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New Species of the Earthworm Genus *Anisochaeta* (Oligochaeta: Megascolecidae) from New South Wales

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ABSTRACT. The number of *Anisochaeta* from New South Wales is more than doubled to 50 species in the present account. Twenty-seven species are newly described, one of which is tentatively attributed to the dubious genus *Propheretima*. A checklist is presented with the distributions of the twenty-three previously described *Anisochaeta* from NSW that were variously attributed to the genera *Perichaeta, Megascolex*, and *Spenceriella*. One species, *Megascolex crateroides* Boardman, 1943, is herein synonymized with *Anisochaeta gracilis* (Fletcher, 1886b). A replacement name, *Anisochaeta trichaeta*, is proposed for the homonym of the Victorian *Trichaeta australis* Spencer, 1900. A key is provided for currently known NSW species.

The generic definition of *Anisochaeta* is modified to accommodate forms with the newly discovered vesiculate nephridial condition. Several of the new species have setae between the male pores, further reducing the distinctiveness of *Propheretima* from the prior genus *Spenceriella*, which is itself currently synonymized under *Anisochaeta*.

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The current study was instigated under the biodiversity "Hot Spots" project at the Australian Museum to work on unidentified material held in their earthworm collection. The emphasis was on unidentified material in samples from State Forests and Reserves in the northeast region of NSW (mostly collected by Ed Easton in March–May, 1983), but various other specimens from around the State were also examined.

Anisochaeta, widespread throughout the southern states of Australia, appears from the current study to be particularly diverse in the New England region of NSW. One sample of 35 specimens from New England National Park consisted of ten new taxa. Although most NSW species appear highly localized, some have acquired greater ranges via fluvial or human-mediated transportation. Thus *A. exigua murrayana* (Fletcher, 1887a) occurs from the Riverina region of NSW and Victoria to near the mouth of the Murray River in South Australia, *A. tenax* (Fletcher, 1886b) from Sydney has been reported from the Marquesas Islands, in the South Pacific (Michaelsen, 1900: 226), while *A. sebastiani* (Blakemore, 1997b) occurs in southern Queensland and Tasmania as well as in NSW (Blakemore, 1997b: 1838).

The present paper reports on the Australian genus *Anisochaeta* Beddard, 1890 (as recently restored by Blakemore, 1997a: 1822–1824) into which most of the native species that were at one time placed in *Megascolex, Perichaeta, Trichaeta, Spenceriella*, and *Gemascolex* are now transferred. Previously known *Anisochaeta* species are attributed to Fletcher who, in a series of papers (1886–1890), described a total of about 69 species and varieties, including 26 belonging to *Perichaeta*. These *Perichaeta* comprised 16 species and six varieties (total 22 taxa) from NSW, six species from Queensland, and two species each from South Australia and Victoria. Other authors documented *Anisochaeta* species from various Australian states. Spencer (1893, 1895, 1900) described, respectively, 22 (*Perichaeta*) species from Victoria plus one from South Australia, six species from Tasmania, and ten species (as *Trichaeta* and *Megascolex*) from Victoria and Queensland. Michaelsen (1907a,b, 1916) described 22 *Megascolex* species; these were, respectively, eight species (six previously known) from Victoria, South Australia, and NSW; 11 from Western Australia; and three from Queensland. Jamieson (1974b) listed 11 *Spenceriella* and *Gemascolex* species as occurring in South Australia but apparently overlooked the two *Anisochaeta* species and varieties from South Australia described by Fletcher (1890: 1552).

Methods and abbreviations

Most material examined was collected by Ed Easton, but unfortunately his survey methods are unknown. In particular it is not known whether he disregarded exotic species if he came upon them, nor is it known how intensively he sampled at any one locality. The exact location of some sites is also unresolved, especially one recorded on labels as "Face Fern Valley, New England National Park". This park has no "Face Fern Valley", but Tree Fern Valley (G.R. 430261—Ebor 1:25,000 sheet 9337–2–5) in the Point Lookout Section at the west of the New England National Park, is the most likely location (information courtesy of M. Dwyer, NSW Park and Wildlife Service, Dorrigo District). However, about 30 km east on the boundary of the Bellinger River National Park, is Ferny Face ridge (G.R. 753360—Darkwood 1:25,000 9437–3–5). The former location is considered the most likely as Easton's next sampling was further west at Cathedral Rock National Park. Thus, throughout the following text, the label locality "Face Fern Valley" is changed to Tree Fern Valley.

Following Michaelsen's (1900) method, segments are counted from the anterior using the normal and more familiar Arabic numerals (to avoid the confusion inherent in use of Roman numerals), intersegments are designated by a slash (e.g., 3/4), variations shown by a comma, and range by a dash (e.g., 3,4–5). Setae, counted from the ventral-most on each side, have lower case italic letters (e.g., *a, b, c*); setal lines refer to longitudinal setal series. Right- and left-hand-sides are rhs and lhs, respectively. Gut contents are described to give an indication of the ecological strategies of feeding and burrowing. New South Wales is abbreviated to NSW. All examined material is preserved in 80% ethanol and lodged in the Australian Museum, Sydney (with registration beginning AM W) and in the National Earthworm Collection of the CSIRO Division of Entomology, Canberra (ANIC). Locality data are set off with quotation marks when copied from original labels; Australian Map Grid coordinates are prefixed AMG and are derived from maps. Dorsal dissections were performed under magnification, specimens were pinned on a wax tray containing ethanol and sketched using a *camera lucida*.

Figure 1 is annotated thus: acc. gl.—accessory glands; amp.—spermathecal ampulla; clit.—clitellum (shown shaded); diva.—spermathecal diverticulum (often iridescent); d.p.—dorsal pores; g.m.—genital markings; neph.—nephridium; neph. bla.—nephridial bladder; peri.—peristomium (= first segment, lacks setae); pr.—prostatic gland (ducting to male pore); pro.—prostomium (above mouth); sept.—septa; sp.—spermathecae (opening at spermathecal pores). All scale bars are 1 mm. Holotypes, paratypes and non-type specimens are identified in the text by the upper case abbreviations: H, P and S.

Systematics

Anisochaeta Beddard, 1890

Anisochaeta Beddard, 1890: 56.–Blakemore, 1997b: 1822–1824.
Trichaeta Spencer, 1900: 30–31.
Spenceriella Michaelsen, 1907b: 160–161.–Jamieson & Wampler, 1979: 639.
Gemascolex Edmonds & Jamieson, 1973: 23–24.–Jamieson, 1974b: 87.

Diagnosis. Perichaetine (i.e., more than eight setae per segment), at least in the mid- and hind-body. Female pores single or paired on 14. Male pores from tubuloracemose or racemose prostates paired on 18. An oesophageal gizzard in 5 or 6. Nephridia meroic (i.e., more that one pair per segment), at least in the fore-body, avesiculate or vesiculate, often tufted in the anterior. Spermathecae one or more pairs (sometimes unpaired), with one or more extramural diverticula. Calciferous glands and intestinal typhlosole present or absent, intestinal caeca and gizzards absent. Modified penial setae present or absent. Segmental and intersegmental genital markings present but sometimes reduced or absent.

Type species. *Perichaeta coxii* Fletcher, 1886a.

Distribution. Australia, all states, and New Zealand (Lee, 1959: 279).

Remarks. See Blakemore (1997b) for a recent discussion on this genus. The diagnosis is modified to include vesiculate meroic nephridia, as several species in the current study (*A. aemula* n.sp., *A. lavatiolacuna* n.sp., *A. toonumbari* n.sp., *A. yabbratigris* n.sp.) were found to have nephridial bladders. This condition also occurs in the Australian genus *Cryptodrilus* Fletcher, 1886a and the Oriental genus *Pleionogaster* Michaelsen, 1892 (see Blakemore 1997c: 1686–1689, for discussion of these two genera). The possibility of creating a new genus for these vesiculate forms

(as currently used to differentiate the lumbricine genera *Cryptodrilus* and *Notoscolex*) is deferred pending phylogenetic analysis of respective taxa.

Some of the species newly described below have pharyngeal tufted nephridia and either have or lack calciferous glands; intraspecific variations in paired or unpaired female pores are also noted. Moreover, intrasegmental genital markings are reported for several species that are clearly assignable to *Anisochaeta* (e.g., species described by Spencer, 1893, Michaelsen, 1907a, and in *Trichaeta australis* Spencer, 1900). These observations remove the only remaining justification for the genus *Gemascolex*, as noted by Blakemore (1997b: 1823–1824), and reinforce synonymy of this genus with *Anisochaeta*.

Checklist, with distributions, of previously described *Anisochaeta* species from New South Wales

Several of Fletcher's species have type material that is not traceable, but there is a possibility some specimens remain unrecognized in parts of the Fletcher Collection donated to the Australian Museum.

1 *Perichaeta attenuata* Fletcher, 1889: 1552–1555; *Anisochaeta attenuata*.–Beddard, 1890: 56; *Megascolex attenuatus*.–Michaelsen, 1900: 216. From Mt Wilson. (Type AM W1343).

2 *Perichaeta australis* Fletcher, 1886a: 561–565, figs. 9–11; 1886b: 956–957; 1887a: 399; *Megascolex australis*.–Michaelsen, 1900: 222–223. From Burrawang and Sydney (Mt Wilson specimens were transferred to *Perichaeta monticola* Fletcher, 1887a). (Syntypes missing).

> Transfer of Victorian *Trichaeta australis* Spencer, 1900 to Anisochaeta, makes this a junior secondary homonym of *Anisochaeta australis* (Fletcher, 1886a). Under article 60 of the ICZN the replacement name: *Anisochaeta trichaeta* **n.nom.** is proposed here for Spencer's species.

3 *Perichaeta austrina* Fletcher, 1886b: 956–957, fig. 5; 1887a: 399; 1890: 1001–1002; *Megascolex austrinus*.–Michaelsen, 1900: 223; 1907a: 16–17. From Burrawang, Sydney and (Michaelsen) Blue Mountains between Mt Victoria and the Jenolan Caves region. (Syntypes missing).

4 *Megascolex celmisiae* Jamieson, 1973: 242–246, figs., 5C, 6H, 7F, table 2. From Mt Kosciuszko. (Types: H, P1–20, AM W4662–2682).

> The description by Sims & Gerard (1985: 136, fig. 49) of specimens introduced from NSW to Strathclyde, Scotland, that they identify as "*Spenceriella minor* (Spencer, 1900)", appears to more closely match *Anisochaeta celmisiae*. These two species usually have, respectively, two and three pairs of spermathecae, although Jamieson (1973: 246) noted that a spermatheca was missing from 7 in one of the two dissected specimens of *A. celmisiae*. Moreover, the figure in Sims & Gerard (1985, fig. 49) has some indication of erasure of a third pair of spermathecal pores in intersegment 6/7.

5 *Perichaeta coxii* Fletcher, 1886a: 565–569; 1889: 1554; *Anisochaeta coxii*.–Beddard, 1890: 56; *Megascolex coxi*.–Michaelsen, 1900: 216. From Mt Wilson. (Syntypes missing).

6 *Perichaeta enormis* Fletcher, 1889: 1555–1556; *Anisochaeta enormis*.–Beddard, 1890: 56; *Megascolex enormis*.–Michaelsen, 1900: 215–216. From Gosford region. (Syntypes missing).

7a *Perichaeta exigua* Fletcher, 1887a: 387–389; *Megascolex exiguus*.–Michaelsen, 1900: 225. From Springwood (Blue Mountains) Randwick and Manly Beach (near Sydney). (Type AM W1347).

7b *Perichaeta exigua* var. *murrayana* Fletcher, 1887a: 389; 1889: 1552; *Megascolex exiguus* var. *murrayana*.–Michaelsen, 1900: 225. From Mulwala on the Murray River, NSW, and (Fletcher, 1889: 1552) from the shores of Lake Alexandrina, South Australia. (Syntypes missing, South Australian material reported by Fletcher from "Adelaide Museum" [sic]).

> On the information available, *Anisochaeta exigua murrayana* probably merits specific status. Reynolds & Cook (1976: 142) erroneously list synonymies of the latter taxon under *Amynthas* and *Pheretima*.

8 *Perichaeta fecunda* Fletcher, 1887a: 401–402; 1890: 1003–1004, 1007–1008; *Megascolex fecundus*.–Michaelsen, 1900: 225, 234. From Mt Wilson and Lawson in the Blue Mountains (Types: AM W1346).

> Fletcher (1890: 1007–1008) described a possibly distinct variety of *Anisochaeta fecunda* (Fletcher, 1887) from Burrawang that is, nevertheless, similar to his "Variety b" of *Anisochaeta macleayi* (Fletcher, 1889) as noted by (Fletcher, 1890: 1005–1006), also from Burrawang. Fletcher (1889: 1550–1551) further described one species, and its varieties, as *Perichaeta indissimilis*, from Lake Alexandrina, South Australia, that also appears closely allied to *A. fecunda*.

9 *Megascolex fletcheri* Michaelsen, 1907a: 21–22, figs. 14–15. From the Jenolan Caves region of the Blue Mountains. (Syntypes, Hamburg Museum 6889, and AM W3432).

10 *Perichaeta gracilis* Fletcher, 1886b: 958–960 (non *Perichaeta gracilis* Bourne, 1887); *Megascolex gracilis*.–Michaelsen, 1900: 220; *Megascolex crateroides* Boardman, 1943: 174–176, figs. 4–5, **n.syn.** From Auburn near Parramatta and (Boardman) Mt George in the Jenolan Caves region. (Type, AM W3320; Boardman's specimen is AM W3320).

> *Megascolex crateroides* is here synonymized with *Anisochaeta gracilis* as there are no appreciable differences between the specimen described by Boardman and Fletcher's previous description.

11 *Perichaeta hamiltoni* Fletcher, 1887a: 399–401; *Megascolex hamiltoni*.–Michaelsen, 1900: 234. From beside Cudgegong River, Guntawang. (Types, AM W1349).

12 *Megascolex jenolanensis* Boardman, 1943: 176–178, figs. 6, 7. From the Jenolan Caves region. (Types, AM W3317–3319).

13 *Perichaeta macleayi* Fletcher, 1889: 1556–1558; 1890: 1003–1007; *Megascolex macleayi*.–Michaelsen, 1900: 223; *Spenceriella macleayi*.–Blakemore & Elton, 1994: 251–154, fig. 1. Type locality is Sydney, also from Mt Victoria in the Blue Mountains, Raymond Terrace, Morpeth, Coonabarabran and from the banks of the Namoi at Gunnedah; reported from Richmond (Blakemore & Elton, 1994) and Deniliquin in the Riverina region, NSW (Barley & Kleinig, 1964); now known also from Broulee, Oolong, Book Book (near Wagga Wagga), NSW, and Churchill and Yea, Victoria (Blakemore, unpub.). (Syntypes, AM W1344–1345).

Fletcher (1890) described three varieties and three sub-varieties of *Anisochaeta macleayi* (Fletcher, 1889). Whereas *c* sub-varieties (from Mt Victoria, Raymond Terrace, Morpeth, Coonabarabran and Gunnedah) agree tolerably on information given, varieties *a* and *b* (from Mt Wilson, Lawson and Burrawang) differ considerably. Thus all varieties may not be conspecific.

14 *Perichaeta macquariensis* Fletcher, 1890: 1000–1002; *Megascolex macquariensis*.–Michaelsen, 1900: 224. From the banks of the Macquarie River at Dubbo. (Syntypes: AM W972, AM W976, AM W977).

15 *Megascolex mediaeviae* Michaelsen, 1907a: 19–21, fig. 13. From Blue Mountains, between Mt Victoria and Jenolan Caves near *Halfway* guesthouse. (Syntypes, Hamburg Museum HM V6900).

16 *Perichaeta monticola* Fletcher, 1887a: 390–391; *Perichaeta australis* (part.) Fletcher, 1886a: 565; *Megascolex monticola*.–Michaelsen, 1900: 223; 1907a: 16, fig. 11; Boardman, 1943: 170–173, fig. 3. From Blue Mountains, Mt Wilson (type locality) to the Jenolan Caves region. (Neotype, AM W1390).

Boardman (1943: 173) describes a variety of this taxon.

17 *Perichaeta raymondiana* Fletcher, 1887a: 398–399; *Megascolex raymondianus*.–Michaelsen, 1900: 224. From Raymond Terrace on the Hunter River. (Syntypes missing).

18 *Megascolex rodwayi* Stephenson, 1931: 53–55, fig. 8; Boardman, 1943: 173–174. From Hampton (type locality) and the Jenolan Caves region. (Syntypes, Natural History Museum, London, BMNH 1930:2.7.4–6).

19 *Anisochaeta sebastiani* Blakemore, 1997b: 1836–1838, fig. 17. From Taringa (Queensland), Launceston (Tasmania) and Broulee (NSW). (Types: ANIC RB.94.16.1-2, Queen Victoria Museum, Launceston, 14:3475).

20 *Perichaeta tenax* Fletcher, 1886b: 953–957, fig. 4; 1890: 1014–1015; *Perichaeta albida* Michaelsen 1892; *Megascolex tenax*.–Michaelsen, 1900: 226. From Auburn near Parramatta (type locality), County of Cumberland and Springwood in the Blue Mountains; and (Michaelsen) from "Marquesas de Mendoza?". (Types: missing according to Reynolds & Cook [1976: 178]).

21 *Megascolex wiburdi* Boardman, 1943: 168–170, figs. 1–2. Mt George in the Jenolan Caves region. (Types: AM W3309–3310).

22 *Perichaeta wilsoniana* Fletcher, 1887a: 400–401; *Megascolex wilsonianus*.–Michaelsen, 1900: 234; *Megascolex willsonianus* [sic].–(*lapsus*) Michaelsen, 1907a: 17. From Mt Wilson and (Michaelsen) the Jenolan Caves region. (Types: AM W1350).

The following key treats species from NSW, both new and known. In addition to the characters given in the generic diagnosis, many species have a ventrally cleft peristomium, setae often increasing in number posteriorly, last hearts in 12, paired ovisacs in 14, and intestinal origin in or near 16. However, some species have exceptions to some of these states. Intraspecific variation is occasionally found in the female pore (single or double), in the exact commencement of dorsal pores, in the duplication of spermathecal diverticula, and in the extent of the development of an intestinal typhlosole—suggesting that these latter characters may be less reliable for separation of some taxa.

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Key to *Anisochaeta* (and *Propheretima*) species in New South Wales

For confirmation, keyed specimens must be compared with species-descriptions because it is probable that many undescribed species await discovery.

1 One pair of spermathecal pores 2

—— Two pairs of spermathecal pores 3

—— Three pairs of spermathecal pores 36

—— Four pairs of spermathecal pores 47

—— Five pairs of spermathecal pores in *cd* lines; calciferous glands absent ..... *A. lavatiolacuna* n.sp.

2(1) Four or five pairs of calciferous pouches in 9,10–13; seminal vesicles in 11 and 12 ..... *A. exigua exigua* (Fletcher, 1887a) and varieties

—— Calciferous arrangement similar [default interpretation of Fletcher]; seminal vesicles in 9 and 12 ..... *A. exigua murrayana*

3(2) Calciferous glands absent 4

—— Calciferous glands present 25

4(3) Spermathecal pores in *a* or *ab* lines 5

—— Spermathecal pores in or lateral to *b* lines 9

5(4) Seminal vesicles in 12 only 6

—— Seminal vesicles in 9 and 12 7

6(5) 17 setae per segment anteriorly; genital markings single, midventral in 18 ..... *A. fletcheri*

—— 8 setae per segment anteriorly; genital markings paired in 18 or single, midventral in 17 and 19 ..... *A. mediaeviae*

7(5) Genital markings in 17 and 19 paired more widely than male pores 8

—— Genital markings in 17 and 19 closely paired or midventral ..... *A. flava* n.sp. and varieties

8(7) Spermathecal pores just median of *a* lines; prostates S-shaped ..... *A. angusticlavia* n.sp.

—— Spermathecal pores in *ab* lines; prostates bilobed ..... *A. conspecta* n.sp.

9(4) Spermathecal pores mostly in *b* lines 10

—— Spermathecal pores lateral of *b* lines 19

10(9) Anterior genital markings in 10 and/or 11 form 88-like tetrad 11

—— Anterior genital markings unpaired, mid-ventral or non-tetrad pair 13

11(10) Tetrad markings in 10 and 11 median of *a* lines ..... *A. novaeanglica* n.sp.

—— Tetrad markings in 10 or 11 in *ab* lines 12

12(11) Tetrad markings in 10; spermathecal diverticula as long as ampullae ..... *A. wiburdi*

—— Tetrad markings in 11; spermathecal diverticula shorter than ampullae ..... *A. ima* n.sp.

13(10) Anterior markings unpaired, mid-ventral 14

—— Anterior markings paired 15

14(13) Anterior markings in 10 and/or 11 sucker-like ..... *A. toonumbari* n.sp.

—— Anterior markings in 9–11,12 button-like discs ..... *A. bulla* n.sp.

15(13) Spermathecal diverticula extend beyond ampulla 16

—— Spermathecal diverticula shorter than ampulla 17

16(15) Small size (about 35 mm); female pore single; gizzard weak; nephridia vesiculate ..... *A. aemula* n.sp.

—— Moderate size (70–90 mm); female pores paired; gizzard strong; nephridia avesiculate ..... *A. tunicata* n.sp.

17(15) Small size (about 35 mm); first dorsal pore 5/6; no markings on 17; nephridia reduced ..... *A. paucula* n.sp.

—— Moderate size (75–150 mm); first dorsal pore 3/4/5; markings in 17 and 19 at least 18

18(17) Size 75–90 mm; setae evenly spaced; markings on 17 postsetal ..... *A. ancisa* n.sp.

—— Size 120–150 mm; setae *bc* > *ab*; markings in 17 presetal ..... *A. rodwayi*

19(9) Spermathecal pores in *b-c* lines 20

—— Spermathecal pores lateral of *c* lines 23

20(19) Setae about 60 per segment; seminal vesicles in 11 and 12 ..... *A. calpetana* n.sp. (part)

—— Setae 20–44 per segment; seminal vesicles in 9 and 12 21

21(20) Accessory markings absent or reduced; gizzard rudimentary; typhlosole absent ..... *A. sebastiani*

—— Accessory markings well developed; gizzard large; typhlosole present 22

22(21) Anterior markings irregular in outline, absent from 17; spermathecal ampullae finely corrugated ..... *A. liberalis* n.sp.

—— Markings disc-like anteriorly, present on 17; spermathecae smooth, elongate ..... *A. calvasaxea* n.sp.

23(19) Spermathecal pores in *c-e* lines 24

—— Spermathecal pores in *g* lines ..... *A. virgata* n.sp.

24(23) First dorsal pore 5/6; markings absent from 19; flaps over male pores ..... *A. garilarsoni* n.sp.

—— First dorsal pore 3/4/5; markings in 19; male pores on penes ..... *A. aterpaenulata* n.sp.

25(3) Calciferous glands (or lateral pouches) six pairs in 8–13 26

—— Calciferous glands (or lateral pouches) two to four pairs 28

26(25) First dorsal pore 10/11; spermathecal diverticula paired ..... *A. enormis*

—— First dorsal pore 12/13; spermathecal diverticula unpaired 27

27(26) Seminal vesicles 11 and 12; last hearts 13 ..... *A. coxii*

—— Seminal vesicles 9 and 12; last hearts 12 ..... *A. attenuata*

28(25) Calciferous glands (or lateral pouches) four pairs 29

—— Calciferous glands or pouches two or three pairs 31

29(28) Anterior markings form 88-like tetrad in 10; calciferous glands 10–13 ..... *M. monticola*

—— Markings not tetrad; calciferous glands or pouches in 10–13 or 11–14 30

30(29) Setae 60; first dorsal pore 5/6; spermathecal pores in *bc*; calciferous pouches paired in 10–13; seminal vesicles in 11 and 12 ..... *A. calpetana* n.sp. (part)

—— Setae 24–32; first dorsal pore 3/4/5; spermathecal pores in *a* lines; calciferous glands paired extramural in 11–14; seminal vesicles in 9 and 12 ..... *A. erica* n.sp.

31(29) Calciferous glands three pairs 32

—— Calciferous glands in two segments 34

32(31) Anterior markings 88-like tetrad in 9 and 10; spermathecal pores in *b,c*; calciferous glands paired in 11–13 ..... *A. tenax*

—— Anterior markings absent or not tetrad; spermathecal pores lateral of *d* 33

33(32) Large size (c. 145 × 9 mm); spermathecal pores in *f*; accessory genital markings absent; setae absent between male pores; calciferous glands paired 10–12 ..... *A. australis*

—— Moderate size (100 × 3 mm); spermathecal pores in *de*, genital markings numerous; setae between male pores; calciferous glands paired 11–13 ..... *Propheretima monsmonitionis* n.sp.

34(31) Spermathecal pores in *a* lines; gizzard weak; calciferous glands annular in 13 and 14 ..... *A. palustris* n.sp.

—— Spermathecal pores in *b,c* lines; gizzard large; calciferous glands paired in 11 and 12 35

35(34) Spermathecal pores in *b* lines; genital markings in (9) 10 and 11 disc-like ..... *A. filix* n.sp.

—— Spermathecal pores in *c* lines; markings in 10 and/or 11 with eye-like pores ..... *A. macleayi* and varieties

36(1) Calciferous glands absent 37

—— Calciferous glands present 41

37(36) Spermathecal pores in *ab* lines 38

—— Spermathecal pores lateral of *b* lines 39

38(37) Genital markings pore-like in *ab* in 10, pore-like or ridges lateral to male pores; typhlosole absent ..... *A. celmisiae*

—— Markings disc-like in *bc* in 9 and 10, none lateral on 18; typhlosole present ..... *A. rava* n.sp.

39(37) Spermathecal pores in *c-d* lines; genital markings absent from anterior, present in 19; no setae between male pores ..... *A. lata* n.sp.

—— Spermathecal pores in *d-f* lines; markings in anterior present or absent, present on 18 or 17 and 19; setae between male pores 40

40(39) Spermathecal pores in *d-e* lines; markings in anterior absent, paired on 18; gizzard large; intestinal origin 17 ..... *A. gracilis*

—— Spermathecal pores in *e-f* lines; markings in 7 and 8, 17 and 19; gizzard weak; intestinal origin 16 ..... *A. yabbratigris* n.sp.

41(36) Calciferous glands four or five pairs in 10–13,14 42

—— Calciferous glands three pairs in 10–12 43

42(41) Size < 100 mm; penial setae absent; calciferous glands 10–13 ..... *A. wilsoniana*

—— Size 130–180; penial setae present; calciferous glands 10–13,14 ..... *A. macquariensis*

43(41) Size < 100 mm; anterior genital markings in 10 or 9,10 rectangular 44

—— Size > 100 mm; anterior markings absent, midventral or paired in 10 or 9,10 45

44(43) Spermathecal pores in *a* lines; genital marking unpaired midventral in 16, 17, 19–20,21 (not 18); first dorsal pore 3/4/5; intestinal origin 15 ..... *A. rubeospina* n.sp.

—— Spermathecal pores in *b* lines; genital marking paired in 17, 19 and in 18 median to male pores; first dorsal pore 5/6; intestinal origin 16 ..... *A. austrina*

45(43) Genital markings paired in 10 or 9,10 and 16,17 and 19 (not 18); setae in anterior *aa* = 4 *ab* ..... *A. chani* n.sp.

