainudrilus vallus* appears most closely related to *A. brendae*, known from mangroves in the Northern Territory; the atria are virtually identical in these two species. *Ainudrilus brendae*, however, has smaller (only 50  $\mu\text{m}$  long) and consistently more numerous penial chaetae (two per bundle) than *A. vallus*. Moreover, even if the spermathecal "ducts" of *A. brendae* are interpreted as homologous to the spermathecal "vestibules" of *A. vallus*, they are not bipartite (cf. Figure 1d; Erséus, 1997b: figure 2K).

There are also some freshwater representatives of *Ainudrilus* that possess hair chaetae, *A. nharna* Pinder and Brinkhurst, 2000, and two newly discovered species, described by Pinder

and Halse (2001) and Erséus and Grimm (2002). All of these, however, have multiple penial chaetae, and differ in their genital anatomy from *A. vallus*.

### Distribution and habitat

Known only from the Dampier area, Western Australia. Intertidal medium sand.

## Genus *Heronidrilus* Erséus and Jamieson, 1981

### *Heronidrilus* cf. *gravidus* Erséus, 1990

Figure 2

?*Heronidrilus gravidus* Erséus, 1990c: 248–249, figure 3.

*Heronidrilus* cf. *gravidus*; Erséus, 1997b: 103.

### New material

WAM V 4290 through V 4294, five specimens, and SMNH Main Coll. 43903–43916, 14 specimens: all from Station DP00-14B. SMNH Main Coll. 43917–43919, three specimens: two from Station DP00-12B, one from Station DP00-11C.

### Brief description of new material

Three complete specimens 10.8–16.5 mm long, with 51 to about 85 segments (posteriormost segments of longest worm not fully differentiated). Somatic chaetae bifid, with upper tooth shorter and much thinner than lower, (two) three to four (five) per bundle in preclitellar segments, (one) two (three) per bundle in postclitellar segments. Penial chaetae either absent, or bifid (i.e., similar to somatic chaetae), or occasionally, single-pointed with hooked tips (Figure 2a); when present, penial chaetae one or two per bundle. Rudimentary male pores sometimes visible, located in line with ventral chaetae, in middle of XI. Spermathecal pores (and spermathecae) absent. Pair of testes present in X, and numerous mature sperm present in some (but not all) clitellate specimens. Ovaries in XI (Figure 2b–c: o), and, in clitellate specimens, a few large, yolky, eggs (Figure 2b: e) generally present. In most specimens, male genital ducts rudimentary (Figure 2b), each comprising sperm funnel, a solid cord representing vas deferens, and a small, compact structure representing atrium. In a single specimen from Station DP00-14B (Figure 2c), atria more developed, slender, somewhat club-shaped, about 330 µm long, about 50 µm wide; lumen, however, not visible, and atria probably still non-functional. Further, in this worm, vasa deferentia not observed, but mature sperm abundant in X and parts of adjacent segments.

### Remarks

*Heronidrilus* is a circumtropical genus with a majority of its species described from the Indo-Pacific region (Erséus and Jamieson, 1981; Erséus, 1984a, 1990b, 1992a, 1993, 1997a–c; Erséus and Davis, 1989). *Heronidrilus gravidus*, however, was described from the Caribbean area in the Atlantic Ocean (Erséus, 1990c), and a morphologically similar form, "*H.* cf. *gravidus*", was subsequently reported from Australia's Northern Territory (Erséus, 1997b) While all other named species develop complete male genitalia, the members of the *gravidus*-complex have rudimentary male ducts and have been regarded as uniparental, possibly



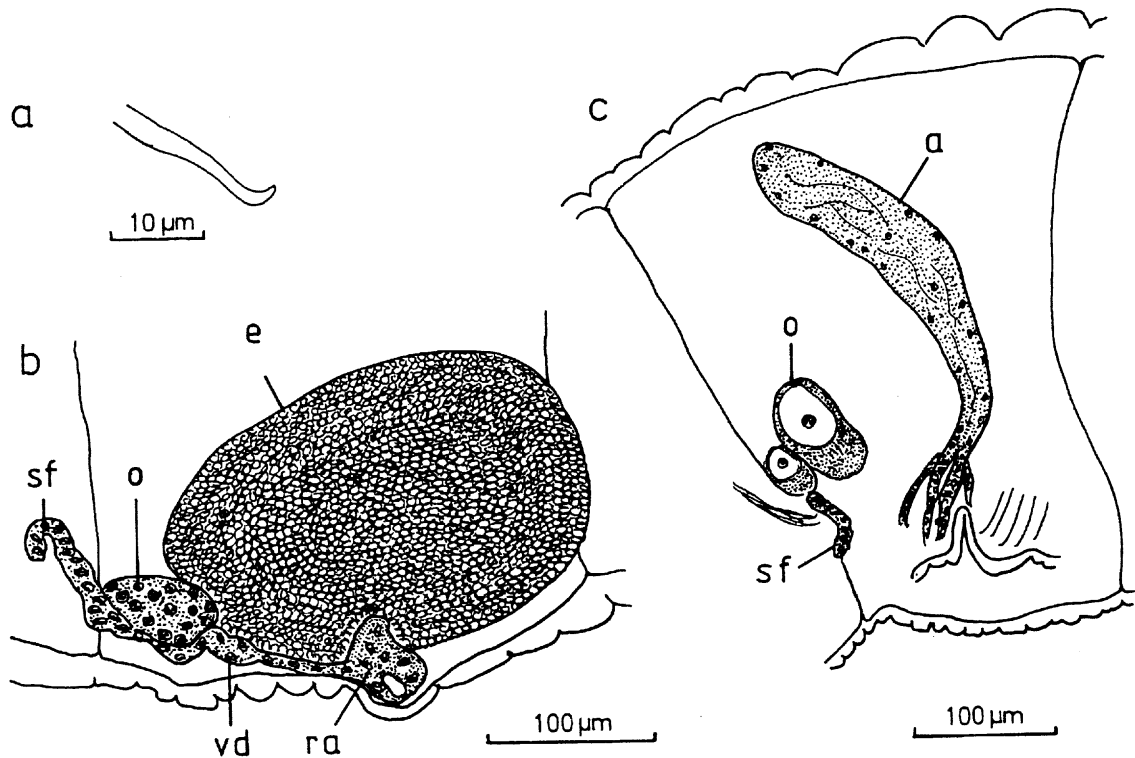


Figure 2 *Heronidrilus* cf. *gravidus*, a: single-pointed penial chaeta; b: ovary, mature egg and rudimentary male duct in segment XI of a clitellate specimen; c: ovary and rudimentary(?) male duct of another specimen.

parthenogenetic worms. Erséus (1997b: 103) pointed out, however, that "the genus may include more than one form that has evolved parthenogenesis", i.e. the Caribbean and Australian individuals may not be conspecific or even monophyletic.

The new specimens from the Dampier area share many features with the Northern Territory material, and also from a geographical point of view, it seems likely that both lots represent one continuous population of *Heronidrilus*. Noteworthy, however, is the greater variation in the male reproductive system (amount of sperm, shape of penial chaetae and atrial rudiments) shown by the Dampier material. The specimen depicted in Figure 2c is indeed so different from the other individuals that it could be interpreted as belonging to a separate species. For the time being, however, this form is still considered as uniparental, i.e. that it reproduces either parthenogenetically or by self-fertilization, which may explain the instability in the development of the male sexual organs. It could be mentioned that, in *H. cf. gravidus*, the consistent lack of spermathecae as well as occasional occurrences of single-pointed penial chaetae (known also for the Darwin material; Erséus, 1997b), point at a possible phylogenetic affinity to *H. heronae* (Erséus and Jamieson, 1981), but the exact systematic position of the present species can probably not be resolved on the basis of morphological data only.

### Distribution and habitat

If the present form indeed is *H. gravidus*, the species is known from Western Australia (new record), Northern Territory, and Belize. Intertidal and subtidal sand, in Belize to at least 7 m depth.

**Genus *Heterodrilus* Pierantoni, 1902*****Heterodrilus decipiens* Erséus, 1997**

*Heterodrilus claviatriatus* (*partim*); Erséus, 1993: 341–342, figure 3; not *Heterodrilus claviatriatus* Erséus, 1981a.

*Heterodrilus decipiens* Erséus, 1997a: 396–398, figure 2.

**New material**

WAM V 4295, one specimen, and SMNH Main Coll. 43920–43921, two specimens: all from Station DP00-5A.

