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# The Aquatic Oligochaeta Known from Australia, New Zealand, Tasmania, and the Adjacent Islands

by

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# THE AQUATIC OLIGOCHAETA KNOWN FROM AUSTRALIA, NEW ZEALAND, TASMANIA, AND THE ADJACENT ISLANDS

## SUMMARY

Between 1888 and 1915, ten papers on the aquatic oligochaetes of this region were published, but only seven more in the last half century. This paper records five haplotaxids, one lumbriculid, at least nine phreodrilids, nineteen naidids, sixteen or more tubificids and two aeolosomatids (although the latter are not recognized as oligochaetes). Twenty-seven new records are listed, as well as new findings of species already known from the region. The location of all types and representative specimens is given where known.

## I. INTRODUCTION

The study of the systematics and ecology of aquatic Oligochaeta has been neglected in most parts of the world, but perhaps nowhere as much as in Australia, Tasmania, and New Zealand, and the adjacent islands. This is surprising in view of the early interest shown, particularly by W. B. Benham, F. E. Beddard, E. J. Goddard, and W. Michaelsen. These authors published a total of ten papers between 1888 and 1915, indicating that a number of species of the small but interesting families Haplotaxidae and Phreodrilidae were to be found in the area. Both of these families show important traces of the evolutionary origins of the aquatic families of the Oligochaeta if not of the group as a whole (Brinkhurst and Jamieson, 1971).

Since these early publications there appear to have been only seven papers published on the aquatic oligochaetes of the area in over half a century. Hence many of the commoner forms remain to be recorded, even some of the species generally considered to be cosmopolitan in distribution.

This lack of interest in the group cannot be attributed to their ecological insignificance. Aquatic oligochaetes, especially the Tubificidae, may be very abundant in soft sediments in both fresh and salt water, and may be found from the smallest pond to the ocean depths beyond the continental shelf. The activities of worms in sediment clearly affect the chemical exchanges at the mud/water interface, the microbiota of the sediment (Brinkhurst and Chua, 1969) and the productivity of the ecosystem by virtue of converting organic sediments and their microbiota into fish food (Kennedy, 1968) as well as food for predatory midges, leeches and other invertebrates.

This review is presented now in order to draw attention to the need for further studies of the aquatic oligochaetes of the region as part of the expanding worldwide interest in the group. There are presumably common species that have not been collected to date, and others that have been attributed to known species that may require re-description and subsequent re-evaluation. Many of the new records are based on small numbers of preserved specimens, and doubt is expressed as to the true identity of several species. If this review stimulates local workers to correct its errors and omissions then it will have achieved its primary goal.

Descriptions and synonymies have been kept brief. For more detailed keys and descriptions see Brinkhurst and Jamieson (1971).

## II. SYSTEMATICS

### Keys to the Aquatic Oligochaeta of Australasia

The following key should be regarded as *provisional* and is placed here as a guide to the *known* species only. It is only to be expected that species not yet known to occur in the region or new species, will be found for some time to come. Full keys to the aquatic Oligochaeta will be found in Brinkhurst and Jamieson (1971).

#### 1. KEYS TO FAMILIES

1. Prostomium ciliated. Internal septation incomplete. Hair setae in all setal bundles. Minute worms (up to 10mm, normally much smaller—c.1mm.).
  - Aeolosomatidae (?Archannelida)
  - (Only two species to date, *A. niveum*, *A. hemprichi*)
  - Prostomium naked. Septation more or less complete. Hair setae in dorsal bundles or absent. Almost always larger than 10mm. . . . . 2
2. Setae two per bundle . . . . . 3
  - Setae more than two per bundle . . . . . 4
3. Setae simple pointed . . . . . Family Haplotaxidae—Key 2.
  - Setae bifid with upper tooth small to indistinct . . . . . Family Lumbriculidae
  - (Only one species, *Lumbriculus variegatus*)
4. Dorsal setae start on III, hair setae plus short setae not emerging from setal sacs, or on posterior segments only in parasitic forms. Ventral setae paired, often one bifid and one simple pointed, often differ in thickness. . . . . Family Phreodrilidae—Key 3.
  - Dorsal bundles from II or from V, VI or posterior bundles or absent. Ventral setae numerous, almost always bifid. . . . . 5
5. Usually less than 2 cm. long, delicate transparent worms, sometimes with eyes and/or gills, or proboscis developed on prostomium. Pectinate setae rare in dorsal bundles. May burrow in mud, or swim, or crawl over weed. Asexual reproduction forming chains. . . . . Family Naididae—Key 4.
  - Usually more than 2 cm. long, red worms that coil readily, without eyes, proboscis, or gills (except *B. sowerbyi*—qv). Pectinate setae often present in dorsal bundles where hair setae occur. Always burrow in sediment, head down. Asexual reproduction rare, not forming chains. . . . . Family Tubificidae—Key 5.

## 2. KEY TO FAMILY HAPLOTAXIDAE

- |  |                      |   |
|--|----------------------|---|
| 1. Ventral setae large, single; dorsal setae small | <i>H. heterogyne</i> |   |
| — Setae paired and all of a similar size .. .. .   | .. .. .              | 2 |
| 2. Two pairs of ovaries                            | <i>H. smithii</i>    |   |
| — One pair of ovaries .. .. .                      | .. .. .              | 3 |
| 3. Both pairs of male pores on XII, close together | <i>H. violaceus</i>  |   |
| — Male pores separate in XI and XII                | <i>H. africanus</i>  |   |

## 3. KEY TO PHREODRILIDAE

- |  |                         |   |
|--|-------------------------|---|
| 1. Living on crayfish <i>Astacopsis</i> .. .. .                                  | .. .. .                 | 2 |
| — Free living .. .. .  | .. .. .                 | 3 |
| 2. Dorsal setae from XXXI–XLIII  | <i>P. goddardi</i>      |   |
| — Dorsal setae from IV   | <i>P. fusiformis</i>    |   |
| 3. Spermathecae absent   | <i>P. notabilis</i>     |   |
| — Spermathecae present in mature specimens .. .. .                               | .. .. .                 | 4 |
| 4. Spermathecal pores dorso/lateral .. .. .                                      | .. .. .                 | 5 |
| — Spermathecal pores ventro/lateral .. .. .                                      | .. .. .                 | 7 |
| 5. Inner duct of pseudopenis coiled once or twice within muscular sac            | <i>P. beddardi</i>      |   |
| — Inner duct of pseudopenis coiled many times within muscular sac .. .. .        | .. .. .                 | 6 |
| 6. Ventral setal bundles with one bifid and one simple pointed seta              | <i>P. mauienensis</i>   |   |
| — Ventral setal bundles with setae dissimilar in form but both simple pointed    | <i>P. subterraneus</i>  |   |
| 7. Spermathecal setae unmodified in mature specimens                             | <i>P. campbellianus</i> |   |
| — Spermathecal setae modified in mature specimens .. .. .                        | .. .. .                 | 8 |
| 8. Spermathecal setae paired. Rudimentary vestibulae on spermathecal pores       | <i>P. lacustris</i>     |   |
| — Spermathecal setae single (?). Large muscular vestibulae on spermathecal pores | <i>P. litoralis</i>     |   |

## 4. KEY TO NAIDIDAE

- |   |                                 |    |
|---|---------------------------------|----|
| 1. Dorsal setae absent  | <i>Chaetogaster</i> spp.        |    |
| — Dorsal setae present .. .. .  | .. .. .                         | 2  |
| 2. Dorsal setae beginning in II   | <i>Pristina</i>                 | 3  |
| — Dorsal setae beginning in IV, V, or VI .. .. .  | .. .. .                         | 6  |
| 3. Proboscis absent. Needles bifid with long parallel teeth                                       | <i>P. idrensis</i>              |    |
| — Proboscis present .. .. .   | .. .. .                         | 4  |
| 4. Hair setae of III longer than the rest   | <i>P. longiseta</i>             |    |
| — Hair setae of III similar to other hair setae .. .. .   | .. .. .                         | 5  |
| 5. Needle setae simple pointed. No giant ventral setae  | <i>P. proboscidea</i>           |    |
| — Needle setae finely bifid. Enlarged giant setae often present in IV, V, or VI or some of these. | <i>P. aequiseta</i>             |    |
| 6. Gills present .. .. .  | .. .. .                         | 7  |
| — Gills absent .. .. .  | .. .. .                         | 14 |
| 7. Gills ciliated digitiform processes on nearly all segments from VI on                          | <i>Branchiodrilus hortensis</i> |    |
| — Gills bunched around anus   | <i>Dero</i> spp.—               | 8  |
| 8. Branchial fossa with palps   | <i>Dero (Aulophorus)</i>        | 9  |
| — Branchial fossa without palps   | <i>Dero (Dero)</i>              | 10 |
| 9. Dorsal setae begin in V, needles bifid   | <i>D. (A.) furcatus</i>         |    |
| — Dorsal setae begin in VI, needles palmate   | <i>D. (A.) flabelliger</i>      |    |
| 10. Dorsal setae from IV. Two divergent processes on branchial fossa. (5 pairs of gills)          | <i>D. (D.) dorsalis</i>         |    |
| — Dorsal setae from VI. No divergent processes on branchial fossa .. .. .                         | .. .. .                         | 11 |
| 11. Needles pectinate .. .. .   | .. .. .                         | 12 |
| — Needles bifid .. .. .   | .. .. .                         | 13 |
| 12. Needles with three equal teeth  | <i>D. (D.) pectinata</i>        |    |
| — Needles with lateral teeth and a series of fine intermediate teeth                              | <i>D. (D.) asiatica</i>         |    |
| 13. Branchial fossa prolonged posteriorly   | <i>D. (D.) nivea</i>            |    |
| — Branchial fossa not prolonged   | <i>D. (D.) digitata</i>         |    |

Also *Nais bretscheri*

14. Hair setae of VI elongate. Body wall encrusted with foreign matter  
*Slavina appendiculata* 15  
 — No elongate hair setae. Body wall usually naked . . . . . *Nais* 16
15. Needles with fine teeth, short and equal or long parallel and equal  
 — Needles large, pectinate, or with teeth of obviously unequal thickness *Allonais* 17
16. Needle teeth long, parallel, fine  
*N. elinguis*  
 — Needle teeth short, diverging *Nais* sp.  
 (probably *N. variabilis* and/or *N. communis*)
17. Needle teeth equally long or upper longer than lower, 1-5 intermediate teeth  
*A. pectinata* 18  
 — Needle teeth unequal, upper teeth shorter than lower . . . . . *A. paraguayensis*
18. Upper tooth of needle rudimentary, much thinner than lower, sometimes bifid  
*A. inaequalis*  
 — Upper tooth of needle distinct, 1-4 fine intermediate teeth present, or upper tooth appearing replicate