—— Anterior markings wanting, swollen or thickened ventrally in 17 and 18 often with paired papillae; setae in anterior *aa*>2*ab*<4*ab* 46

46(45) Setae 24–36; in anterior dorsal setal gap = 2 *ab*, ventral setal gap slightly wider ..... *A. raymondiana*

—— Setae 16–30; in anterior dorsal setal gap = 4 *ab*, *aa* not quite so wide ..... *A. hamiltoni*

47(1) Size < 80 mm; spermathecal pores in *b* lines; first dorsal pore in 4/5; calciferous pouches in 10–14; last hearts 13 ..... *A. fecunda*

—— Size > 100 mm; spermathecal pores in *ab* lines; first dorsal pore in 5/6; calciferous glands paired in 10–13; last hearts 12 ..... *A. jenolanensis*

Anisochaeta aemula n.sp.

Fig. 1

Material examined. HOLOTYPE: AM W24544, (H), Washpool State Forest, NSW, c. 29°16'S 152°22'E, collected 9.iii.1992, M. Gray & P. Croft, pit trap sample set 22.ii.1992, "17CM Trap 3 FN 5082" (mature, figured and dissected). PARATYPES: none. The original sample contained 2 immature specimens that could not be positively identified as this species.

External features. Length 35 mm. Width: about 1.5 mm. Segments: 70. Colour: uniform buff in alcohol, clitellum light brown. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: small in 4/5, larger from 5/6. Setae: 24 on segments 12 and 20, 26–28 per segment posteriorly. Nephropores: lateral pores at anterior of segments near *h* lines, especially obvious on clitellum. Spermathecal pores: 7/8/9 in *b* setal lines. Female pore: single on 14. Male pores: on 18 in *ab* lines at centre of flat eye-like papilla. Genital markings: whole ventral aspect of 10 and 11 tumid to *d* lines with paired presetal sucker-like discs embedded at anterior of segments in *b* lines; on 17 paired wide pads postsetal in *ab* lines co-joined posteriorly by tumid rim; on 19 similar pads presetal in *bc* lines within circular rims.

Internal anatomy. Septa: none especially thickened. Gizzard: rudimentary or weakly muscular, barely wider than oesophagus in 6. Oesophagus: dilated most in 11–13 but not calciferous, narrows in 15. Nephridia: vesiculate meroic, tubules clustered ventrally in 5 and 6 (not definitely tufted) then spread laterally with about 5 or 6 tubules per side and with small bladders in series laterally on each side (whether connecting with one or more tubules indeterminate), nephridia smaller after clitellum but bladders persist. Vascularization: dorsal vessel single onto pharyngeal mass in 4; hearts 10–12 increasingly large and connected to supra-oesophageal vessel. Spermathecae: paired in 8 and 9, ampulla spherical on equally long duct with long clavate diverticulum. Male organs: holandric, seminal vesicles racemose in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: in 13 sheet-like with several egg strings; small stalked ovisacs paired in 14. Prostates: flattened tubuloracemose (almost racemose) in 18–19, duct narrow; penial setae absent. Large sessile glands, probably associated with genital markings, present ventrally in 17 and 19 (see Fig. 1). Intestine: from 16; typhlosole absent; gut contents organic matter and dark topsoil.

Remarks. *Anisochaeta aemula* exemplifies the vesiculate condition of the genus. Lateral excretory bladders (vesicles) associated with the nephridia have not been previously recognized in *Anisochaeta* species although they are found in several species in the current account (see *A. lavatiolacuna, A. toonumbari, A. yabbratigris*). *Anisochaeta aemula* is distinguished from superficially similar species of the genus *Perionychella*, as the latter have holoic nephridia (one pair per segment), with or without bladders. Presence of nephridial bladders in species of these two genera may be homoplasic, or indicative of retention via common ancestry, whereby the meroic condition in *Anisochaeta* is an apomorphy. Alternatively, the acquisition of nephridial bladders may be autapomorphic within *Anisochaeta*. Testing of these possibilities by molecular or cladistic analysis is beyond the resources of the current study.

Anisochaeta aemula resembles *A. flava* (also from the Washpool site which itself resembles *A. wiburdi*) and *A. ancisa*. Apart from nephridial bladders, the distinguishing characters of *A. aemula* are the distribution of its genital markings, weak gizzard, spermathecal diverticula longer than ampullae, and the large glands in 17 and 19 that possibly have a secretory function associated with the genital markings on these two segments.

Etymology. *Aemulus*: rivalling, jealous—a reference to its resemblance to *Perionychella* species.

Distribution and habitat. Washpool State Forest, sympatric with *Anisochaeta flava, A. garilarsoni* and *A. lavatiolacuna*. Numerous unidentifiable (damaged or immature) *Anisochaeta* specimens were obtained from these Washpool samples, but no other earthworm genera were present. Pit trap collection indicates that this species is active on the surface of the soil. The weak digestive system, organic matter in the intestine, and nephridial bladders for moisture regulation, also suggest that this species is a topsoil or litter dweller.

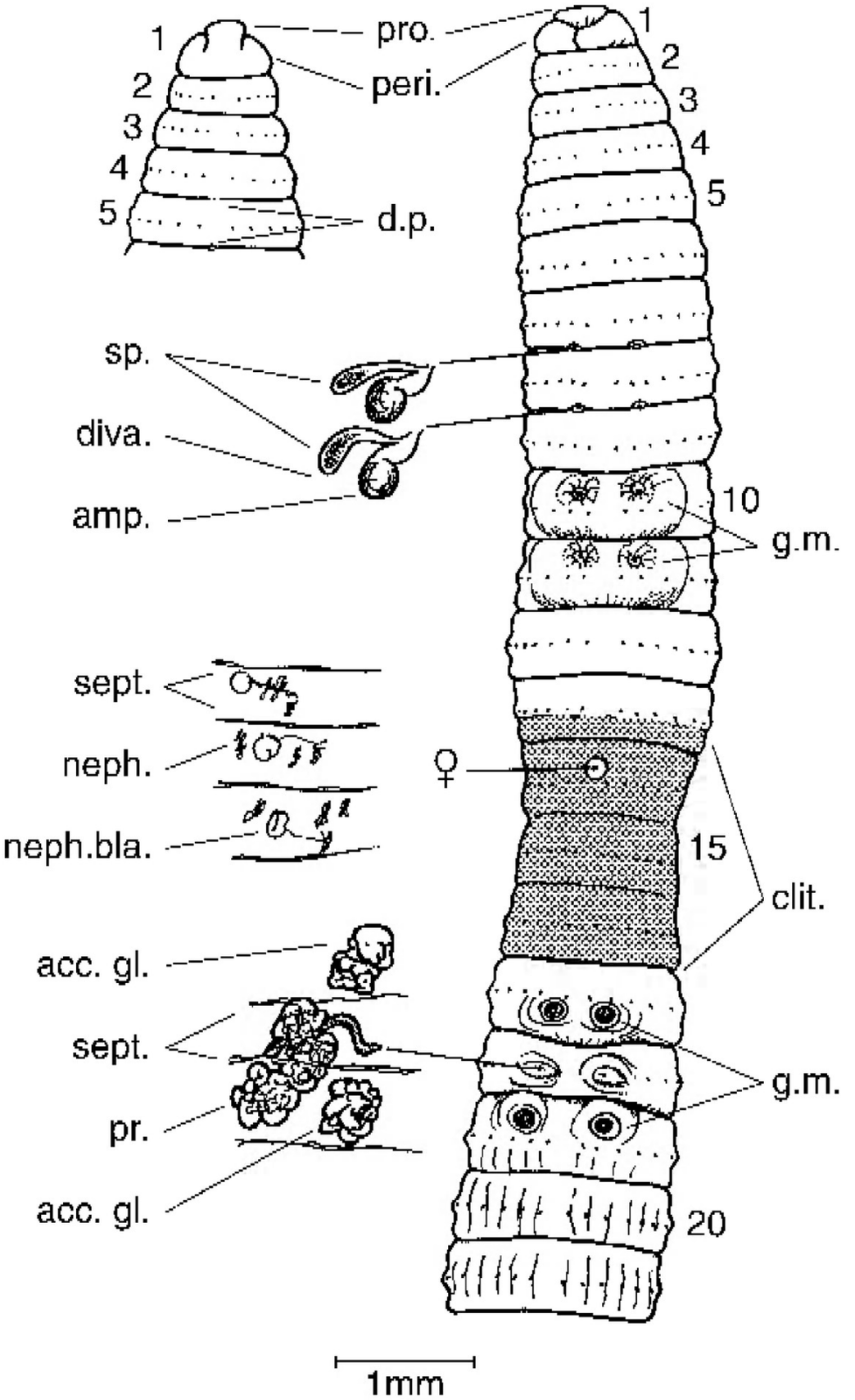

Figure 1. *Anisochaeta aemula* ventral view of holotype with dorsal view of prostomium, spermathecae, nephridial arrangement on lhs in segments 13–15, accessory glands in 17 and 19, and lhs prostate in 18–19.

Anisochaeta ancisa n.sp.

Fig. 2

Material examined. HOLOTYPE: AM W24470, (H), label reads: "Face Fern Valley, New England National Park, NSW" [probably Tree Fern Valley—see above], c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.25, (P1), same details as H (mature, dissected); AM W24471, (P2), same details as H (mature); ANIC RB.98.2.26, (P3), same details as H (aclitellate mature, dissected).

External features. Lengths (mm): 85 (H), 90 (P1), 80 (P2), 75 (P3). Width: about 2.5 mm. Segments: 108 (H), 120 (P1). Colour: anterior and dorsum dark brown with violet iridescence and darker mid-dorsal line, clitellum orange. Prostomium: open epilobous tapering; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: small in 3/4, open from 4/5 (occluded on clitellum). Setae: 24 on 12 and 20, 34 posteriorly. Nephropores: not found. Spermathecal pores: 7/8/9 centred in *b* lines within tumid lips that extend almost from *a* lines to *c* lines. Female pore: single (in H, P2), closely paired on 14 (in P1, P3). Male pores: on apices of large dome-shaped mounds that are deeply sunken within common ventral field on 18. Genital markings: on 8 (in P1 only), paired sucker-like discs presetal and centred in *b* lines, on 10 similar paired discs (all specimens), on 11 smaller paired discs centred on *a* lines (all specimens); on 17 paired circular pads postsetally centred in *a* lines within common sunken pit that extends almost to *c* lines; on 19 oblique presetal dark pits that taper from line of male porophores to the centre of the mid-ventral setal gap where they are almost confluent. Sunken male field and markings in 17 and 19 occur in all specimens.

Internal anatomy. Septa: none especially thickened. Gizzard: muscular but compressible barrel in 5. Oesophagus: not especially dilated, widest in 13, valvular in 15. Nephridia: avesiculate meroic, not tufted but tubules numerous and larger in anterior, no funnels found. Vascularization: dorsal vessel single; hearts 10–12 connected to weak supra-oesophageal vessel that runs 8,9–12,13. Spermathecae: paired in 8 and 9, ampulla compressed along its axis to be as wide or wider than it is long, tapering duct with medium sized diverticulum near its exit. Male organs: holandric, seminal vesicles large racemose in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: in 13 long egg strings; paired ovisacs in 14. Prostates: flattened tubuloracemose in 18–19, duct muscular; penial setae absent. Intestine: from 16; typhlosole absent; gut contents organic soil with few grits.

Remarks. *Anisochaeta ancisa* differs from *A. rodwayi*—firstly, in the distribution of genital markings, described by Stephenson "as small, round, darker spots" on 10, 11, and 16 and 17 (presetally), as well as and on 19–21 (in *A. ancisa* the markings on 17 are postsetal); secondly, on its tufted nephridia in segments 3–5. Boardman (1943: 173–174) provides additional data on variation within *A. rodwayi* that reinforce these differences from *A. ancisa*.

Species that resemble *Anisochaeta ancisa* in the present account are *Anisochaeta conspecta* and *Anisochaeta flava*.

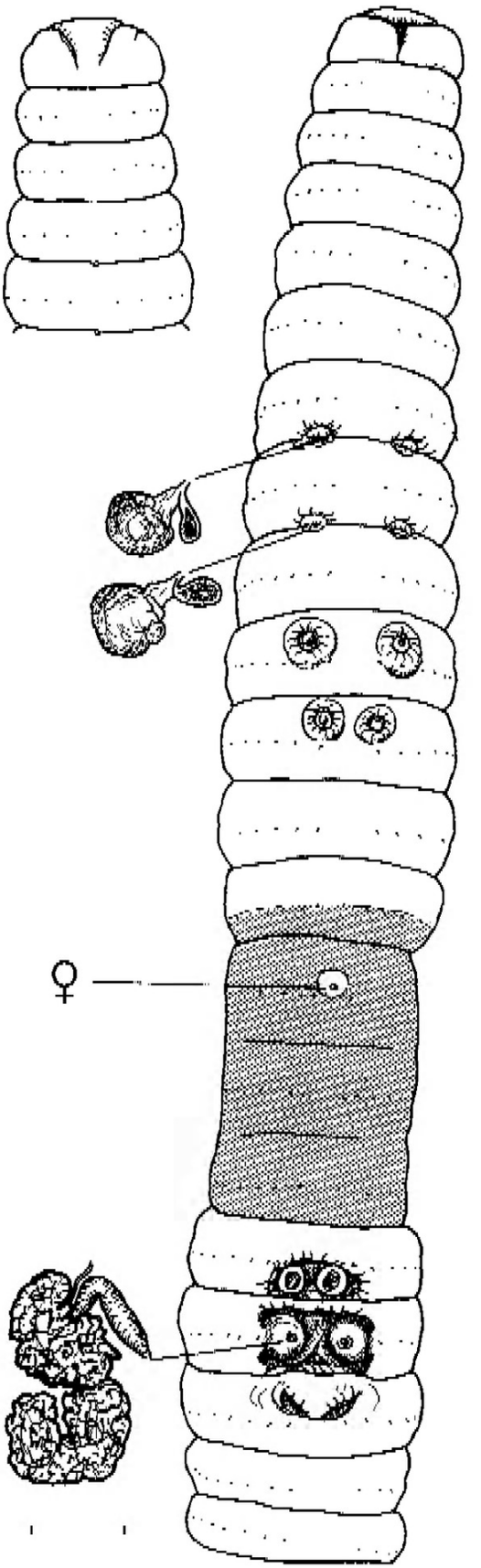

Figure 2. *Anisochaeta ancisa* ventral view of holotype with dorsal view of prostomium, spermathecae and lhs prostate in 18–19.

Similar markings in 10 and 11, are found in *A. conspecta* but it has more extensive markings on, and after, the clitellum as well as spermathecae and prostates that both differ in shape and more ventral openings. *Anisochaeta flava* perhaps comes closest to the current species, but has anterior markings on segments 9 or 10 only, tends to have fewer setae, more widely paired female pores and tufted nephridia. Additional distinctive characters of *A. ancisa* are the prominent spermathecal pores, and the male porophores and markings in adjacent segments which are emphasized by surrounding hollow depressions.

Etymology. *Ancisus*: cut round—for the markings around the male pores.

Distribution and habitat. Tree Fern Valley—found in association with several other congeners (i.e., *A. filix, A. lata, A. liberalis, A. novaeanglica, A. paucula, A. tunicata, A. virgata*; see also *A. bulla* varieties). It is perhaps especially in such situations of high diversity, where mate recognition is crucial, that closely related species can be separated on variations in genital markings.

Anisochaeta angusticlavia n.sp.

Fig. 3

Material examined. HOLOTYPE: AM W24550, (H), Yabbra State Forest, NSW, c. 28°30'S 152°40'E, collected 2.iv.1992, M. Gray & D. Charley, pit trap sample set 15.iii.1992, "2BG Trap 19 FN 5118" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.54, (P1), same location as H but "Trap 13 FN 5112" (mature, dissected); AM W24551, (P2), same details as P1 (mature); ANIC RB.98.2.55, (P3), same location as H but collected 15.iii.1992, pit trap set 27.ii.1992, "Trap 13 FN 5102" (mature, dissected); AM W24552, same details as P3 (mature); ANIC RB.98.2.56, same details as P3 (mature); AM W24553, (P6, P7), same details as P3 (two matures, one aclitellate); AM W24557, (P8), same location as H but collected 15.iii.1992, pit trap sample set 27.ii.1992, "Trap 19 FN 5108" (mature).

External features. Lengths (mm): 65 (H), 80 (P1), 58 (P2), 80 (P3), other specimens 38–65. Width: about 2.5 mm. Segments: 110 (H), 104 (P1), 95 (P2). Colour: in alcohol, anterior dorsum puce with darker mid-dorsal line, after clitellum pigment fades except for this line which continues to tail; clitellum buff. Prostomium: open epilobous parallel; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: from 4/5. Setae: 20 on 12 and 20, only one or two setae added further posteriorly. Nephropores: not found. Spermathecal pores: 7/8/9 within small puckered lips just ventral of setal *a* lines. Female pores: paired on 14. Male pores: on 18 on flat pads (with what looks like small pore-like dimples near male pores) approximately in *ab* lines and within raised and yellow tumid field that fills ventral aspect of 18 and extends to *d* lines. Genital markings: on 10 and 11, small paired and confluent discs in *ab* presetally (all specimens except H and P7, where only occur on 11, and P8 where absent); on 17 widely paired discs approximately in *c* lines within common tumid and elongate mainly postsetal pad; on 19 similar arrangement as in 17, but presetal, plus more median paired discs in *bc* lines postsetally that overhang 19/20. Paired markings within raised pads present in 17 and 19 in all specimens, P2–P7 have extra pair presetally in 17 (mirroring those in 19).

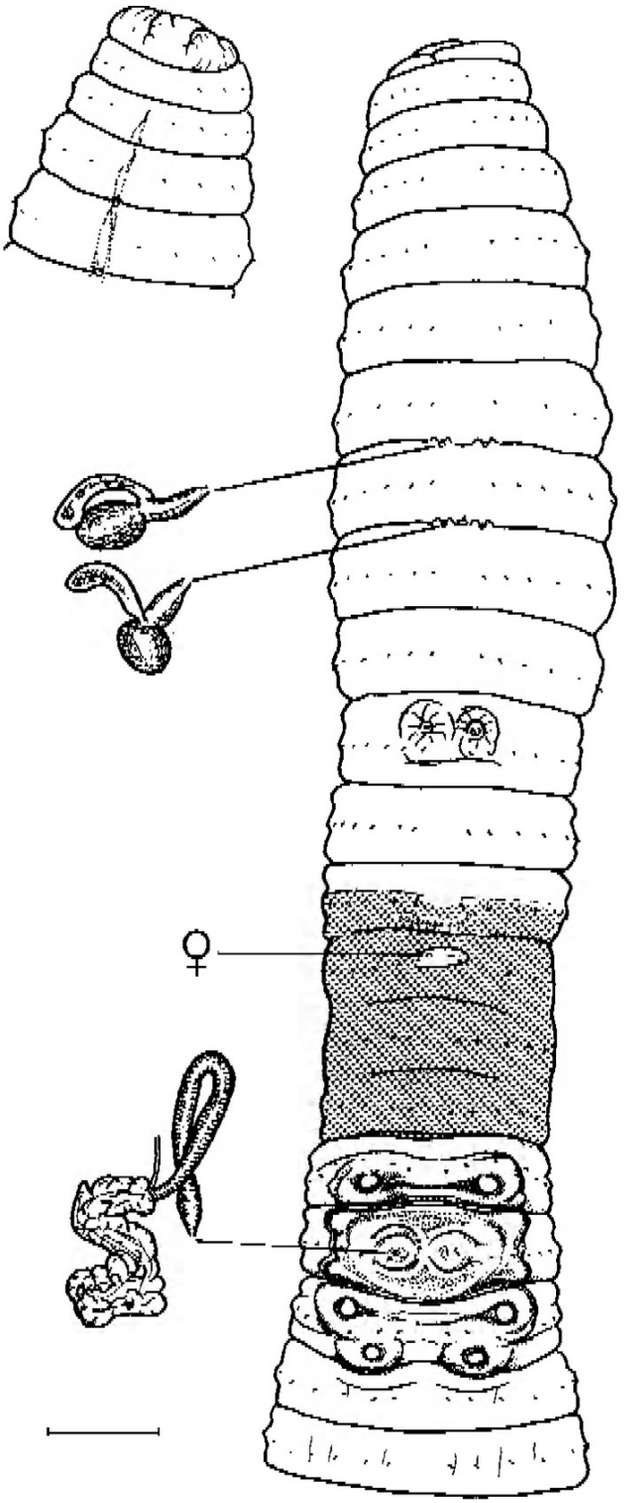

Figure 3. *Anisochaeta angusticlavia* ventral view of holotype with dorsal view of prostomium, spermathecae and lhs prostate in 18–19.

Internal anatomy. Septa: 9/10–11/12 only slightly thickened. Gizzard: muscular barrel in 5. Oesophagus: dilated and vascular in 8–14,15 (except where compressed by seminal vesicles in 9 and 12), appears transitional to intestine in 15. Nephridia: avesiculate meroic, tufted in 5–6, then as several small tubules per side, especially fine after clitellum. Vascularization: dorsal vessel single; hearts 10–12 from supra-oesophageal vessel that runs 9–14. Spermathecae: paired in 8 and 9, ampulla spherical on equally long narrow duct with diverticulum that attaches at the junction of ampulla and duct and curves beyond ampulla. Male organs: holandric, seminal vesicles large, racemose in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: in 13 with long egg strings; paired ovisacs in 14. Prostates: flattened tubuloracemose in 18–19, duct long, narrow and folded back on itself; penial setae absent. Intestine: origin in 16; typhlosole absent; gut contents fine yellow soil with some organic debris and grits.

Remarks. Characteristics of *Anisochaeta angusticlavia* are the widely paired, prominent and often symmetrical genital markings in 17 and 19, spermathecal pores ventral in setal *a* lines, and the distinctively long prostate ducts and spermathecal diverticula. Morphologically it resembles several other quadrithecal species in the current account that lack calciferous glands but may have tufted nephridia in the anterior, differing from these by the points just noted. Spermathecal pores in setal *a* lines are met with in Michaelsen's *A. fletcheri* and *A. mediaeviae*, but both differ on other points, especially having seminal vesicles in 12 only.

Etymology. *Angusticlavia*: "wearing a narrow purple stripe", referring to the mid-dorsal line.

Distribution and habitat. Yabbra State Forest, from pit trap samples. Other species obtained from this location were *A. calpetana, A. yabbratigris*, and one variety of *A. bulla* (see descriptions below) plus several other specimen of *Anisochaeta* and *Digaster* spp. that were either too immature or in insufficient numbers for adequate description.

Anisochaeta aterpaenulata n.sp.

Fig. 4

Material examined. HOLOTYPE: AM W24497, (H), Bald Rock National Park, NSW, c. 28°51'S 152°03'E, 28.iii.1983, Ed Easton, "Jar 36 Sp 49" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.43, (P1), same details as H (mature, dissected); AM W24498, (P2), same details as H (aclitellate mature, dissected); ANIC RB.98.2.44, (P3), same details as H (subadult); AM W24499, (P4–P8), same details as H (5 specimens: juveniles and immatures that agree superficially); ANIC RB.98.2.45, (P9), same location as H except "Jar 37 Sp 49 100 m from base of Bald Rock" (mature).

External features. Lengths (mm): 75 (H, P1, P2), 65 (P3), 42–65 (P4–P8), 70+ (P9). Width: about 3 mm. Segments: 98 (H, P1). Colour: anterior dorsum iridescent black with darker mid-dorsal line, after clitellum pigment sooty brown except for this line which continues to tail, ventrum and intersegments

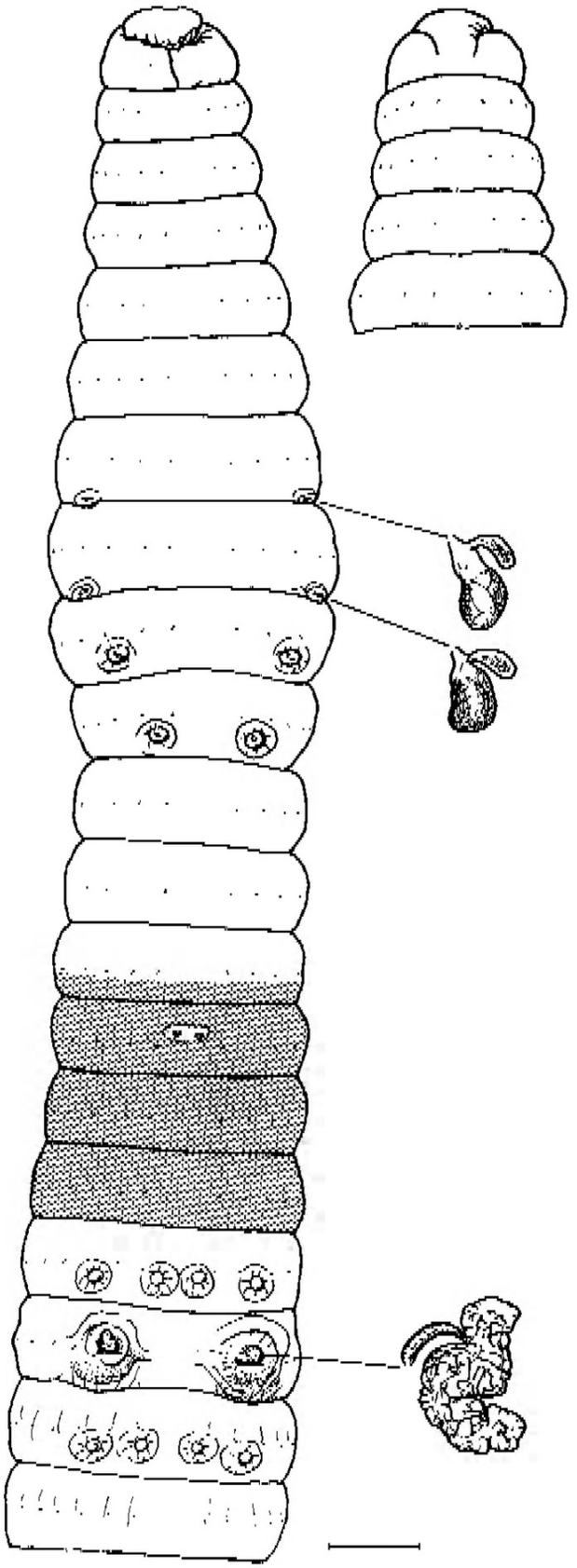

Figure 4. *Anisochaeta aterpaenulata* ventral view of holotype with dorsal view of prostomium, spermathecae and rhs prostate in 18–19.

pale; clitellum tan. Prostomium: wide open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: small in 3/4, larger from 4/5 (continuous on clitellum). Setae: 22 on 12, 26 on 20, up to 40 posteriorly. Nephropores: lateral pores at anterior of segments seen from 5, in *g* or *h* lines in anterior, with other less obvious pores at anterior of segments and equatorial near some setae. Spermathecal pores: 7/8/9 widely paired with large apertures just lateral of *d* lines. Female pores: paired on 14. Male pores: on 18 at centre of largish pads that extend from *a* to *c* lines within copulatory chambers on tip of small penes eversible from roof of chambers (no setae intervene between male pores). Genital markings: all postsetal, widely paired white-centred sucker-like discs median of *c* lines on 9 (on H only); similar more median discs approximately in *ab* lines on 10 (all other mature specimens); on 17 two pairs of discs one pair in *bc*, one pair median in *aa* (only the outer couple present in P2, there are three median discs on 17 in P9); on 19 markings similar to those on 17 are repeated (only outer couple present in P2). Markings are consistently in 10, 17 and 19.