**Brief description of new material**

Length 6.1–6.9 mm, 55–59 segments. Width at XI, 0.19–0.20 mm. Somatic chaetae 36–58  $\mu\text{m}$  long, 2–4.5  $\mu\text{m}$  wide, two per bundle in segments II to IX, one representing each bundle thereafter. Anterior chaetae trifid, from X or XI bifid. Penial chaetae 41–51  $\mu\text{m}$  long, 2.5–3  $\mu\text{m}$  thick at middle, two per bundle, divergent (i.e., inner ends wider apart than outer ends). Male pores somewhat ventral to lines of ventral somatic chaetae, spermathecal pores in line with these chaetae. Atria tubular, 325–355  $\mu\text{m}$  long, 19–25  $\mu\text{m}$  wide, with muscular layer 1–2  $\mu\text{m}$  thick. Spermathecae pear-shaped; when present, sperm as random mass in spermathecal ampullae.

**Remarks**

This species, already known from other parts of Western Australia, albeit first identified as *H. claviatriatus* (see Erséus, 1993), was described in detail and compared with its closest relatives by Erséus (1997a). The new specimens conform well with the previous descriptions, also with regard to dimensional details.

**Distribution and habitat**

Western Australia. Intertidal and subtidal sand, to at least 24 m depth.

***Heterodrilus devexus* Erséus, 1997**

Figure 3

*Heterodrilus devexus* Erséus, 1997a (*partim*): 402–404, figure 4A–D (but not figure 4E).

**New material**

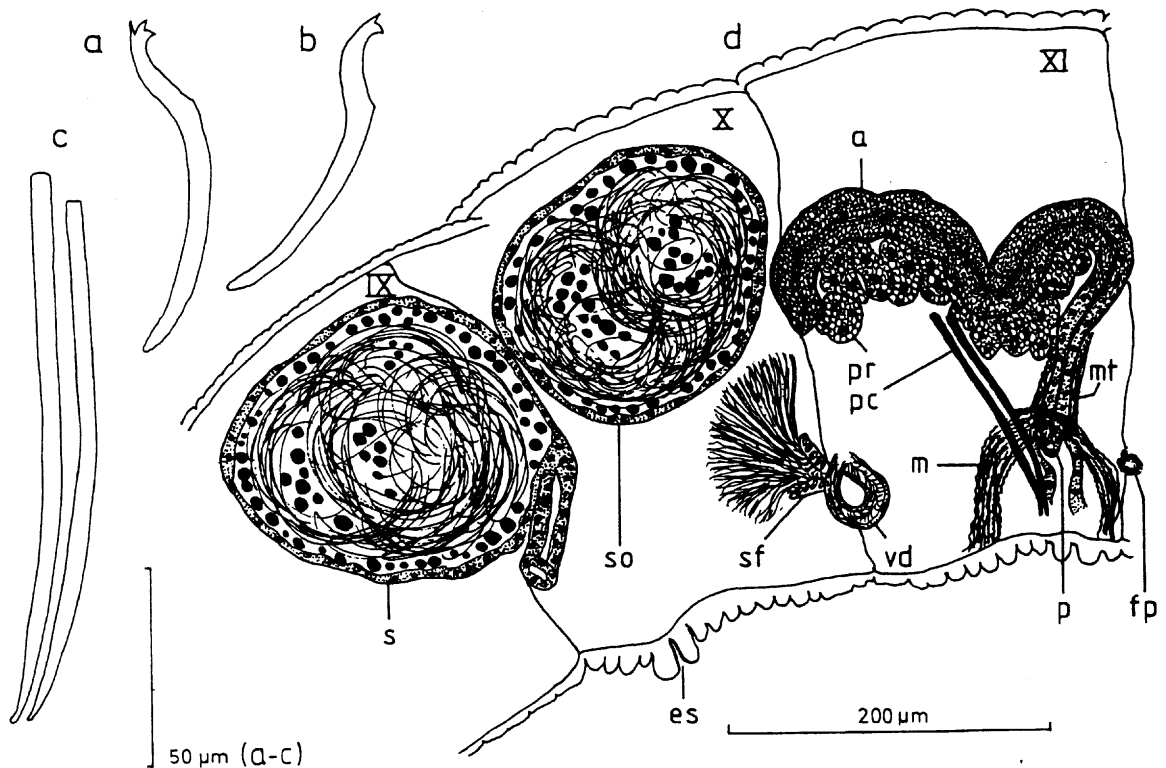
WAM V 4296 through V 4308, 13 specimens: six from Station DP00-5A, four from Station DP00-8C, and three from Station DP00-18B. SMNH Main Coll. 43922–43955, 34 specimens: three from Station DP00-16A, 21 from Station DP00-18A, two from each of Stations DP00-8B, DP00-15B and DP00-16E, and one from each of Stations DP00-2, DP00-4, DP00-6A and DP00-8A.

**Description of new material** (measurements based on seven randomly selected specimens).

Length 6.2–9.2 mm, 52–63 segments. Width at XI, 0.27–0.46 mm. Prostomium rounded triangular, but variable in proportions. When fully developed, clitellum extending over 2/3X–XII. Somatic chaetae two per bundle in segments II–IX, thereafter one chaeta representing each

bundle. Chaetae of II-IX (or -X, -XI or -XII) trifold (Figure 3a), each with middle tooth generally longer than upper and lower, and often with upper tooth conspicuously slender and well separated from middle one by deep cleft (cf. Figure 3a). Trifold chaetae smallest in segment II, 35–60  $\mu\text{m}$  long, 2.5–3  $\mu\text{m}$  thick at node; largest near clitellum, 75–100  $\mu\text{m}$  long, 5.5–7  $\mu\text{m}$  thick at node. Chaetae from X (or from XI, XII or XIII) bifid (Figure 3b), with widely diverging, broad teeth; upper tooth somewhat smaller than lower. Bifid chaetae variable in size, but those in region near clitellum tend to be largest, 70–95  $\mu\text{m}$  long, 5.5–7  $\mu\text{m}$  thick at node. Penial chaetae (Figure 3c; 3d: pc) single-pointed, slender, two per bundle, either perpendicular to long axis of body or obliquely directed towards posterior. These chaetae 110–145  $\mu\text{m}$  long, 3.5–5  $\mu\text{m}$  thick at middle; entally not markedly wider, ectally tapering into thin tips. Within bundle, penial chaetae more or less parallel, or with inner ends slightly wider apart than outer ends. Tips of bundles (of two sides) close together, in middle of ventral depression of body wall in XI (see below). A pair of transverse epidermal slits located close together, mid-ventrally in anterior part of X, immediately posterior to spermathecal pores (Figure 3d: es); probably functioning as anchoring sites for penial chaetae of concopulant during copulation. Male pores paired, in line with ventral somatic chaetae, in ventral depression of body wall, posteriorly in XI. Spermathecal pores paired, located immediately dorsal to line of ventral somatic chaetae [but not as far as midway between this line and lateral line] in anteriormost part of X. Female pores in line with ventral somatic chaetae in intersegmental furrow between XI and XII.

Pharyngeal glands in IV-VI. Coelomocytes round, granulated, abundant. Male genitalia (Figure 3d) paired. Vas deferens about 10  $\mu\text{m}$  wide, appear to be irregularly coiled, but not



**Figure 3** *Heterodrilus devexus*, a: trifold somatic chaetae from segment X; b: bifid somatic chaetae from segment XII; c: bundle of penial chaetae; d: lateral view of male genitalia and spermathecae in segments IX-XI.

observed in its full length; entering apical end of atrium. Atrium cylindrical, more or less M-shaped, 375–500 µm long, 29–50 µm wide (i.e., 10–17 times longer than wide), with thin, only 1–1.5 µm thick, muscular layer, and ciliated and for most parts granulated inner epithelium. Prostate glands broadly attached to ventral surface of most of length of atrium. Ectal part of atrium tapering, non-granulated, leading to small penial papilla inside a small sac. Thin (monocellular) layer of mesodermal tissue 'anchoring' this duct to body wall (Figure 3d: mt). A part of ventral body wall in XI heavily muscular (Figure 3d: m), i.e., muscle fibres encircling an area containing both male pores and tips of penial chaetae. Spermathecae (Figure 3d: s, so) with distinct, narrow, ducts, and large oval ampullae; latter containing large bundles of sperm and numerous secretory granules. Typically, one spermatheca confined to X, the other extending forwards into IX.

### Remarks

This Western Australian species was originally described with reference to the holotype specimen from the Buccaneer archipelago in Kimberley, as well as a second worm from the Montebello Islands (Erséus, 1997a). The latter individual, however, was only tentatively attributed to *H. devexus* and not given paratype status, as its chaetal arrangement was somewhat different from that of the holotype, and as it lacked spermathecae as well as the ventral depression in the male pore segment. It was also shown (op. cit.: figure 4E) that the penial chaetae of the Montebello specimen were entally much broader than those of the *H. devexus* holotype (op. cit.: figure 4C).