## 5. KEY TO TUBIFICIDAE

1. Gills present as mid dorsal and mid ventral filaments on posterior of body  
*Branchiura sowerbyi*
- Gills absent . . . . . 2
2. Setae all simple pointed  
*Telmatodrilus multiprostatatus* 3  
 — Most setae bifid or pectinate . . . . . 4
3. Hair setae present . . . . . 4  
 — Hair setae absent . . . . . 12
4. Hair setae very fine, spirally twisted (marine)  
*Monopylephorus irroratus* 5  
 — Hair setae stout, not twisted . . . . . 6
5. All setae relatively fine and numerous. Ventral setae and anterior dorsal setae (apart from hairs) bifid with upper tooth thinner and shorter than lower, upper tooth duplicate in some dorsal setae  
*Aulodrilus* 6  
 — All setae relatively thick and not so numerous. Dorsal setae clearly pectinate with lateral teeth broad and intermediate teeth usually finer, ventral setae mostly bifid, mostly with upper tooth as or longer than lower . . . . . 7
6. Dorsal setae from VI or so, oar shaped  
*A. pigueti* 7  
 — Dorsal setae all of one form, bifid with upper tooth shorter and thinner than lower  
*A. plurisetata*  
*Tubifex tubifex* 8
7. No modified genital setae in mature specimens  
 — Modified genital setae present in mature specimens . . . . . 8
8. Penial setae present on XI. Coelomocytes present  
*Rhyacodrilus* 9  
 — Spermathecal setae present on X (unless genital region displaced forward by regeneration of head end).  
 Coelomocytes absent . . . . . 10
9. Prostate glands absent  
*R. simplex*  
 — Prostate glands present *R. coccineus*
10. Spermathecal setae broad, spatulate  
*Potamothelex bavaricus*  
 — Spermathecal setae long, narrow *Antipodrilus* 11
11. Anterior ventral setae with upper tooth as thick as but much longer than the lower  
*A. timmsi*  
 — Anterior ventral setae with upper tooth a little longer and thinner than the lower  
*A. davidis*
12. Anterior setae bifid, posterior setae pectinate  
*Telmatodrilus pectinatus* 13  
 — All setae bifid, or a few simple pointed, none pectinate . . . . . 14
13. Setae with upper tooth shorter and thinner than the lower (endemic to Macquarie Island)  
*Macquaridrilus benettiae* 14  
 — Setae with upper tooth as long as or longer than lower (cosmopolitan species) . . . . . 15
14. Some posterior setae simple pointed. Prostates diffuse. Coelomocytes present. No cuticular penis sheaths (marine)  
*Monopylephorus rubroniveus*  
 — No simple pointed setae. Prostates compact. Coelomocytes absent. Cuticular penis sheaths present in mature specimens . . . . . *Limnodrilus* 15
15. Upper tooth of anterior setae thick and much longer than the lower. Penis sheaths mostly 1-4 times longer than broad  
*L. udekemianus*  
 — Upper teeth as long as, or longer than lower, usually thinner than lower. Penis sheaths more than 4 times longer than broad . . . . . 16
16. Penis sheaths up to 14 times longer than broad (the commonest tubificid anywhere).  
*L. hoffmeisteri*  
 — Penis sheaths up to 43 times longer than broad *L. claparedeianus*

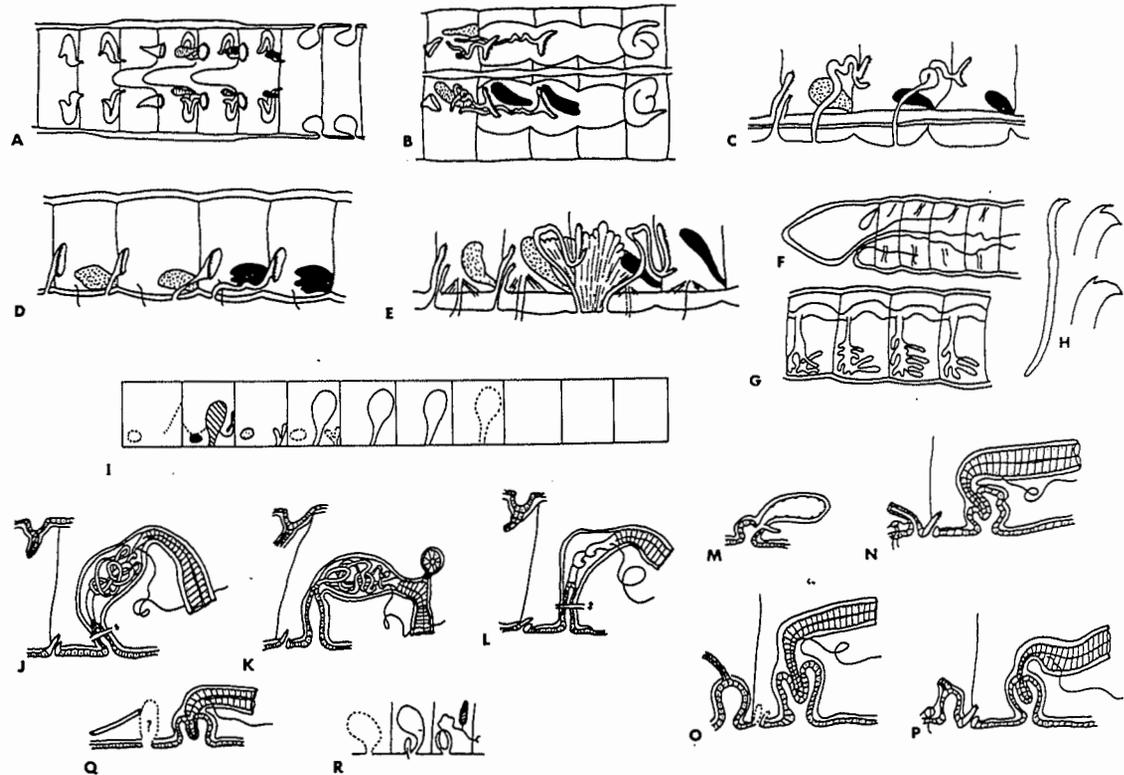


FIG. 1.—A—E: Reproductive organs of Haplotaenidae (A,B—dorsal view, C—E—lateral view, anterior to right). A—*H. heterogyne*; B—*H. violaceus*; C—*H. africanus*; D—*H. smithii*; E—*H. hologynus*. F—I: *Lumbriculus variegatus*. F—prostomium; G—lateral blood vessels of posterior segments; H—setae (entire, and tips of anterior and posterior seta); I—plan of reproductive organs (anterior to left). J—R: Termination of male reproductive organs, Phreodrilidae. J—*P. subterraneus*; K—*P. maurienensis*; L—*P. beddardi*; M—*P. notabilis*; N—*P. lacustris*; O—*P. campbellianus*; P—*P. litoralis*; Q—Subgenus *Astacopsidrilus* (*P. goddardi*, *fusiformis*, *novus*); R—Subgenus *Shizodrilus* (*P. nothofagi*, *major*).  
In A—E and I testes are shown black, ovaries stippled.

## Family HAPLOTAXIDAE

Setae single or closely paired, sigmoid or distally hooked; dorsals sometimes smaller than ventrals, absent to some extent in some species. Genital setae modified in some species. Testes\* in X and XI, ovaries in XII or XII and XIII. Spermathecae one to four pairs anterior to the gonads.

Cosmopolitan.

\*Some species or some specimens may be found in which the reproductive organs become displaced forwards or backwards without disturbing the serial arrangement of parts. This is sometimes due to regeneration of the anterior end, but when all known specimens of a species display the character the explanation is unknown. The same variation is met with in most families.

## HAPLOTAXIS HETEROGYNE Benham, 1903

(FIG. 1A)

*Haplotaxis heterogyne* Benham, 1903; 1904b.

l=20mm, s=60. Prostomium long but undivided. Setae four per segment, ventrals two to three times larger than the dorsals in all but anterior segments, dorsal setae present throughout. Clitellum in XI to  $\frac{1}{2}$  XIV, annular. Spermathecal pores antero-lateral on VIII and IX. Male pores not seen. Female pores lateral on XIII. Gizzard in IV. Testes and male funnels paired in X and XI, ovaries and female funnels in XII. Spermathecae paired in VIII and IX.

Lake Wakatipu, S. Island, New Zealand. Two worms at 550 ft.

Types not located.

The species badly needs re-investigation in view of advances in knowledge concerning the family as a whole.

## HAPLOTAXIS VIOLACEUS (Beddard, 1891)

(FIG. 1B)

*Pelodrilus* sp. Beddard, 1891a.

*Pelodrilus violaceus* Beddard, 1891b.

l=26–52mm. Prostomium short and blunt. Setae closely paired, simple-pointed. Clitellum XI–XIII, dorsal only. Spermathecal pores above b close to 7/8 on VIII. Male pores minute, two pairs on XII above b. Female pores 12/13 above b. Eversible pharynx present. Septal glands in V–VII. Testes and male funnels paired in X and XI; vasa deferentia long and coiled, those from funnels on 10/11 traverse XI to enter XII anteriorly; those of 11/12 coiled in XII opening closely behind the others. Ovaries in XII. Spermathecae in VIII, long and bent upon themselves.

Ashburton, New Zealand, in rich wet soil near a swamp.

Type. British Museum (Natural History) 1904/10/20/1039–41 plus other material.

## HAPLOTAXIS AFRICANUS (Michaelsen, 1905)

(FIG. 1C)

*Pelodrilus darlingensis* Michaelsen, 1905.

*Pelodrilus tuberculatus* Benham, 1909; Michaelsen, 1924.

l=25–70mm, s=70–128. Prostomium short and broad. Setae paired, simple-pointed. Clitellum  $\frac{1}{2}$  XI – XIII or XIV. Spermathecal pores in 7/8, lateral. Male

pores on XI and XII in or above ventral setae line. Female pores 12/13 in ventral setal line. Eversible pharynx, septal glands from V – VII or IX. Testes and male funnels paired in X and XI. Ovaries and female funnels paired in XII. Spermathecae large, paired in VIII.

Auckland, Adam Stewart Islands; Campbell Island, Collie, South-West Australia.

Types not located.

A single specimen obtained by B. G. Jamieson (Australian Museum) in an acid stream in a *Melaleuca* swamp opposite Bribie Island, coastal Queensland (2.9.1967) resembles this species. The position of the male pores could not be determined from the sections, and there are two pairs of spermathecae (in VII and VIII) with the pores at the anterior margin of the segment. The sperm sac in XI extends from 10/11, but that from 11/12 extends to XVIII. Septal glands extend from V or even IV to IX. Testes are present in X and XI, ovaries in XII. The specimen is probably identifiable as *H. africanus* (Australian Museum W.4279).