Internal anatomy. Septa: 7/8–11/12 only slightly thickened. Gizzard: moderately muscular in 5, only slightly larger than oesophagus in 6. Oesophagus: not especially dilated (calciferous glands absent). Nephridia: avesiculate meroic, not tufted in anterior but dense clusters ventrally to 9 then migrate laterally to approximately at anterior and posterior of most setae; no structures found corresponding to lateral nephropores (i.e., no bladders); funnels not found. Vascularization: dorsal vessel single; hearts 10–12 from weak supra-oesophageal vessel. Spermathecae: paired in 8 and 9, ampulla tapers to duct, medium sized clavate diverticulum ectally. Male organs: holandric, seminal vesicles racemose in 9 and, larger, in 12, testes and funnels in 10 and 11 (iridescent only in 11). Ovaries: in 13 as sheets terminating in several egg strings; paired ovisacs in 14. Prostates: flattened tubuloracemose in 18–19 from moderately muscular duct; penial setae absent. Intestine: origin in 16; typhlosole absent; gut contents organic matter.

Remarks. Previously known *Anisochaeta* species from NSW which, like *A. aterpaenulata*, have 2 pairs of spermathecae in 7/8/9 and lack of extramural calciferous glands are *A. fletcheri* and *A. mediaeviae, A. rodwayi, A. sebastiani* and *A. wiburdi*. These species differ from *A. aterpaenulata*, not least, by having spermathecal pores more ventral in *a, b* or *c* setal lines and, where present, by their genital markings. In the present account, *A. garilarsoni* and *A. virgata* are morphologically similar, and all three species are darkly pigmented. However, *A. garilarsoni* lacks markings in 19 and has dorsal pores from 5/6; while *A. virgata* has presetal markings in 10 and 19 (i.e., opposite to *A. aterpaenulata*), intestinal origin apparently in 15, and longer spermathecal diverticula. Characteristics of *Anisochaeta aterpaenulata* are widely paired spermathecal pores in *d* lines, distinctive arrangement of the genital markings postsetally in (9), 10, 17 and 19, and the male pores on small penes.

Etymology. *Aterpaenulata*: "cloaked in black" for its distinctly dark colouration.

Distribution and habitat. Bald Rock National Park (see also *A. calvasaxea* and *A. ima*). Dark body pigmentation and organic matter in intestine suggests that this species is active on the surface layer of soil.

Anisochaeta bulla n.sp.

Fig. 5

Material examined. HOLOTYPE: AM W24459, (H), Cathedral Rock National Park, NSW, c. 30°25'S 152°15'E, 18.iii.1983, Ed Easton, "Jar 18 Sp 8" (mature, possible posterior regenerate, figured and dissected). PARATYPES: ANIC RB.98.2.20, (P1), same details as H (mature, dissected); AM W24460, (P2), same details as H (mature, dissected); ANIC RB.98.2.21, (P3), same details as H (mature); AM W24461, (P4), same details as H (mature); AM W24462, (P5–P11), same details as H (7 specimens: 4 aclitellate matures, one damaged plus 3 juveniles). (The original sample also contained 4 or 5 other specimens, plus fragments, that were either too damaged or too immature to allow adequate description).

Non-type material. AM W24466, (S1), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, one of several specimens, dissected); AM W24473, (S2), same details as S1 (subadult, dissected); AM W24458, (S3), Grafton—Glen Innes Road, 19.iii.1983, Ed Easton "Jar 26 Sp 27?/31?" (mature, dissected, one of seven specimens—the others being three apparently different *Anisochaeta* spp. that were either aclitellate or otherwise unsuitable for adequate description).

External features. Body of H tapers to tail, other specimens have slightly spade-shaped tails. Lengths (mm): 82+ (H), 100 (P1), 85 (P2), 90 (P3), 95 (P4). Width: about 3 mm. Segments: 110+ (H), 149 (P1), 109 (P2). Colour: pale unpigmented in alcohol, clitellum buff. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: 14–16 and encroaching slightly onto adjacent segments. Dorsal pores: small in 3/4, open from 4/5. Setae: 16 on 12, 20 on 20, 16–28 posteriorly; setae well spaced ventrally and more crowded dorsally, occasional setae missing in anterior. Nephropores: not found. Spermathecal pores: 7/8/9 in or near *b* lines. Female pores: paired on 14. Male pores: on 18 on small mounds in *ab* that are sunken in crescentic troughs. Genital markings: four in 9–12 (H, P1, P4–P6, S2) or three in 9–11 (P2, P3, P7–11, S1, S3) midventral sucker-like discs in tumid mounds that extend to setae *a*; ventral aspect of 18–19 tumid to *c* lines with three small papillae lateral to male pores on 18 plus several smaller papillae just below the line of 17/18 and 18/19 corresponding with interval between male papillae (all specimens, but the distribution of the papillae around the male pores varies somewhat).

Internal anatomy. Septa: 7/8–11/12 only slightly thickened. Gizzard: large muscular barrel in 5, displaced to occupy ½7 to ½9 (i.e., two segment lengths). Oesophagus: not especially dilated (calciferous glands absent), narrow and valvular in 15. Nephridia: avesiculate meroic, tufted in 5–7 then spread equatorially with about 20 small discrete tubules per side. Vascularization: dorsal vessel single; hearts

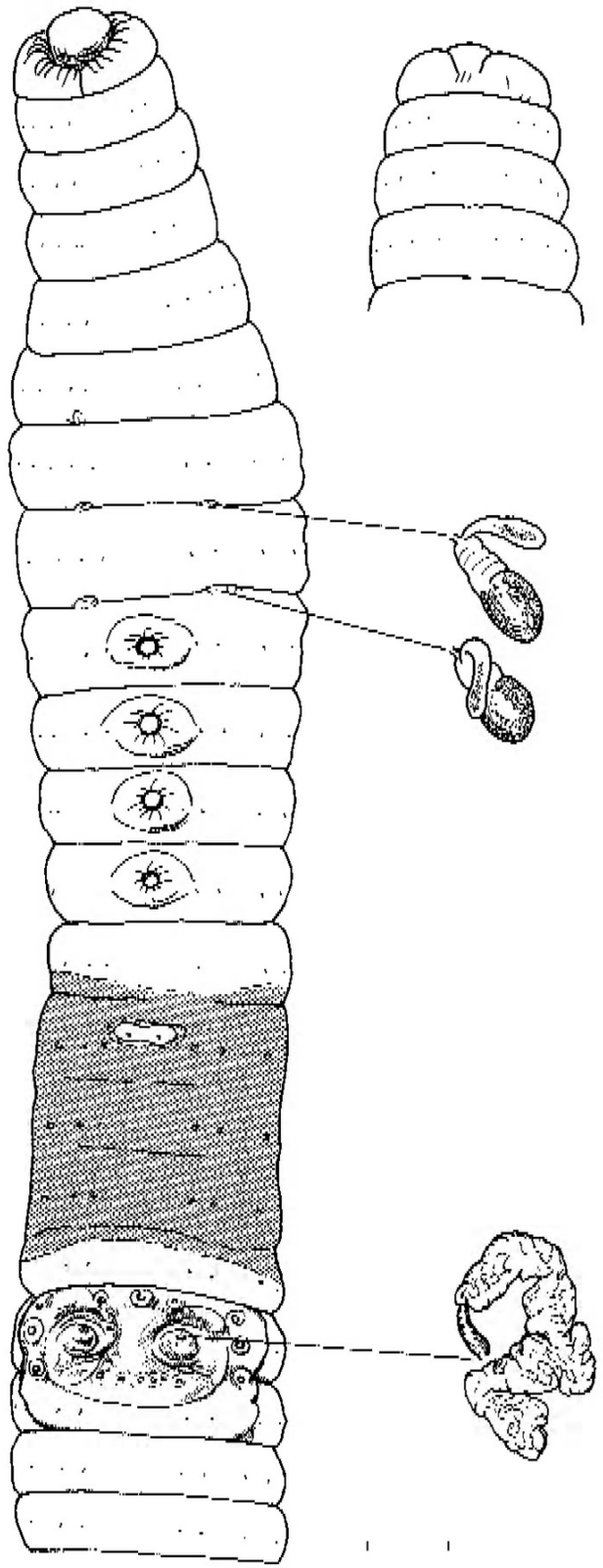

Figure 5. *Anisochaeta bulla* ventral view of holotype with dorsal view of prostomium, spermathecae and rhs prostate in 18.

10–12, supra-oesophageal vessel weak. Spermathecae: paired in 8 and 9, saccular ampulla on almost equally wide duct, medium sized clavate diverticulum ectally; ampulla, duct and diverticulum all approximately same length. Male organs: holandric, seminal vesicles racemose saccular in 9 and elongate in 12; testes and funnels iridescent in 10 and 11. Ovaries: in 13 long and feather-like; paired ovisacs in 14. Prostates: flattened tubuloracemose in 18–19 from short muscular duct; penial setae absent. Intestine: origin in 16; thin but deeply lamellate typhlosole develops from 20; gut contents sandy organic soil. (Non-type specimens differed internally, S1 and S2 lacked appreciable typhlosole, while S3 had typhlosole but also had four pairs of extramural calciferous glands in 10–13, amongst other differences).

Remarks. The prominent button-like mid-ventral genital markings distinguish *Anisochaeta bulla*. Morphologically it is similar to *Anisochaeta tunicata*, both species have tufted nephridia, a large gizzard, lack calciferous glands and have two pairs of spermathecal pores in *b* setal lines. However, in *A. tunicata* the anterior markings are paired and, further, the spermathecae have different forms.

Several other *Anisochaeta* populations having mid-ventral genital markings similar to those in *A. bulla* were identified, but are unresolved, in the current study. One specimen from Yabbra State Forest (AM W24555), and two specimens from the original sample from Cathedral Rock had two markings in 9–10; five specimens from Gibraltar Range National Park (AM W24568) had five mid-ventral markings in 9–13. As with the non-type material described above, it is not certain that these specimens are attributable to *A. bulla*.

Etymology. *Bulla*: button—for the genital markings.

Distribution and habitat. Cathedral Rock National Park is just west of New England National Park.

Anisochaeta calpetana n.sp.

Fig. 6

Material examined. HOLOTYPE: AM W24563, (H), Twin Bridges, Gibraltar Range National Park, NSW, c. 29°30'S 152°20'E, c. 20.iii.1983, Ed Easton, "3,000' [1,000 m] Jar 27 Sp 8" (aclitellate mature, figured and dissected). PARATYPES: ANIC RB.98.2.59, (P), Yabbra Scrub, Yabbra State Forest, 28°38'S 152°30'E, 12.xii.1988, Smith, Hines, Pugh & Webber, "UNE Focal Peak Survey, Pit Trap Y2" (clitellate mature, darkened and brittle specimen, missing tip of tail, dissected).

External features. Body stout. Lengths (mm): 110 (H), 110+ (P). Width: about 4 mm. Segments: 165 (H), 93+ (P). Colour: anterior and tail gunmetal grey, rest of body dark brown above with faint mid-dorsal line, light brown ventrally; in P clitellum darker. Prostomium: epilobous almost tanylobous with mid-dorsal furrow; peristomium ventrally cleft. Clitellum: in P ½14 to ½17. Dorsal pores: from 5/6. Setae: approximately 60 throughout, small forming almost complete circle with only narrow ventral and dorsal gaps. Nephropores: not found. Spermathecal pores: small in 7/8/9 in *bc* lines. Female pores: small, closely paired on 14. Male pores: on 18 on tumid mounds as transverse slits, setae absent from the hollow between male pores. Genital markings: on 10 presetally a pair of small

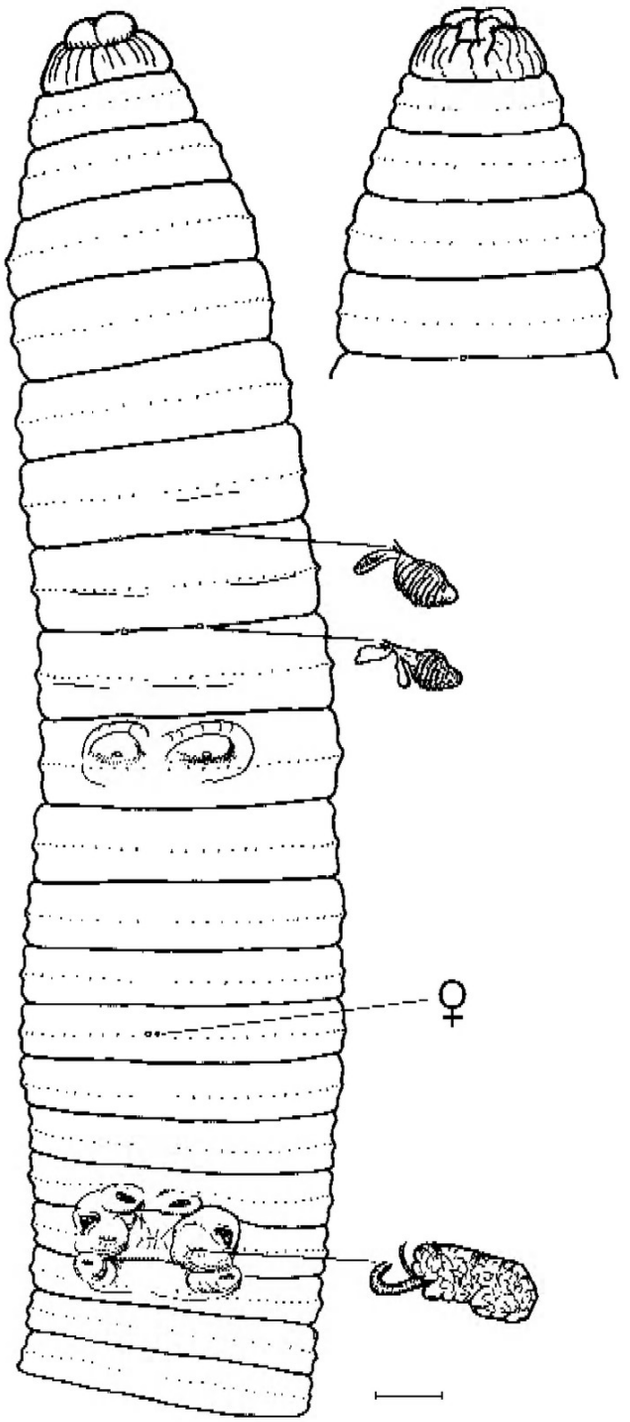

Figure 6. *Anisochaeta calpetana* ventral view of holotype with dorsal view of prostomium, spermathecae and rhs prostate in 18.

discs just anterior to *c* setae on prominent mounds within generally tumid patch that extends laterally and encompasses *f* or *g* lines (only this tumid patch and no discs present in P); on 17 postsetally are paired oblique dark pits in *a* or *b* lines on tumid pads; on 18 paired triangular pits anterolateral to mounds of male pores on tumid pads that encroach on 17/18; on 19 presetally a pair of dark pits in *d-e* lines on tumid pads that encroach on 18/19. For both specimens, the mounds of the male pores and the tumidity of the three adjacent sets of markings are united around the male pores obscuring the intersegmental furrows.

Internal anatomy. Septa: 5/6 thin to base of gizzard, 6/7–11/12/13 increasingly thickened, then thinning. Gizzard: large, muscular barrel in 5. Oesophagus: with paired lateral pouches in 10–13, these pouches are supplied by the supra-oesophageal vessel and have internal lamellae but are not pinched off from the oesophagus so do not form extramural calciferous glands (in H only, in P oesophagus not especially dilated); oesophagus narrows in 14–15. Nephridia: avesiculate meroic, tufting not noted in anterior, numerous parietal tubules that are smaller after the clitellum and closer to the anterior septa although no funnels found. Vascularization: dorsal vessel single onto the pharyngeal mass in 4; hearts 10–12, from moderately developed supra-oesophageal vessel. Spermathecae: paired in 8 and 9, wrinkled, saccular ampulla tapers to duct with medium sized clavate diverticulum ectally, diverticulum may be slightly bifid at tip and one spermatheca had two diverticula on one side. Male organs: holandric, seminal vesicles elongate racemose in 11 and 12 (absent from 9 in H but rudimentary in P); testes and funnels only slightly iridescent in 10 and 11. Ovaries: in 13 composed of fine strings; small paired ovisacs in 14. Prostates: blocky tubuloracemose or racemose in 18 from short muscular duct; penial setae absent but numerous tendons extend from 18 to segments 17 and 19. Intestine: origin in 16; typhlosole absent; gut contents dark organic soil (H) or reddish soil (P).

Remarks. Distinctive characters of *A. calpetana* are the stout, dark body, numerous (about 60) setae per segment, the distribution of its genital markings (paired on 10 and 17–19) and the seminal vesicles in 9, 11 and 12 rather than the more usual 9 and 12. On each of these character, *A. calpetana* differs from *A. cormieri* (Jamieson & Wampler, 1979: 641–644) from Queensland which, nevertheless, it resembles morphologically.

Although oesophageal pouches are noted in the holotype of *A. calpetana* in 10–13 these are not extramural and are not construed as true calciferous glands (this was also the situation in descriptions of *A. rodwayi* and *A. wiburdi*). Supernumerary diverticula are met occasionally in other species (e.g., *A. enormis* and *A. erica* n.sp.).

Etymology. *Calpetana*: "from Gibraltar" (Latin).

Distribution and habitat. Gibraltar Range National Park at 1,000 m and Yabbra State Forest, at the latter location from "dry-subtropical rain forest, sheltered slope 600–900 m". The dark pigmentation, numerous setae (for mobility and protection), gut contents and collection in a pit fall trap suggest that this species is sometimes active on the soil surface.

Anisochaeta calvasaxea n.sp.

Fig. 7

Material examined. HOLOTYPE: AM W24572, (H), Bald Rock National Park, NSW, 28°51'S 152°03'E, 28.iii.1983, Ed Easton, "Jar 36 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.61, (P1), same details as H (mature, dissected); AM W24573, (P2), same details as H (mature); ANIC RB.98.2.62, (P3), same details as H (mature); AM W24574, (34 paratypes), same details as H (34 specimens that agree superficially: 17 matures, 16 aclitellate matures or subadults, 1 immature). (The sample also contained 3 anomalous *Anisochaeta* sp. specimens, AM W24575, that were larger and had different arrangements of genital markings).

External features. Anterior dorsoventrally depressed, tail slightly spade-shaped. Lengths (mm): 100 (H), 110 (P1), 90 (P2), 105 (P3). Width: about 3 mm. Segments: 117 (H), 118 (P1). Colour: uniform buff in alcohol, clitellum brick red. Prostomium: tapering epilobous, almost tanylobous with mid-dorsal furrow; peristomium ventrally cleft. Clitellum: 14–16 and encroaching onto adjacent segments. Dorsal pores: from 4/5. Setae: 20 per segment throughout but some lines irregular posteriorly and odd extra setae added. Nephropores: small pores seen irregularly at anterior of segments in midbody. Spermathecal pores: small in 7/8/9 near *b* lines. Female pores: paired (possibly single on P3) on 14. Male pores: on 18 as narrow lateral slits on darker low mounds that occupy approximately *a-c* lines. Genital markings: on 10 postsetally, and on 11 and 12 presetally, pairs of sucker-like discs approximately in *ab* lines but converging posteriorly; on 17 postsetally and 19 presetally similar paired discs just median to interval of male pores, those in 19 slightly closer together. Markings on 12 often wanting or just an analogue present (in 31 out of 37 specimens) and occasionally a secondary pair of discs are present just posteromedian to *a* setae on 19 (on P2 and two other specimens).

Internal anatomy. Septa: 7/8–12/13 increasingly thickened, then thinning. Gizzard: large muscular barrel mainly in 5 but thin septum 5/6 attaches at about one third of its length and can scarcely be traced to the base, thus it may possibly be partly in 6, displaced to occupy 7 to ½8. Oesophagus: not especially dilated although has longitudinal lamellae on internal surfaces (not calciferous), narrows in 15. Nephridia: avesiculate meroic, tufted in 4–5, then spread laterally as bands of numerous sets of parietal tubules, reduced after clitellum; bladders and funnels not found. Vascularization: dorsal vessel single; hearts 10–12, from weak supra-oesophageal vessel. Spermathecae: paired in 8 and 9, slender ampulla on thin duct with clavate diverticulum ectally, ampulla, duct and diverticulum approximately same length. Male organs: holandric, seminal vesicles racemose in 9 and 12; testes and funnels iridescent in 10 and 11. Ovaries: in 13 as broad sheets with several egg-strings; small paired ovisacs in 14. Prostates: elongate, finely lobulate tubuloracemose in 18, duct long and slender and folded back on itself; penial setae absent. Intestine: origin in 16; deep lamellar typhlosole develops from 20; gut contents dark soil with few grits. No internal glands are associated with genital markings in 17 and 19 as were found in *A. aemula*.

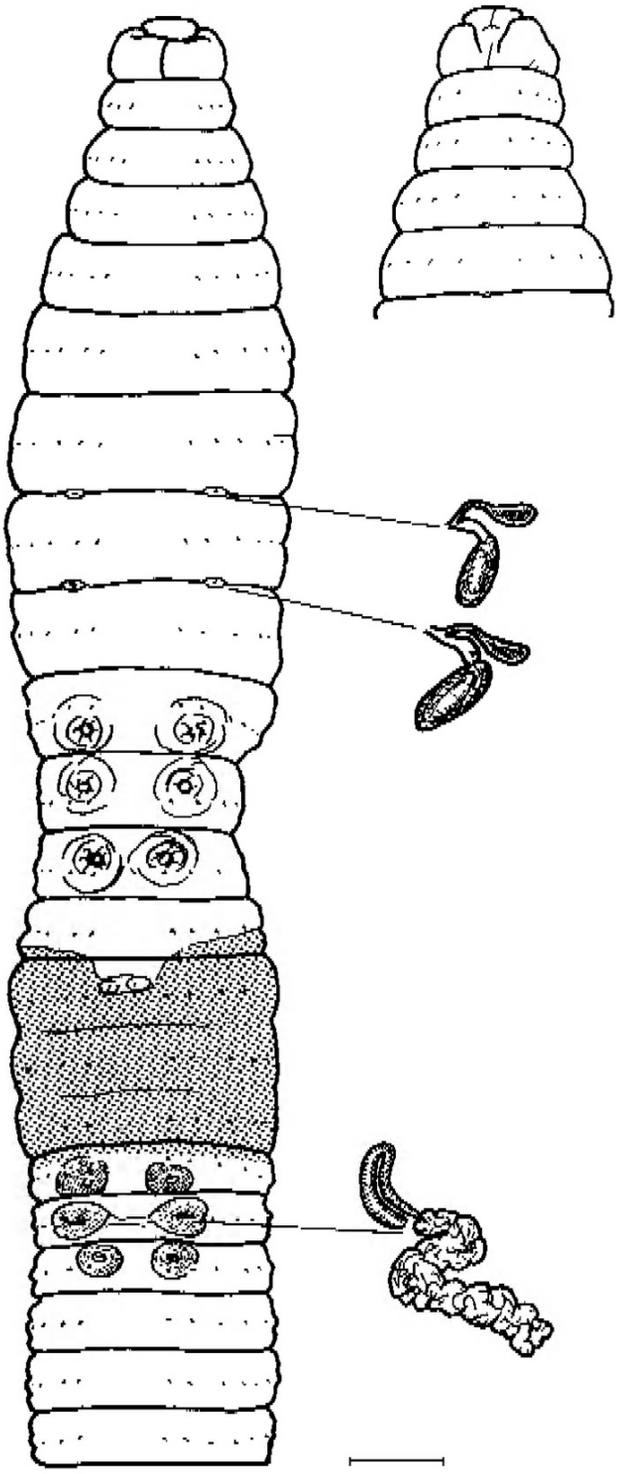

Figure 7. *Anisochaeta calvasaxea* ventral view of holotype with dorsal view of prostomium, spermathecae and rhs prostate in 18–19.

Remarks. The genital markings in *Anisochaeta calvasaxea* resemble those found in *A. aemula, A. flava*, and *A. tunicata*. The markings on 10, however, are postsetal, rather than presetal as in these other species (or more widely paired

than those of *A. flava* variants). Moreover, *A. calvasaxea* further differs from *A. aemula* by having a well-developed gizzard and by lacking nephridial bladders and lacking internal glands in 17 and 19. While the paired markings around the male pores in *A. flava* are midventral and co-joined. The similarity with *A. tunicata* is closer (to the extent that there are 20 setae per segment and the gizzard appears partly in 6 in both species), but this species has more extensive markings on segments 8,9–13 and spermatheca and prostates that are less slender than those found in *A. calvasaxea*.

Etymology. *Calvasaxea*: of bald rock.

Distribution and habitat. Bald Rock National Park (along with *A. aterpaenulata* and *A. ima*).

Anisochaeta chani n.sp.

Fig. 8

Material examined. HOLOTYPE: ANIC RB.98.2.47, (H), Neville nr. Orange, NSW, c. 33°42'S 148°15'E, May 1998, K. Yin Chan, (mature, tip of tail missing, figured and dissected). PARATYPES: AM W24537, (P1), same details as H (mature, tip of tail missing, dissected); ANIC RB.98.2.48, (P2), same details as H (mature); AM W24538, (P3), same details as H (weakly clitellate mature, tip of tail missing, dissected); ANIC RB.98.2.49, (P4), same details as H (aclitellate subadult that lacks genital markings but agrees superficially). ANIC RB.97.3.4, (P5), Cowra, NSW, 9.vii.1992, possibly collected by Nielsen, donated by J.C. Buckerfield, (mature specimen, dissected).

External features. Lengths (mm): 130+ (H), 120+ (P1), 150 (P2), 105 (P3), 90 (P4), 220 (P5). Width: 4–5 mm (P5 7–8 mm). Segments: 160 (P2), 142 (P5). Colour: anterior dorsum dark blue-grey to flanks, whole of ventrum and hind-body pale (with dark mid-dorsal line in P5); clitellum dark (reddish in P5). Prostomium: open epilobous with weak mid-dorsal furrow (more tanylobous in P5); peristomium ventrally cleft. Clitellum: ½13 to ½17. Dorsal pores: small in 4/5, larger from 5/6. Setae: large in anterior, 20 on 12, 28 on 20 and 30–34 towards posterior. Nephropores: not found. Spermathecal pores: obvious in 6/7/8/9 in *ab* but slightly closer to *b* lines. Female pores: paired on 14. Male pores: on 18 at centres of mounds wider than *a* lines surrounded by darker, sunken, dumb-bell-shaped area with tumid lateral borders extending to *c* lines. Genital markings: on 10 two pairs of small markings, one pair just anterolateral to *b* setae, the other pair median and inferior to *ab* on both sides (P5 has an extra pair of small markings just median to setae *a* on 9); in 16 and 17 equatorially merged paired markings, those in 16 median to *aa*, those in 17 slightly wider extending to *a-b* lines; in 19 paired oblique slits or sunken discs within tumid papillae linked by narrow bridge just presetal to *a* setae and median to the line of the male pores.