The more extensive material of *H. devexus* from the Dampier area broadens the basis for circumscribing this taxon. In these worms, the posterior extension of the trifid chaetae varies greatly, the last such chaetae being located in any of segments IX–XII; this range of variation now must be regarded as intraspecific. On the other hand, however, the morphology of the penial chaetae (i.e., with the inner ends not being markedly wider than the rest of the chaetae; see Figure 3c; and Erséus, 1997a: figure 4C), is consistent in all the new specimens of *H. devexus*. This suggests that the Montebello worm (see above) indeed represents another taxon. Most probably it is conspecific with *H. carinatus* sp.n. (see below).

In all the new specimens of *H. devexus*, as well as in *H. carinatus*, and, to an even greater extent, in *H. densus* Erséus, 1997(a) (also a Western Australian species), the male pore area is heavily muscular. Although not noted in the original description of *H. devexus*, the same feature is present in the holotype (WAM 102-96) re-examined by us. Thus, *H. densus* now appears more similar to *H. devexus* than what was originally stated; especially the paratype of *H. densus* (SMNH 4833, also re-examined) is difficult to distinguish from the latter. Indeed, several of the morphological differences between the two species (summarized by Erséus, 1997a: table 1) are now less clear-cut than before, in the light of the variation noted for the new material from the Dampier area (see Description above). For instance, the orientation of the penial chaetae, originally described as oblique in *H. devexus* but "erect" (perpendicular to body axis) in *H. densus*, varies considerably in the Dampier material. On the other hand, the holotype of *H. densus* (WAM 104-96) has a distinctly more prominent "muscular male bulb" (Erséus, 1997a: figure 5D, table 1) than seen in any of the present specimens of *H. devexus*. Thus, synonymy of the two taxa is not formally suggested here, but the status of *H. densus* should be reconsidered when additional material of this form (so far only known from the Montebello Islands) becomes available.

Further, in the original descriptions of *H. devexus*, *H. obliquus* Erséus, 1997, *H. densus* and

*H. dolosus* Erséus, 1997, Erséus (1997a) stated that the epidermal slits associated with spermathecal pores are located "immediately anterior to" these pores. This was a lapsus calami; the intended meaning was "immediately posterior to".

### Distribution and habitat

Western Australia. Intertidal or barely subtidal, medium to coarse sand.

### *Heterodrilus carinatus* sp. n.

Figure 4

?*Heterodrilus devexus* Erséus, 1997a (*partim*): 402–404, figure 4E (but not figure 4A–D).

### Holotype

WAM V 4309, whole-mounted specimen.

### Type locality

Western Australia, Dampier area, E part of Nickol Bay, E of Cleaverville, intertidal pool (Station DP00-5A).

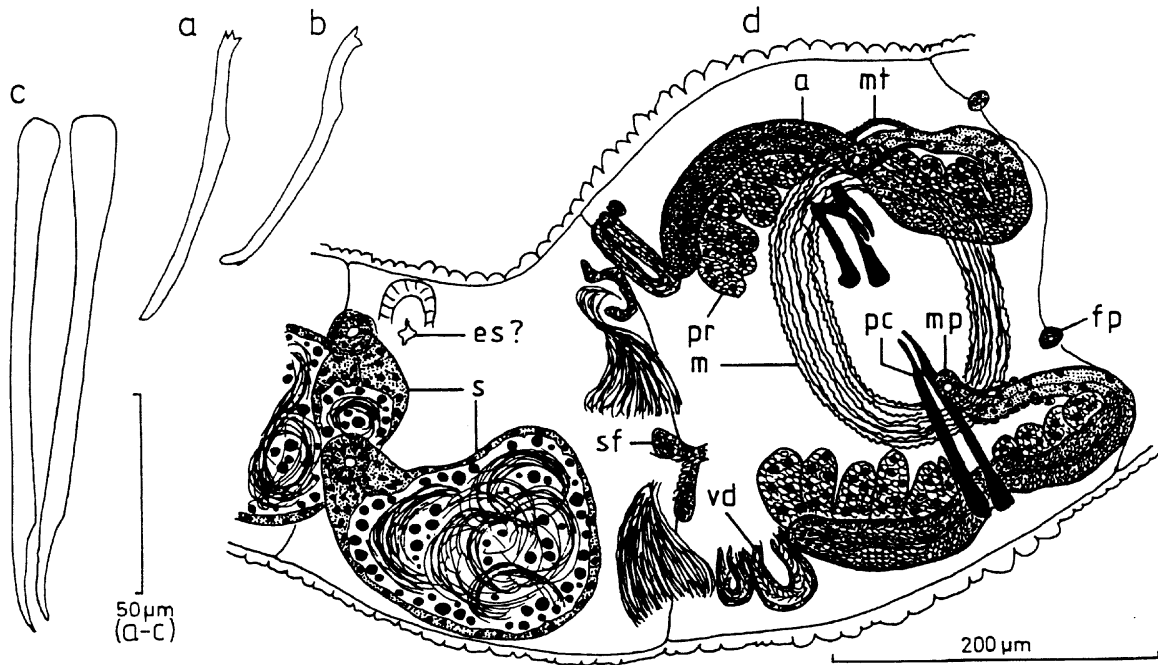
### Other material

SMNH Main Coll. 16954 (former Cat. No. 1534), one specimen from Montebello Islands, Western Australia, tentatively identified as *H. devexus*; for details, see Erséus (1997a).

### Description of holotype

Length 9.4 mm, 58 segments. Width at XI, 0.36 mm. Prostomium rounded triangular, longer than wide. Clitellum extending over XI–XII. Somatic chaetae two per bundle in segments II–IX, thereafter one chaeta representing each bundle. Chaetae of II–X(XI) trifid (Figure 4a), with middle tooth longer than upper and lower [but upper tooth not as slender, and not as well separated from middle one by deep cleft, as in *H. devexus* (cf. Figure 3a)]. Trifid chaetae 40–75  $\mu\text{m}$  long, 2.5–5  $\mu\text{m}$  thick at node; longest near clitellum. From XI(XII), chaetae bifid (Figure 4b), with widely diverging, broad teeth; upper tooth somewhat smaller than lower. Bifid chaetae variable in size, maximally about 65  $\mu\text{m}$  long, 5  $\mu\text{m}$  thick at node. Penial chaetae (Figure 4c; 4d: pc) single-pointed, slender, two per bundle, perpendicular to long axis of body. These chaetae about 125  $\mu\text{m}$  long, about 5.5  $\mu\text{m}$  thick at middle, entally conspicuously wider (about 12  $\mu\text{m}$ ), ectally with keel-shaped nodes and then tapering into thin, somewhat curved, tips. Within bundle, penial chaetae parallel. Tips of bundles (of two sides) close together, in middle of ventral depression of body wall in XI. Epidermal slits close to spermathecal pores appear to be present (Figure 4d: es?), but details unclear. Male pores paired, in line with ventral somatic chaetae, posteriorly in XI. Spermathecal pores paired, located mid-way between lines of ventral somatic chaetae and lateral lines in anteriormost part of X. Female pores in line with ventral somatic chaetae in intersegmental furrow between XI and XII.

Pharyngeal glands in IV–VI. Coelomocytes round, granulated, abundant. Male genitalia (Figure 4d) paired. Vas deferens up to about 17  $\mu\text{m}$  wide, appear to be irregularly coiled, but not observed in its full length; entering apical end of atrium. Atrium cylindrical, more or less M-shaped, 425  $\mu\text{m}$  long, about 27  $\mu\text{m}$  wide (i.e., 16 times longer than wide), with 1–2  $\mu\text{m}$  thick



**Figure 4** *Heterodrilus carinatus* sp. n. a: trifid somatic chaetae from segment IX; b: bifid somatic chaetae from segment XIII; c: bundle of penial chaetae; d: ventral view of male genitalia and spermathecae in segments X-XI.

muscular layer, and ciliated and for most parts granulated inner epithelium. Prostate glands broadly attached to ventral surface of most of length of atrium. Ectal part of atrium tapering, non-granulated, leading to small (penial?) papilla, but copulatory sac poorly developed, if present at all. Thin (monocellular) layer of mesodermal tissue 'anchoring' this duct to body wall (Figure 4d: mt). A part of ventral body wall in XI heavily muscular (Figure 4d: m), i.e., muscle fibres encircling an area containing both male pores and tips of penial chaetae. Spermathecae (Figure 4d: s) with large oval ampullae containing large bundles of sperm and numerous secretory granules; ducts somewhat muscular, but not well set off from ampullae. One spermatheca confined to X, the other extending into IX.

### Etymology

Named *carinatus*, Latin for "keel-shaped", for the characteristic nodes on the penial chaetae.