#### HAPLOTAXIS SMITHII (Beddard, 1888)

(FIG. 1D)

*Phreoryctes smithii* Beddard, 1888, 1890.

l=50–200mm. Prostomium with a transverse furrow. Setae closely paired, dorsals the shorter posteriorly, sigmoid, simple-pointed. Clitellum annular,  $\frac{1}{2}$  X – XIII. Spermathecal pores lateral on VII and VIII (sometimes VI also). Male pores minute, above ventral setal line on XI, in setal line of XII. Female pores on setal line of 12/13 and 13/14. Pharynx eversible, septal glands ? V – IX. Testes and male funnels paired in X and XI, ovaries and female funnels paired in XII and XIII. Male and female ducts very similar. Spermathecae in (? VI) VII and VIII.

Ashburton, New Zealand, in marshy soil and a pool.

Type. British Museum (Natural History) 1904/10/20/731–3 plus other material.

Additional material from Lake Coleridge, Canterbury, New Zealand, at 138 m, 19.4.1967, coll. M. Flain. (Otago Museum A69.46–51).

#### HAPLOTAXIS HOLOGYNUS (Michaelsen, 1907)

(FIG. 1E)

*Pelodrilus hologynus* Michaelsen. Benham, 1909; Jackson, 1931.

*Pelodrilus aucklandicus* Benham, 1909.

*Pelodrilus bipapillatus* Michaelsen, 1924.

l=48–55mm, s=100–140. Prostomium conical, with a transverse furrow. Setae two per bundle, all simple pointed. Clitellum XII –  $\frac{1}{2}$  XIV. Spermathecal pores lateral in 6/7, or 7/8; male pores in line with the ventral setae, posterior on XI, anterior on XII; female pores in 12/13 and 13/14. Eversible pharynx (?), septal glands in V–VIII or IX. Testes and male funnels paired in X and XI, ovaries and female funnels in XII and XIII; spermathecae paired in VII, with long ampullae partly occluding VIII.

Southwest Australia, Auckland Isles, Adam Island, Stewart Island.

Type. (Of *Pelodrilus aucklandicus*) Otago Museum A69.30–35 (original numbers in vials A07.280,290).

The species is divided into two subspecies as follows:

*Haplotaxis hologynus hologynus* (Michaelsen, 1907)

No oesophageal diverticula. Spermathecae in VII, elongate with indistinct ducts.

Southwest Australia, Auckland Isles, Adams Island, Stewart Island.

*Haplotaxis hologynus bipapillatus* (Michaelsen, 1924)

Oesophageal diverticula in XIV from XIII. Spermathecae in VIII (? with distinct ducts).

Stewart Island.

### Family LUMBRICULIDAE

LUMBRICULUS VARIEGATUS (Müller, 1774)

(FIG. 1F-I)

l=up to 100mm, s=170. Dark green pigment anteriorly. Setae two per bundle, bifid with rudimentary upper tooth. Male pores usually a single pair between VII and XII. Usually four pairs of small spermathecae beginning two segments (sometimes one) posterior to atrial segment, pores between lateral line and line of dorsal setae. Atria associated with one or two pairs of testes, cylindrical, usually confined within a single segment. One or two pairs of ovaries beginning in the post-atrial segment; Dorsal blood vessel with lateral vessels bearing blind diverticulae, especially posteriorly.

Formerly Holarctic, now known from S. Africa, Australia, New Zealand and Tasmania.

Creek by Waterworks road, Tasmania, 22.12.1964, coll. J. F. Greenhill, Tasmanian Museum K222; stream 2 miles E. of Arap University, New Zealand, 17.12.1967, stream at Lower Hutt, 22.2.1962, Rongatai Pond, Wellington 22.9.1961, Tawa Experimental Pond, Wellington, 8.8.1966; stream at Milton, Palmerston North, coll. R. G. Ordish; saw mill pool Rotorua, February 1966, swamp pool by Lake Ngapouri, 1.7.1966, coll. G. Fish. Bantry Bay Reservoir, Sydney, Australia, 30.9.1965, coll. V. Jolly; ?Farmers Creek, University of Queensland, 5.10.1961, coll. B. G. Jamieson.

This is the sole representative of the family to be found in the Southern Hemisphere, but it would appear to have been introduced since the time when Benham and Beddard were active. It is possible that they could have overlooked the species, as even *Tubifex tubifex* is recorded here for the first time in this region, but the dominant mode of reproduction being asexual in this lumbriculid makes it a good candidate for worldwide dispersal by man.

### Family PHREODRILIDAE

Dorsal setae from III, hair setae and short needles scarcely emerging from setal sacs; ventral setae two per bundle from II, single-pointed or bifid or one of each kind; simple-pointed setae often thinner and straighter than bifid setae. Spermathecal setae sometimes modified. Testes in XI, ovaries in XII, male pores usually on XII, female pores in 12/13, spermathecal pores on XIII or shifted one or two segments forward. Spermathecae one pair posterior to gonads.

Southern Hemisphere.

## PHREODRILUS SUBTERRANEUS Beddard, 1891

(FIG. 1J)

*Phreodrilus subterraneus* Beddard, 1891b.

l=50mm. Dorsal setae from III, one hair and two short setae in follicles. Ventral setae both simple-pointed but one thicker and more curved than the other. No spermathecal setae. Vasa deferentia open into atria basally. Pseudopenes extremely long, distal part of male duct and pseudopenis enclosed in a muscular sac, true male pores deep in the penis sac. Spermathecal pores dorsal, with muscular vestibulae.

In a well, Ashburton, New Zealand.

Type. British Museum (Natural History) 1904/10/20/1056-9; plus other material.

## PHREODRILUS MAUIENENSIS sp. nov.

(FIG. 1K)

Dimensions unknown. Dorsal setae from III, one hair and two short setae within follicles. Ventral setae one broad, clearly bifid with upper tooth shorter than lower, the other thinner, straighter and simple pointed. No spermathecal setae. Pseudopenes extremely long, distal part of male duct and pseudopenis enclosed in a muscular sac, to which is attached a small globular organ. Vasa deferentia open into atria basally. Spermathecal pores dorsal, with muscular vestibulae.

Lake Okataina, New Zealand 50 m. June 1966, coll. G. Fish.

Type. Holotype Otago Museum A69.22; paratype A69.23.

Also Lake Coleridge 138 m, 19.4. 1967, coll. M. Flain (Otago Museum A.69.6-7).

## PHREODRILUS BEDDARDI Benham, 1904

(FIG. 1L)

*Phreodrilus beddardi* Benham, 1904a.

l=40mm, s=78. Dorsal setae from III, a hair seta and two small setae within the follicles. Ventral setae both simple-pointed, one thinner and straighter than the other. No spermathecal setae. Vasa deferentia open into atria basally. Pseudopenes long, terminal part of male duct coiled once or twice within muscular sac, short penis sacs. Spermathecal pores dorsal, with muscular vestibulae.

Ashburton, New Zealand.

Type not located.

Also Lake Coleridge, 180 m, 28.2.1967, coll. M. Flain (specimens in the Otago Museum, A.69.8,10,11,12).

## PHREODRILUS NOTABILIS (Benham, 1907)

(FIG. 1M)

*Phreodriloides notabilis* Benham, 1907.

l=8mm. Dorsal setae from III, one or two hair setae in anterior bundles, ?short setae not emerging from follicles. Ventral setae single, simple-pointed, sometimes two per bundle. No spermathecal setae. Vasa deferentia open into atria basally. Small eversible pseudopenes. No spermathecae or spermathecal pores. Atria ? lack glandular lining.

Blue Lake, Mount Kosciusko, c. 12 m.

*Type.* The Australian Museum G.5606-9.

A single specimen was described and the species has never been recorded again. A complete description of fresh material is needed to settle questions raised by the apparently unique form of the atria.

PHREODRILUS LACUSTRIS Benham, 1903

(FIG. 1N)

*Phreodrilus lacustris* Benham, 1903, 1904a.

*Hesperodrilus lacustris* (Benham). Michaelsen, 1924.

1=20mm, s=75. Dorsal setae from III, one hair and an occasional short secondary seta. Ventral setae paired, one minutely bifid, one simple-pointed, posteriorly both bifid. Spermathecal setae paired, longer and finer than the other ventrals, distal end sharply curved. Vasa deferentia open into atria basally. Long true penes present. Spermathecal pores ventral, with rudimentary vestibulae.

Lakes Wakatipu, Manapouri, New Zealand, South Island from between about 50 m to 300 m.

*Type* not located.

Lake Coleridge, New Zealand 90-194 m, 1.3.1967, 19.4.1967, coll. M. Flain (Otago Museum, A69.9, 13-16).

The few intact setae on the Lake Coleridge specimens lacked even a minute tooth and appeared simple-pointed.

PHREODRILUS CAMPBELLIANUS Benham, 1909

(FIG. 1O)

*Phreodrilus campbellianus* Benham, 1909.

*Hesperodrilus campbellianus* (Benham). Michaelsen, 1924.

1=18mm, s=60. Dorsal setae from III, single hair setae. Ventral setae paired, one bifid, one simple-pointed or both bifid in some segments. No spermathecal setae. Vasa deferentia open into atria basally. Long true penes present. Spermathecal pores ventral, with vestibulae.

Campbell Island.

*Type.* Otago Museum A69.38-39.

PHREODRILUS LITORALIS (Michaelsen, 1924)

(FIG. 1P)

*Hesperodrilus litoralis* Michaelsen, 1924.

1=18mm, s=55-65. Dorsal setae from III, hair like. Ventral setae paired, one bifid, one simple-pointed. Spermathecal setae paired, thin, simple-pointed. Vasa deferentia open into atria basally. Long true penes present. Spermathecal pores ventral, with vestibulae.

Campbell Island.

Type not located.

The last three entities may become united under the name *P. lacustris* when the variability within species in this family is better understood.

PHREODRILUS GODDARDI Brinkhurst, 1965

(FIG. 1Q)

*Astacopsidrilus notabilis* Goddard, 1909a.

*Hesperodrilus notabilis* (Goddard). Michaelsen, 1924.

*Phreodrilus goddardi* nom. nov. Brinkhurst, 1965.

(non) *Phreodrilus notabilis* (Benham, 1907).

l=5.5mm, s=53. Dorsal setae from XXI-XLIII only. Ventral setae from II, paired, one bifid one simple-pointed. No spermathecal setae. Vasa deferentia open into atria basally. True penes present. Spermathecal pores? Parasitic on the crayfish *Astacopsis serratus* Shaw.

Bulli District, New South Wales, Australia.

Type not located.

near Sydney.

PHREODRILUS FUSIFORMIS (Goddard, 1909)

*Astacopsidrilus fusiformis* Goddard, 1909a.

*Hesperodrilus fusiformis* (Goddard). Michaelsen, 1924.

l=2.8mm, s=46. Dorsal setae from IV, hair setae best developed posteriorly. Ventral setae paired, one bifid, one simple-pointed, most strongly developed in the posterior third of the body. No spermathecal setae. Vasa deferentia open into atria basally. True penes present. Spermathecal pores? Parasitic on the crayfish *Astacopsis serratus* Shaw.