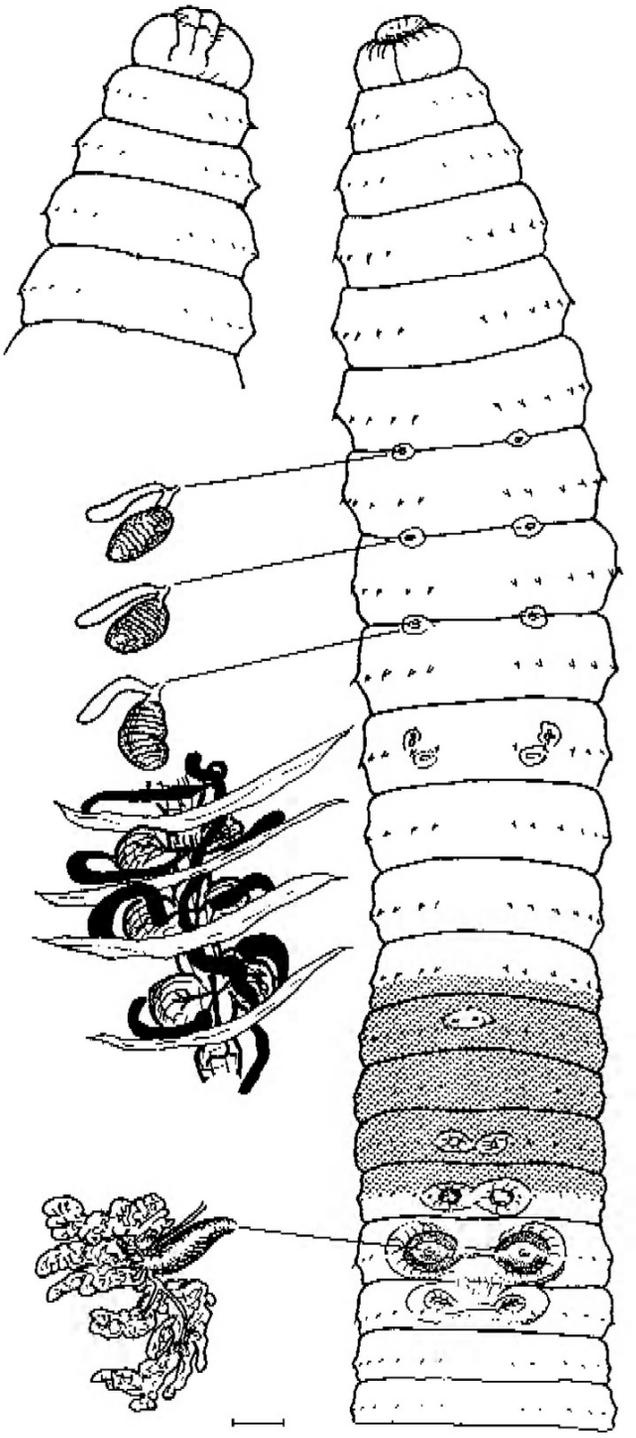

Figure 8. *Anisochaeta chani* ventral view of holotype with dorsal view of prostomium, spermathecae, oesophagus and vascularization in 9–13 showing three pairs of calciferous glands in 10–12, and lhs prostate in 18–19 with externally branching ducts.

Internal anatomy. Septa: 5/6/7/8 displaced rearwards by gizzard, 8/9–12/13 increasingly thick then thinning. Gizzard: large muscular conical in 5 but deflected, corresponding to width of segments 7–8. Oesophagus: lateral extramural calciferous glands paired in 10–12 (three pairs), supplied with blood vessels from supra-oesophageal vessel and lamellate internally with white (calcium) granules; oesophagus narrows in 13–15. Nephridia: avesiculate meroic, tufted in (3)4–5, then spread laterally and reduce in size with bands of numerous (about 15–20 per side) parietal tubules; bladders and funnels not found.

Vascularization: dorsal vessel single onto pharyngeal mass in 3; hearts 10–12 from supra-oesophageal vessel that runs 10 to ½13. (In 10 and 11 at least, hearts connect to the supra-oesophageal vessel with only small connectives to the dorsal blood vessel). Spermathecae: three pairs in 7, 8 and 9; large finely furrowed ampulla on short thin duct joined by clavate diverticulum just longer than the ampulla; (diverticula white rather than iridescent). Male organs: holandric, racemose seminal vesicles elongate and flimsy in 9 and 12; testes and funnels free in 10 and 11, (iridescence not noted). Ovaries: fan-shaped in 13; small paired ovisacs in 14. Prostates: racemose dispersed lobes in 18–19 supplying external ducts that converge, along with vas deferens, at apex of thick muscular duct; penial setae absent; many tendons or muscle fibres fan out from 18 to segments 16–19. Intestine: origin in 16; typhlosole absent; gut contents fine yellow soil (or red sandy soil with many quartz grits in Cowra specimen).

Remarks. Previously known *Anisochaeta* species from NSW with 3 pairs of spermathecae in 6/7/8/9 near *b* lines and 3 pairs of calciferous glands in 10–12, as in *A. chani*, are Fletcher's species *A. austrina, A. raymondiana* and, possibly, *A. hamiltoni*. (*A. rubeospina* in this account, has spermathecal pores in *a* lines).

Fletcher (1886b: 956–957) described sexthecal *Anisochaeta austrina*, comparing it with quadrithecal *A. australis*. Although close morphologically, *A. austrina* differs from *A. chani*, not least, by the anterior genital markings in 9 and 10 being much more prominent and by having an extra pair of papillae median to male pores on segment 18 (see Fletcher, 1886b, fig. 5). Fletcher (1987: 398–400) briefly describes *A. raymondiana* (from Raymond Terrace, Hunter River) and *A. hamiltoni* (from besides the Cudgegong River at Guntawang near Mudgee), comparing them with *A. austrina* (or perhaps he meant *A. australis*). On the information given, they both appear to differ from *A. chani* by having genital markings on 17 and 18 only (i.e., not recorded in 16 nor 19). Further, *A. raymondiana* has narrow mid-dorsal and mid-ventral setal gaps and testis sacs, and *A. hamiltoni*, while having wider setal gaps, has only indistinct swellings on 9 and 10 and also a second pair of papillae (with or without pores) on 18 in addition to papillae with pores on 17 (and 18). (Types of this latter species, AM W1349, were not inspected).

Unique combination of characters in *A. chani* are the large spermathecal pores in 6/7/8/9 in *ab* but perhaps closer to *b* setal lines, the distinctive shape of the spermathecae and multi-lobed prostates, and the distribution of genital markings (on (9),10, 16, 17 and 19). Slight variations are noted for the larger Cowra specimen but as it agrees on most points it is considered to be conspecific.

Etymology. Named in recognition of the collector Dr K. Yin Chan of the New South Wales Department of Agriculture, Wagga Wagga.

Distribution and habitat. Neville township approximately 50 Km south of Orange, and 50 Km north of Cowra. Found "In pasture soil in high numbers" at the former type locality.

Anisochaeta conspecta n.sp.

Fig. 9

Material examined. HOLOTYPE: AM W24560, (H), Richmond Range State Forest, NSW, 28°31'S 152°44'E, c. 27.iii.1983, Ed Easton, "Jar 35 Sp 31" (mature, possibly a posterior regenerate after segment 76, figured and dissected). PARATYPES: ANIC RB.98.2.58, (P1), same details as H (mature, dissected); AM W24559, (P2), same details as H (mature posterior amputee); AM W24561, (P3–P7), same details as H (5 specimens: mature or subadult, several posterior amputees).

External features. Lengths (mm): 85 (H), 100 (P1), 70+ (P2), 70–88 (P3–P7). Width: about 3 mm. Segments: 93+ (H), 104 (P1). Colour: anterior dorsum dark orange-brown with faint blue mid-dorsal line, remainder of body yellowy in alcohol; clitellum orange. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: from 4/5. Setae: 20 per segment for most of body length, increasing up to 30 on caudal segments. Nephropores: small dots noted intersegmentally approximately in line with alternate setal lines. Spermathecal pores: as large curved slits on prominent mounds in 7/8/9 in *ab* but closer to setal *a* lines with ridged arcs surrounding pores. Female pores: paired on 14. Male pores: on 18 as small cruciform slits on opposed mounds that almost meet ventrally within darker rims extending to *b* lines. Genital markings: on 10 and 11 (all specimens) two pairs of circular discs, presetal centred in *ab* lines; on 16 (H and P2 only), 17 (all mature specimens), 19 (H, P1, P2 only), 20 (H, P1, P2, P3 only) and 21 (H, P1, P2, P3 only) large paired postsetal discs approximately in *bc* lines; on 19 (all matures) additional pair of irregular discs encircled by darker rims that are ventrally united by narrow isthmus just anterior to setal arc and just longer than interval of male pores. Thus genital markings of mature specimens are consistently on 10, 11, 17 and presetally on 19.

Internal anatomy. Septa: none especially thickened. Gizzard: large muscular barrel in 5. Oesophagus: dilated and vascularized in 8–14 but not calciferous; narrow in 15. Nephridia: avesiculate meroic, large tufts in 4–6, then dispersed as discrete sets of tubules, about 10 per side, equatorial in forebody, thicker on clitellar segments, small in intestinal segments; bladders, funnels and connections to nephropores not found. Vascularization: dorsal vessel single onto pharyngeal mass in 4; hearts 10–12 from weak supra-oesophageal vessel. Spermathecae: two pairs in 8 and 9; large conical ampulla on short duct joined by medium length clavate diverticulum. Male organs: holandric, racemose seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: fan-shaped in 13; small paired ovisacs in 14. Prostates: bilobed, racemose in 18–19, anterior lobe circular, larger posterior lobe folded elongate, both providing external ducts that unite, along with vas deferens at apex of long looped duct; penial setae absent. Intestine: origin in 16; typhlosole absent but low dorsal ridge noted; gut contents gritty topsoil.

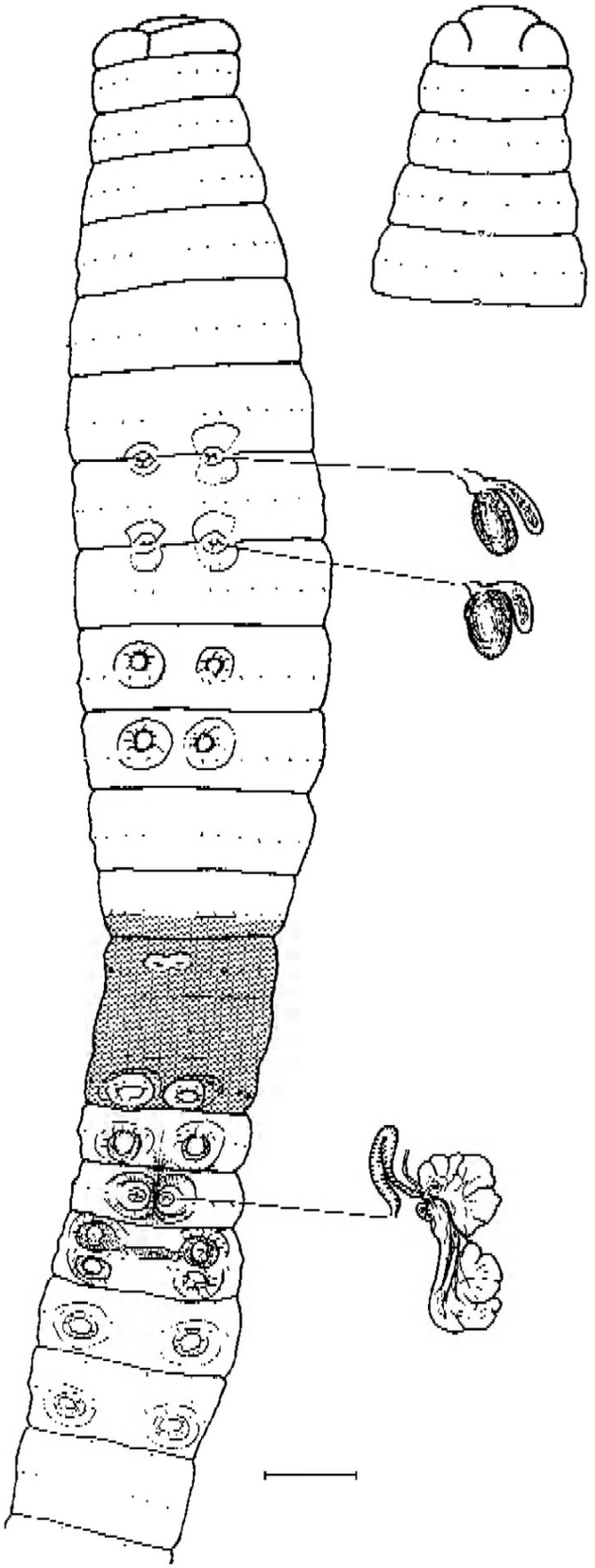

Figure 9. *Anisochaeta conspecta* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–19 with externally branching ducts and vas deferens.

Remarks. Features of *Anisochaeta conspecta* are the slit-like male and spermathecal pores, the bilobed racemose prostates, the shape of the spermathecae and the distribution of the genital markings. Especially distinctive is the narrow isthmus linking the glandular markings on the anterior of segment 19. Stephenson's *A. rodwayi* has genital markings, when most abundant, in segments 10,11,16,17,19–21+ (see Boardman, 1943:174 for variations). This distribution is similar to that in *A. conspecta*, however, the markings in *A. rodwayi* are always placed anterior of the setal ring and are more closely paired: either confluent ventrally or united by a narrow glandular bar.

Etymology. *Conspectus*: conspicuous—a reference to the genital markings.

Distribution and habitat. Richmond Range; a specimen of *A. toonumbari* n.sp. was found in same sample.

Anisochaeta erica n.sp.

Fig. 10

Material examined. HOLOTYPE: AM W24448, (H), 500 m east of Junction Holes, near Barrington River, NSW, c. 31°59'S 151°45'E, 15.iii.1983, Ed Easton, "Jar 8 Sp 8" (mature, figured and dissected). (The sample also contained many specimens, AM W24536, that are possibly the smaller *A. palustris*, but are too immature to identify with certainty). PARATYPES: ANIC RB.98.2.15, (P1), Edwards Swamp, Barrington Tops, (?15).iii.1983, Ed Easton, "Jar 11 Sp 12", "c. 500 m West of Junction Pools—1 large specimen at depth of 2 ft" (mature, dissected); AM W24549, (P2), same details as H (juvenile with weak genital markings, dissected); AM W24450, (P3), same details as H (juvenile agrees superficially).

External features. Body mostly circular in section except tail which flares to form spade-shape. Lengths (mm): 100 (H), 120 (P1). Width: about 4 mm. Segments: 116 (H, P1), 96 (P2). Colour: uniform pale in alcohol. Prostomium: tapering epilobous; peristomium ventrally cleft. Clitellum: not developed but slightly marked in 14–17 in both H and P1. Dorsal pores: 3/4 minute, larger from 4/5. Setae: 24 on 12, 28 on 20, up to 32 on tail. Nephropores: not found. Spermathecal pores: small lateral pores in slight lips at anterior margin of segments 8 and 9 in *a* lines. Female pores: small paired on 14. Male pores: on 18 on small elliptical papillae approximately in *ab* lines. Genital markings: on 9–11 three sets of widely paired discs presetal and centred in *b* lines with tumid rim extending from *a* to *c* lines; in 18 and 19 two sets of paired white discs presetal in *b* lines, within common dark patch that surrounds both discs and male pores on each side (i.e., midventrum unmarked). This arrangement of genital markings pertains to H and P1.

Internal anatomy. Septa: 8/9–11/12/13 thickened. Gizzard: large muscular cone in 5 but displaced to occupy length of 7–9 and preceded by large crop. Oesophagus: four pairs of kidney-shaped calciferous glands in 11–14 attach laterally to oesophagus by short ducts; valvular in 15. Nephridia: avesiculate meroic, equatorial forests of numerous tubules,

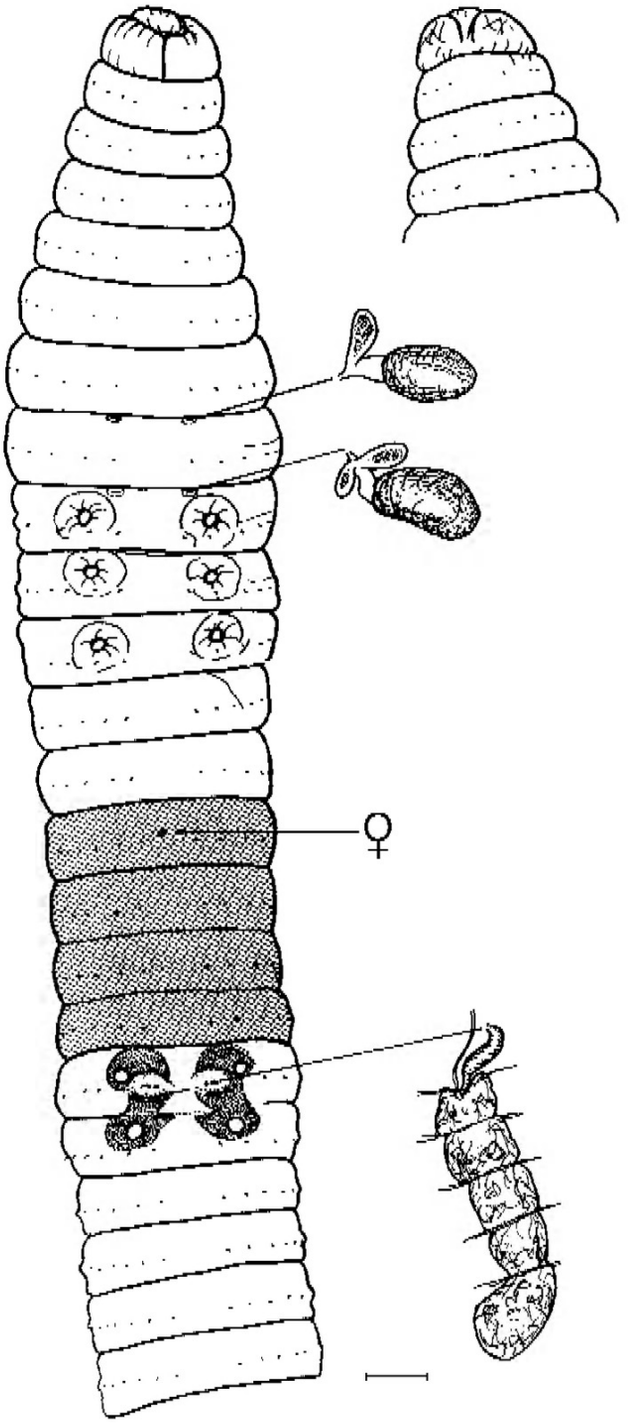

Figure 10. *Anisochaeta erica* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18–23 with vas deferens.

large in forebody, especially 6–9; smaller and fewer in intestinal segments where they number about eight per side; bladders and funnels not found. Vascularization: dorsal vessel single; hearts 10–12, supra-oesophageal vessel supplies calciferous glands. Spermathecae: two pairs in 7 and 8 but ducting to 7/8 and 8/9 (i.e., reflexed into preceding segments); conical ampulla on short duct joined ectally by short clavate diverticulum (8 rhs in H only has two diverticula). Male organs: holandric, small racemose seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: compact or elongate in 13; small paired ovisacs in 14. Prostates: elongate tubuloracemose in 18–23 (lhs in H deflected forwards 18–14); penial setae absent. Intestine: origin in 16 (septum 15/16 distended forwards); large T-shaped typhlosole develops from 16,17; gut contents brown organic loam.

Remarks. Four previously described *Anisochaeta* species from NSW are reported to have 4 pairs of calciferous gland. Fletcher's *A. monticola* has 4 pairs, but in segments 10–13, and, although similar with 2 pairs of spermathecae, differs in the distribution of genital markings, amongst other points. *Anisochaeta exigua* has 4 (or 5) pairs in 10–13,14, but has only one pair of spermathecae. *Anisochaeta macquariensis* has 3 (or 4) pairs in 10–13,14 but has 3 pairs of spermathecae. *Anisochaeta jenolanensis* has four pairs in 10–13, but has 4 pairs of spermathecae.

Anisochaeta erica is unique in having 3 pairs of calciferous glands in 11–14 and 2 pairs of spermathecae. Moreover, is has a distinctive arrangement of genital markings and a well-developed T-shaped typhlosole.

Etymology. *Erica*: heather—a reference to the habitat.

Distribution and habitat. Near Barrington River, Barrington Tops. From "area of heather-like shrubs" and from "tussock grass", the latter sample from depth of c. 60 cm. *Anisochaeta palustris* n.sp. is from the same area.

Anisochaeta filix n.sp.

Fig. 11

Material examined. HOLOTYPE: AM W24476, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.31, (P1), same details as H (mature, dissected); AM W24477, (P2), same details as H (mature); ANIC RB.98.2.32, (P3), same details as H (weakly clitellate mature); AM W24478, (P4), same details as H (mature); ANIC RB.98.2.36, (P5), same details as H (aclitellate mature, dissected).

External features. Body stout, circular in section except tail slightly spade-shaped. Lengths (mm): 135 (H), 150 (P1), 160 (P2), 125 (P3), 90 (P4), 110 (P5). Width: about 5–6 mm. Segments: 130 (H), 135 (P1). Colour: beige in alcohol with faint mid-dorsal line, clitellum puce, prostomium: tapering almost tanylobous; peristomium ventrally cleft. Clitellum: ½13 to ½17. Dorsal pores: 4/5 small dot, open from 5/6. Setae: 20 on 12, 24 on 20, about 32 on tail. Nephropores: not found. Spermathecal pores: wide openings in 7/8/9 in or just median to *b* lines. Female pores: paired on 14. Male pores: wide openings on 18 on apices of small round prominences approximately in *ab* lines, hollow trough between. Genital markings: on 9,10–11 and on 17 and 19, paired presetal sucker-like discs in *ab* (those in 9 absent in P1); smaller secondary pairs more median and postsetal on 11 (not in P4, P5), between male pores on 18 and single (or paired in P3) discs midventral on 19 (not in P5).

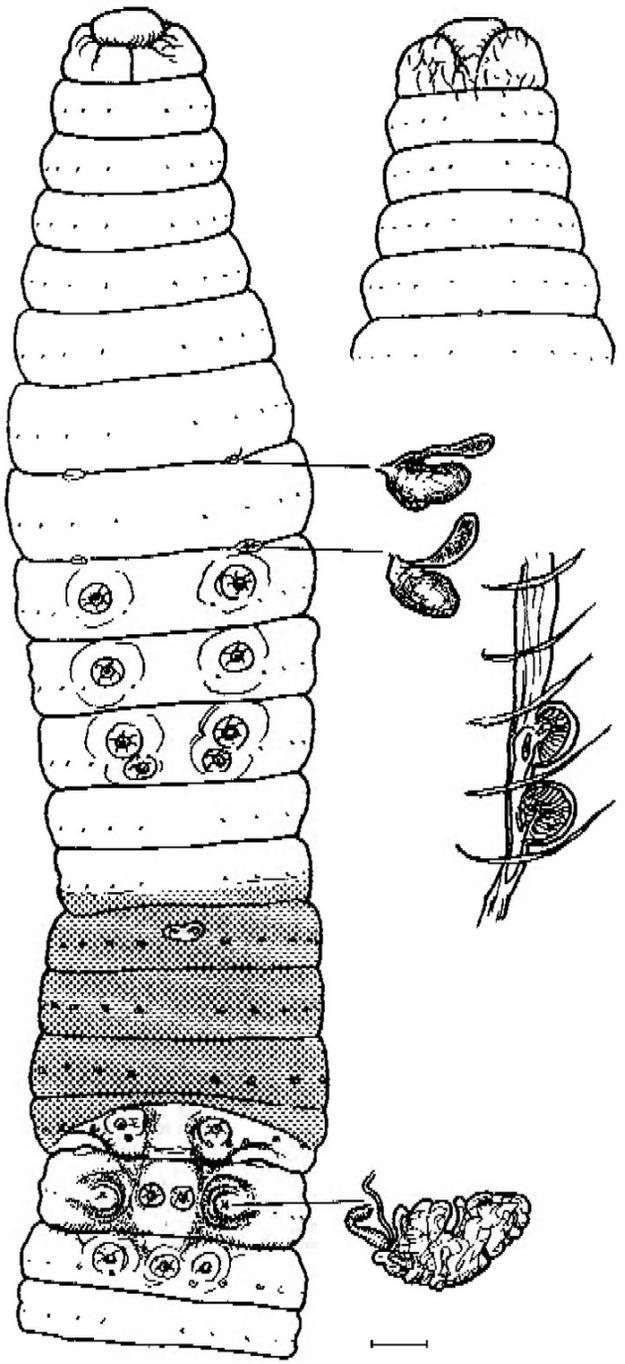

Figure 11. *Anisochaeta filix* ventral view of holotype with dorsal view of prostomium, spermathecae, oesophagus in 9–13 showing sectioned sessile calciferous glands on lhs in 11 and 12, and rhs prostate in 18 with vas deferens.

Internal anatomy. Septa: 7/8/9–12/13/14 slightly thickened. Gizzard: spheroidal muscular in 5. Oesophagus: in 11 and 12 two pairs of laterally sessile extramural calciferous glands; narrows in 14–15. Nephridia: avesiculate meroic, somewhat tufted in 5–6,7 then spread laterally as several equatorial, filamentous tubules; funnels and bladders not found. Vascularization: dorsal vessel single; hearts 10–12 from supra-oesophageal vessel which also branches to calciferous glands in 11 and 12. Spermathecae: two pairs in 8 and 9, tapering saccular ampulla poorly defined from duct with longer clavate diverticulum at base. Male organs: holandric, racemose seminal vesicles saccular in 9 and elongate in 12; testes and funnels in 10 and 11. Ovaries: palmate with numerous strings in 13; small paired ovisacs in 14. Prostates: flattened tubuloracemose in 18, duct short and overlain by tendons; penial setae absent. Intestine: origin in 16; true typhlosole absent; gut contents soil and fresh or decayed plant remains.

A slender, dark nematode was removed from the ventral blood vessel in P1 and sent to the Australian Museum nematologist, Dr G.L. Baker, for identification.

Remarks. *Anisochaeta filix* has two pairs of sessile calciferous glands in 11 and 12 and two pairs of spermathecae in 8 and 9. These characters are shared with *Anisochaeta macleayi* which is morphologically close. This latter species, recently redescribed in Blakemore & Elton (1994), differs in its less robust body, more lateral spermathecal pores and distribution of its genital markings. Especially distinctive in typical populations of *A. macleayi* are the two pairs of prominent mounds presetally in 10 and 11, each with an eye-like pore on its summit.

Etymology. *Filix*: fern—a reference to the locality name.