### Remarks

This new species appears closely related to both *H. devexus* and *H. densus* (see Erséus, 1997a; and Remarks for *H. devexus* above); all three taxa have long, M-shaped atria, bichaetal bundles of (slender) penial chaetae and strong muscles surrounding the male pore area. As indicated above, *H. devexus* and *H. densus* are similar and may even be synonymous, but *H. carinatus* is easily distinguished from both of them by the broad inner ends of its penial chaetae (cf. Figures 3c and 4c; Erséus, 1997a: figure 5C). There appear to be other differences too. The somatic chaetae are maximally only 75 µm long (and 5 µm thick) in *H. carinatus*, but up to 100 µm (7 µm) in *H. devexus* and 90 µm (6.5 µm) in *H. densus*. Further, in *H. carinatus*, the spermathecal ducts are not as well set off from the ampullae as they are in *H. devexus*/*H. densus*

(cf. Figures 3d, 4d). Finally, in the new species, the spermathecal pores are located midway between the lines of the ventral chaetae and the lateral lines, which is somewhat dorsal to the position noted for *H. devexus*. Erséus (1997a: 406) claimed that these pores are "mid-way" in *H. densus* too, but upon a re-examination of the type material, we are no longer convinced about this. In the holotype of *H. densus*, one spermathecal pore is clearly located dorsal to the lines of the ventral chaetae, but the row of body wall nuclei that in most aquatic oligochaetes reveals the position of the lateral line (see Stephenson, 1930: 36–37), is not visible in the spermathecal region and thus gives no good reference point for how much "dorsal" the pore is. In the paratype, on the other hand, the spermathecal pores themselves cannot be observed, as none of them is on the coverslip side of the mounted worm.

The single specimen from the Montebello Islands previously attributed to *H. devexus* (see Erséus, 1997a, and above) probably is *H. carinatus* too. However, it lacks spermathecae, probably because it is sexually not fully mature (e. g., a clitellum is not developed), so the location of the spermathecal pores, which seems to be taxonomically important for *H. carinatus*, is 'unknown' for this specimen. At any rate, as concluded above, the Montebello individual does not seem to belong to *H. devexus*.

#### **Distribution and habitat**

Known only from Western Australia. Lower intertidal medium to coarse sand (holotype from Dampier area), and subtidal (4 m) clean coarse sand (specimen from Montebello Islands).

### **Subfamily PHALLODRILINAE**

#### **Genus *Albanidrilus* Erséus, 1992(b)**

#### ***Albanidrilus pulcher* sp. n.**

#### **Figure 5**

#### **Holotype**

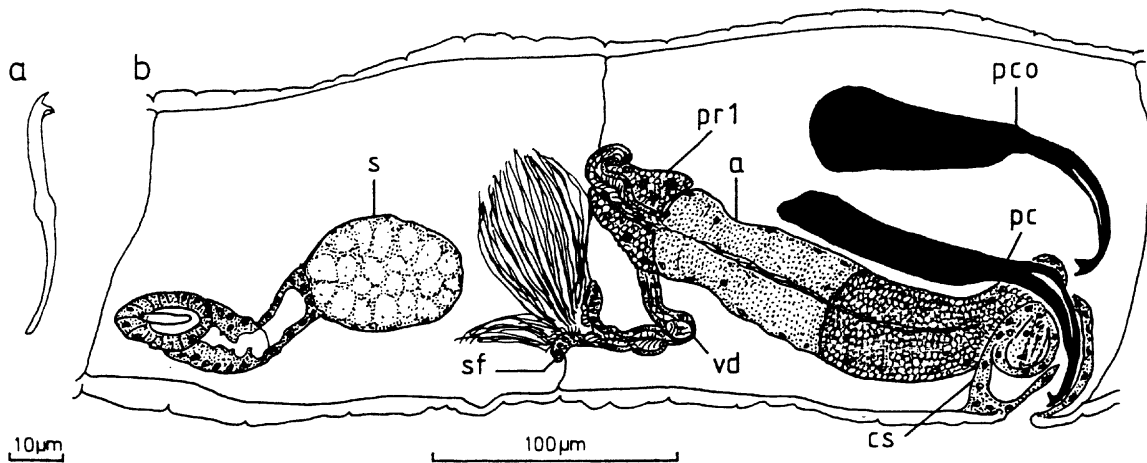
WAM V 4310, whole-mounted specimen.

#### **Type locality**

Western Australia, Dampier Archipelago, NW of Enderby Island (Station DP00-20).

#### **Description**

Length 3.6 mm, 21 segments. Holotype intact at both ends, but preclitellar region shorter than normal for a tubificid and lacking a pharynx (head region may be regenerated after amputation). Width at genital region 0.17 mm. Prostomium slightly longer than wide, tapering (not bulbous). Clitellum not developed. Somatic chaetae (Figure 5a) bifid, with upper tooth somewhat thinner and shorter than lower, and with subdental ligament and conspicuous node. Bifid chaetae 35–50 µm long, with ectal parts 2–3 µm thick, ental parts distinctly thinner, three (occasionally two) per bundle anteriorly, two per bundle in postclitellar segments. Penial chaetae (Figure 5b: pc, pco), one on each side of segment VIII, conspicuous, about 135 µm long (measured as a straight line between opposite ends), each consisting of somewhat flat ental part, about 30 µm wide at inner end, and curved, maximally about 9 µm wide, ectal part, the end of which is grooved and terminates in a bifid tip. Penial chaetae enclosed in complex sacs, latter



**Figure 5** *Albanidrilus pulcher* sp. n., a: somatic chaeta; b: somewhat lateral view of genitalia in segments X-XI.

involving also terminal parts of male ducts. Male pores paired in line with ventral chaetae, posteriorly in VIII. Spermathecal pores paired, slit-like, located immediately ventral to lateral lines, anteriorly in VII.

Pharyngeal glands in (III)IV, but poorly developed (possibly due to regeneration of head region; see above). Male genitalia (Figure 5b) paired. Vas deferens 10–15 µm wide, non-muscular, somewhat coiled, shorter than and entering apical end of atrium. Atrium elongate, about 180 µm long, 40–50 µm wide, with thin outer muscular layer, and thick, granulated (and ciliated?) epithelium. Ental end of atrium truncate, this end bearing a cap-like (anterior) prostate gland; vas deferens seems to penetrate this prostatic 'cap'. Inner epithelium of ectal half of atrium histologically similar to anterior prostate; this tissue possibly homologous to a posterior prostate gland, but such gland externally on atrium absent. Ectal end of atrium tapering, terminating at inner end of folded copulatory sac; latter difficult to distinguish from sac of penial chaeta. Spermathecae (Figure 5b: s) with (1) voluminous, thick-walled vestibules, 45–50 µm long, 29–34 µm wide, (2) cylindrical, thin-walled, duct proper, about 35 µm long, 14–22 µm wide, and (3) oval ampullae, about 60 µm long, about 45 µm wide; ampulla solid, without lumina and sperm, i.e., not completely developed.

### Etymology

Named *pulcher*, Latin for "beautiful", for its astonishing penial chaetae.

### Remarks

As indicated above, the seemingly anterior shift in the position of the genital organs (to VII–VIII instead of X–XI as is normal for a tubificid) in the available specimen of this species may be accidental and not species-specific.

*Albanidrilus pulcher* appears most closely related to *A. cultrifer* Erséus, 1997(a), another Western Australian taxon. Both species have large single, basally broad, penial chaetae, and seem to lack external posterior prostate glands of the atria, i.e., two features that are likely to be synapomorphic, although the broad penial chaetae are shared also by *A. coxensis* Erséus, 1997(b) from Australia's Northern Territory. The new species differs from *A. cultrifer* by (1) its



longer, and clearly bifid, penial chaetae (the inner ends of the penial chaetae of *A. cultrifer* are short and axe-shaped, and the outer ends are single-pointed), (2) its spermathecal pores being placed in a 'normal' phallodriline position vis-à-vis the anterior septum of the spermathecal segment (in *A. cultrifer*, the pores are located anterior to the septum, i.e. in the segment in front of this segment), and (3) its smaller anterior prostate glands. In *Albanidrilus coxensis*, the spermathecal openings are in the same position as in *A. pulcher*, but *A. coxensis* has single-pointed penial chaetae, and these chaetae are at least two per bundle. Moreover, in *A. coxensis*, both the anterior and posterior prostate glands are well developed.

#### **Distribution and habitat**

Known only from the Dampier Archipelago, Western Australia. Subtidal, at about 13 m depth.

#### **Genus *Pectinodrilus* Erséus, 1992(b)**

##### ***Pectinodrilus multiplex* (Erséus, 1990)**

*Phallodrilus multiplex* Erséus, 1990a: 60–62, figure 8.

*Pectinodrilus multiplex*; Erséus, 1992b: 36, figure 19G; 1993: 352–353, figure 9; 1997a: 416–417; 1997b: 113.