Gosford District, New South Wales, Australia.

Type not located.

It is almost certain that this is only a more modified version of the above (*P. goddardi*).

Other Phreodrilidae have been described or observed from the area but none of them can be recognized as established species. *Phreodrilus novus* Jackson, 1931 was originally described under the generic name of *Astacopsidrilus*. The specimen sectioned was said to have two pairs of testes, spermathecal setae are present, but the male funnels and spermathecal pores were not found. They were described from specimens collected at Kalamunda in a pool at the foot of Lesmurdie Falls. The worms are clearly ground-water species to judge from the remarks of Jackson (1931). Two species described under the generic name *Schizodrilus* by Stout (1958) also seem peculiar in that, according to the illustrations, thin vasa deferentia run straight to the penes, but a discrete prostate gland is attached to each some way along its length. These species (*S. nothofagi*, *S. major*, types in the Dominion Museum, Wellington, New Zealand, no catalogue numbers), clearly belong to the family by virtue of the characteristic setal arrangement. Both species reproduce asexually by fragmentation, and *S. major* has coelomocytes, both unique characteristics within the family. (Fig. 1R.)

*Phreodrilus mauianus* Benham, 1903 (also as *P. mauiensis* in Benham 1904a) and *Tasmaniaedrilus tasmaniaensis* Goddard and Malan, 1913 are insufficiently

described to permit a distinction to be made between these and other species with similar characteristics.

In Tasmania several undescribed phreodrilids occur. One was noted by Goddard (1909*b*) and several were found in collections by Dr. W. D. Williams and A. V. Dartnall. Of the latter, one resembles *P. lacustris* or *litoralis* but has all of the ventral setae distinctly bifid. Spermathecal setae are present. A second species, recorded from Lake Pedder along with the former, has a thin slightly curved simple-pointed seta and a thick, curved bifid seta in each bundle, but the reproductive system is unknown. A third species from Lake Pedder had ornamented hair setae and a proboscis on the prostomium, both unique characters in the family. Other specimens with completely bizarre setal arrangements were found in Tasmania, but these may not even be attributed to a particular family at present.

#### Family TUBIFICIDAE

Prostomium without a proboscis. No eyes. Dorsal setae from II bifid, or pectinate, with or without hair setae in some or all segments; ventral setae mostly bifid; setae indefinite in number. Spermathecal setae or penial setae sometimes modified, very rarely both in a single species. Clitellum on a few segments in the region of the gonads. Testes and ovaries paired in successive segments, usually X and XI. Spermathecae a single pair in testes-bearing segment, usually in X, or single or absent. Atria and male pores one segment behind testes, penes often present. Asexual reproduction by fragmentation.

Cosmopolitan.

Few of the cosmopolitan species in this family are based on types, and so original illustrations and descriptions are generally accepted as types.

Most of the specimens examined (other than those attributed to new species) have been returned to the collectors.

#### TUBIFEX TUBIFEX (Müller, 1774)

(FIG. 2A)

l=20–200mm, s=34–120. Anterior dorsal setae 1–4 or 6 serrate hairs and 3–5 pectinate setae with several irregular intermediate teeth, posteriorly hair setae progressively reduced in length and then missing, pectinate setae progressively lose intermediate teeth. Ventral setae 3–6 or 10 per bundle, upper tooth thinner but not much longer than the lower, becoming relatively shorter posteriorly where number as low as two per bundle. No genital setae. Vasa deferentia extremely long, atria comma-shaped, large stalked prostates on anterior faces of atria. Thimble-shaped penis sheaths present, but thin. Spermathecae present or absent, spermatozeugma elongate. Coelomocytes absent.

Cosmopolitan.

Lake Ngapouri, New Zealand, 1.7.1966, coll. G. Fish; ?Kainga, 10 km N. of Christchurch, New Zealand, 6.5.1955 in a canal draining a gravel works, coll. E. C. Yung; Pigroot Creek, Ranfurly, Palmerston, Otago, New Zealand, 23.1.1964, coll. V. Stout (plus immature specimens from many localities in New Zealand—almost certainly *T. tubifex*); ? littoral, Lake Monger, Western Australia, 20.x.1962, coll. D. H. Edward; Downfall Creek, Chermshire, Queensland, Australia, coll. R. Mitchell.

This cosmopolitan species is common in grossly polluted situations in many parts of the world, but is otherwise not a very commonly encountered species. It has never been recorded from Australasia, and while I have seen many specimens that may well be attributable to this species, few have been sufficiently mature to permit certain identification.

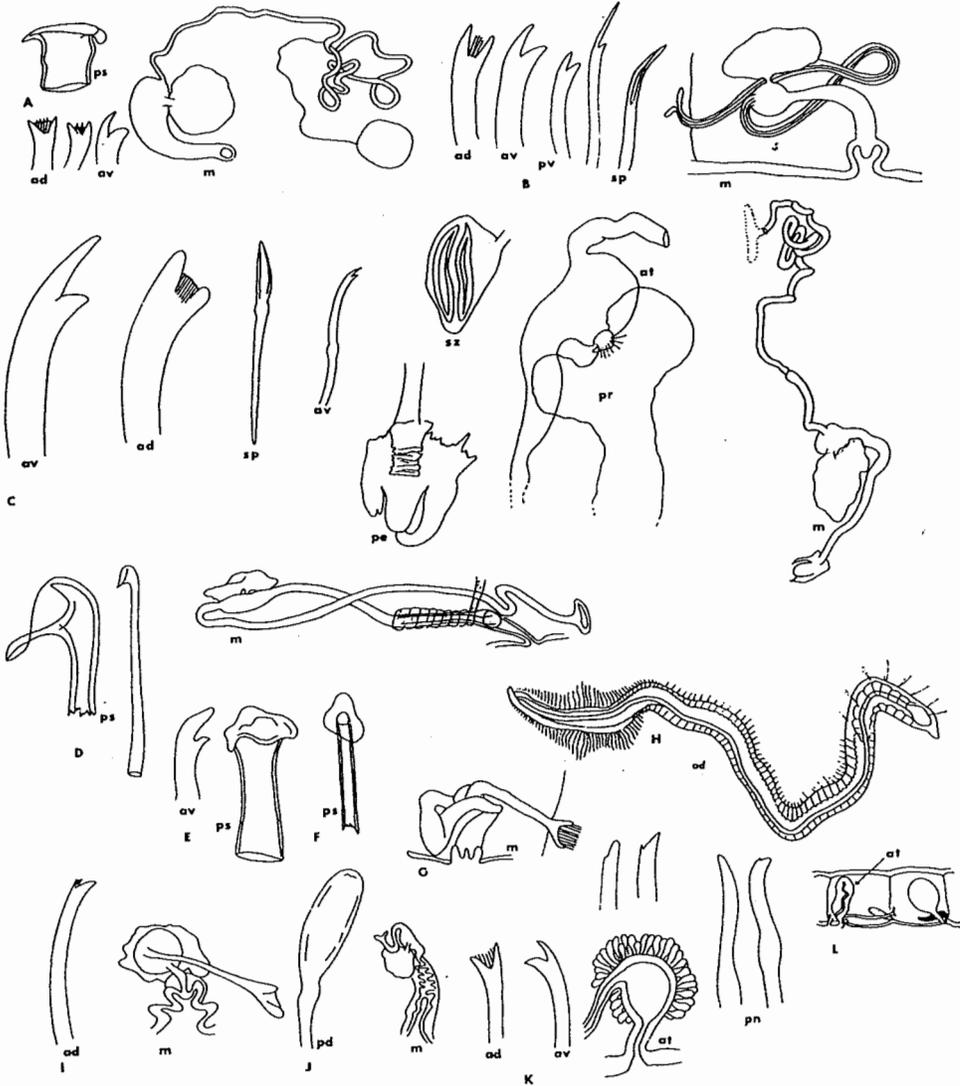


FIG. 2.—Characteristic features of some Tubificidae.

A—*Tubifex tubifex*; B—*Antipodrilus davidis*; C—*Antipodrilus timmsi*; D—*Limnodrilus hoffmeisteri*; E—*L. udekemianus*; F—*L. claparedeianus*; G—*Potamothrix bavaricus*; H—*Branchiura sowerbyi* (whole animal); I—*Aulodrilus plurisetus*; J—*A. pigueti*; K—*Rhyacodrilus coccineus*; L—*R. simplex*. a=anterior (seta), at=atrium, d=dorsal (seta), m=male duct, pn=penial setae, pe=penis, ps=penis sheath, p=posterior (seta), pr=prostate, sp=spermathecal setae, sz=spermatzeugma, v=ventral (seta).

2.0-4.0mm

## ANTIPODRILUS DAVIDIS (Benham, 1907)

(FIG. 2B)

*Tubifex davidis* Benham, 1907.

l=25-40mm. Dorsal bundles with 3-7 hair setae, 2-4 pectinate setae. Ventral bundles with 3-5 bifid setae, anteriorly the upper tooth longer and thinner than the lower. Spermathecal setae in X hollow ended or with a short lower tooth. Vasa deferentia long, atria very small and narrowing abruptly to form ejaculatory ducts. Penes small, no thickened cuticular sheaths. Spermathecae present. Coelomocytes absent.

*Type locality.* Blue Lake, Mount Kosciusko, New South Wales, Australia. Also Rotorua Lake, offshore, New Zealand, 1966; Lake Rotoehu, May 1966, coll. G. Fish (Otago Museum A69.26-9); Cambridge, Tasmania, 30.8.1966, coll. A. Dartnall (Tasmanian Museum K221: 3 slides and 1 vial).

*Type.* The Australian Museum, G5610-11.

The genus *Antipodrilus* was erected by Brinkhurst in Brinkhurst and Jamieson (1971).

## ANTIPODRILUS TIMMSI sp. nov.

(FIG. 2C)

Dimensions unknown. Anterior dorsal bundles with 2-5 serrate hairs, 3-5 pectinate setae with the upper tooth somewhat longer than the lower, many intermediate teeth; anterior ventral bundles with 3-5 (mostly 4) setae with the upper tooth markedly longer and somewhat thinner than the lower; posteriorly fewer setae, dorsals with upper tooth becoming longer, pectination less apparent or absent, ventrals similar to anterior setae but upper tooth relatively thinner and less pronouncedly longer than the lower. Spermathecal setae narrowly blade-shaped distally, about as large as normal ventral setae. Vasa deferentia long, entering atria frontally opposite the large stalked prostates; atria almost spherical at union with prostates and vasa deferentia, narrowing abruptly to form long ejaculatory duct; penes long without specially thickened cuticular sheaths, Spermathecae with spermatozeugma. No coelomocytes. Reproductive organs arranged as defined for the family.

*Type locality.* Lake Bullenmerri near Camperdown, Victoria 13m, 65m. 13.8.1969, coll. B. V. Timms.