Distribution and habitat. Tree Fern Valley—from same sample as several other *Anisochaeta* spp (see *A. ancisa*).

Anisochaeta flava n.sp.

Fig. 12

Material examined. HOLOTYPE: AM W24543, (H), Washpool State Forest, NSW, c. 29°16'S 152°22'E, collected 9.iii.1992, M. Gray & P. Croft, pit trap sample set 22.ii.1992, "17CM Trap 2 FN 5081" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.52, (P1), same location as H but "collected 22.ii.1992, set 6.ii.1992, Trap 2 FN5061" (mature, dissected); AM W24545, (P2), same details as P1 (mature, dissected); ANIC RB.98.2.53, (P3), same details as P1 (subadult); AM W24412, (P4), 200 m north of Twin Bridges, Gibraltar Range National Park, NSW, c. 29°30'S 152°20'E, c. 20.iii.1983, Ed Easton, "Jar 28 Sp 31" (mature, figured and dissected); ANIC RB.98.2.6, (P5), same details as P4 (mature, dissected).

Non-type material. AM W24413, (S1), same details as P4 (mature, dissected); ANIC RB.98.2.7, (S2), and AM W24414, (S3), same details as P4 (mature); ANIC RB.98.2.8, (S4), same details as P4 (mature, dissected); AM W24415, (S5–S11), same details as P4 (seven subadult or immature specimens).

External features. Body slightly dorsoventrally flattened. Lengths (mm): 88 (H), 90 (P1), 71 (P2), 62 (P4), 55 (P5). Width: about 3 mm. Segments: 86 (H), 126 (P1), 127 (P2), 110 (P4), 101 (P5). Colour: golden straw colour or uniform buff in alcohol, clitellum yellow, no mid-dorsal line. Prostomium: epilobous; peristomium ventrally cleft. Clitellum: ½13,14–16. Dorsal pores: from 4/5. Setae: 16 on 12, 16–18 on 20, about 20 on tail. Nephropores: not

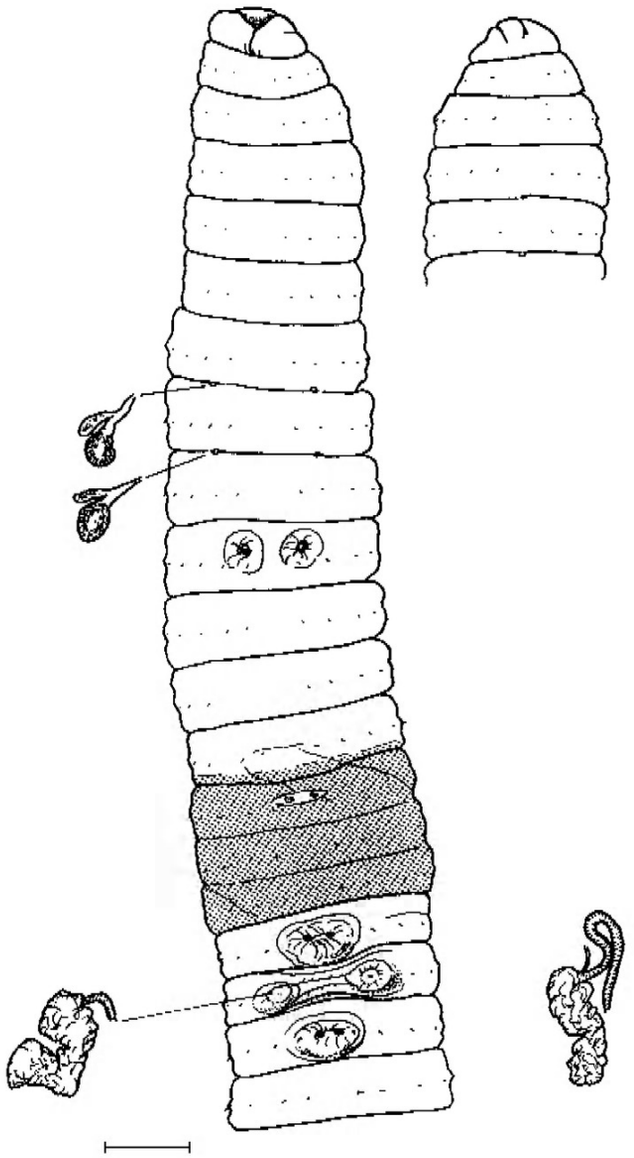

Figure 12. *Anisochaeta flava* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–19 (prostate of P1 also figured with long duct and vas deferens).

found. Spermathecal pores: small in 7/8/9 in *ab* lines either closer to *b* or to *a* lines. Female pores: paired on 14. Male pores: on 18 on small round papillae approximately in *ab* lines and joined medially by small trough. Genital markings: on 10 paired sucker-like discs in *ab*, either presetal or postsetal; on each of 17 and 19, paired mid-ventral discs (sometimes discs linked by narrow line) near equator in common tumid pad that encompasses *aa*. Variations in genital markings: those in 10 are presetal in Washpool specimens, postsetal in Gibraltar specimens; in P5 the anterior markings are in 9 not 10; posterior markings are equatorial in Washpool specimens and elongate rather than paired in P2, but just postsetal in Gibraltar specimens, in P5 there is left-hand-side analogue only on 19.

Internal anatomy. Septa: none especially thickened (H) or slightly so in 8/9–11/12 (P4). Gizzard: large muscular in 5 but displaced to occupy length of 7–8. Oesophagus: increasingly dilated in 9–14 but not calciferous; narrowing in 15. Nephridia: avesiculate meroic, tufted in some or all of 4–6, then spread laterally with several small tubules per side. Vascularization: dorsal vessel single; hearts 10–12 connected to supra-oesophageal vessel. Spermathecae: two pairs in 8 and 9, spherical ampulla on slightly longer narrow duct with medium sized clavate diverticulum on duct (towards ental part in Washpool specimens, toward ectal end in Gibraltar specimens). Male organs: holandric, racemose seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: sheet-like in 13; small paired ovisacs in 14. Prostates: elongate tubuloracemose in 18–19, duct either short (H) or long, thin and folded back on itself (P1, P2, P4, P5); penial setae absent. Intestine: origin in 16; typhlosole absent; gut contents fine yellow or loamy soil.

Remarks. The distribution of genital markings distinguishes *A. flava* from other known species with two pairs of spermathecae and lacking calciferous glands. It compares with *A. noctiluca* (Jamieson & Wampler, 1979) from Lamington National Park, Queensland. In that species the genital markings differ being medianly conjoined presetal prominences on 10 with widely paired presetal pore-like centres plus unpaired glandular troughs on 17 and 19 that are, respectively, postsetal and presetal (i.e., not equatorial nor closely paired in 17 and 19 as in *A. flava*). Boardman's *Anisochaeta wiburdi* has markings in 9, 10, 17 and 19, but those in 9 are postsetal, those in 10 form a tetrad, and the paired equatorial pore-like markings in 17 and 19 are wider, immediately medial of setae *a* (see also *A. novaeanglica* n.sp.).

Varietal specimens, noted under non-type material above (S1–S11), resemble *A. noctiluca* by having puce pigmentation, 24 setae per segment in the forebody, spermathecae just lateral of *b* lines and markings in 17 and usually 19 that, while respectively postsetal and presetal, support paired discs like *A. flava*. As a consequence these are not attributed to *A. flava* nor *A. noctiluca* pending further investigation of permissible variation within these two taxa.

Etymology. *Flavus*: yellow, golden—a reference to the colouration.

Distribution and habitat. Washpool State Forest (with *Anisochaeta aemula, A. garilarsoni* and *A. lavatiolacuna*). Gibraltar range specimens were collected "in rainforest with tree fern" (with *A. calpetana*).

Anisochaeta garilarsoni n.sp.

Fig. 13

Material examined. HOLOTYPE: AM W24487, (H), Washpool State Forest, NSW, c. 29°16'S 152°22'E, collected 19.iii.1992, M. Gray & P. Croft, pit trap sample set 9.iii.1992, "17CM Trap 4 FN5093" (mature, figured and dissected). (H was damaged dorsally in 8–10 and a ?dipteran larva removed from the wound placed in a vial in the sample jar). PARATYPES: ANIC RB.98.2.50, (P1), same location as H but collected 9.iii.1992, set 22.ii.1992, "Trap 8 FN5087" (mature posterior amputee, dissected); AM W24541, (P2), same details as P1 but "Trap 2 FN5081" (mature,

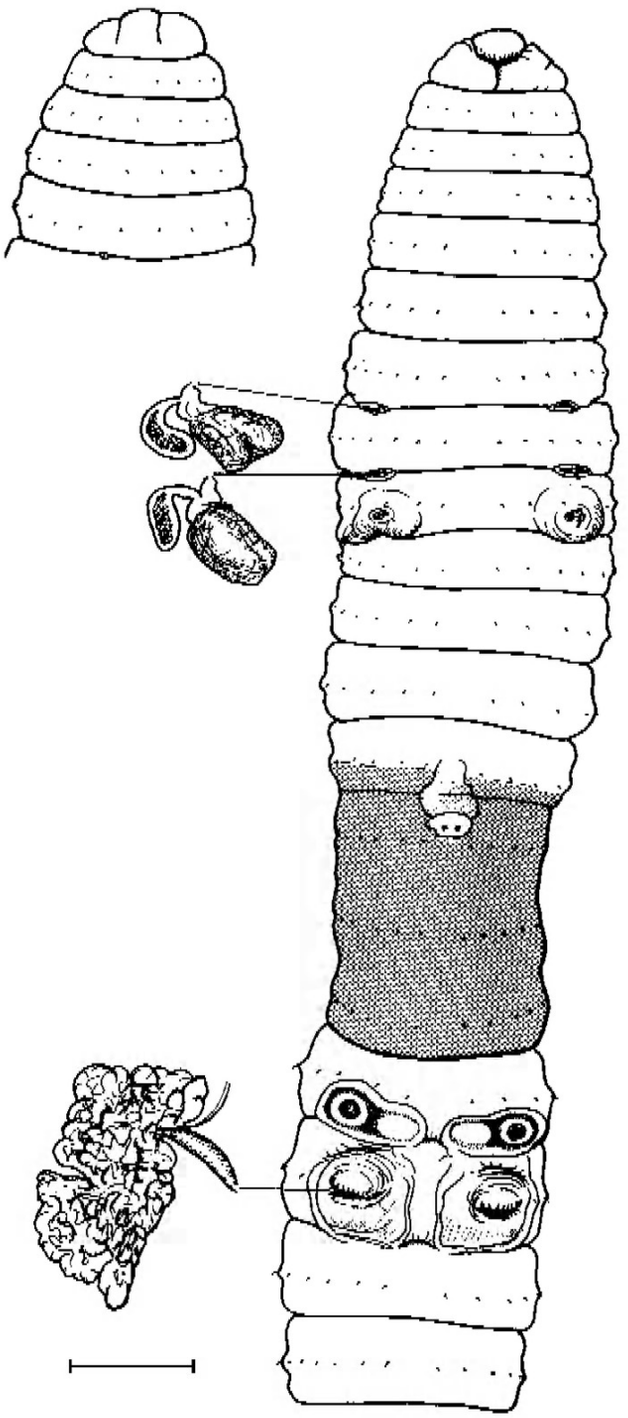

Figure 13. *Anisochaeta garilarsoni* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–19 with vas deferens.

dissected); AM W24542, (P3, P4), same details as P2 (two specimens, a weakly clitellate mature, dissected, plus an immature that superficially agrees); ANIC RB.98.2.51, (P5), same details as P1 but "Trap 3, FN5082" (weakly clitellate mature); AM W24546 (P6), same details as P1 but collected 22.ii.1992 "Trap 2 FN5061" (aclitellate anterior amputee lacking first 4 segments).

Non-type material. AM W24570, (S1–S5), Twin Bridges, Gibraltar Range National Park, NSW, c. 29°30'S 152°20'E, 1,000 m, c. 20.iii.1983, Ed Easton, "Jar 27 Sp 31" (5 mature specimens which superficially agree, one exactly, the others have some variation of markings).

External features. Lengths (mm): range 42–60 mm, 60 (H), 46+ (P1), 58 (P2), 50 (P3), 42 (P5). Width: about 2 mm. Segments: 93 (H), 62+ (P1), 89 (P2). Colour: anterior dorsum dark red-grey, puce after clitellum fading to tail, clitellum buff. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13,14–16 with dorsal dimple in 13. Dorsal pores: from 5/6. Setae: 24–28 per segment throughout. Nephropores: not found. Spermathecal pores: in 7/8/9 as widely paired lateral slits that occupy whole interval of *cd* or *de* lines. Female pores: paired on 14. Male pores: on 18 in wide and deep (eversible) pouches covered by thick hood approximately in *bc* lines, at centre of flat squarish rimmed pad that occupies ventral aspect of 18 from *a* to *c* lines on each side. Genital markings: large postsetal tumid mounds paired in *b-d* lines each with central pore in same line as spermathecae in 9 (H), or 10 (P2, P3, P5, P6) or lhs analogue only in 10 (P1); on 17 postsetally widely paired discs in *bc* lines with secondary less well defined pads more median and closer to posterior furrow, both markings within common rimmed pad on each side (all matures except P2 which lacks the outer discs on 17 but has additional pair midventrally in 18/19 in *aa*). Summary: markings usually paired postsetal in 9 or 10 and 17.

Internal anatomy. Septa: none especially thickened. Gizzard: compact weakly muscular in 5 (note: P2 is anomalous as gizzard is dislocated in segment 7). Oesophagus: only slightly dilated in 13–14, calciferous glands absent. Nephridia: avesiculate meroic, not especially tufted in anterior although tubules larger, spread laterally with about ten-twelve per side near anterior septa, reduced in size after clitellum; funnels and bladders not found. Vascularization: dorsal vessel single; hearts 10–12 from weak supra-oesophageal vessel. Spermathecae: two pairs in 8 and 9, saccular sometimes almost bifid ampulla on short duct with medium sized curving diverticulum at midlength. Male organs: holandric, thickly racemose seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: compact in 13; small paired ovisacs in 14. Prostates: flattened blocky tubuloracemose in 18–19,20, duct short; penial setae absent. Intestine: poorly differentiated from oesophagus, appears to be in 15 (in H) as dorsal blood vessel has lateral branches (cf. in 13–14) or 16 (in P1, P2, P3) as dorsal blood vessel is more closely applied (cf. more anteriorly); typhlosole absent; gut contents organic woody fragments and debris.

Remarks. With dark pigmentation and widely paired spermathecal pores, *Anisochaeta garilarsoni* is superficially similar to *A. aterpaenulata* and *A. virgata*, all three species also lack calciferous glands. However, *A. garilarsoni* is smaller, has fewer setae at least in the posterior, and lacks the genital markings on 19 that characterize these other two species. In other ways (e.g., shape of spermathecae, dorsal pores, intestinal origin), *A. garilarsoni* is somewhat intermediate to these two species although the hooded male pores are an additional distinction.

Etymology. Named in honour of Gary Larson, the cartoonist who has recently produced a popular booklet on earthworm ecology (Larson, 1998).

Distribution and habitat. Washpool State Forest (with *A. aemula, A. flava* and *A. lavatiolacuna*), and Gibraltar Range (with *A. bulla* varieties, *A. calpetana* and *A. flava*). Whether these pit trap specimens were damaged before or after capture, and the causes of the damage, are unclear.

Anisochaeta ima n.sp.

Fig. 14

Material examined. HOLOTYPE: AM W24576, (H), 100 m from base of Bald Rock, Bald Rock National Park, NSW, c. 28°51'S 152°03'E, 28.iii.1983, Ed Easton, "Jar 27 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.63, (P1), same details as H (mature, dissected); AM W24577, (P2), same details as H (mature); ANIC RB.98.2.64, (P3), same details as H (mature); AM W24578, (P4–P16), same details as H (13 specimens: 2 mature, 8 aclitellate, 2 juveniles, some damaged).

External features. Body slightly dorsoventrally depressed and coiled. Lengths (mm): 70 (H), 90 (P1), 70 (P2), 85 (P3). Width: about 2–2.5 mm. Segments: 95 (H), 116 (P1). Colour: unpigmented in alcohol, clitellum pale. Prostomium: open epilobous with dorsal furrow; peristomium ventrally cleft. Clitellum: 14–16 but encroaches slightly onto adjacent segments. Dorsal pores: small in 3/4, open from 4/5 (occluded on clitellum). Setae: 20 throughout, but not all rows regular. Nephropores: not found but small pores seen at anterior of segments in line with every second or third seta in midbody. Spermathecal pores: 7/8/9 in *b* lines. Female pores: paired on 14. Male pores: on 18 in *ab* lines at centre of large flat pads that are darker and taper to mid-ventrum. Genital markings: in 11, tetrad of discs just lateral to and above and below setae *a* on each side, each disc within tumid pad that lies within *ab* lines, pads meet at setal arc to give overall 88 appearance (all mature specimens although sometimes one or two discs absent, one specimen has additional pair anteriorly on 10); on 17 paired oblique markings postsetal in *ab* lines (all specimens); on 19 small, paired pore-like dots just posteromedian to *a* setae within tumid pads that extend to *b* lines (all specimens except the one with markings in 10 where the dots are presetal).

Internal anatomy. Septa: 9/10–11/12 slightly thickened. Gizzard: large and muscular in 5 (and partly in 6 as septum 5/6 attaches at about mid-length). Oesophagus: dilated and vascularized but not calciferous, narrows in 15. Nephridia: avesiculate meroic, slightly tufted in 4–6 then as long stringy clusters of tubules that reduce in size after clitellum. Vascularization: dorsal vessel single; hearts 10–12 connected to weak supra-oesophageal vessel. Spermathecae: paired in 8 and 9, ampulla saccular on equally long duct with short, ectally bulbous diverticulum. Male organs: holandric, seminal vesicles racemose in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: in 13 sheet-like with several egg strings, oocytes large; small ovisacs in 14. Prostates: tubuloracemose in 17–19, duct especially thick and muscular, penial setae absent. Intestine: from 16, deep lamellar typhlosole develops from 18, gut contents fine soil dark with charcoal.

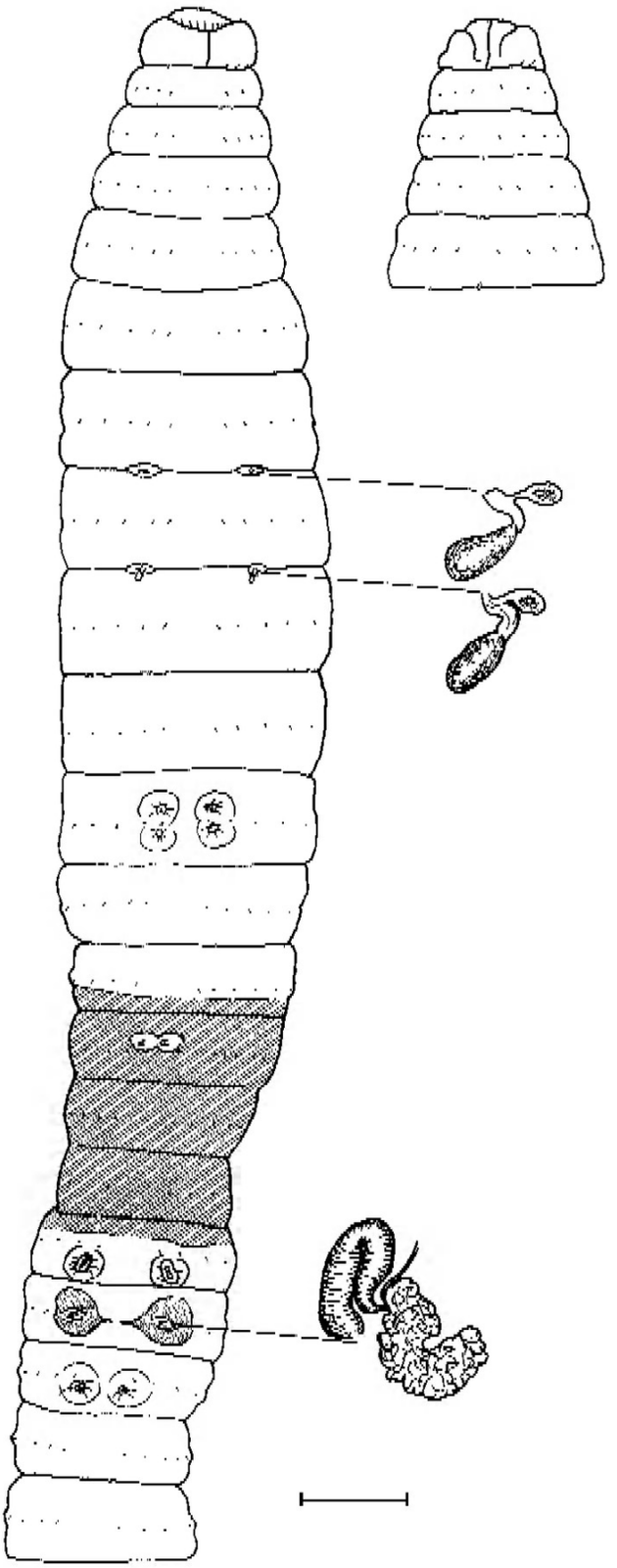

Figure 14. *Anisochaeta ima* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18–19 with thick duct looping into 17 and vas deferens.

Remarks. *Anisochaeta ima* typically has tetrad (88-like) markings on segment 11, similar markings are found in other congeneric species but usually they occur on segments 9 and 10 or 10 and 11 (i.e., most consistently on 10—see *A. novaeanglica*, this account). Such markings occur in *Anisochaeta tenax, Anisochaeta monticola* and *Anisochaeta jenolanensis*, being described as "8-shaped" or "8-like" by Fletcher. All three of these species occur in the vicinity of Sydney/Blue Mountain region and differ, at least, by having extramural calciferous glands. (In the current study, a sample of 4 specimens [AM W24493] from Blue Mountains were identified with *A. tenax*; having 88-like markings in 9 and 10, and three pairs of calciferous glands in 11–13. Slight differences from Fletcher [1886b: 953–955; 1890: 1014–1015] were that the dorsal blood vessel was not doubled and that the spermathecal diverticula were just longer than the ampullae).

Anisochaeta ima is further characterized by the distinctive male field, thick prostatic duct and the shape of the spermathecae.

Etymology. *Imus*: from the bottom or base of Bald Rock mountain.

Distribution and habitat. Bald Rock National Park, northeastern NSW, from soil under "ferns and eucalypts". *Anisochaeta aterpaenulata* and *A. calvasaxea* were collected nearby.

Anisochaeta lata n.sp.

Fig. 15

Material examined. HOLOTYPE: AM W24467, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, dissected). PARATYPES: ANIC RB.98.2.24, (P1), same details as H (mature, slightly abnormal as segments 10–11, 11–12 fused ventrally, internal segmentation normal); AM W24468, (P2), same details as H (aclitellate mature, dissected); ANIC RB.98.2.29, (P3) same details as H (juvenile that agrees externally).

External features. Body circular in section with slightly spade-shaped tail. Lengths (mm): range 80–110 mm, 110 (H), 100 (P1), 80 (P2), 60 (P3). Width: about 3 mm. Segments: 110 (H, P2), 100 (P1). Colour: anterior dorsum grey-brown with darker mid-dorsal line, clitellum buff. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: from 5/6. Setae: 20 on 12, 22 on 20, about 40 on tail. Nephropores: not found. Spermathecal pores: in 6/7/8/9 in *cd* lines. Female pore: single on 14. Male pores: on 18 at centres of widely paired mounds that occupy *bc* at least, no setae intervene. Genital markings: on 19 paired discs just anterior and superior to *a* setae (all specimens).

Internal anatomy. Septa: 7/8–11/12 slightly thickened. Gizzard: compact muscular in 5, occupies one segment length. Oesophagus: increasingly dilated in 11–14, calciferous glands absent, valvular in 15. Nephridia: avesiculate meroic, clustered ventrally but not tufted in anterior, in midbody have ranks of about ten to twelve small tubules per side in two irregular rows near anterior septum and equatorial; funnels and bladders not found. Vascularization: dorsal vessel single onto pharyngeal mass in 4; hearts 10–12 from supra-oesophageal vessel traced 6–12. Spermathecae: three pairs in 7–9, spherical ampulla

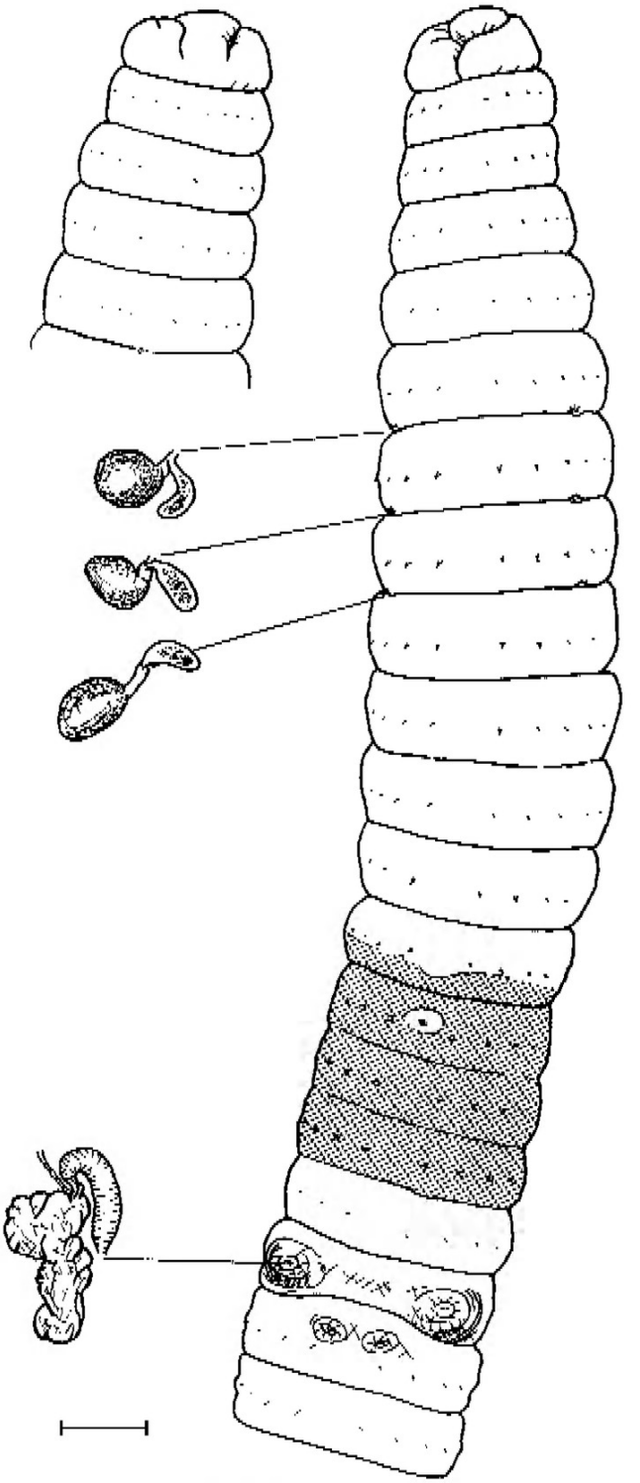

Figure 15. *Anisochaeta lata* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–19 with thick looping duct and vas deferens.

on short duct with medium sized curving diverticulum ectally. Male organs: holandric, large seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: as long strings in 13; large paired ovisacs in 14. Prostates: blocky, tubuloracemose in 18–19, duct thick and curved; penial setae absent. Intestine: origin 16; typhlosole absent; gut contents colloidal soil with organic fragments.