#### **New material**

WAM V 4311 through V 4315, five specimens, and SMNH Main Coll. 43956–43969, 14 specimens: all from Station DP00-16E. SMNH Main Coll. 43970, one specimen from Station DP00-14G.

#### **Remarks**

*Pectinodrilus multiplex* is already well documented from Western Australia and the Northern Territory (references, see above). The species has complex male genital ducts and numerous penial chaetae; in the Dampier specimens, these chaetae are mostly between eight and 12 per bundle, occasionally as few as four or as many as about 16 per bundle. The tips of the penial chaetae, the details of which are generally difficult to see, have previously been described as "somewhat clubbed with a thin apical hook" (Erséus, 1990a: figure 8B). The Dampier material shows greater morphological variation in this character; some penial chaetae are single-pointed with simple curved tips, others are clubbed with the apical hooks, and yet others are more typically bifid (each with two curved teeth). Six of the new specimens are complete; they are 5.3–8.4 mm long, with 49–73 segments.

#### **Distribution and habitat**

Western Australia, Northern Territory. Intertidal and subtidal sand, to at least 1.5 m depth.

#### **Genus *Bathydrilus* Cook, 1970**

##### ***Bathydrilus paramunitus* sp. n.**

Figure 6

#### **Holotype**

WAM V 4316, whole-mounted specimen.

### Type locality

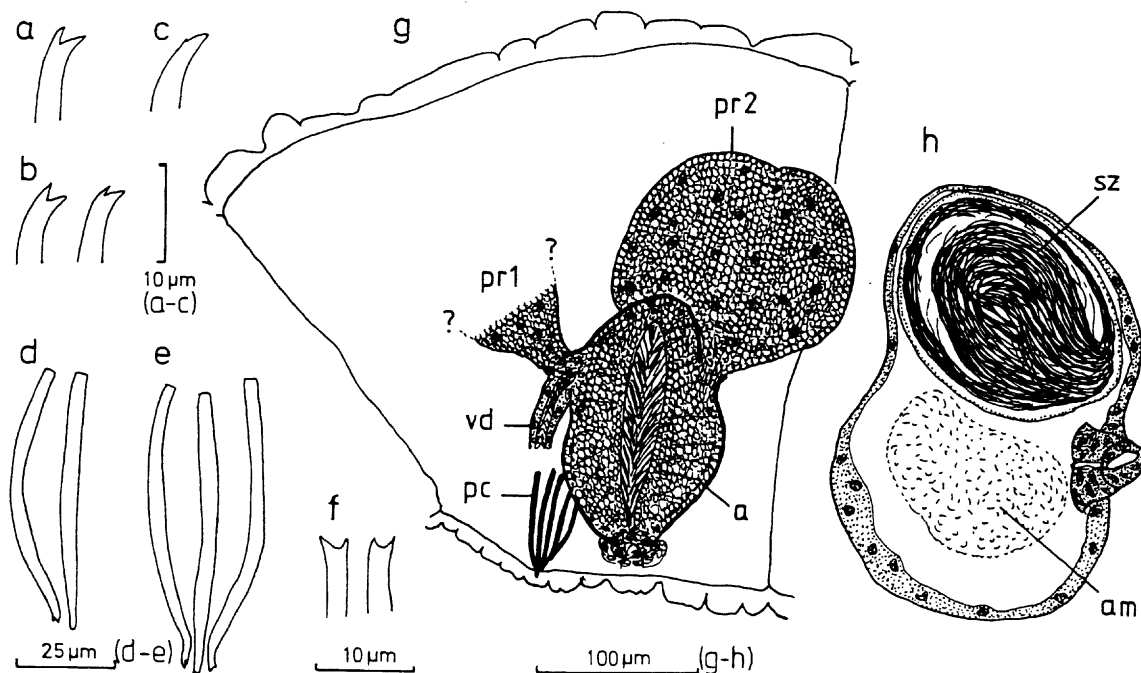
Western Australia, Dampier Archipelago, NW of Dampier shopping center (Station DP00-16E).

### Paratypes

WAM V 4317 through V 4319, three specimens, and SMNH Type Coll. 5502-5504, three specimens: all from type locality.

### Description

Holotype 12.8 mm long, but missing prostomium and eight first segments, provided genital organs (see below) are in position as in paratypes; if so, originally with 86 segments. All paratypes incomplete, considerably shorter and with fewer remaining (posterior) segments than holotype. Width at XI, 0.33–0.60 mm. Prostomium more or less triangular, generally about as long as wide. Clitellum extending over X–XII. Narrow transversal patches of epidermal glands present at level of chaetae in many segments, both anterior and posterior to clitellum; patches either forming complete rings around body, or restricted as two lateral stripes, one on each side. Somatic chaetae 40–65  $\mu\text{m}$  long, 2–3.5  $\mu\text{m}$  thick, two or three (occasionally four) per bundle. Preclitellar chaetae bifid with upper tooth thinner and shorter than lower (Figure 6a). In segments immediately posterior to clitellar region, chaetae similar to preclitellar ones (Figure 6b), thereafter with upper tooth becoming progressively shorter and reduced almost completely in posteriormost segments (Figure 6c). In all bifid chaetae, curvature of lower tooth is a smooth



**Figure 6** *Bathydriilus paramunitus* sp. n., a: anterior somatic chaeta; b: postclitellar, mid-body, somatic chaetae; c: somatic chaeta from posterior end of body; d: bundle of two penial chaetae from one paratype; e: bundle of three penial chaetae from another paratype; f: tips of penial chaetae; g: male genitalia in segment XI (note that penial chaetae are five per bundle), holotype; h: spermatheca of a paratype.

continuation of that of setal shaft (see Remarks). Penial chaetae 75–85  $\mu\text{m}$  long, 3.5–4  $\mu\text{m}$  thick, generally two (Figure 6d) or three per bundle (Figure 6e), occasionally only one, or (holotype) as many as five per bundle (Figure 6g: pc). Tips of penial chaetae somewhat variable, some bifid and similar to those of somatic chaetae (cf. Figure 6a–b), other chisel-shaped (Figure 6f) or even bluntly single-pointed. Within bundle, outer tips closer together than inner ends (Figure 6d–e: g). Tips of both bundles near mid-ventral line of worm. Male pores paired, immediately ventral to lines of ventral somatic chaetae, posterior to middle of XI. Spermathecal pores paired in lateral lines, in most anterior part of X.

Pharyngeal glands in IV–(VI)VII(VIII). Anterior septa not conspicuously muscular (see Remarks). Male genitalia (Figure 6g) paired. Vas deferens not observed in its full length in any specimen, but entering anterior face of atrium at about one third from atrial apex. Atrium erect, oval-to-spindle-shaped, 125–200  $\mu\text{m}$  long, 70–100  $\mu\text{m}$  wide, with thin outer muscular layer, and granulated and heavily ciliated inner epithelium. Atrium opening to exterior through simple pore; copulatory sac absent. Prostate glands large, anterior one attached to atrium at entrance of vas deferens; posterior one attached to posterior face of atrium, at some distance from atrial apex and more or less opposite to entrance of vas. Spermathecae (Figure 6h) consisting of short, narrow duct, and large oval or spherical ampulla; exact shape and size of latter difficult to see in most specimens. In post-copulatory specimens, sperm as conspicuous, round or somewhat triangular-to-bell-shaped, spermatozeugmata (Figure 6h: sz) in spermathecal ampullae. Ampullae sometimes containing also large amorphous masses of secretion (Figure 6h: am).

### Etymology

Named *paramunitus* for its close similarity with *B. munitus* (see Remarks).

### Remarks

*Bathydrilus paramunitus* is most closely related to *B. munitus* Erséus, 1990(d), a species from Victoria, on the southern coast of Australia. The taxa have virtually identical atria and spermathecae, and *B. munitus* has penial chaetae (generally three or four per bundle) that fall within the numerical range observed for *B. paramunitus*. Nevertheless, chaetal characteristics clearly separate the two species. Most striking is the rather unusual feature of *B. munitus* to have the lower teeth of the somatic bifid chaetae positioned almost perpendicular to the chaetal shafts (see Erséus, 1990d: figure 1A–B), whereas the lower teeth are not so in the new taxon (Figure 6a–c). Second, the tips of the penial chaetae are sharply single-pointed in *B. munitus*, but generally bifid or chisel-shaped in *B. paramunitus*. Finally, in *B. munitus*, some anterior septa are conspicuously muscular, whereas the septal musculature is normal, i.e., only moderately developed, in *B. paramunitus*.