*Type.* Australian Museum, W.4276-8.

Two other specimens attributable to this genus were found in the littoral of Lake Monger, Western Australia, by D. H. Edward (17.10.1956) but the setae were so badly damaged that a clear decision as to their identity cannot be made.

## LIMNODRILUS HOFFMEISTERI Claparede, 1862

(FIG. 2D)

?*Limnodrilus lucasi* Benham, 1903.

?*Limnodrilus vej dovskyanus* Benham, 1903.

l=20-35mm, s=55-95. Setae all bifid, anteriorly with 3-10 (mostly 7) per bundle, proportions of the teeth variable. Vasa deferentia very long, atria small, bean-shaped with prostates stalked, ejaculatory ducts long. Penes elongate in stout

tubular penis sheaths surrounded with spiral muscles. Sheaths up to 14 times longer than broad, hood either a scalloped plate or bent at right angles to the shaft. Spermathecae present, with spermatozeugma. Coelomocytes absent.

Cosmopolitan.

This species is found in every freshwater habitat examined, and is very abundant in polluted places. It has been reported from a number of localities in Australia and New Zealand, but has not yet been found in Tasmania.

*LIMNODRILUS UDEKEMIANUS* Claparede, 1862

(FIG. 2E)

l=20-90mm, s=c.160. Setae all bifid, anteriorly with 3-8 per bundle, with the upper tooth much longer and thicker than the lower; posteriorly setae fewer and upper tooth less markedly divergent in thickness and length from the lower. Vasa deferentia long, atria small, prostates large. Penis sheaths mostly 1-4 times longer than broad, sometimes more, with the hood a short flange. Spermathecae present, with spermatozeugma. Coelomocytes absent.

Cosmopolitan.

Moggill Creek, Brisbane, Queensland, 31.5.1966, coll. B. G. Jamieson; Downfall Creek, Chermside, Queensland, coll. R. Mitchell; ?Lake Monger, Western Australia, 20.11.1962, coll. D. H. Edward. ?Lake Pedder, Tasmania, littoral, S. Shore, coll. W. D. Williams.

*LIMNODRILUS CLAPAREDEIANUS* Ratzel, 1868

(FIG. 2F)

l=30-60mm, s=50-120. Setae all bifid, anterior bundles with 4-9 per bundle, some with upper tooth much longer than lower but about as thick as or thinner than the lower, fewer posteriorly. Vasa deferentia long, atria small, prostates large. Penis sheaths thick, up to 43 times longer than broad, with narrow pear-shaped hoods set at an angle to the shaft when viewed laterally. Spermathecae present, with spermatozeugma. Coelomocytes absent.

Cosmopolitan.

Lake Okaro, New Zealand, 23.5.1966, Rotorua Lake, 27.5.1966, Lake Ngapouri, 1.7.1966, coll. G. Fish.

*POTAMOTHRIX BAVARICUS* (Öschmann, 1913)

(FIG. 2G)

l=15-35mm, s=55-80. Dorsal anterior bundles with 1-5 straight hair setae, 2-5 pectinate setae, ventral setae 3-4 per bundle, the upper tooth thinner than the lower but equally long, posteriorly 2-3 with teeth sub-equal in length. Spermathecal setae, large hollow ended, lanceolate distally. Vasa deferentia short, atria elongate tubular, prostate glands absent. Penes present, without penis sheaths. Spermathecae present, with spermatozeugma. Coelomocytes absent.

Lake Purrumbete, near Camperdown, Victoria, Australia, at 5m, 21.8.1969, coll. B. V. Timms (Australian Museum W4275).

Corio Pool, Rottneest Island, Australia, 10.10.1959, coll. D. H. Edward; Lake Okataina, New Zealand, c.50m, June 1966, coll. G. Fish (Otago Museum A69.24.5). Three of the specimens seen to date have been identified by examining the setae on the assumption that the spermathecal setae are sufficiently distinctive to permit an identification. Mr. Timms's specimen was mature enough to be identified as a *Potamothrix* for certain.

BRANCHIURA SOWERBYI Beddard, 1892

(FIG. 2H)

l=38-185mm, s=74-240. Dorsal anterior bundles with 1-3 or more short hair setae, 11-12 setae with bifid tips and sometimes a small intermediate tooth, the upper tooth often rudimentary or absent. Ventral setae similar, but no hair setae, 10-11 per bundle. Vasa deferentia short, broad, atria tubular with diverticulae. Eversible pseudopenes. Prostate glands diffuse. Spermathecae present, no spermatzeugma. Coelomocytes absent. Dorsal and ventral gill filaments on most posterior segments.

Cosmopolitan.

Goldcreek, Brookfield, Queensland, Australia, May 1966, coll. L. Cribb; Lake Claremont and L. Monger, Western Australia, 20.11.1962, coll. D. H. Edward.

AULODRILUS PLURISETA (Piguet, 1906)

(FIG. 2I)

l=10-25mm, s=65-105. Anterior dorsal bundles with up to 8 short bayonet shaped hair setae, and up to 10 setae with 1 to several upper teeth which are thinner and shorter than the lower. Anterior ventral setae up to 16 per bundle with short thin upper teeth. Vasa deferentia fairly long, atria globular, prostates solid but attached by broad bases. Large eversible pseudopenes. Spermathecae present, sperm in bundles. Coelomocytes absent.

Cosmopolitan (?not S. America).

Lake Coleridge, New Zealand, 138m, 19.4.1967, coll. M. Flain; branch of the Yule River, Yanda Yarra, Queensland, Australia, 27.9.1964, coll. B. G. Jamieson.

AULODRILUS PIGUETI Kowalewski, 1914

(FIG. 2J)

l=2-28mm, s=100. Dorsal anterior bundles with 4-5 or up to 10 simple-pointed or bifid setae, the upper tooth shorter and thinner than the lower or absent, and 2-5 hair setae which often start in IV-VII, beyond VII bifid setae become oar-shaped. Anterior ventral setae with 4-7 or 11 bifid setae with the upper tooth shorter and thinner than the lower. Penial setae modified, two hollow spoon-shaped setae per bundle. Vasa deferentia short, atria bean-shaped, prostates large with broad bases. Large eversible pseudopenes open via a median inversion of the body wall. Spermathecae present, sperm in bundles. No coelomocytes.

Cosmopolitan.

Pine Hill Rock, near Balladonia, Western Australia, 6.12.1959; Pond near Tully, Queensland, 20.7.1966, coll. B. G. Jamieson.

## RHYACODRILIS COCCINEUS (Vejdovsky, 1875)

(FIG. 2K)

*Branchiura pleurotheca* Benham, 1907.

l=10-35mm, s=60-110. Anterior dorsal bundles with 3-5 hair setae, up to 5 pectinate setae with a series of fine intermediate teeth, hair setae missing from a number of posterior segments. Ventral setae 3-5 per bundle, upper tooth thinner and a little longer than the lower, penial setae 3-5 per bundle, knobbed with the heads close together. Vasa deferentia short, entering atria laterally, atria globular, prostate diffuse. Spermathecae present, sperm in bundles. Coelomocytes present.

Eurasia, N. America, Australasia.

*Types.* (*B. pleurotheca*) Australian Museum G5612-4. Blue Lake, Mount Kosciusko.

?Lake Okataina, c.50m, New Zealand, June 1966, coll. G. Fish.

## RHYACODRILUS SIMPLEX (Benham, 1903)

(FIG. 2L)

*Taupodrilus simplex* Benham, 1903.

l=15mm, s=70. Dorsal anterior bundles with 3-4 pectinate setae with 1-2 hair setae in most bundles, absent in some. Ventral setae 4-6 per bundle, the upper tooth thinner than the lower and as long or longer, some with intermediate spines. Penial setae up to 8 per bundle, simple-pointed and hooked. Vasa deferentia coiled around atria, no prostate cells. Spermathecae present, sperm in bundles. Coelomocytes present.

Lake Taupo, Lake Waikare, Lake Manapouri, New Zealand. Also Lake Coleridge, New Zealand, 135m, 194m, 1.3.1967, 138m, 19.4.1967, coll. M. Flain (Otago Museum A69.19-21).

The species may well merit separation into the distinct genus *Taupodrilus*, contrary to most recent opinion.

## MONOPYLEPHORUS IRRORATUS (Verrill, 1873)

(FIG. 3A)

*Rhizodrilus aucklandicus* Benham, 1909; Michaelsen, 1924.

l=15-35mm, s=70-90. Anterior dorsal bundles with 1-2 thin hair setae with twisted distal ends in most bundles, with up to 4 setae, the upper tooth longer and thinner than the lower, rarely with a single intermediate tooth. Ventral bundles with 3 or even up to 7 setae anteriorly, upper tooth longer and thinner than the lower. Penial setae rarely modified. Vasa deferentia short, prostates diffuse covering atria, protrusible pseudopenes present. Spermathecae present, no spermatozeugma. Coelomocytes present.

Brackish water. Cosmopolitan.

*Type.* (*R. aucklandicus*) A69.40-43. Auckland Isles. Perseverance Harbour, Campbell Island.

> long as?