Remarks. Having 3 pairs of spermathecae opening near *d* lines and lacking calciferous glands, *Anisochaeta lata* is similar to *A. gracilis* that differs with regards to the male field (described with male pores as transverse slits in *bc* lines, with seta *a* retained and a pair of papillae just anterior to the male pores; other genital markings are often wanting—see Fletcher, 1886b: 959 and Boardman, 1943, fig. 4). Moreover, *A. gracilis* has tufted nephridia, seminal vesicles in 11 and 12 and spermathecal diverticula that may be as long as the ampullae.

Characteristics of *A. lata* are three sets of widely paired spermathecal pores, lack of calciferous glands, genital markings in 19 and thick prostatic ducts (similar to those in *A. ima*).

Etymology. *Latus*: wide—a reference to the spermathecal and male pores.

Distribution and habitat. Tree Fern Valley, New England National Park.

Anisochaeta lavatiolacuna n.sp.

Fig. 16

Material examined. HOLOTYPE: AM W24485, (H), Washpool State Forest, NSW, c. 29°16'S 152°22'E, collected 19.iii.1992, M. Gray & P. Croft, pit trap sample set 9.iii.1992, "17CM Trap 4 FN5093" (mature, figured and dissected). (Specimen fragile, now broken in half). PARATYPES: ANIC RB.98.2.38, (P1), same details as H but "Trap 3 FN5092" (aclitellate mature, dissected); AM W24486, (P2), same details as P1 (juvenile, dissected).

External features. Lengths (mm): 44 (H), 30 (P1), 28 (P2). Width: about 1.5 mm. Segments: 88 (H), 98 (P1). Colour: pale unpigmented in alcohol, clitellum buff. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: from 5/6. Setae: 24 on 12 and on 20, about 30 on tail. Nephropores: difficult to determine, approximately lateral at anterior of segments in *g* or *h* lines. Spermathecal pores: in 4/5/6/7/8/9 in *cd* lines. Female pores: on 14, single (H, P2) or closely paired (P1). Male pores: on 18 on low mounds approximately in *bc* lines, no setae intervene. Genital markings: presetal discs in *bc* lines on 10 (paired H, P1, P2), on 11 (rhs only on H, paired P1, P2), on 12 (lhs only P1); postsetal discs on 19 large in *bc* lines just impinging on furrow 19/20 (H, P1, P2).

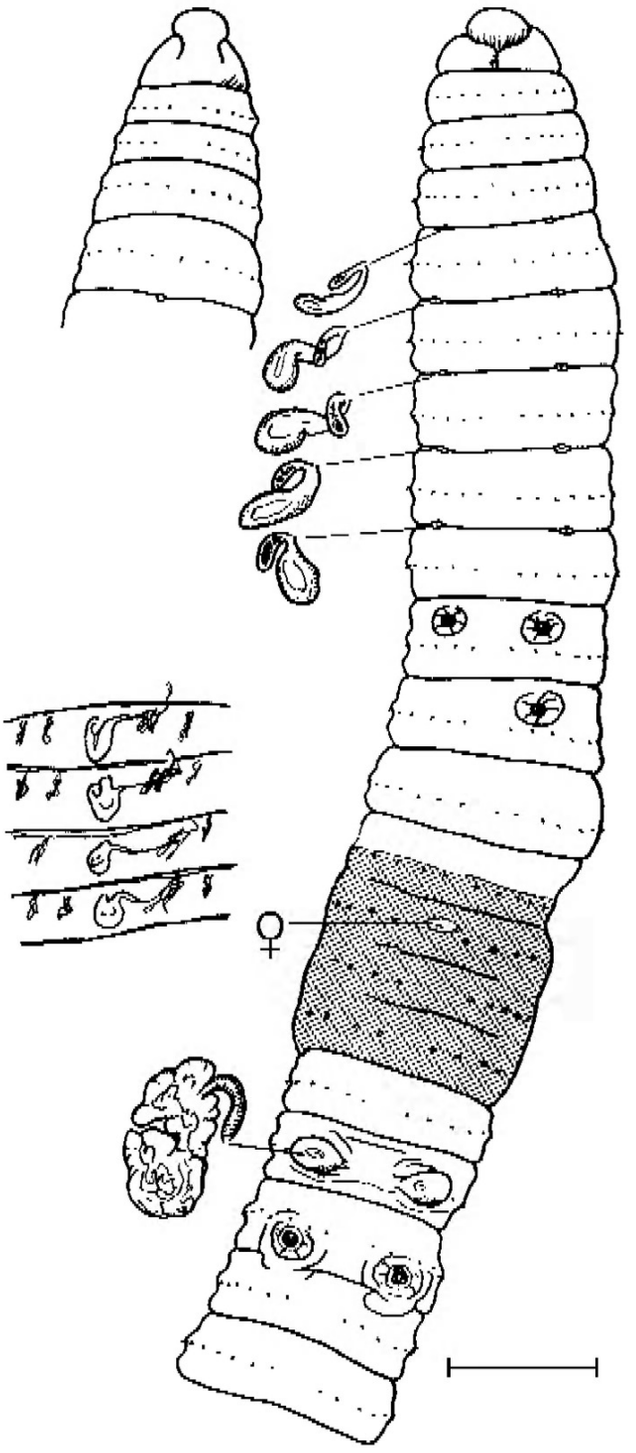

Figure 16. *Anisochaeta lavatiolacuna* ventral view of holotype with dorsal view of prostomium, spermathecae, nephridial arrangement on lhs around segments 23–26, and lhs prostate in 18–19.

Internal anatomy. Septa: none especially thickened. Gizzard: large but only slightly muscular in 5. Oesophagus: dilated in 13–14, calciferous glands absent, valvular in 15. Nephridia: vesiculate meroic, tufting not noted in anterior, about six per side, one lateral nephridium enlarged with preseptal funnel and V- or heart-shaped terminal bladder, other nephridia small and discrete near anterior septum. Vascularization: dorsal vessel single; hearts 10–12 from weak supra-oesophageal vessel in 7–12. Spermathecae: five

pairs in 5–9, conical ampulla on tapering duct with short diverticulum ectally. Male organs: holandric, seminal vesicles in 9 and, larger, in 12; testes and funnels in 10 and 11. Ovaries: as long strings in 13; small paired ovisacs in 14. Prostates: blocky tubuloracemose in 18–19, duct short curved; penial setae absent. Intestine: origin 16; typhlosole absent; gut contents yellow loamy soil.

Remarks. *Anisochaeta lavatiolacuna* has 5 pairs of spermathecae, lacks calciferous glands and has nephridial vesicles laterally. On this last character it resembles *A. aemula* and *A. toonumbari*, both of which, nevertheless, have only 2 pairs of spermathecae. Spencer (1893) describes *Anisochaeta* species from Victoria, several having 5 pairs of spermathecae, but all differ from *A. lavatiolacuna* at least with regards their genital markings.

Etymology. *Lavatio-lacuna*: wash-pool.

Distribution and habitat. Washpool State Forest (see *A. aemula, A. flava, A. garilarsoni*).

Anisochaeta liberalis n.sp.

Fig. 17

Material examined. HOLOTYPE: AM W24479, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.33, (P1), same details as H (mature, dissected); AM W24480, (P2), same details as H (mature); ANIC RB.98.2.34, (P3), same details as H (posterior amputee mature); AM W24481, (P4), same details as H (mature); ANIC RB.98.2.35, (P5), same details as H (posterior amputee mature); AM W24482, (P6) same details as H (posterior amputee mature).

External features. Lengths (mm): 150 (H), 165+ (P1), 130 (P2), 140 (P4). Width: about 5 mm. Segments: 115 (H), 122+ (P1), 123 (P2). Colour: uniform beige in alcohol (no mid-dorsal line), clitellum brick red. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: most of 13–17. Dorsal pores: small in 3/4, open from 4/5 (not on clitellum). Setae: 24 on 12, about 32 on 20, about 30 on tail. Nephropores: not found. Spermathecal pores: large within tumid lips in 7/8/9 in *b-c* lines. Female pores: on 14, paired or (P4) single. Male pores: on 18 on large opposed mounds approximately in *a-b,c* lines. Genital markings: irregularly outlined and asymmetrically paired mostly presetal papillae in *a-b,c* lines on 9 (often), 10 and 11 (always) and 12 (occasionally); two pairs of small discs near male porophores: one pair just anterolateral on 18, other pair posterolateral in 18/19; sunken arcs span both pairs of discs above and below the male porophores.

Internal anatomy. Septa: 9/10–12/13 with some thickening. Gizzard: large muscular cone in 5 but displaced to occupy 7–8, preceded by large crop. Oesophagus: not especially dilated (calciferous glands absent). Nephridia: avesiculate meroic, finely tufted in 5–6, then form parietal bands of numerous discrete tubules. Vascularization: dorsal vessel single; hearts 10–12 from supra-oesophageal vessel in 9–13. Spermathecae: two pairs in 8 and 9, saccular finely furrowed ampulla on tapering duct with medium sized diverticulum ectally. Male organs: holandric, seminal vesicles in 9 and 12; testes and funnels in 10 and 11. Ovaries: as delicate sheets in 13; small paired ovisacs in 14. Prostates: tubuloracemose in 18–20, duct narrow; penial setae absent. Intestine: origin 16 (deflects septum 15/16 anteriorly); deep T-shaped typhlosole develops from 19; gut contents fine colloidal soil and a few grits.

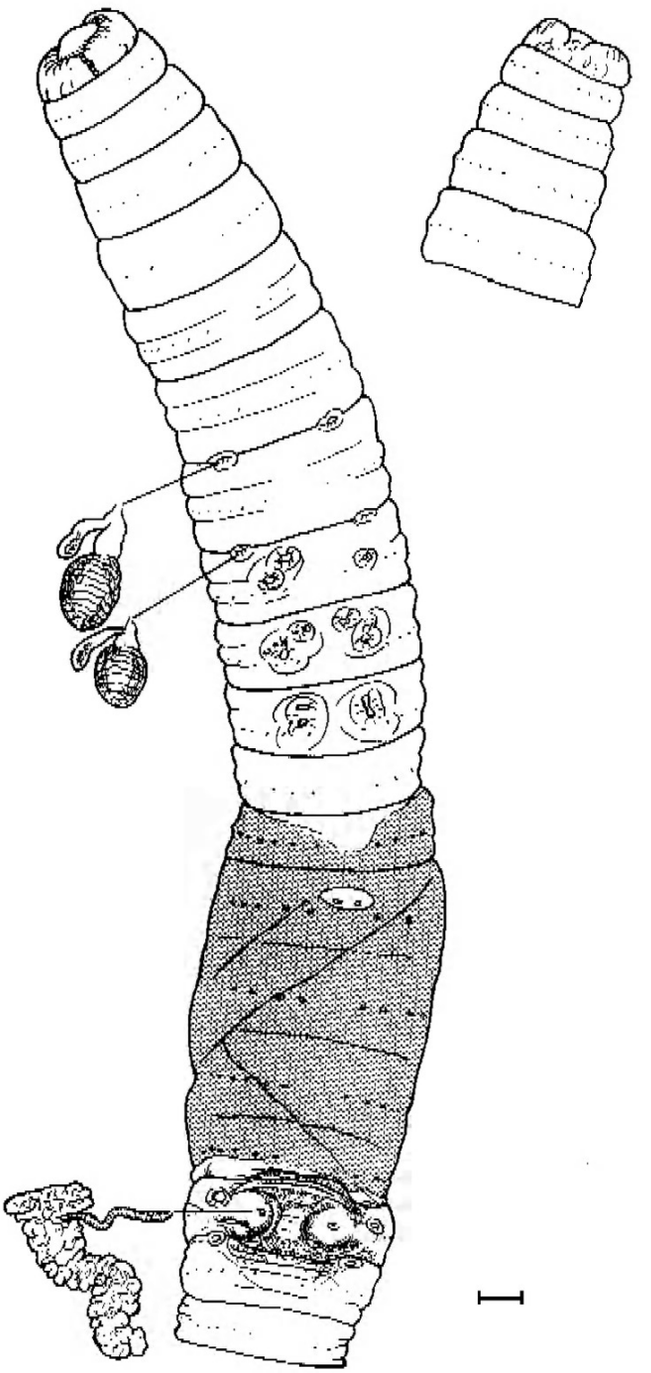

Figure 17. *Anisochaeta liberalis* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–20.

Remarks. *Anisochaeta liberalis* compares with *A. rodwayi* that also has 2 pairs of spermathecae and lacks calciferous glands. Notable differences in the latter species are in the distribution of the genital markings—both more regularly paired and more ventral spots on 10, 11, 16, 17 and 19–21,22, the gizzard soft, and conspicuous dilations of the oesophagus in 10–13. Boardman (1943: 173–174) described specimens of *A. rodwayi* that have an additional pair of seminal vesicles in 10.

Distinctive characters of *A. liberalis* are the freely arranged genital markings in anterior segments (9–12), the opposed male porophores and the T-shaped typhlosole.

Etymology. *Liberalis*: handsome genital markings, freely or liberally distributed.

Distribution and habitat. Tree Fern Valley, New England National Park.

Anisochaeta novaeanglica n.sp.

Fig. 18

Material examined. HOLOTYPE: AM W24457, (H), Toms Cabin, New England National Park, NSW, c. 29°30'S 152°30'E, 18.iii.1983, Ed Easton, "Jar 17 Sp 8" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.22, (P1), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, dissected); AM W24465, (P2), same details as P1 (mature, dissected); ANIC RB.98.2.23, (P3), same details as P1 (mature, dissected); AM W24469, (P4), same details as P1 (mature, posterior amputee); ANIC RB.98.2.28, (P5), same details as P1 (mature, complete).

External features. Lengths (mm): range 64–78; 64 (H), 78 (P1), 75 (P2), 65 (P3), 35+ (P4), 66 (P5). Width: 2.5–3 mm. Segments: range 95–114; 114 (H), 95 (P1), 105 (P2), 97 (P3). Colour: uniform buff in alcohol, clitellum light brown. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: 14–16 but encroaches slightly onto adjacent segments. Dorsal pores: small in 3/4, open from 4/5. Setae: about 24 throughout, tend to be less dense dorsally and not all rows regular. Nephropores: not found. Spermathecal pores: 7/8/9 in *b* lines. Female pores: paired on 14. Male pores: in 18 on slight mounds in *ab* lines. Genital markings: in 10 and 11, tetrads of discs just median to and above and below *a* setae within tumid pads that extend to setae *b* (all specimens); on 17 paired postsetal pads in *b-c* lines, conjoined by faint dark band (H, P1, P4) or dark patches only (P3, P5); small papillae sometimes present lateral to male pores (P1, P2, P3, P5); on 19 paired presetal dark patches below male pores (all specimens).

Internal anatomy. Septa: 10/11–12/13 slightly thickened. Gizzard: in 5 as large muscular barrel that occupies 7–9. Oesophagus: increasingly dilated in 9–13 with internal lamellae but not constituting calciferous glands, valvular in 15. Nephridia: avesiculate meroic, large in 5–7 but not tufted; equatorial bands of about twenty small tubules per side in midbody. Vascularization: dorsal vessel single; hearts 10–12 connected to weak supra-oesophageal vessel. Spermathecae: paired in 8 and 9, ampulla saccular on short duct with single diverticulum. Male organs: holandric, seminal vesicles racemose in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: palmate in 13; ovisacs present in 14. Prostates: tubuloracemose in 18–20, penial setae absent. Intestine: from 16; deep lamellar typhlosole develops from 18 or 19; gut contents loamy soil.

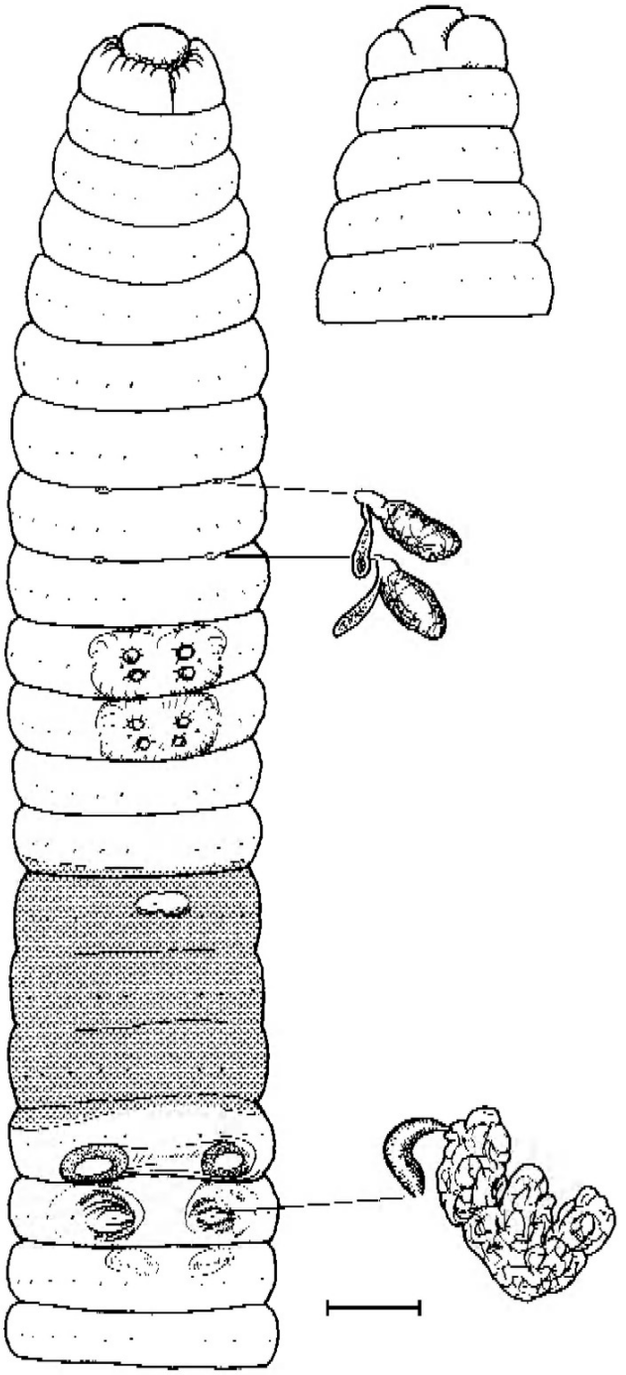

Figure 18. *Anisochaeta novaeanglica* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18–20.

Remarks. *Anisochaeta novaeanglica* is comparable with *A. curtisi* (Jamieson & Wampler, 1979) from Blackall Range and Lamington Plateau, southeastern Queensland, that was placed in a *cormieri* species-group characterized by absence

of calciferous glands (Jamieson & Wampler, 1979: 640). *Anisochaeta curtisi* was differentiated from the only other member of this group then known to have a tetrad of pore-like markings in 10 (that is *A. wiburdi*), by its having these far median to setae *a* (Jamieson & Wampler, 1979: 647). *Anisochaeta novaeanglica*, then, is differentiated from *A. curtisi* by having these markings wider, just median to setae *a*, and from *A. wiburdi* by having these markings narrower than *ab* lines (see also *A. ima*). *Anisochaeta novaeanglica* further differs from both these species by having lighter pigmentation (although preservation may cause bleaching), diverticula which do not extend distally as far as the ampullae, and the presence of a typhlosole. The importance of this latter character is uncertain as a typhlosole may be present or absent in varieties of some species (e.g., *A. bulla*).

Etymology. *Novae-anglica*: of New England.

Distribution and habitat. New England National Park, northeastern NSW, found in association with several other congeneric species.

Anisochaeta palustris n.sp.

Fig. 19

Material examined. HOLOTYPE: AM W24451, (H), Edwards Swamp, c. 500 m west of Junction Pools [sic], north bank of Barrington River, NSW, c. 31°59'S 151°45'E, ?15.iii.1983, Ed Easton, "Jar 11 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.16, (P1), same details as H (mature, dissected); AM W24552, (P2), same details as H (weakly clitellate mature, dissected); ANIC RB.98.2.17, (P3) same details as H (weakly clitellate mature, dissected); (original sample contained several immature specimens that possibly belong to several species). AM W24453, (P5–P8), 200 m east of Junction Holes, 5 m above Barrington River, NSW, c. 31°59'S 151°45'E, 15.iii.1983, Ed Easton, "Jar 7 Sp 8" (five specimens that superficially agree, 4 matures, one clitellate, three aclitellate, one damaged, and one immature).

External features. Body circular in section. Lengths (mm): 55 (H), 50 (P1), 40 (P2, P3). Width: 1–2 mm. Segments: 90 (H), 98 (P1). Colour: pale unpigmented in alcohol, clitellum orange. Prostomium: closed epilobous; peristomium ventrally cleft. Clitellum: ½13 to ½17. Dorsal pores: small dot in 3/4, open from 4/5. Setae: 16 on 12, 16–18 on 20, 16–20 on tail. Nephropores: not found. Spermathecal pores: within tumid lips in 7/8/9 in *ab* but closer to *a* lines. Female pore: single on 14. Male pores: on 18 near setal *a* lines on slight mounds within sunken field that extends from setal arcs of 17 and 19 as wide as *b* lines. Genital markings: in 10 and 11, paired presetal discs in *ab* lines, (in H with small ancillary disc median and just superior to those in 10); small papillae at edges of male field in 17/18 and 18/19, single mid-ventral in 17/18 and closely paired mid-ventral in 18/19 (in all specimens except P2, P3 which have only preclitellar markings).

Internal anatomy. Septa: none especially thickened. Gizzard: in 5, small muscular, elongate and not much wider than pharynx. Oesophagus: narrow except for 13 and 14 which are dilated with internal lamellae (= two annular

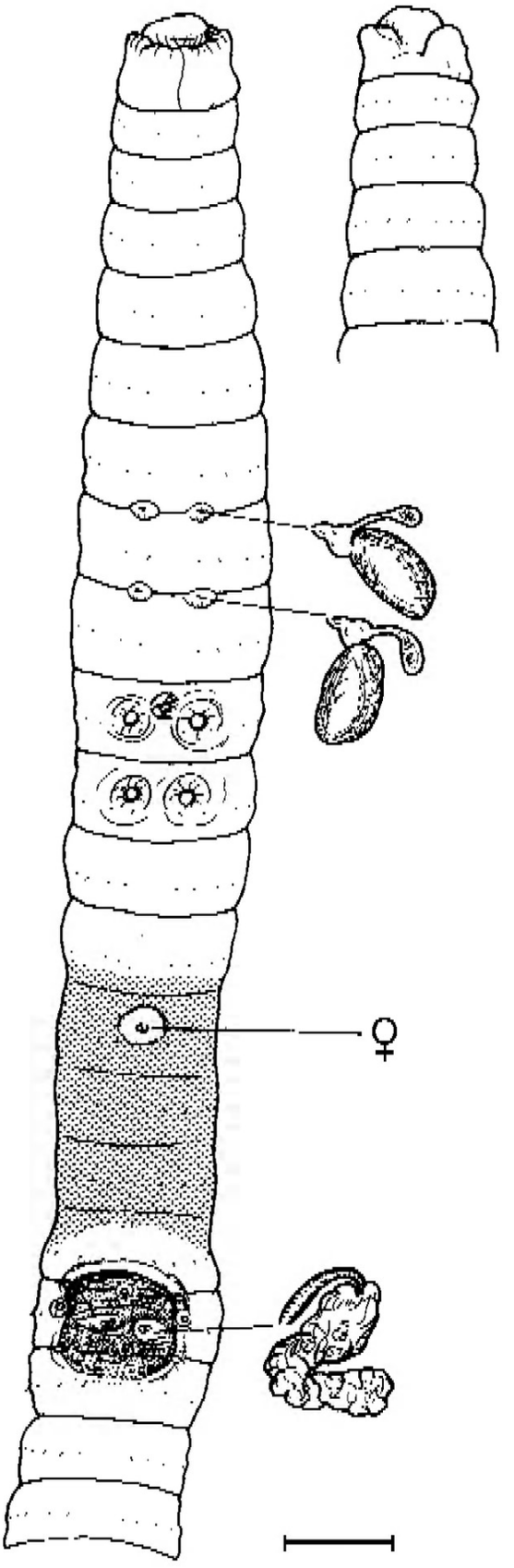

Figure 19. *Anisochaeta palustris* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18–19.

calciferous glands); narrow in 15 to ½16 (= valve). Nephridia: avesiculate meroic, equatorial bands of numerous tubules, large in 5–8 but not definitely tufted, smaller in midbody. Vascularization: dorsal vessel single onto pharyngeal mass in 4; hearts large in 10–12. Spermathecae: paired in 8 and 9, turgid orange ampulla saccular on short duct which is dilated midlength where joined by single medium sized diverticulum. Male organs: holandric, seminal vesicles in 9 and 12, iridescent testes and funnels in 10 and 11. Ovaries: palmate with numerous strings in 13; ovisacs paired in 14. Prostates: tubuloracemose in 18–19, penial setae absent. Intestine: from ½16; typhlosole absent; gut contents woody organic debris.

Remarks. *Anisochaeta palustris* has 2 pairs of spermathecae in *ab* lines and lacks extramural calciferous glands although the oesophagus has annular glands in 13 and 14 (cf. those in 11 and 12 in *A. filix*). It is unique in the arrangement of genital markings: large paired discs presetal in 10, 11 and insunk male field often with regularly arranged small papillae. The large spermathecal pores and preclitellar genital markings are reminiscent of those in *A. ancisa*, and *A. conspecta* which are also morphologically similar. However, these two species have a few more setae, larger gizzards, and differ in their respective arrangements of posterior genital markings, as well as lacking the annular oesophageal glands in 13 and 14.

AM W24536, consisting of several specimens from 500 m east of Junction Holes, Barrington River, NSW, c. 31°59'S 151°45'E, 15.iii.1983, Ed Easton, "Jar 8 Sp 8", resemble *A. palustris* superficially but the one dissected had five pairs of extramural calciferous glands in 10–14 so is not conspecific.

Etymology. *Palustris*: from the swamp.

Distribution and habitat. Edwards Swamp, Barrington River, from tussock grass.

Anisochaeta paucula n.sp.

Fig. 20

Material examined. HOLOTYPE: AM W24484, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.37, (P), same details as H (mature, dissected).

External features. Lengths (mm): 38 (H), 30 (P). Width: about 1.5 mm. Segments: 83 (H), 90 (P). Colour: straw coloured in alcohol; clitellum buff. Prostomium: tapering epilobous; peristomium ventrally cleft. Clitellum: ½13 to ½17. Dorsal pores: from 5/6. Setae: about 14 on 12 and on 20, 18 on tail. Nephropores: not found. Spermathecal pores: in 7/8/9 in or near *b* lines. Female pores: paired on 14. Male pores: small on 18 at centres of small circles in ab. Genital markings: (H, P) small paired presetal discs on 10 in *ab*, on 19 centred in *a* and on 20 just median of *a* lines.