A single *Bathydrilus* specimen was described from the Northern Territory by Erséus (1997b). It was not attributed to any particular species, but it was tentatively regarded as a new species with some affinity to *B. munitus* (and also *B. superiovasatus* Erséus, 1981b). However, this "*Bathydrilus* sp." also differs from *B. paramunitus* with regard to its postclitellar (somatic) 'bundles' being unicheatal, and its penial chaetae (three per bundle) being sharply single-pointed and larger (about 100  $\mu\text{m}$  long, 5–6  $\mu\text{m}$  thick) than those of *B. paramunitus*.

### Distribution and habitat

Known only from the Dampier Archipelago, Western Australia. Subtidal medium to coarse sand, 0.5 m depth.

**Genus *Duridrilus* Erséus, 1983(a)*****Duridrilus piger* Erséus, 1984**

*Duridrilus piger* Erséus, 1984a: 154–155, figures 12–13; 1990b: 285; 1997a: 421–422, figure 11; 1997b: 118.

**New material**

SMNH Main Coll. 43971, one specimen from Station DP00-11C.

**Brief description of new material**

Specimen incomplete, consisting of 18 first segments only. Width at XI, 0.40 mm. Prostomium small, retracted. Cuticle densely covered with papillae; papillae small in preclitellar segments, larger in postclitellar segments. Clitellum extending over 1/3X-2/3XII. Chaetae bifid, with upper tooth smaller than lower, increasingly so in postclitellar segments. Chaetae two to three per bundle in II-VIII, one to two per bundle thereafter. Male pores paired in XI; area of these pores encircled by oval arrangement of body wall muscles fibers (see Erséus, 1984a: figure 12e–f). [Male genitalia as described by Erséus, 1984a.] Spermathecae with narrow ducts and large, oval ampullae. Sperm as curved bundles in spermathecae.

**Remarks**

A single individual from the Montebello Islands in north-western Western Australia was tentatively identified as *D. piger*, although its spermathecae had longer (and more slender) ducts than expected for this species, and although muscle fibers encircling the male pores could not be observed (Erséus, 1997a). The worm from the Dampier area is at a later stage of maturity; its spermathecae are better developed and contain sperm, and its male pores are encircled by muscles fibers. It thus confirms the occurrence of *D. piger* in Western Australia.

**Distribution and habitat**

Western Australia, Northern Territory and Hong Kong. Lower intertidal and subtidal sand, to at least 15 m depth.

**Genus *Coralliodrilus* Erséus, 1979*****Coralliodrilus bidentatus* Erséus, 1993**

*Coralliodrilus bidentatus* Erséus, 1993: 359–361, figure 14.

**New material**

SMNH Main Coll 43972, one specimen from Station DP00-16B.

**Remarks**

This species is already known from Rottneet Island in Western Australia (Erséus, 1993). The new specimen conforms well with the original description, although its atria (about 180 µm long) are longer than those of the original material (110–170 µm long).

**Distribution and habitat**

Queensland (Great Barrier Reef) and Western Australia. Lower intertidal and subtidal medium to coarse sand, to at least 8 m depth.

**Genus *Olavius* Erséus, 1984(b)*****Olavius clavatus* (Erséus, 1981)**

*Phalodrilus clavatus* Erséus, 1981b: 20–21, figures 9–10, tables II–III.

*Olavius clavatus*; Erséus, 1984b: 260, figure 23; 1993: 366–368, figure 18; 1997a: 428–429, table 2; 1997b: 120.

**New material**

SMNH Main Coll. 43973, one specimen from Station DP00-2.

**Remarks**

This gutless tubificid has repeatedly been recorded from the tropical parts of Australia (Erséus, 1981b, 1984b, 1993, 1997a–b), and its occurrence in the Dampier area was expected. The specimen conforms well with previous descriptions. The present specimen has 55–75 µm long penial chaetae, five to six per bundle, and about 80 µm long atria.

**Distribution and habitat**

Queensland (Great Barrier Reef), Northern Territory and Western Australia. Intertidal and subtidal sand, to at least 14 m depth.

**Subfamily LIMNODRILLOIDINAE****Genus *Doliodrillus* Erséus, 1984(a)*****Doliodrillus divarticulatus* Erséus, 1985**

*Doliodrillus divarticulatus* Erséus, 1985: 144–146, figure 11; 1997a: 443–444; Erséus, 1997b: 120–121; Gustavsson and Erséus, 1999: 473–476, figure 5f, table 1.

**New material**

SMNH Main Coll. 43974–43976, three specimens from Station DP00-14E.

**Remarks**

This species is already known from the Montebello Islands in Western Australia (Erséus, 1997a), and it appears widespread in the Indo-West Pacific region (references above).

**Distribution and habitat**

Saudi Arabia, Western Australia, and Northern Territory; recently also found in southern China (Wang and Erséus, in press). Intertidal and subtidal mangrove sediments, brackish-water and marine.

Genus *Tectidrilus* Erséus, 1982*Tectidrilus borioides* sp. n.

## Figure 7

**Holotype**

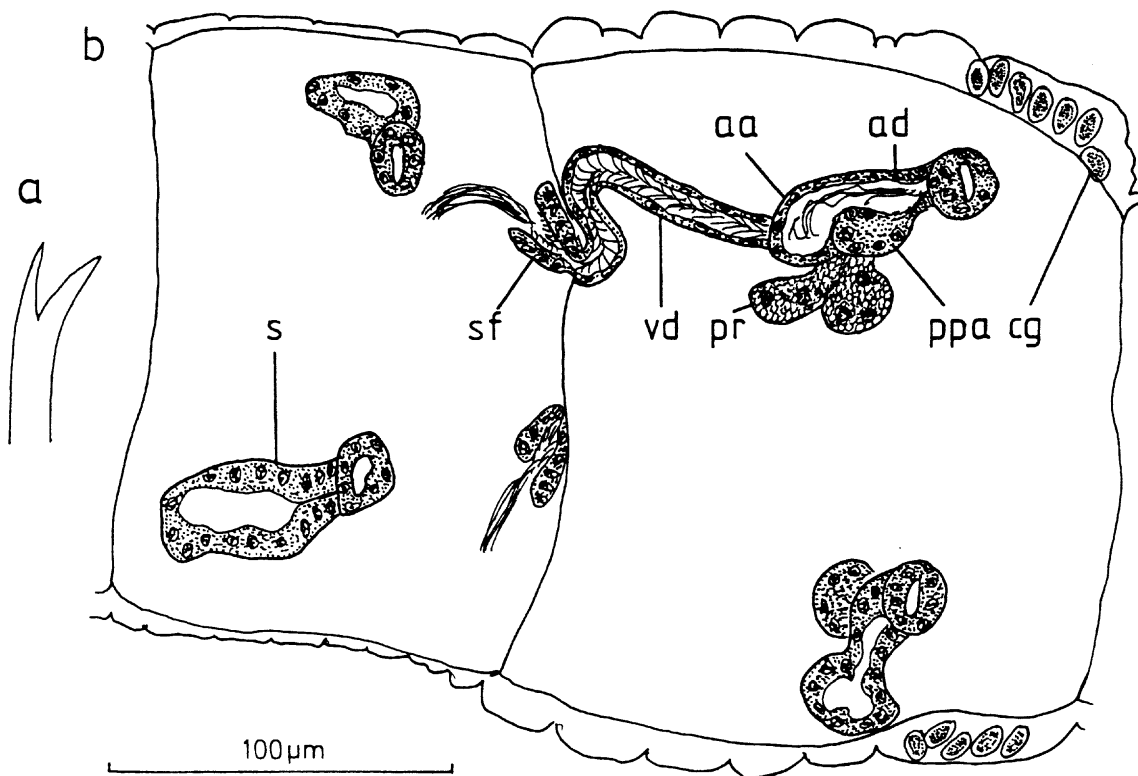
WAM V 4320, whole-mounted specimen.

**Type locality**

Western Australia, Dampier area, Nickol Bay, Karratha Beach (Station DP00-12B).

**Description**

Length more than 1.7 mm, more than 14 segments; holotype not complete. Width at IX, 0.22 mm. Prostomium about as long as wide, appearing partially retractile. Clitellum short, confined to XI and anteriormost XII. Chaetae (Figure 7a) bifid, with upper tooth somewhat thinner than, but almost as long as lower. Chaetae 35–50  $\mu\text{m}$  long, 1.5–2  $\mu\text{m}$  thick, two per bundle in segments II–VIII, one representing each bundle thereafter; chaetae totally absent from genital segments. Male pores paired in line with ventral chaetae, posterior to middle of XI. Spermathecal pores paired in line with ventral chaetae, posterior to middle of X.



**Figure 7** *Tectidrilus borioides* sp. n., a: free-hand drawing of chaeta; b: ventral view of male genitalia and spermathecae in segments X–XI. Note that, on one side of the worm (bottom of figure), only parts of the male duct are completely visible.