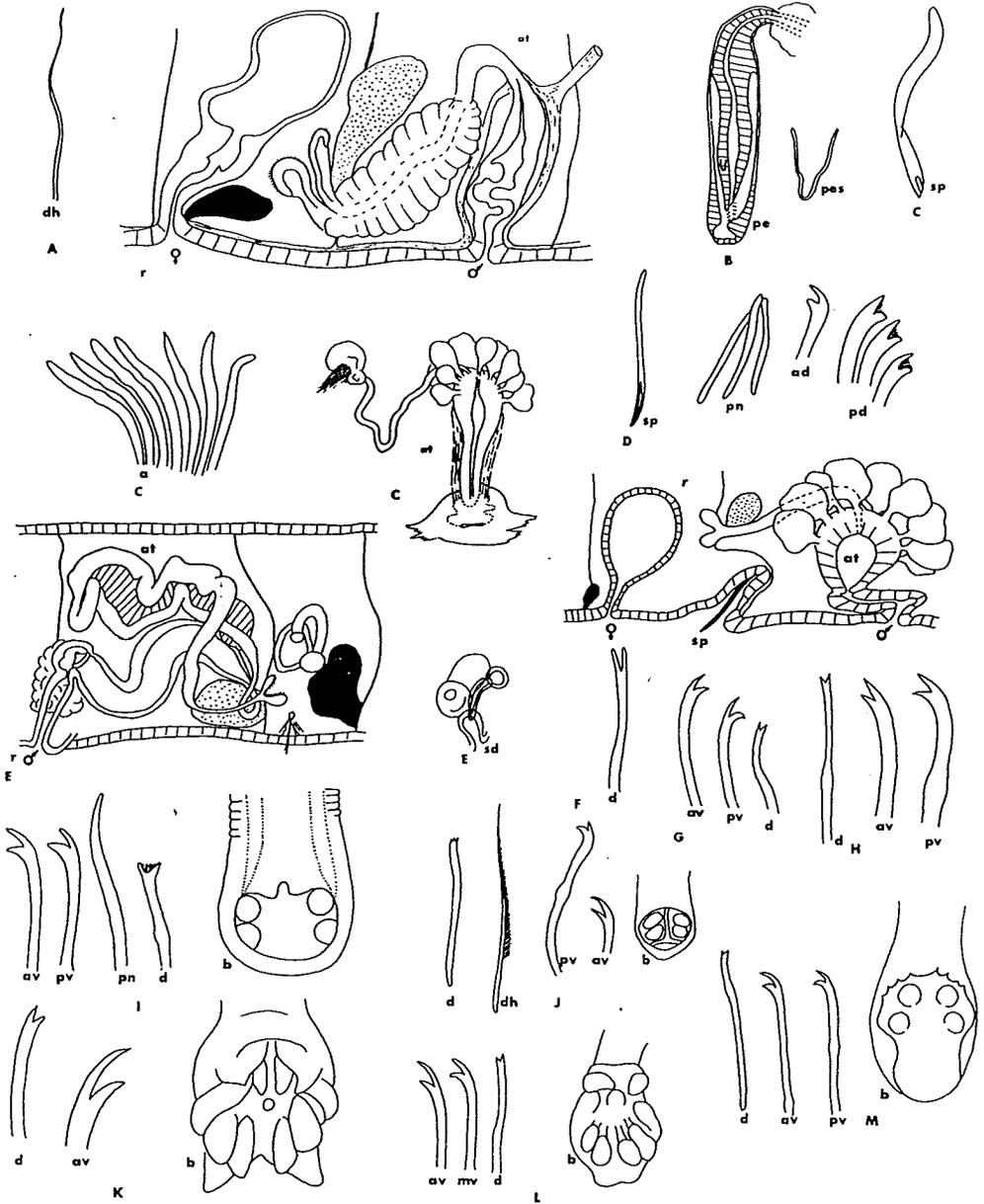


FIG. 3.—Characteristic features of some Tubificidae and Naididae.

A—*Monopylephorus irroratus*; B—*M. rubroniveus*; C—*Telmatodrilus multiprostatas*; D—*Telmatodrilus pectinatus*; E—*Macquaridrilus bennettiae*; F—*Nais elinguis*; G—*N. communis*; H—*N. variabilis*; I—*Dero asiatica*; J—*D. pectinata*; K—*D. dorsalis*; L—*D. digitata*; M—*D. nivea*.

a=anterior (setae), at=atrium, b=branchial apparatus, d=dorsal (seta), h=hair seta, m=median, ♂=male pore, p=posterior (seta), pn=penial setae, pes=penial stylet, pe=penis, r=reproductive organs, sd=spermatheca plus diverticulum, ♀=spermathecal pore, sp=spermathecal setae, v=ventral (seta). Testes in black, ovaries stippled.

Discovery of the type at Otago made possible the correct identification of the species, described by Benham as lacking hair setae but having some fine fibres caught up in the setal bundles. These fibres are in fact the unusual thin hair setae of this common brackish water species.

MONOPYLEPHORUS RUBRONIVEUS Levinsen, 1884

(FIG. 3B)

*Rhizodrilus kermadecensis* Benham, 1915.

l=10-40mm, s=48-74. Setae mostly bifid, with the upper tooth as long as or longer than and thinner than the lower, 4-6 anteriorly, 2 posteriorly, many may be simple-pointed. Vasa deferentia short, atria tubular, prostates diffuse, eversible pseudopenes weakly developed. Spermathecae present, spermatozeugma absent. Coelomocytes present.

Brackish water, cosmopolitan.

Waterhole on Meyer Island, Kermadec Islands.

Type not traced.

TELMATODRILUS MULTIPROSTATUS sp. nov.

(FIG. 3C)

l=16mm, s=65. Setae all simple-pointed, up to 8 anteriorly, as few as three posteriorly. Spermathecal setae large, spatulate. Atria elongate pear-shaped, many small prostates on atria. Eversible pseudopenes present. Spermathecae ? with spermatozeugma. No coelomocytes.

*Type locality.* Lake Pedder, Tasmania, March 2-4, 1966, coll. W. D. Williams.

*Type.* Australian Museum, W4178-82.

TELMATODRILUS PECTINATUS sp. nov.

(FIG. 3D)

Dorsal anterior bundles with 9-12 setae, ventral bundles with 11-14, upper tooth much longer than the lower and slightly hooked. Posterior bundles with 5-8 pectinate setae. Vasa deferentia moderately long, atria pear-shaped with numerous prostates. Atria open into eversible chamber. Spermathecae present, ? spermatozeugma. Spermathecal setae modified, penial setae present, ? unmodified.

*Type locality.* Lake Pedder, Tasmania, 2.3.1966 (coll. W. D. Williams), 11.2.1967, coll. A. Dartnall.

*Type.* Australian Museum, W4176-7.

MACQUARIDRILUS BENNETTAE Jamieson, 1968

(FIG. 3E)

*Macquaridrilus bennettiae* Jamieson, 1968.

l=6.5-12.5mm, s=40-49. Setae all bifid with the upper tooth shorter and thinner than the lower, 3-5 per bundle, absent on XI. Vasa deferentia long, atria tubular ?

with many prostates, ejaculatory duct with tightly spiral muscles ending in short penes. Spermathecae with diverticula. Coelomocytes absent.

*Type locality.* Shallow pool at 300' on Wireless Hill, Macquarie Island, coll. E. Bennett, 12.12.1965.

*Type.* British Museum (Natural History) 1967.9.37-53. Paratypes Queensland Museum.

#### OTHER TUBIFICIDAE

Several unidentifiable specimens have been reported in the literature or found in collections. Michaelsen (1907) described *Clitellio abjornseni*, the types of which are in Perth along with the Jackson collection. Attempts to borrow this type material have thus far failed, and so the relationship of *C. abjornseni* to *C. arenarius* remains conjectural. A specimen resembling *Bothrioneurum vej dovskyanum* was found in an ornamental pond in the Botanic Garden, Christchurch, New Zealand, by E. C. Yung (28.1.1965).

#### Family NAIDIDAE

Prostomium, with or without proboscis. Eyes present or absent. Dorsal setae may begin in II, III, IV, or VI or further back or (rarely) be totally absent, simple-pointed or bifid, rarely pectinate or palmate needles, with or without hair setae, ventral setae from II, an indefinite number of bifid or simple-pointed setae. Genital setae sometimes modified. Clitellum in the region of the gonads. Testes and ovaries paired, in successive segments, usually in IV-V, V-VI, or VII-VIII. Atria and male pores without penes one segment behind testes. Spermathecae one pair in testes bearing segment. Asexual reproduction by budding, forming chains, or by fragmentation.

Cosmopolitan.

As with the Tubificidae, type specimens are the exception rather than the rule.

Most of the specimens examined have been returned to the collectors.

#### CHAETOGASTER sp.

Various specimens clearly attributable to this genus have been observed, but I cannot trust myself to identify the species represented in collections of preserved material. The material came from Erewhon sheep dip, Canterbury, New Zealand, 15.1.1965; pond alongside Wendon-Waikaka Road, Southland, N.Z., 20.1.1964; tailings pond near Miller's Flat, Otago, N.Z., 20.1.1964, coll. V. Stout.

*Chaetogaster limnaei* inhabits the mantle cavity and digestive glands of freshwater gastropods.

#### NAIS ELINGUIS Müller, 1773

(FIG. 3F)

l=2.2-12mm, s=15-37. Dorsal setae 1-3 hairs and needles per bundle, needles with long parallel teeth, the upper longer than the lower. Ventral setae 2-5 per bundle, those of II-V slightly longer, straighter and thinner than the rest, with

the upper tooth about twice as long as the lower; from VI on upper tooth twice as long as lower and from half as thick to the same thickness. Swims with lateral movements.

Cosmopolitan, frequent in brackish water, abundant in organically polluted streams.

Trevethan Creek, Cook Highway, Cape York Peninsula, Queensland, Australia, 19.7.1966; Tinaroo Falls Dam reservoir, Atherton Tableland, Queensland, 17.7.1966; coll. B. G. Jamieson.

#### Nais sp.

Many specimens clearly attributable to the genus *Nais* but which otherwise show few distinguishing characteristics when preserved are probably attributable to the cosmopolitan *N. communis* and *N. variabilis*. Both species should be easily established as part of the Australasian fauna by examining locally collected material. (Fig. 3G, H).

#### DERO ASIATICA Černosvitov, 1930

(FIG. 3I)

l=approximately 4mm, s=36. Dorsal setae from VI, usually one hair and one needle, needle with strongly diverging prongs and 3-4 fine intermediate teeth. Ventral setae in II-V straighter and thinner than the rest, the upper teeth longer than the lower, the rest with the upper tooth as long as or shorter than the lower. Branchial fossa with median incision in the dorsal margin, ? two pairs of gills.

Known only from Turkestan. A naidid with pectinate setae that resembles this species was found in Lake Lyndon, New Zealand, at 4m, 14.4.1965, by V. Stout.

#### DERO PECTINATA Aiyer, 1929

(FIG. 3J)

l=approximately 2mm, s=19-25. Dorsal setae from VI, 1 plumose hair and one needle with three equal teeth. Ventral setae of II-V 4 per bundle, about twice as long as the rest, straighter and thinner, with longer upper tooth; in the rest, 2-4 per bundle with longer thicker lower tooth. Two pairs of small knob-like gills on ventral wall of fossa.

Known from southern India, West Indies. Specimens resembling this species collected by B. G. Jamieson at 23° 27' 30" S. on the Tropic of Capricorn near Rockhampton, Queensland, Australia, 22.7.1966.

#### DERO DORSALIS Ferroniere, 1899

(FIG. 3K)

l=10-30mm, s=23-150. Dorsal setal bundles from IV, 1 hair and 1 bifid needle, upper tooth slightly longer than lower. Ventral setae of anterior segments with longer upper tooth, teeth becoming equally long posteriorly or upper slightly shorter. Branchial fossa with two diverging processes from postero-lateral border, and normally 5 pairs of gills. Tube dwelling.

Europe, South and East Asia.

Australian specimens from B. G. Jamieson, collected Cape Hillsborough, Queensland, 9.5.1966 by E. M. Marks.

*DERO DIGITATA* (Müller, 1773)

(FIG. 3L)

l=6-32mm, s=20-105. Dorsal setae from VI, 1 hair and 1 needle, double pronged with upper tooth 1-2 times as long as lower. Ventral setae in II-V 3-6 per bundle longer than the rest, upper tooth  $1\frac{1}{2}$ -2 times as long as the lower, the rest 2-5 per bundle, teeth about equally long. Branchial fossa normally with 4 pairs of gills, sometimes some lacking or others divided forming extra gills. Swims with spiral movements. In mucous tubes.