Internal anatomy. Septa: 7/8–12/13 slightly thickened. Gizzard: in 5, muscular compact. Oesophagus: not modified,

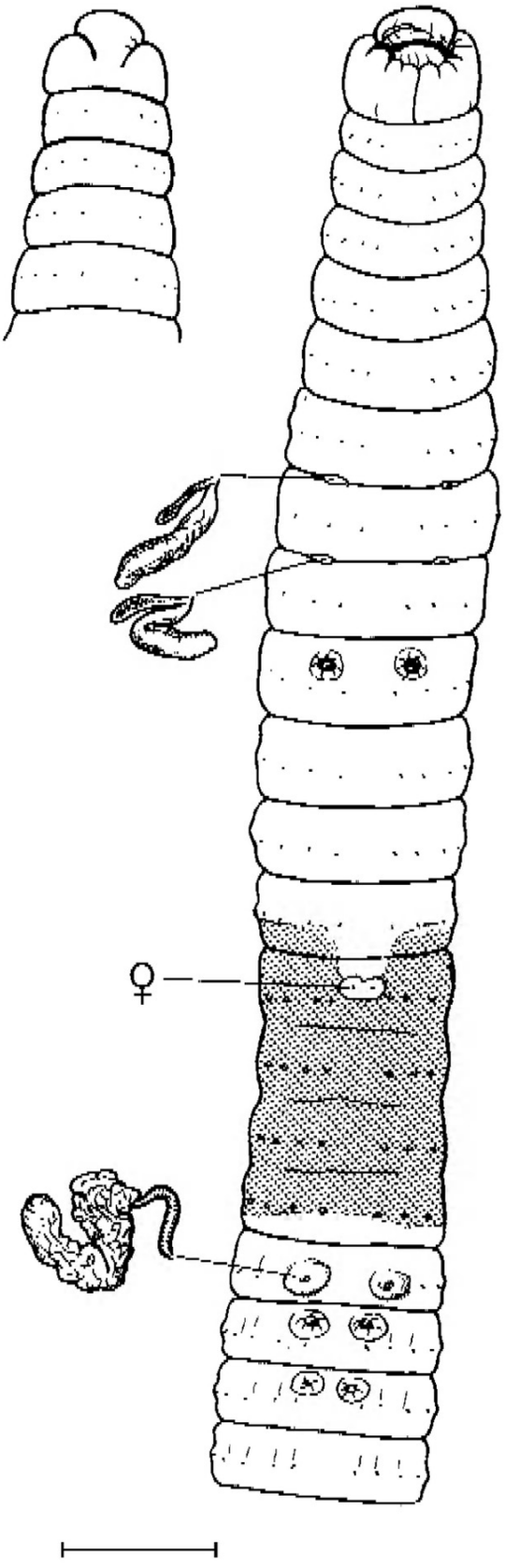

Figure 20. *Anisochaeta paucula* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18.

valvular in 15 and part of 16. Nephridia: avesiculate meroic, tufts not demonstrable, in anterior two sets of tubules per side (seen in segments 8 and 13), in intestinal segments three sets of tubules per side; bladders and funnels not found. Vascularization: dorsal vessel single; large hearts in 10–12 from weak supra-oesophageal vessel in 9–12. Spermathecae: 8 and 9, elongate ampulla tapers to duct with medium length clavate diverticulum near base. Male organs: holandric, seminal vesicles in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: long palmate in 13; small ovisacs in 14. Prostates: tubuloracemose in 18 on narrow duct, penial setae absent. Intestine: origin ½16,16; typhlosole absent; gut contents organic soil.

Remarks. *Anisochaeta paucula* is distinguished from morphologically similar species described in this paper by its small size, few setae, reduced numbers of nephridia and the distribution of its small genital markings in 10, 19 and 20.

Etymology. *Pauculus*: very few—for the reduced nephridia.

Distribution and habitat. Tree Fern Valley, New England National Park.

Anisochaeta rava n.sp.

Fig. 21

Material examined. HOLOTYPE: ANIC RB.97.5.4, (H), Bago-Maragle State Forests, NSW; Ecologically Sustainable Management Project Sample BM110, location details are given as "off De Beazevilles Rd; bearing point is 210 m E of Poison Rock Ck crossing on hillcrest—then bearing 186° for 40 m", Courabyra Sheet No. 8526-4S DGPS AMG 611318 6056240; elevation 1,115 m; shallow basalt soil with high worm activity; P.J. Ryan, 24.iv.1996, (mature, figured and dissected). PARATYPES: none.

External features. Length 75 mm. Width: 3.5–4.0 mm. Segments: 135. Colour: uniform grey in alcohol. Prostomium: tapering epilobous; peristomium ventrally cleft. Clitellum: 14 to ½17. Dorsal pores: small in 3/4, wider from 4/5. Setae: 20 on 12 and 20, about 28–30 on tail. Nephropores: not found. Spermathecal pores: in 6/7/8/9 in mid-*ab* lines. Female pores: paired on 14. Male pores: small in *ab* lines within common dumb-bell shape. Genital markings: on 9 and 10, small postsetal discs in *bc* lines, those on 10 combined with additional presetal pair (to give a wide tetrad of 88-like markings); on 16, 17 and 19, 20 mid-ventral tumid pads equatorial extending to *b* lines, some with weakly defined pore-like discs median of *a* lines.

Internal anatomy. Septa: none especially thickened. Gizzard: large in 5, muscular aubergine-shaped displaced to occupy most of length of segment 6–8. Oesophagus: dilated and white in 11–12, but calciferous glands absent. Nephridia: avesiculate meroic, tufted in 4 and 5, then reduce in size to become equatorial bands of numerous tubules; bladders and funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass; hearts in 10–12. Spermathecae: three pairs in 7–9, ampulla elongate tapering to duct with long clavate diverticulum near base. Male organs: holandric, seminal vesicles in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: palmate in 13; ovisacs not found. Prostates: bilobed racemose in 18–19, penial setae absent. Intestine: origin ½16; deep lamellar typhlosole develops from 19; gut contents reddish soil.

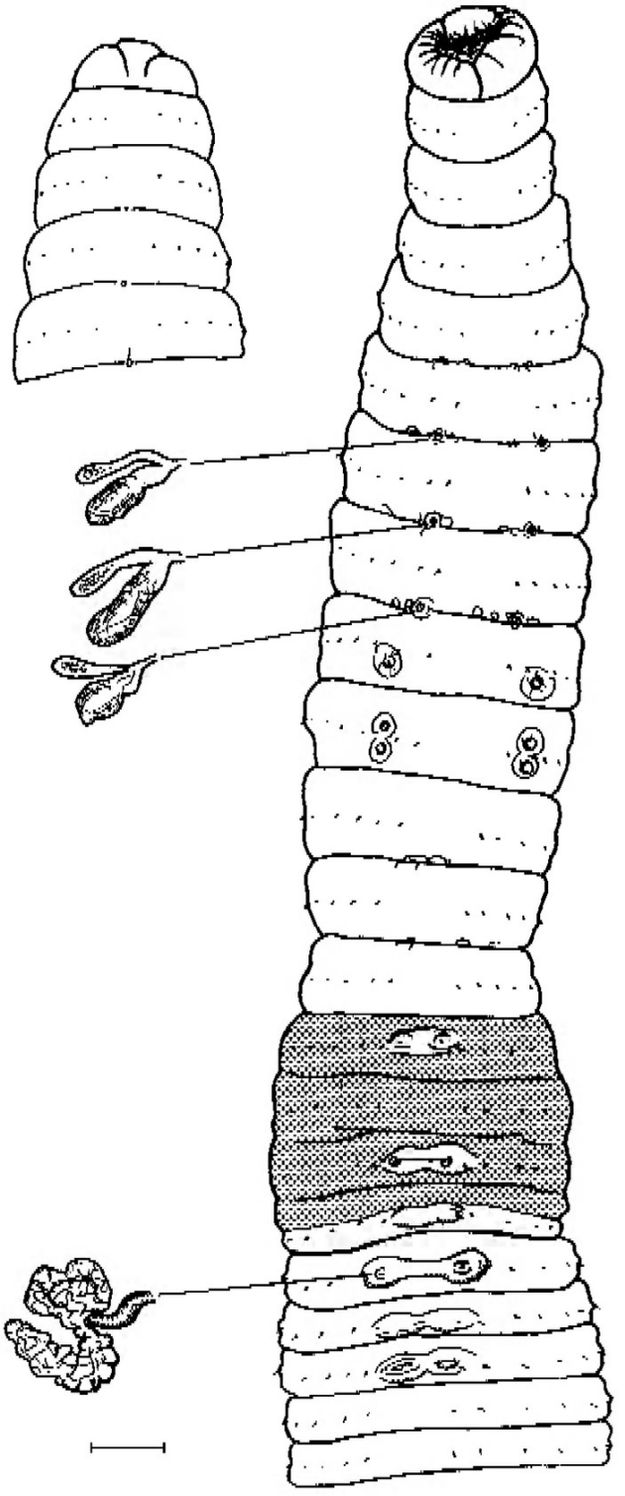

Figure 21. *Anisochaeta rava* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–19.

Remarks. *Anisochaeta rava*, with three pairs of spermathecae in *ab* lines and lacking calciferous glands, is morphologically similar to *A. celmisiae*. They are primarily distinguished

by differences in the distributions of genital markings. Markings in *A. celmisiae* are typically paired low prominences on 10 each with central pore-like disc presetal and median to *b* (sometimes extra postsetal disc present to form tetrad on 10 but still median to *b* lines rather than lateral as in *A. rava*); smooth midventral markings mostly postsetal in 17, and mostly presetal in 19; plus markings, pore-like or ridges, lateral to male pores. *Anisochaeta rava* has discs on 9 and 10, mid ventral pads on 17 and 19 and lacks markings on 18. Additionally, *A. rava* has a stronger gizzard and a typhlosole.

Etymology. *Ravus*: grey.

Distribution and habitat. Bago-Maragle State Forests are adjacent to and west of Kosciuszko National Park. These specimens were collected as part of a multi-disciplinary survey of forest soil ecosystem conducted by CSIRO, the Australian National University, and various state Forestry Departments. All fauna collections were made by Phil Ryan and Neil McKenzie (CSIRO Forestry, Canberra), and David Jacquier and Peter Leppert (CSIRO Land and Water). Further site and soil survey details can be obtained from Dr Phil Ryan. Found at the same general locality was *A. rubeospina.*

Anisochaeta rubeospina n.sp.

Fig. 22

Material examined. HOLOTYPE: ANIC RB.97.5.5, (H), Bago-Maragle State Forest; NSW, ESM Sample BM126; "2° and 250 m from track/crest", Courabyra Sheet No. 8526-4S DGPS AMG 603014 6052807; elevation 1,295 m; granodiorite soil; N.J. McKenzie, 23.v.1996, (mature, figured and dissected). PARATYPES: AM W25447, (P1), same details as H, (mature, dissected); ANIC RB.97.5.7, (P2), same details as H, (mature, dissected).

External features. Lengths (mm): 80 (H), 75 (P1), 100 (P2). Width: 4.5–5.0 mm. Segments: 132 (H), 104 (P1). Colour: anterior dorsum dark brown with distinct darker red mid-dorsal line continued to tail, otherwise pale; clitellum buff. Prostomium: tapering epilobous; peristomium ventrally cleft. Clitellum: ½13 to ½17,17. Dorsal pores: small in 3/4, wider from 4/5. Setae: about 20 on 12, about 24 on 20 and on tail. Nephropores: not found. Spermathecal pores: small in 6/7/8/9 in *a* lines. Female pores: paired on 14. Male pores: on opposed prominences in *a* lines. Genital markings: on 10 paired squarish pads, conjoined anteriorly, extending *a-c* lines with lateral slits presetally in *a-b*; midventral elliptical pads with central slit-like depressions in *aa* in 16, 17 19, in *bb* in 20, 21; paired tumid discs lateral to male porophores, one pair superior, one pair inferior, tumid between on either side. Variations in marking are: on P1 on 10 eye-like and on 18 only one pair of papillae immediately lateral to male porophores, otherwise same; P2 has no markings on 10, and longitudinal ridges without papillae lateral to male pores, otherwise same.

Internal anatomy. Septa: 8/9–12/13 slightly thickened. Gizzard: in 5, large muscular barrel with anterior flange. Oesophagus: in 10–12, three pairs of lateral calciferous pouches, each with internal lamellae. Nephridia: avesiculate meroic, tufted in 4 and 5, then reduce in size to become

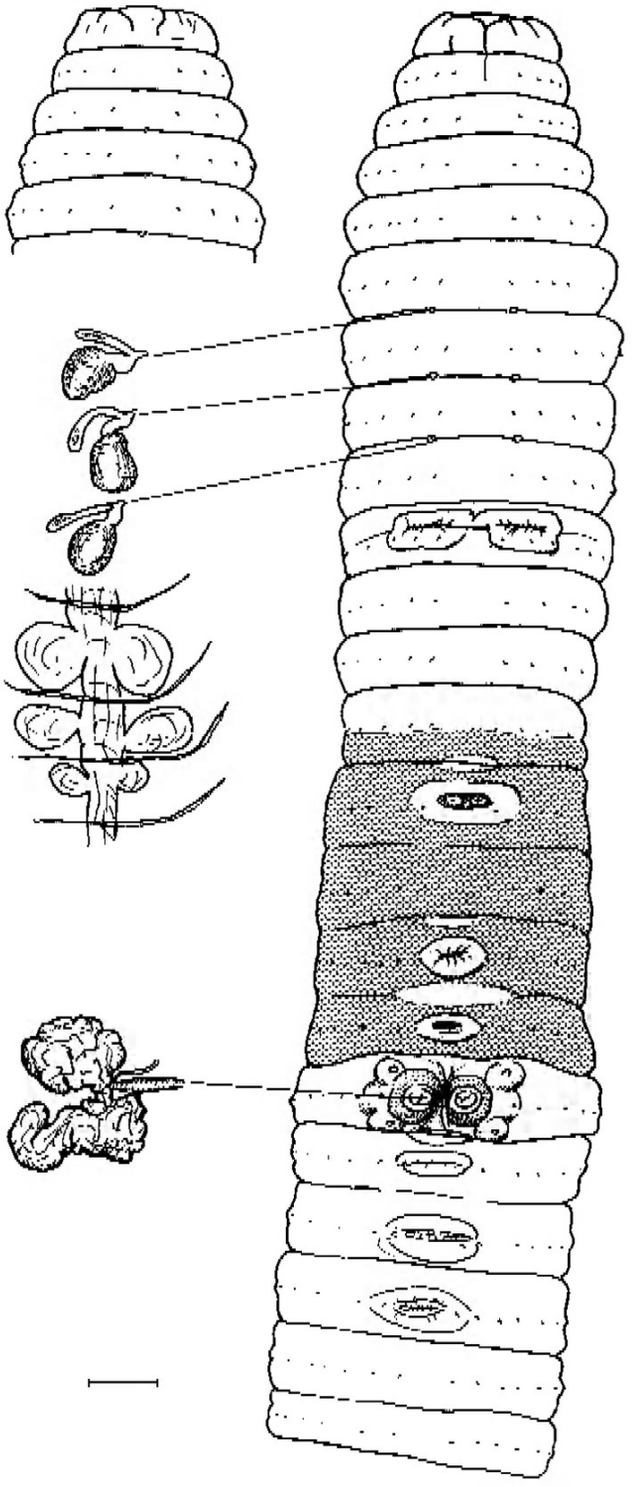

Figure 22. *Anisochaeta rubeospina* ventral view of holotype with dorsal view of prostomium, spermathecae, calciferous pouches on the oesophagus in 10–12, and lhs prostate in 18–19 with vas deferens.

equatorial bands of numerous tubules, ten or more per side; bladders and funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass; hearts in 10–12 from supra-oesophageal vessel. Spermathecae: three pairs in 7–9, saccular ampulla on narrow duct with medium length clavate diverticulum near base. Male organs: holandric, seminal vesicles in 9 and 12, testes and funnels in mucus in

10 and 11. Ovaries: small in 13; ovisacs not found. Prostates: bilobed racemose in 18–19, penial setae absent. Intestine: origin 15; typhlosole absent; gut contents organic debris and woody material.

Remarks. *Anisochaeta rubeospina* has 3 pairs of spermathecae and 3 pairs of pouch-like calciferous glands. Known species with this arrangement (*A. austrina, A. raymondiana, A. chani* and *A. hamiltoni*) all differ by having spermathecal pores in *b* lines and intestinal origin in 16 and in the distributions of their genital markings.

Etymology. *Rubeo-spina*: red spine.

Distribution and habitat. Bago-Maragle Forest, same survey project and locality as *A. rava*, but site details not available.

Anisochaeta toonumbari n.sp.

Fig. 23

Material examined. HOLOTYPE: AM W24488, (H), Toonumbar State Forest, NSW, 28°28'S 152°43'E, 27.iii.1983, Ed Easton, "Jar 34 Sp 50" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.39, (P1), same details as H (mature, dissected); AM W24489, (P2), same details as H, (mature posterior amputee, dissected); ANIC RB.98.2.40, same details as H, (mature posterior amputee); AM W24490 (P4), same details as H, (mature); ANIC RB.98.2.41 (P5), same details as H, (aclitellate mature); AM W24491, (P6), same details as H, (weakly clitellate mature); ANIC RB.98.2.42, (P7), same details as H, (mature); AM W24492, (P8–P14), same details as H, (7 specimens, one an anterior portion of a mature, six aclitellate matures plus 7 tail fragments in original sample jar). AM W24562, (P15), Richmond Range State Forest, NSW, 28°31'S 152°44'E, c. 27.iii.1983, Ed Easton, "Jar 35 Sp 31" (aclitellate mature, dissected).

External features. Pharynx everted in H. Lengths (mm): range 60–80; 80 (H), 60 (P1), 66 (P4), 80 (P6), 65 (P7), 70 (P15). Width: about 2–3 mm. Segments: 123 (H), 100 (P1). Colour: unpigmented (bleached) in alcohol; clitellum reddish. Prostomium: epilobous (P1 and other specimens); ventral cleft weak or absent. Clitellum: ½13–16 (H and P1, P2) or ½13,14 to ½16 (in P3, P4, P7). Dorsal pores: 3/4 small, open from 4/5. Setae: small and difficult to count, about 20 throughout most of body with 20–16 counted on tail. Nephropores: not found. Spermathecal pores: in 7/8/9 small pores within large lips in *b* lines. Female pores: closely paired on 14. Male pores: on tips of small eversible penes in *ab* lines on small elliptical porophores, no setae intervene. Genital markings: (in H only) on 10 and 11 large midventral sucker-like discs with tumid borders extending to *a* or *b* lines; segments 16 and 17 (postsetally), and 18 (presetally) each with two pairs of laterally conjoined discs, the outer pair large and circular in approximate line of male pores, the inner pair elongate in the midventral gap; 20–30 with paired or single markings presetally mostly in the interval *aa*. Only the markings in 11, 17 and 18 are present on the paratypes but these correspond to those found in the holotype.

Internal anatomy. Body has much opaque mucus internally. Septa: none especially thickened. Gizzard: long muscular barrel in 5 (septum 5/6 can be traced to base of gizzard). Oesophagus: not especially dilated, valvular in

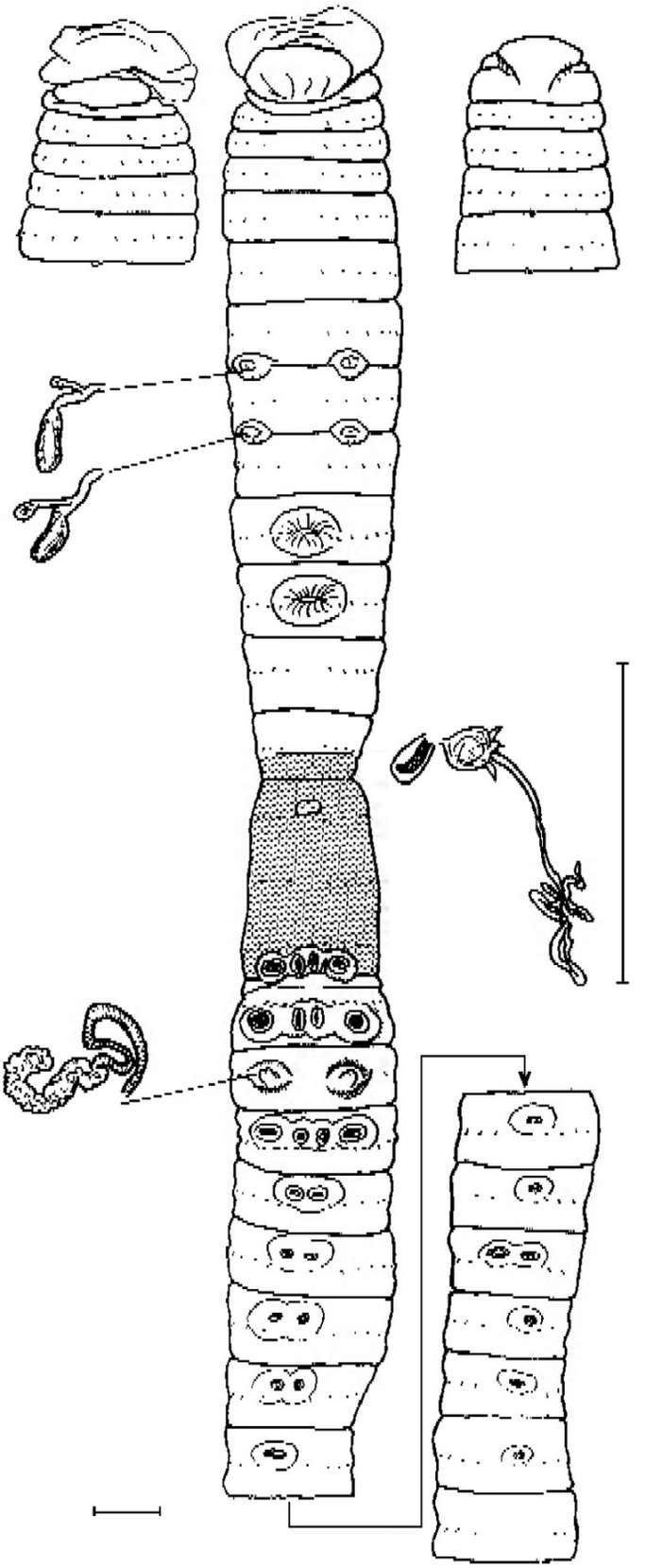

Figure 23. *Anisochaeta toonumbari* ventral view of holotype with dorsal view of prostomium of H and P1 (pharynx everted in H), spermathecae, and lhs prostate in 18–19 with long duct; also shown is enlargement of nephridium with terminal bladder near *h* or *i* seta on rhs in segment 8.

15. Nephridia: vesiculate meroic, tufted in 4 and 5, thereafter smaller tubules with intermittent bladders immediately below seta (in H small bladders seen below *a* and *c* setae in 6 and *c* seta in 7; in P1 seen near *d* and *i* setae in 7–9), after clitellar segments tubules reduce in size and number (about five or six per side) those below *a* or *b*, and *c* or *f*, and *g* or *h-i* setae usually with small sub-spherical bladders; i.e., usually with three small bladders per side; funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass in 4; large hearts in 10–12 from weak supra-oesophageal vessel in 8–12. Spermathecae: in 8 and 9, elongate ampulla on equally long duct joined near midlength or more anteriorly by medium sized diverticulum. Male organs: holandric, seminal vesicles elongate in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: thin and sheet-like with large oocytes in 13; small ovisacs in 14. Prostates: narrow tubuloracemose in 18–19 (tubular with incised gland that in section (H and P1) have narrow central duct with fine side branches), duct long and thin; penial setae absent. Intestine: origin 16; thin lamellar typhlosole develops from 19; gut contents grey sandy soil.

Remarks. *Anisochaeta toonumbari* has vesiculate meronephridia, as do *A. aemula, A. lavatiolacuna*, and *A. yabbratigris*. Postclitellar genital markings are most developed in the holotype compared to the other specimens where markings are found only in 11, 17 and 19. Those in 19 are reminiscent of, though differ from, the conjoined markings on this segment in sympatric *A. conspecta* and in *A. rodwayi*. The distinguishing features of *A. toonumbari*, in addition to the nephridial bladders, are the genital markings: sucker-like in 11, lateral in 17 and 19; the elongate, spermathecae and prostates; and the thin typhlosole.

Etymology. The species epithet is formed from the word "Toonumbar".

Distribution and habitat. Toonumbar and Richmond Range State Forest; found with *A. conspecta* at the second locality.

Anisochaeta tunicata n.sp.

Fig. 24

Material examined. HOLOTYPE: AM W24472, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, posterior amputee, figured and dissected). PARATYPES: ANIC RB.98.2.27, (P1), same details as H (mature, dissected); AM W24474, (P2), same details as H, (aclitellate subadult missing tip of tail).

External features. Lengths (mm): 70+ (H), 87 (P1), 55+ (P2). Width: about 3 mm. Segments: 109 (P1). Colour: anterior and dorsum grey-brown in alcohol with darker mid-dorsal line on paler hind-body; clitellum orange. Prostomium: wide epilobous; peristomium ventrally cleft. Clitellum: ½13 to ½17, weaker ventrally. Dorsal pores: 3/4 small, from 4/5 open. Setae: 20 throughout. Nephropores: not found. Spermathecal pores: in 7/8/9 in or near *b* lines. Female pores: closely paired on 14. Male pores: at centres of large, dark and slightly sunken patches within lateral slits covered by small flaps that hinge laterally. Genital markings: paired presetal markings in 8 (weakly in H only), 9–13 (all specimens) converging from approximate line of spermathecal pores to *a* lines posteriorly; on 18 small indistinct patches may occur anterior to male pores; on 19 paired ill-defined pads within darker patches presetal and just lateral to interval of male pores.