Pharyngeal glands well developed in IV-V. Pair of oesophageal diverticula present in anterior part of IX, communicating with oesophagus in middle of segment. Male genitalia (Figure 7b) paired. Vas deferens longer than atrium, but poorly visible; only approximate outline of it indicated in Figure 7b. Atrium small, club-shaped, totally about 65  $\mu\text{m}$  long, consisting of hollow, about 22  $\mu\text{m}$  wide, ampulla, and short duct. Prostate gland small, lobed, communicating with compact prostatic pad inside atrial ampulla. Atrial duct opening to exterior through simple pore. Atrium of one side of holotype containing sperm. Latero-posterior to each male pore, body wall (clitellum) containing a group of about ten small oval (copulatory) glands (Figure 7b: cg); these glands possibly multicellular, but confined to within the (otherwise unilayered) clitellar epithelium. Spermathecae (Figure 7b: s) simple, club-shaped, up to about 70  $\mu\text{m}$  long, 28  $\mu\text{m}$  wide, but probably not fully developed (sperm absent inside).

### Etymology

Named *borioides*, for its resemblance to *T. bori* (see Remarks).

### Remarks

The most striking feature of this species is its possession of two groups of distinct copulatory glands in the posterior part of segment XI (Figure 7b: cg). Among the congeners, anything similar is present only in *T. bori* (Righi and Kanner, 1979), a species known from the Caribbean area in the Atlantic Ocean as well as Hawaii in the Pacific (Righi and Kanner, 1979; Erséus, 1982; Erséus and Davis, 1989). However, while *T. borioides* has about ten glands in each group, all contained within the clitellar epithelium, *T. bori* has fewer (maximally six on each side) and larger glands that are sunken into the coelomic cavity (see Erséus, 1982: figure 33). Moreover, *T. bori* has pseudopenes, whereas the atria of the new taxon open directly to the exterior through simple pores.

### Distribution and habitat

Known only from the Dampier area, Western Australia. Intertidal pool with coarse to medium sand.

### Genus *Limnodriloides* Pierantoni, 1903

#### *Limnodriloides lateroporus* Erséus, 1997

*Limnodriloides lateroporus* Erséus, 1997b: 127–128, figure 15; 1997a: 444; 1997c: 46–47, figure 5.

### New material

SMNH Main Coll. 43977, one specimen from Station DP00-13.

### Remarks

This single specimen is not well preserved, and the details of its male genitalia are not clear, but the combination of its chaetal pattern, size of oesophageal diverticula, and small, globular spermathecae with mid-lateral pores fits exactly with the description of *L. lateroporus*. Moreover, what can be seen of the male ducts indicates that they are simple and small, which also supports this identification. The species was originally described from the Northern

Territory (Erséus, 1997b) and soon after also recorded from the Montebello Islands in Western Australia (Erséus, 1997a), and Hong Kong in southern China (Erséus, 1997c). Its presence in the Dampier region could therefore be expected.

#### **Distribution and habitat**

Western Australia and Northern Territory (Australia), and Hong Kong. Intertidal and subtidal (sometimes muddy) sand, to at least 19.5 m depth.

#### ***Limnodriloides tenuiductus* Erséus, 1982**

*Limnodriloides tenuiductus* Erséus, 1982: 247–248, figure 26; 1985: 149–150, figure 14; 1990b: 300–302, figure 18.

#### **New material**

WAM V 4321, one specimen from Station DP00-16B.

#### **Brief description of new material**

Specimen 4.3 mm long, with 43 segments. Width at XI, 0.27 mm. Clitellum extending over XI–XII. Chaetae bifid, two (occasionally one) per bundle in preclitellar segments, one representing each bundle thereafter. Spermathecal pores paired, in line with dorsal chaetae in middle of X (but dorsal chaetae absent in this segment). Atria tubular and coiled, consisting of small atrial ampullae and long atrial ducts; former bearing prostate gland, latter terminating in pseudopenial papillae inside deep copulatory sacs. Spermathecae oval, each merely an ampulla (duct virtually absent), 63  $\mu\text{m}$  long, 42–53  $\mu\text{m}$  wide, containing small, slender spermatozeugmata.

#### **Remarks**

This species, although already known to be widely distributed in the Indo-West Pacific region (Erséus, 1990b), has not been found in Western Australia before.

#### **Distribution and habitat**

Western Australia (new record), Queensland (Great Barrier Reef), southern China, Saudi Arabia. Intertidal and subtidal sediments, to at least 4 m depth.

#### ***Limnodriloides armatus* Erséus, 1982**

*Limnodriloides armatus* Erséus, 1982: 238–240, figures 18–19; 1997a: 448–449.

#### **New material**

WAM V 4322 through V 4328, seven specimens: four from Station DP00-8B, three from Station DP00-8C. SMNH Main Coll. 43978–43985, eight specimens: two from Station DP00-15B, one from each of Stations DP00-10, DP00-11B, DP00-11C, DP00-12B, DP00-14D, and DP00-15A.

#### **Remarks**

Originally described from Queensland's Great Barrier Reef (Erséus, 1982), this species was



subsequently reported from the Montebello Islands (Erséus, 1997a), which is not far from the Dampier area. The new specimens conform well with the previous lots of material, but their spermathecal chaetae, all located immediately posterior to the mid-ventral, unpaired, spermathecal pore, are up to 175 µm long, which is greater than the maximum length (145 µm) reported before.

### **Distribution and habitat**

Western Australia, Queensland. Intertidal and subtidal sandy or silty sediments, to at least 12 m depth.

### ***Limnodriloides rubicundus* Erséus, 1982**

*Limnodriloides rubicundus* Erséus, 1982: 226–228, figure 10. Other references listed by Erséus (1997b: 126).

### **New material**

WAM V 4329 through V 4334, six specimens, and SMNH Main Coll. 43986–43997, twelve specimens: all from Station DP00-14E. SMNH 43998, one specimen from Station DP00-14F.

### **Remarks**

*Limnodriloides rubicundus*, originally described from the Northwest Atlantic (Erséus, 1982), has been recorded from warm regions of all major oceans, including the Indian Ocean coast of Western Australia (Erséus, 1993). However, the possibility that this taxon is a mixture of several species has been suggested (Erséus, 1997b). The new specimens all have slender, somewhat muscular atrial ampullae, and also in other respects they resemble the original (Caribbean) material well (see Erséus, 1982: figure 10).

### **Distribution and habitat**

Western Australia, Northern Territory, Queensland, Fiji, Hawaii, southern China, Barbados, Venezuela, Belize, Bahamas, Bermuda, United States east coast (Florida through Delaware). Intertidal and subtidal, largely muddy or fine sediments, to at least 74 m depth.

### ***Limnodriloides tarutensis* Erséus, 1986**

Figure 8

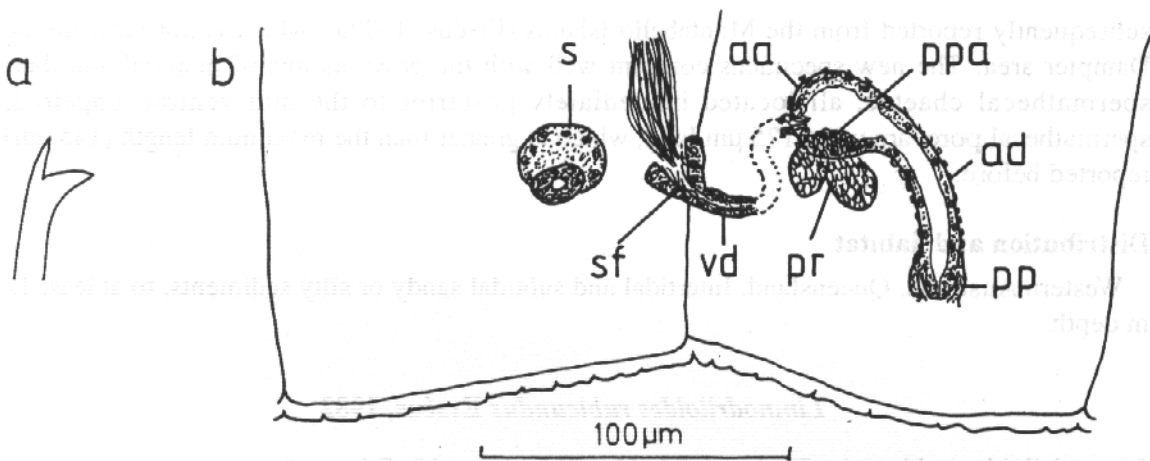
*Limnodriloides tarutensis* Erséus, 1986: 3–5, figure 1.

### **New material**

WAM V 4335, one specimen from Station DP00-14F.