Cosmopolitan.

There is an extensive list of synonyms of this species, and there is some disagreement as to the identity of many of the forms included herein. (Brinkhurst in Brinkhurst and Jamieson, 1971).

Botanic Garden ornamental pond, Christchurch, New Zealand, 28.1.1965; gravel workings at Kainga, 10 m north of Christchurch, N.Z. 6.5.1965; Lichfield lagoon, 27 m north of Christchurch, N.Z. 20.1.1965; coll. E. C. Yung. Pond opposite Pyramid Valley, North Canterbury, N.Z., 29.11.1964; larger pond at foot of L. Pukaki, Canterbury, N.Z., 8.1.1964; coll. V. Stout. Bank of dry Elliot River, Townsville Road, Queensland, Australia, 15.7.1966; coll. B. G. Jamieson.

*DERO NIVEA* Aiyer, 1929

(FIG. 3M)

l=2.5-10mm, s=23-45. Dorsal setae from VI on, 1 hair and 1 bifid needle with equal teeth. Ventral setae of II-V longer and thinner than the rest, with upper tooth twice as long as lower, in the rest teeth about equal. Branchial fossa slightly prolonged backwards with 3 pairs of short stumpy gills.

Europe, Asia, North America, Africa.

? Lake Lyndon, New Zealand, 1.5m, 14.4.1965; coll. V. Stout.

Laura River, 50 m south of Cooktown, Cape York, Queensland, Australia, 18.7.1966; creek near Tully, 30 m from Innisfail, Queensland, 16.7.1966; Trevethan Creek, Cook Highway, Queensland, 19.7.1966; coll. B. G. Jamieson.

*DERO (AULOPHORUS) FURCATUS* (Müller, 1773)

(FIG. 4A)

*Dero roseola* Nicholls, 1921; Jackson, 1931.

l=6-20mm, s=35-82. Dorsal setae from V onwards, 1 hair and 1 bifid needle with slightly longer lower tooth. Ventral setae of II-IV 2-5 per bundle with long teeth, the upper longer than the lower; from V on slightly shorter with teeth subequal. Branchial fossa with parallel palps and 3-4 pairs of gills. Swimming with transverse horizontal movements. Inhabit attached or portable tubes of foreign matter.

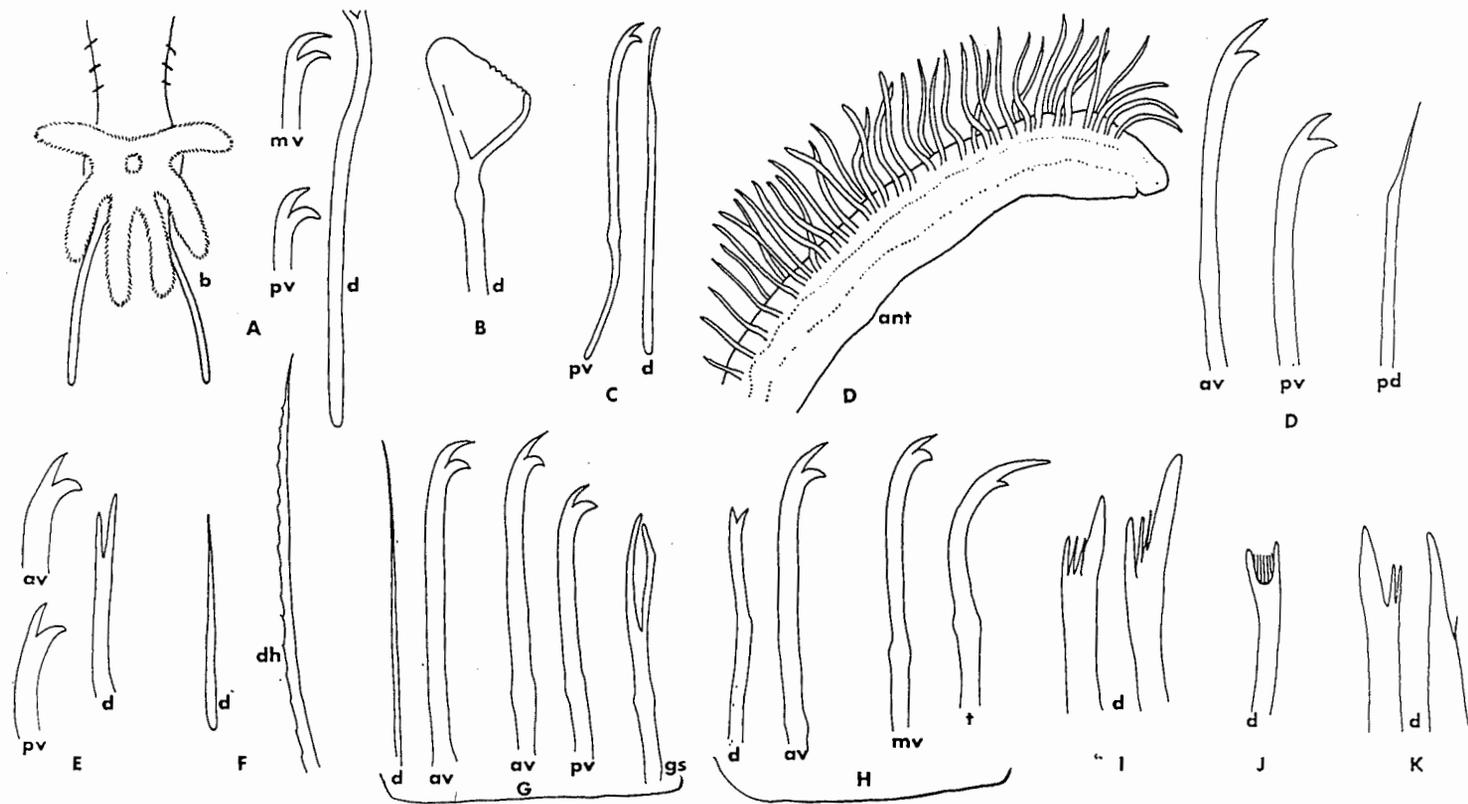


FIG. 4.—Characteristic features of some Naididae.

A—*Dero (Aulophorus) furcatus*; B—*Dero (Aulophorus) flabelliger*; C—*Slavina appendiculata*; D—*Branchiodrilus hortensis*; E—*Pristina idrensis*; F—*P. proboscidea*; G—*P. longiseta*; H—*P. aequiseta*; I—*Allonais inaequalis*; J—*A. pectinata*; K—*A. paraguayensis*. a=anterior (seta), ant=anterior end (whole worm), b=branchial apparatus, d=dorsal (seta), gs=genital (seta), h=hair (seta), m=median (seta), p=posterior (seta), t=giant seta, v=ventral (seta).

Cosmopolitan.

South Perth, Australia in a trough supplied with mineral water from a deep bore (Nicholls, 1921; Jackson, 1931). Record not confirmed.

*DERO (AULOPHORUS) FLABELLIGER* Stephenson, 1931

(FIG. 4B)

$l=2.75\text{mm}$ ,  $s=27$ . Dorsal setae from VI on, 1 hair and 1 palmate needle with strongly divergent teeth and broad obliquely cut web. Ventral setae of II-V 5-7 per bundle, more than double the length of the rest, upper tooth longer than the lower; those following with upper tooth one-third as thick and half as long as the lower. Branchial fossa with 2-3 pairs of long cylindrical gills and long parallel palps. In tubes of foreign matter.

Africa (Kenya), China.

University of Queensland campus, pool and Farmers' artificial lake, Queensland, Australia; Laura River, 50 m south of Cooktown, Cape York, Queensland, 18.7.1966; coll. B. G. Jamieson.

Australian specimens seem to have only two long pairs of gills, the third being either much smaller and contracted (hence invisible in preserved mounts) or absent.

*SLAVINA APPENDICULATA* d'Udekem, 1855

(FIG. 4C)

$l=2-20\text{mm}$ ,  $s=23-46$ . Eyes present. Dorsal bundles from VI on, 1-2 stout hairs (1-3 per bundle in VI and strongly elongate) and 1-2 straight needles with distal part effilated and tip often distended. Ventral setae 2-5 per bundle, in II-V thinner and in II slightly longer than the rest, upper tooth thinner and slightly longer than lower.

Cosmopolitan.

Lake Coleridge, Canterbury, New Zealand, 135 and 194 m, 1.3.1967; coll. M. Flain (Otago Museum A69.17-18). ?L. Georgina, near L. Coleridge, Canterbury, N.Z.; 17.3.1963; coll. V. Stout.

*BRANCHIODRILUS HORTENSIS* (Stephenson, 1910)

(FIG. 4D)

$l=\text{up to } 50\text{mm}$ ,  $s=35-120$ . Gills present on nearly all segments from VI on. Dorsal setae 2-5 per bundle, on anterior part of body enclosed within gills, on posterior part usually one hair projecting freely and, in those segments, 1-2 straight-tipped needles. Ventral setae all of one type, upper tooth thinner than the lower but as long as or longer than it. No swimming.

East and South Asia, Africa.

Tropic of Capricorn,  $23^{\circ} 27' 36''$  S. near Rockhampton, Queensland, Australia, 22.7.1966; coll. B. G. Jamieson.

## PRISTINA IDRENSIS Sperber, 1948

(FIG. 4E)

? *Pristina taita* Stout, 1956.? *Pristina nothofagi* Stout, 1958.

l=3-4mm, s=14-18. No proboscis. Hair setae 1-2 per bundle, non-serrate (?or very finely so), needles 1-2 per bundle, curved distally, bifid with teeth long and parallel, lower tooth slightly longer than upper, in IV needles longer and stouter than elsewhere. Ventral setae 3-7 per bundle, teeth equally long. Coelomocytes present.

Europe, ?N. America, ?New Zealand.