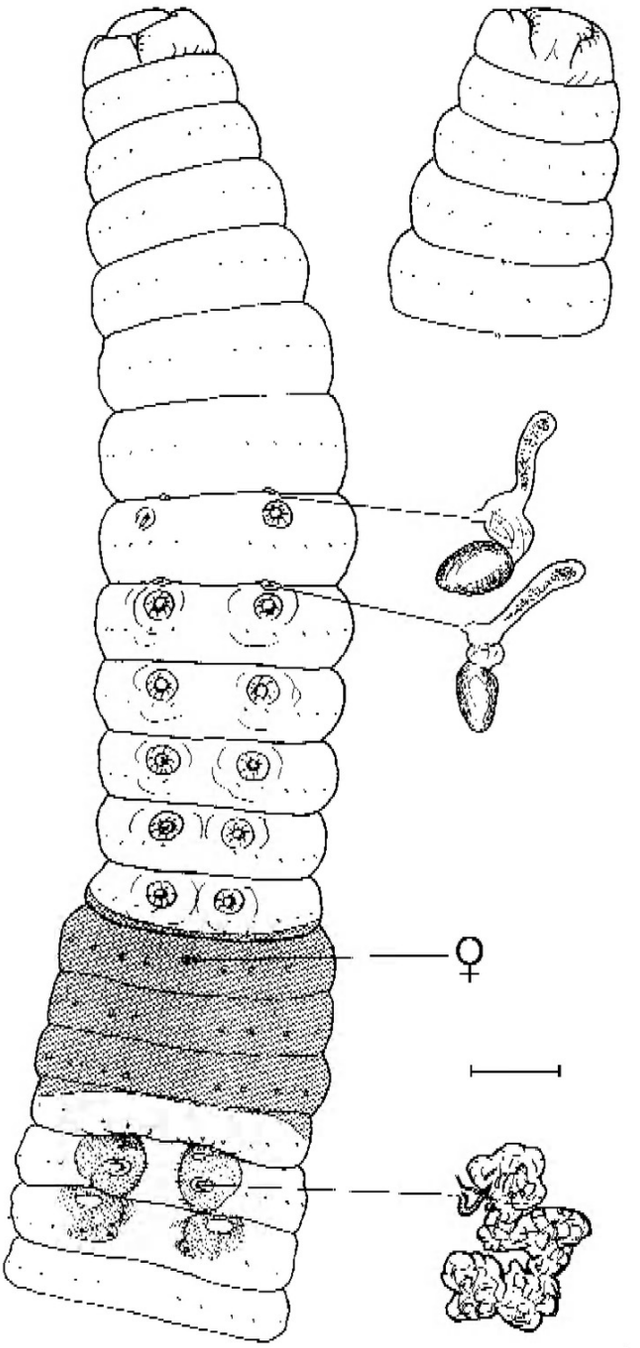

Figure 24. *Anisochaeta tunicata* ventral view of holotype with dorsal view of prostomium, spermathecae, and rhs prostate in 18–19 with vas deferens.

Internal anatomy. Septa: none thickened especially, septum 5/6 thin and displaced dorsally. Gizzard: in 5 and possibly part of 6, (septum 5/6 attaches to top third of gizzard and can only be traced, with difficulty, for about another third; septum 6/7 at base of gizzard). Oesophagus: with regular dilations 8–14, valvular in 15. Nephridia: avesiculate meroic, tufted in 5 and

6, then become bands of thick but short tubules on body wall, smaller after clitellum with approximately one or two at site of each seta except ventralmost where none seen; bladders and funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass in 4; large hearts in 10–12 from large supra-oesophageal vessel in 8,9–13. Spermathecae: 8 and 9, conical ampulla on equally long duct that is dilated in middle opposite where long diverticulum joins. Male organs: holandric, seminal vesicles in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: long palmate in 13; small ovisacs in 14. Prostates: thickly tubuloracemose in 18–19 on short duct, penial setae absent. Intestine: origin 16; deep lamellar typhlosole develops from 20; gut contents dark organic soil.

Remarks. *Anisochaeta tunicata* is morphologically similar to *A. bulla* and both species have rows of genital markings in the anterior. Although these are single and mid-ventral in *A. bulla*, it is possible that the paired markings in *A. tunicata* are analogous. Unique features of *A. tunicata*, apart from the genital markings, are the shape of the spermathecae and the flaps covering the male pores.

Etymology. *Tunicatus*: wearing a tunic—a reference to markings resembling a buttoned, double-breasted jacket.

Distribution and habitat. Tree Fern Valley, New England National Park.

Anisochaeta virgata n.sp.

Fig. 25

Material examined. HOLOTYPE: AM W24475, (H), Tree Fern Valley, New England National Park, NSW, c. 30°30'S 152°30'E, 17.iii.1983, Ed Easton, "Jar 15 Sp 31" (mature, slightly damaged dorsally in 20–21, figured and dissected). PARATYPE: ANIC RB.98.2.30, (P), same details as H (subadult, dissected).

External features. Lengths (mm): 80 (H), 50 (P). Width: 4 mm. Segments: 88 (H and P). Colour: anterior dorsum dark iridescent gun-metal grey, postclitellum dark but setal rings paler to give distinct transverse striped appearance, dark mid-dorsal line also present. Prostomium: open epilobous; peristomium ventrally cleft. Clitellum: ½13–16. Dorsal pores: small dot in 5/6, open from 6/7. Setae: about 30 on 12 and 20, about 48 on tail. Nephropores: not found. Spermathecal pores: widely paired in 7/8/9 in *g* lines. Female pores: paired on 14. Male pores: widely paired on 18 as lateral lipped openings at centres of concentrically wrinkled large pads surrounded by a white rim almost filling segment in *b-e* lines (in P male pores are simple in *cd* lines); no setae intervene. Genital markings: on 10, paired presetal discs in *d* lines (H and P); paired sunken pits with smooth dark discs at centre in 17 postsetally and 19 presetally in *b-e* lines within white rims (H only, P lacks these markings).

Internal anatomy. Septa: none especially thickened. Gizzard: in 5, compact muscular barrel displaced to occupy width of segment 6. Oesophagus: linear narrow, 6–14. Nephridia: avesiculate meroic, not tufted in anterior, as numerous parietal tubules; funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass; hearts large in 10–12 with connective to weak supra-oesophageal vessel. Spermathecae: paired in 8 and 9, ampulla pear-shaped on short duct with long diverticulum ectally. Male organs: holandric, seminal vesicles in 9 and, larger, in 12, iridescent testes and funnels in 10 and 11. Ovaries: palmate with numerous strings in 13; ovisacs paired in 14. Prostates: widely tubuloracemose or racemose in 18–20, penial setae absent. Intestine: suddenly in 15; typhlosole absent; gut contents at anterior of large dead leaf fragments and organic matter, further back this material is compressed. (The paratype agrees internally except that the reproductive organs are less developed).

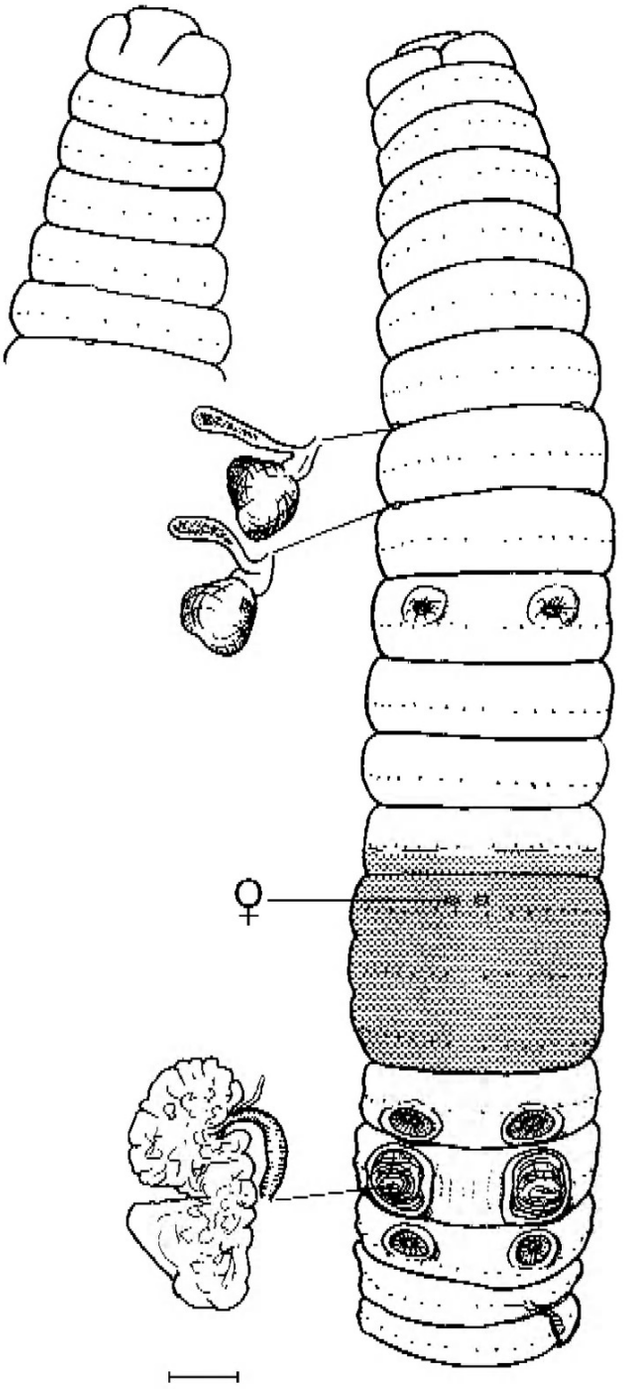

Figure 25. *Anisochaeta virgata* ventral view of holotype with dorsal view of prostomium, spermathecae, and lhs prostate in 18–20 with vas deferens.

Remarks. *Anisochaeta virgata* is similar to *A. aemula* and *A. garilarsoni* (e.g., quadrithecal, lacking calciferous glands and having similar shaped spermathecae and prostates). Major differences in *A. virgata* are more lateral spermathecal pores, and exact arrangements of genital markings. Moreover, *A. aemula* has lateral nephridial vesicles, and glands associated with its markings in 17 and 19; while *A. garilarsoni* has fewer setae, and flaps associated with its male pores. The wide spermathecal pores and distinctive male field are unique characters of *A. virgata*.

Etymology. *Virgatus*: striped.

Distribution and habitat. Tree Fern Valley, New England National Park.

Anisochaeta yabbratigris n.sp.

Fig. 26

Material examined. HOLOTYPE: AM W24554, (H), Yabbra State Forest, NSW, c. 28°30'S 152°40'E, collected 15.iii.1992, M. Gray & D. Charley, pit trap sample set 27.ii.1992, "2BG Trap 13 FN 5012" (mature, figured and dissected). PARATYPES: ANIC RB.98.2.57, (P1), same location as H but "Trap 15 FN 5104" (mature, dissected); AM W24555, (P2), same details as H, but collected 2.iv.1992, set 15.iii.1992 "Trap 14, FN5113" (mature).

External features. Lengths (mm): 58 (H), 52 (P1), 50 (P2). Width: about 2 mm. Segments: 80 (H, P1, P2). Colour: anterior dorsum red-brown with darker mid-dorsal line that persists to tail, pigment lighter after clitellum but setal arc pale to give distinct striped appearance; clitellum buff. Prostomium: open epilobous; ventrally cleft. Clitellum: ½13–16. Dorsal pores: from 5/6. Setae: small, about 24 on 12 and 20, increasing to 30 in midbody and up to 40 on tail. Nephropores: not found. Spermathecal pores: in 6/7/8/9 small pores lateral in *f* lines. Female pore: single on 14. Male pores: widely paired on low mounds that extend from *c* to *e* lines; setae *a* and *b* retained between pores. Genital markings: small presetal discs: on 7 and 8 in *bc* lines and on 17 and 19 *b,c-d* lines (in all specimens, although in P2 that on 19 on rhs only).

Internal anatomy. Septa: none especially thickened. Gizzard: weakly muscular in 5 (barely wider than pharynx). Oesophagus: pale and thin 6–12, dilated and vascularized 13 and 14 but not calciferous, valvular in 15. Nephridia: vesiculate meroic, not tufted, several (about ten per side) small tubules at anterior and equator of segments, with three or four small rounded bladders near some setae (i.e., associated with every second or third equatorial neprhidium); reduced in size after clitellum. Vascularization: dorsal vessel single; small hearts in 10–12 from weak supra-oesophageal vessel. Spermathecae: in 7, 8 and 9, spherical or oval ampulla on equally long duct joined ectally by medium sized diverticulum. Male organs: holandric, seminal vesicles in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: fan-shaped in 13; small ovisacs in 14. Prostates: racemose with three lobes in 18–19, duct branches externally to each lobe; penial setae absent. Intestine: origin 16; typhlosole absent; gut contents organic debris.

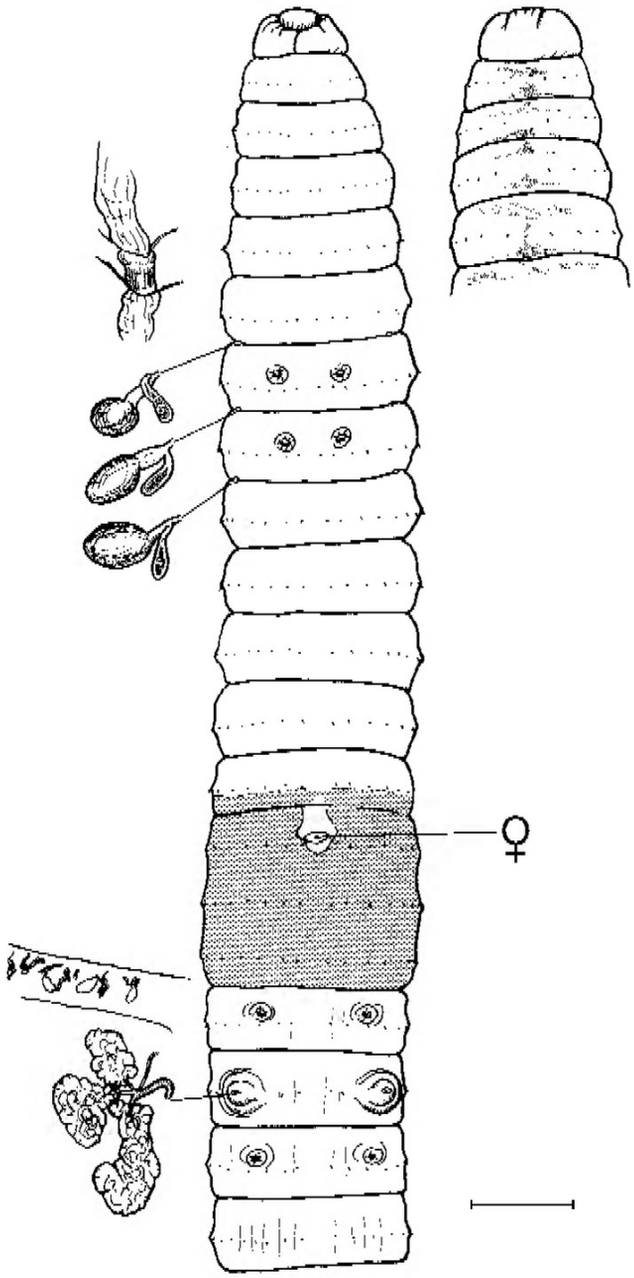

Figure 26. *Anisochaeta yabbratigris* ventral view of holotype with dorsal view of prostomium, weak gizzard in 5, spermathecae, nephridial arrangement on lhs in 17, and lhs trilobed prostate in 18–19 with vas deferens.

Remarks. *Anisochaeta yabbratigris* has three pairs of widely paired spermathecal pores, lacks calciferous glands and has setae median to male pores. These characters are shared with *A. gracilis*, although this species is larger, has different arrangement of male pores and markings, has paired female pores and an intestinal origin in 17, amongst other differences. Distinctive characters of *A. yabbratigris* are the genital markings, vesiculate meronephridia and trilobed prostates.

Setae between the male pores and clitellum restricted to 14–16 are key characters of *Propheretima*. Because the clitellum in *A. yabbratigris* extends ½13–16, it does not qualify for that genus.

Etymology. The name is for a worm from Yabbra State Forest striped like a tiger.

Distribution and habitat. Yabbra State Forest, sympatric with *A. angusticlavia* and *A. calpetana*, as well as other (currently undescribed) congeneric species.

Genus *Propheretima* Jamieson, 1995

Propheretima Jamieson, 1995: 589–590; Blakemore, 1997b: 1839–1843, table 3.

Diagnosis (after Jamieson, 1995: 589). Perichaetine; setae numerous per segment; a few present between the male pores. Female pore single, midvental (or sometimes, *P. hugalli*, paired but very close together). Clitellum (presumably at maximum development), limited to 14–16. Gizzard in 5 (or "virtually vestigial" between 4–6). Calciferous glands present or absent. Intestinal caeca absent. Testes in 10 and 11. (Meroic. Prostates tubuloracemose or racemose).

Type species. *Propheretima eungella* Jamieson, 1995: 590–592, figs. 16,17, from Queensland., (probably a junior synonym of *Perichaeta newcombei* Beddard, 1887—see Blakemore, 1994: 506–510, fig. 2.26; 1997b: 1839–1843, fig. 18).

Distribution. Queensland, northeastern NSW.

Remarks. For a review of *Propheretima*, see Blakemore (1997b). The combination of characters distinguishing this genus from *Spenceriella* (now *Anisochaeta*) was stated by Jamieson (1995:590) to be: presence of setae between the male pores, restriction of clitellum to 14–16 and, "typically", a single female pore. However, several *Anisochaeta* species are known to have setae between the male pores (e.g., *A. gracilis* and *A. yabbratigris* in the current account), as well as *A. notabilis* (Spencer, 1900)—the type-species of *Spenceriella*, see Blakemore (1997b: 1839), *Anisochaeta conondalei* (Jamieson, 1995) and, possibly, *A. indissimilis* (Fletcher, 1889) and *A. illidgei* (Spencer, 1900). Single female pores were found in most, but not all, species formerly placed in *Gemascolex* (now *Anisochaeta*) and are characteristic of several other *Anisochaeta* species (including *A. conondalei*), or they may vary intraspecifically from single to paired (as noted for *A. ancisa, A. calvasaxea, A. lavatiolacuna, A. liberalis* above). Thus the only character remaining for qualification in *Propheretima* is having the clitellum (presumably when the animal is in full breeding condition) restricted to 14–16. However, the exact extent of the clitellum varies intraspecifically, depending on the physiological state of the specimen, on the method of preservation, and on the clarity with which its limits can be defined. Moreover, having the clitellum restricted to, or best developed in 14–16 is found in several *Anisochaeta* species, not least *A. notabilis*, (see Spencer, 1900: 57, fig. 76) as well as *A. conondalei* (see Jamieson, 1995: 594, fig. 20).

Unless further justification for its separation can be found, *Propheretima* should be synonymized in *Anisochaeta*. Nevertheless, the following species is tentatively referred to *Propheretima*, rather than *Anisochaeta*, pending further investigation.

Propheretima monsmonitionis n.sp.

Fig. 27

Material examined. HOLOTYPE: AM W24500, (H), Summit Path, Mt Warning, NSW, c. 28°24'S 153°16'E, 730 m, 26.iii.1992, Ed Easton, "Jar 32 Sp 8" (weakly clitellate mature, figured and dissected). PARATYPES: none.

External features. Length 98 mm. Width: about 2.5 mm. Segments: 106. Colour: anterior dorsum dark grey, after clitellum brown to flanks with pale intersegments, ventrum pale; clitellum buff. Prostomium: widely open epilobous, almost tanylobous; peristomium ventrally cleft. Clitellum: weak defined, 14–16. Dorsal pores: small in 4/5, open from 5/6. Setae: small and dark, about 30 on 12 and 20, increasing to about 50 on tail. Nephropores: not found. Spermathecal pores: small in 7/8/9, just lateral of *d* lines. Female pore: single on 14. Male pores: paired in *c* lines on small mounds; setae *a* retained between pores. Genital markings: small presetal discs on 7–13, 17, 19–22, plus a postsetal pair in 17, mainly paired but irregularly distributed (see figure); small ancillary discs just anteromedian to spermathecal pores on 7 and 8.

Internal anatomy. Septa: none especially thickened. Gizzard: weakly muscular in 5 (barely wider than non-muscular pharynx in 4 and oesophagus in 6). Oesophagus: increasingly dilated in 6–10, in 11–13 paired lateral pouches form sessile calciferous glands with internal rugae; narrower 14–15. Nephridia: avesiculate meroic, dense tubules in 5 resemble tufts, then spread more laterally but still with dense clusters ventrally (at least in 9, 12–16), after clitellum smaller, diffuse, lateral tubules only; funnels not found. Vascularization: dorsal vessel single onto pharyngeal mass in 4; small hearts in 10–12 from weak supra-oesophageal vessel in 10–13 that also supplies calciferous glands. Spermathecae: in 8 and 9, small spherical ampulla tapers to duct with equally long diverticulum ectally. Male organs: holandric, seminal vesicles racemose in 9 and 12, iridescent testes and funnels free in 10 and 11. Ovaries: palmate in 13; small ovisacs in 14. Prostates: flattened racemose in 18, duct curved; penial setae absent (but can see setae *a* and pores of *b* median to where ducts enter body wall). Intestine: origin 16; typhlosole absent; gut contents organic matter.

Remarks. Within *Propheretima* as currently defined, *P. monsmonitionis* is perhaps closest morphologically to *P. newcombei* (Beddard, 1887) differing, at least, on the distribution of genital markings, which, although numerous, are not mid-ventral at any locus in the current species. *Propheretima monsmonitionis* differs from *Anisochaeta* species in the current account that have 2 pairs of spermathecae and 3 pairs of calciferous glands, i.e., *A. australis* and *A. tenax*, by having a weaker gizzard, spermathecal pores more lateral, and more extensive genital markings.

Etymology. After Mt Warning locality.

Distribution and habitat. Mt Warning, found with several other species including *Fletcherodrilus fasciatus* (Fletcher, 1890) (specimen AM W24494 ex "Jar 31, Sp 22"), *Digaster*

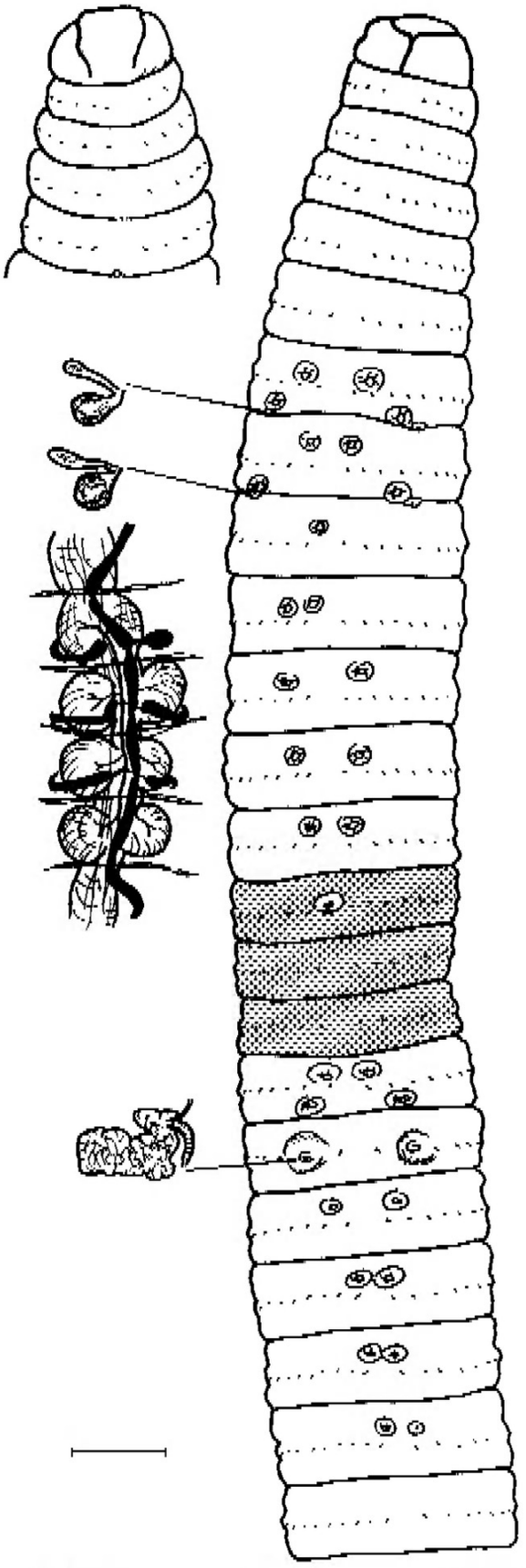

Figure 27. *Propheretima monsmonitionis* ventral view of holotype with dorsal view of prostomium, spermathecae, oesophagus in 9–14 showing vascularization and three pairs of lateral calciferous pouches in 11–13, and lhs prostate in 18.

lamingtonensis Michaelsen, 1916 (specimens AM W24496 ex "Jar 31, Sp 19"); various undescribed *Propheretima* or *Anisochaeta* spp. different to *P. monsmonitionis* (AM W24501, AM W24502 ex "Jar 30, Sp 31"); *Digaster* n.sp. and *Heteroporodrilus* n.sp. Species of these latter two genera will be reported on in a forthcoming paper (Blakemore, in prep.).

Discussion

"It is a matter for comment that the native forms recorded belong, without exception, to the genus *Megascolex* [= *Anisochaeta*], despite the fact that the material examined represents the fruits of much intensive collecting." This observation by Boardman (1943: 168) in introduction to his study of earthworms from the Jenolan Caves region of NSW is pertinent to the findings of the current study. The present samples were mostly from northeast NSW, yet the majority of specimens also belong in *Anisochaeta*. Much of the material examined herein was generated from the survey conducted by Ed Easton during March–May, 1983. Although primarily sorted by him into morpho-species, a single sample of 35 mature and 35 juvenile specimens: "Jar 15 Sp 31" from "Face Fern Valley" (most likely a transcription error for Tree Fern Valley), New England National Park, consisted of ten *Anisochaeta* taxa, nine of these known only from this location, as listed under the account of *A. ancisa* above. This indicates the exceptional diversity and endemicity of native earthworms in this region of NSW. Unfortunately, no details of Easton's collecting methods are available and it is not known whether or not he also found exotic species. However, the material from other studies in the New England region reported here (e.g., Washpool and Yabbra forests) that were previously sorted only to group, did not contain exotic species. In contrast, the more populated Blue Mountains region commonly yields exotic species along with natives in samples (see Fletcher's accounts; Michaelsen, 1907a; Boardman, 1943). Because the region around Sydney has generally been more intensively researched, its importance as a centre of endemicity tends to be over emphasized.

While our knowledge of the diversity and distribution of Australian earthworms, not least of the genus *Anisochaeta* in NSW, is far from complete, clear patterns are emerging. The native fauna of Australia comprises approximately 350 described species in 30 genera. *Anisochaeta* appears particularly speciose with around 100 taxa now known, 50 of these from NSW, yet several species are still not fully resolved and many more undoubtedly await discovery and description. Although most *Anisochaeta* spp. have restricted distributions, reports indicate some have acquired greater ranges via fluvial or human-mediated transportation. Thus, *A. exigua murrayana* occurs from the Riverina region of NSW and Victoria to near the mouth of the Murray River in South Australia; *A. tenax* from Sydney has been reported by Michaelsen (1900) from the Marquesas Islands; *A. macleayi* appears widespread in NSW (Blakemore & Elton, 1994); while *A. sebastiani* was described from Queensland, NSW and Tasmania. Another species, *A. dorsalis* (Fletcher, 1887b), is particularly widespread in Victoria and South Australia as well as in Tasmania (Blakemore, in. prep.).

The difficulties with identifying earthworms when the full extent of the fauna is relatively poorly known, frequently leads to misidentification. Often new native species are ascribed to the morphologically closest classical taxon, falsely extending its frequency and distribution beyond the probable ranges. Exotic species have frequently been similarly confused, for example, *Lumbricus terrestris* Linnaeus 1758 has, in the past, attracted many unverified reports (see Blakemore, 1997a). Undocumented in the current paper are the many samples in the Australian Museums Easton collection labelled "*Megascolex* cf. *monticola*". My preliminary inspection of batches of these (samples between AM W20775 and AM W24357) revealed that they comprised several species, none of which may actually be *A. monticola*. The task of describing these specimens is left to another day.

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