### **Brief description of new material**

Length more than 2.6 mm, more than 20 segments (specimen not complete). Width at XI, 0.19 mm. Prostomium somewhat triangular, shorter than wide. Clitellum extending over parts of XI–XII, probably not fully developed. Chaetae (Figure 8a) about 30–40 µm long, 1.5–2 µm thick, two to four per bundle anteriorly, two per bundle in postclitellar segments. A part of oesophagus



**Figure 8** *Limnodriloides tarutensis*. a: free-hand drawing of chaeta; b: lateral view of male genitalia and spermatheca in segments X-XI.

widened, thick-walled and glandular in IX. Male genitalia (Figure 8b) paired. Vas deferens at least about  $7\ \mu\text{m}$  wide, but not seen in its full length. Atrium club-shaped, ampulla about  $35\ \mu\text{m}$  long,  $25\ \mu\text{m}$  wide, with small prostatic pad and small prostate gland. Atrial duct about  $50\ \mu\text{m}$  long,  $13\ \mu\text{m}$  wide, leading to simple pseudopenis. Spermathecae (Figure 8b: s) small, oval-to-spherical, but not fully developed; no sperm inside.

#### Remarks

This species was originally described on the basis of two specimens from the Arabian Gulf coast of Saudi Arabia (Erséus, 1986). It differs from the closely related *L. rubicundus* by its much shorter atrial ampullae, smaller prostate glands, and less developed spermathecal ampullae. The new individual conforms well with the original description, even in dimensional features.

#### Distribution and habitat

Western Australia (new record), Saudi Arabia. Intertidal and subtidal sediments, either associated with mangroves or seagrass.

### Genus *Smithsonidrilus* Brinkhurst, 1966

#### *Smithsonidrilus ludmillae* Erséus, 1997

*Smithsonidrilus ludmillae* Erséus, 1997b: 122–123, figure 12.

#### New material

WAM V 4336, one specimen from Station DP00-8E.

#### Brief description of new material

Specimen not complete, comprising only prostomium and 17 anteriormost segments. Width at

XI, 0.28 mm. Prostomium triangular with apical papilla. Clitellum extending over XI-2/3XII. Chaete bifid, 35–40  $\mu\text{m}$  long, 1.5–2  $\mu\text{m}$  thick, (one) two to four per bundle anteriorly, two per bundle in segments immediately posterior to clitellum. Male and spermathecal pores paired, in line with ventral chaetae. Oesophageal diverticula (in IX) not visible, indicating that they are small. Vasa deferentia not seen. Atrial ampullae 75–85  $\mu\text{m}$  long, 35–40  $\mu\text{m}$  wide, with distended inner parts, and bearing large lobed prostates. Atrial ducts 65–70  $\mu\text{m}$  long, 13–17  $\mu\text{m}$  wide, terminating in simple pseudopenes. Spermathecae with short narrow ducts, and thin-walled, oval to elongate ampullae; latter 100–170  $\mu\text{m}$  long, about 60–65  $\mu\text{m}$  wide, each containing a mixture of several rather broad spermatozeugmata, and some granules of secretion.

### Remarks

Originally described on the basis of two specimens from Darwin, this species is here recorded from Western Australia for the first time. Except for its marginally larger male ducts and more developed spermathecae, the new specimen conforms well with the type material (Erséus, 1997b).

### Distribution and habitat

Western Australia (new record) and Northern Territory. Intertidal sand.

### *Smithsonidrilus grandiculus* (Erséus, 1983b)

*Marcusaedrilus grandiculus* Erséus, 1983b: 29–30.

*Smithsonidrilus grandiculus*; Erséus, 1990c: 289.

### New material

WAM V 4337 through V 4341, five specimens, and SMNH Main Coll. 43999-44013, 15 specimens, all from Station DP00-16E. SMNH Main Coll. 44014-44022, nine specimens: four from Station DP00-18A, one from each of Stations DP00-8B, DP00-8C, DP00-15A, DP00-15C, and DP00-16B.

### Remarks

This species was originally described on the basis of three specimens from the Great Barrier Reef, Queensland, as *Marcusaedrilus grandiculus* (Erséus, 1983b), but *Marcusaedrilus* was later regarded as a junior synonym of *Smithsonidrilus* (Erséus, 1990c). The new material from the Dampier area is only the second record of the species, which thus now can be expected to occur throughout most of the northern coast of Australia.

Five of the new specimens are complete; they are 4.9–7.0 mm long, with 44–55 segments, which is shorter than the 10.2 mm, and 58 segments, noted for a complete Great Barrier Reef individual (Erséus, 1983b). Furthermore, the number of chaetae shows a greater variation in the new material: the preclitellar chaetae are one to three, occasionally even four (not just one or two) per bundle, and the postclitellar ones are often two (not just one) per bundle. The range extension of these features now eliminates one of the differences between *S. grandiculus* and the Chinese taxon *S. vesiculatus* noted by the original author of the latter (Erséus, 1984a). These two species are closely related, but they are still differentiated by the morphology of their spermathecae. In *S. grandiculus*, when fully developed, the spermathecal ampullae are clearly

bipartite, with an outer wide part containing numerous granules of secretion and an inner, narrower, finger-like part containing the sperm (arranged as slender spermatozeugmata). In *S. vesiculatus*, on the other hand, the ampullae are less clearly bipartite, and they contain no apparent secretory granules.

#### **Distribution and habitat**

Western Australia (new record) and Queensland (Great Barrier Reef). Intertidal and subtidal sand, to at least 4.5 m depth.

#### ***Smithsonidrilus edgari* Erséus, 1993**

*Smithsonidrilus edgari* Erséus, 1993: 381–382, figure 26.

#### **New material**

WAM V 4342 through V 4344, three specimens: two from Station DP00-8C, one from Station DP00-18A. SMNH Main Coll. 44023-44025, three specimens: two from Station DP00-15A, one from Station DP00-16E.

#### **Remarks**

This species was originally described from Cockburn Sound and Rottnest Island in the Perth area (Western Australia); the present record thus demonstrates a considerable range extension to the north. Although most of the new specimens are precopulatory (the spermathecae are not even fully differentiated), they conform to the original description (Erséus, 1993). Only one specimen is complete; it is 6.7 mm long, with 65 segments (the original animals had maximally 60 segments). Moreover, the number of chaetae varies more in the Dampier material than previously reported. Occasionally, there are as many as four chaetae in anterior bundles, and more regularly, many of the posteriormost bundles are represented by two rather than only one chaeta. However, upon re-examination, one SMNH paratype (Type Coll. 4463) of *S. edgari* proved to have a few bichaetal bundles posteriorly too.

#### **Distribution and habitat**

Western Australia. Intertidal and subtidal sand, to at least 2.5 m depth.

### **DISCUSSION**

Previous studies have documented a great species diversity of marine Tubificidae in Western Australia, not only in terms of the total score of species recorded (79 listed by Erséus, 1997a), but also with regard to the high number of taxa found even in a limited collection of specimens. Thus, the total of 188 individuals from the Montebello and Houtman Abrolhos Islands represented 47 different species, 24 of which were each present as a single worm only (Erséus, 1997a). Moreover, there was virtually no overlap in species composition between the Montebello (33 species) and Houtman Abrolhos Islands (16 species), which at least in part was attributed to differences in the predominant habitats of these two sites. A similarly high diversity was noted in a comparable sampling effort of the Tubificidae of the Darwin Harbour in Australia's Northern Territory, with 37 species present among 185 specimens (Erséus, 1997b).

In the Dampier area, 22 species were identified among a total of 185 tubificids examined. Although this is only about one half of the species numbers mentioned for Montebello, Houtman Abrolhos and Darwin above (Erséus, 1997a, b), the diversity pattern is similar: while the six most common species make up 151 (82%) of all the worms, the remaining 16 taxa together comprise only 34 individuals. *Heterodrilus devexus* is the most frequent species, occurring at 12 of the 27 stations sampled, *Limnodriloides armatus* is second, being found at nine stations. Fifteen of the Dampier species were not among the 33 recorded from the Montebello Islands (Erséus, 1997a), and yet the latter islands are located only about 125 km away. This further supports the contention that the northern coast of Australia is a radiation area for marine Tubificidae.

With the new additions reported here (five new species and six new records for the state), 90 species of this group have now been recorded from Western Australia. Still a majority (60 %) of these species are only known from this state, but this may be at least partly a result of the greater sampling effort in Western Australia compared to most other parts of the Indo-Pacific (Erséus, 1997a). Of the six new records for the state, two (*Heronidrilus* cf. *gravidus*, *Smithsonidrilus ludmillae*) were previously known from the Northern Territory, the others from other parts of the Indo-West Pacific region (Saudi Arabia, southern China or Queensland). Such a biogeographical affinity was noted also for the marine tubificid fauna of the Rottneest (Erséus, 1993), Montebello and Houtman Abrolhos Islands (Erséus, 1997a).

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