In describing *P. nothofagi* Stout (1958) made an attempt to distinguish it from other *Pristina* species, the discussion centering around *P. osborni* (as *P. minuta*). No mention was made of several species in which the needles are distinctly bifid (*P. bilobata*, *P. notopora*, *P. rosea*, *P. idrensis* and *P. amphibiotica*) and three others (*P. menoni*, *P. jenkinsi*, *P. breviseta*) were dismissed as being larger with n being 19 instead of 12. In fact the needles of *P. menoni* are simple pointed or bear a fine upper tooth, those of *P. jenkinsi* (not *jenkini*) and *P. breviseta* are obviously bifid but the latter usually has a proboscis (missing in *idrensis*, *nothofagi*, *taita* and other species under discussion). If we consider those *Pristina* species having obviously bifid setae but no proboscis we may erect the following key:

1. Needle teeth very short and about equal	<i>P. osborni (minuta)</i>	
	<i>P. bilobata</i>	
	<i>P. notopora</i>	
— Needle teeth long, upper tooth shorter than lower	.. .. .	2
2. Ventral setae all with teeth equally long	.. .. .	3
— Ventral setae not all with teeth equally long	.. .. .	4
3. Needle teeth long, parallel, upper slightly shorter than lower	<i>P. idrensis</i>	
— Needle teeth diverging, upper about half as long as lower	<i>P. jenkinsi</i>	
4. Anterior ventral setae with upper tooth slightly longer than lower, the difference less posteriorly	<i>P. rosea</i>	
— Anterior ventral setae with upper tooth as long as lower or longer, posteriorly upper tooth shorter than lower	<i>P. amphibiotica</i>	

Liang (1963) regarded *idrensis* as a sub-species of *amphibiotica*. Harman (1965) described *P. longidentata*, and argued its separation from *rosea*, both species having finely serrate hair setae whereas *idrensis* and *amphibiotica* have smooth setae. The hair setae of *jenkinsi* (the second species considered by Harman) are also smooth, and it is difficult to see why this species was discussed without mention of *idrensis* et al. The ventral setae of *longidentata* do not all have the teeth of equal length however and Harman (pers. comm.) recognizes it as a distinct species despite my objections.

The serrations on the hair setae of *rosea* are said to be fine, those on *longidentata* were observed at a magnification of 1000 times with phase contrast, equipment that may show up characteristics overlooked by those less well equipped.

To return to *nothofagi* and *taita*, the details concerning the ventral setae are wanting but the descriptions imply that in all segments the teeth are about equally long. The stomach in *taita* starts in VI as in *amphibiotica* and *idrensis*, and while this is usually taken to be an important diagnostic characteristic I have yet to see a detailed study of its variability (or constancy) in a large series. Stout separates *taita* from these two species on the basis of the position of n, the segments in which the dorsal setae reach maximal length, and the unusual bifurcation of the ventral blood vessel of *taita*. The ratios of the length of the upper tooth to the lower in the needle setae are 6/10 in *taita*, 5/10 in *amphibiotica*, 8/10 in *idrensis*, although how these ratios were determined for the European species is not disclosed, nor

is the number of specimens upon which they are based, nor the variability of this character.

The needle setae of *nothofagi* have nothing in common with those of *P. osborni* (*minuta*) but closely resemble those of the species considered in couplets 3 and 4 above. The separation of *nothofagi* from *jenkinae* and *idrensis* (allowing that the ventral setae of the former have the teeth equally long throughout) was not discussed by Stout (1958), nor were the differences between it and *taita* mentioned, although these seem to be germane to the issue.

Examination of the types of both of Stout's species (Dominion Museum, New Zealand) revealed little. A thorough revision of all the species involved is clearly required before a final decision can be made. Until that time I prefer to regard *Pristina idrensis* as the most likely identity of the New Zealand forms. The whole assemblage may be identifiable with *P. rosea* Piquet, 1906.

PRISTINA PROBOSCIDEA Beddard, 1896  
(FIG. 4F)

l=2-5mm, s=18-36. Prostomium forming a proboscis. Hair setae ? serrate, 1-4 per bundle, needles 1-4 per bundle, simple-pointed, straight, and fine. Anterior ventral setae 2-4, up to 9 posteriorly, all with upper tooth longer than the lower, in 11 longer and thicker than the rest.

South America, Zanzibar, South and East Asia.

Myrtle Creek near Proserpine, Queensland, Australia, 15.7.1966; coll. B. G. Jamieson.

In view of the discussion under *P. idrensis*, it is of interest to note that specimens with and without hair setal serrations were described by Marcus (1947).

PRISTINA LONGISETA Ehrenberg, 1828  
(FIG. 4G)

*Pristina longiseta* Ehrenberg. Jackson, 1931.

Prostomium forming a proboscis. Hair setae serrate, in III extremely long and non-serrate, needles fine, straight, simple-pointed or finely bifid. Ventral setae of II and III differing in shape from the rest, upper tooth 2-3 times as long as lower, in the rest upper tooth less than twice the lower.

Cosmopolitan, subspecies described from N. America (*leidyi*), S. America (*bidentata*) but possibly an Artenkreis.

Brunswick, in a brook, S.W. Australia; Jackson (1931). Creek near Tully, 30 m from Innisfail, Queensland, Australia, 16.7.1966; Tropic of Capricorn, 23° 27' 30" S. near Rockhampton, Queensland, 22.7.1966; Trevethan Creek, Cook Highway, Cape York Peninsula, Queensland, 19.7.1966; bank of dry Elliot River, Townsville Road, Queensland, 15.7.1966; coll. B. G. Jamieson.

PRISTINA AEQUISETA Bourne, 1891  
(FIG. 4H)

l=2-6mm, s=18-23. Prostomium forming a proboscis. Dorsal setae 1-2 finely serrate hairs, 1-2 finely bifid needles. Ventral setae in most segments 5-8 per bundle, those of II longer and thinner than the rest, and with upper tooth twice

↑  
not so noticeable as Yangbuphata (WA)

as long as lower; in III-VII shorter and slightly thicker with upper tooth slightly longer than the lower or, usually, in IV, V, or VI or some of these, enlarged setae, much thicker than the rest with upper tooth more than twice as long as lower or the lower missing; behind VII setae thicker, more curved, with equally long teeth.

Cosmopolitan, also in oligohaline water.

Creek near Tully, 30 m from Innisfail, Queensland, Australia, 16.7.1966; Trevethan Creek, Cook Highway, Cape York Peninsula, Queensland, 19.7.1966; bank of dry Elliot River, Townsville Road, Queensland, 15.7.1966; coll. B. G. Jamieson.

*ALLONAIIS INAEQUALIS* (Stephenson, 1911)

(FIG. 4I)

l=8-18mm, s=40-95. Dorsal setae 1-2 hairs, 1-2 pectinate needles with 1-4 long intermediate teeth, the lower tooth usually longer than the upper. Ventral setae 4-8 per bundle, in II-V slightly thinner and straighter than the rest, the upper tooth slightly longer than the lower, the rest with teeth equally long or the upper slightly the shorter.

Southern Asia, Africa, S. America.

Laura River 50 m south of Cooktown, Cape York Peninsula, Queensland, Australia, 18.7.1966; creek near Tully, 30 m from Innisfail, Queensland, 16.7.1966; Trevethan Creek, Cook Highway, Queensland, 19.7.1966; University Lake, St. Lucia, Brisbane; coll. B. G. Jamieson.

*ALLONAIIS PARAGUAYENSIS* (Michaelsen, 1905)

(FIG. 4K)

l=4-60mm, s=15-200. Dorsal setae beginning in V, VI, or VII, 1-2 hairs, 1-2 needles, simple-pointed or bifid with long teeth, the lower about twice as long as the upper, which may be bifid or single or even strongly reduced. Ventral setae 2-8 per bundle, all about equally long or shorter anteriorly; the upper tooth slightly longer anteriorly, teeth equal posteriorly. Swims with transverse movements, rotating on its axis.

Asia, Africa, N. and S. America.

? 15 m north of Rockhampton, near foot of Mount Etna, Queensland, Australia, 14.7.1966; coll. B. G. Jamieson.

*ALLONAIIS PECTINATA* (Stephenson, 1910)

(FIG. 4J)

l=1.5-8mm, s=15-65. Dorsal setae 1-2 hairs and 1-2 needles per bundle, needles pectinate with 1-5 intermediate teeth. Ventral setae of II-V 3-5 per bundle, upper tooth slightly longer than lower, the rest 2-7 per bundle, teeth equally long.

Asia, Africa.

Creek near Tully, 30 m from Innisfail, Queensland, Australia, 16.7.1966; Trevethan Creek, Cook Highway, Queensland, 19.7.1966; coll. B. G. Jamieson.

## Family AEOLOSOMATIDAE

Brinkhurst (in Brinkhurst and Jamieson, 1971) has advanced reasons for considering this family to belong in some undetermined position outside the Oligochaeta or even the Clitellata. Despite this, as they are traditionally considered to be aquatic oligochaetes, the species known from the region will be briefly reviewed below.

## AEOLOSOMA NIVEUM Leydig, 1865

*Aeolosoma niveum* Leydig. Stout, 1952, 1956, 1958.

Small, first zooid 0.5–0.8. Chains up to 4 zooids, up to 1.5mm. Fission zone after VI to VII (VIII). Prostomium somewhat triangular, slightly wider than the following segments. Ciliated field restricted to the ventral surface; sensory pits round, relatively large, separated from the ventral field. Refractive epidermal glands colourless to faint green. Hair setae subequal, 1–3(4) per bundle, 50–80 $\mu$ .

Raoul Island, Kermadec Islands; Hutt Valley, New Zealand.

## AEOLOSOMA HEMPRICHI Ehrenberg, 1828

*Aeolosoma kashyapi* Stephenson. Stout, 1952, 1956.

*Aeolosoma hemprichii* Ehrenberg. Stout, 1958.

Small, first zooid 0.3–1.9mm, chains up to 6 zooids, up to 2mm. Fission zone after VII, rarely after VI or VIII. Prostomium rounded or slightly triangular, distinctly wider than following segments, ciliated field restricted to ventral surface or with small dorso-lateral continuations; sensory pits round, often indistinct and not clearly separated from ventral field. Epidermal glands globular, orange to dark red. Hair setae unequal, in small specimens sometimes subequal, 2–6(8) per bundle; short setae 1–3(4) per bundle, long setae 0–3(4) per bundle.

Raoul Island, Kermadec Islands; Hutt Valley, New Zealand.

Several species of these small worms will be found once a collector seriously looks for them. Many species have distribution records that indicate a very wide-spread distribution restricted only by the occurrence of collectors.

## III. DISCUSSION

The fauna list for the Australasian region is probably so incomplete as yet that little may be gained by speculating about the zoogeographical aspects of the subject.

The abundance of haplotaxids and phreodrilids in relation to their scarcity elsewhere has already been noted. The recognition of the first lumbriculid to be found in the Southern Hemisphere (it is known also from S. Africa) seems to constitute an example of introduction by man.

The tubificids consist of cosmopolitan forms or odd genera such as *Antipodrilus*, *Macquaridrilus* and, possibly, *Taupodrilus* if this is really distinguishable from *Rhyacodrilus*. Two specimens of the genus *Telmatodrilus* being located in Tasmania adds to the evidence of this being a discontinuously distributed genus,

with these being the first representatives from the Southern Hemisphere. The scarcity of tubificids contrasts with their abundance in the Holarctic region.

The Naididae consists of cosmopolitan forms, together with an Asian-African group which may prove to be a Southern Hemisphere group if more of them are identified from S. America, another region requiring further investigation.

Many of the more interesting species in the area seem to be predominantly ground-water dwelling forms, which is understandable in the large arid areas of Australia but less so in New Zealand, where the same observation can be made.

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