

# New species and records of earthworms (Oligochaeta: Megascolecidae) from Queensland's Scenic Rim

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<https://doi.org/10.17082/j.2204-1478.65.2024.2024-06>

Citation: Dyne, G.R. (2024). New species and records of earthworms (Oligochaeta: Megascolecidae) from Queensland's Scenic Rim. *Memoirs of the Queensland Museum | Nature* 65: 124–145. Brisbane. ISSN 2204-1478 (Online) ISSN 0079-8835 (Print). Accepted: 22 November 2024. Published online: 16 December 2024.

**Keywords:**

earthworms | *Heteroporodrilus* | *Spenceriella* | *Digaster* | endemism | species richness | taxonomy.

## ABSTRACT

The Scenic Rim of south-eastern Queensland, comprising the weathered remnants of Cenozoic volcanic activity, is an integral part of the UNESCO-listed Gondwana Rainforests of Australia World Heritage Area. New earthworm species described here add to our knowledge of the invertebrate component of the rich floristic and faunistic biodiversity of the region. Given the low vagility of earthworms and the fragmented nature of the Scenic Rim, it is likely that many more species are present and yet to be documented.

Widespread intraplate volcanism in south-eastern Queensland during the mid Cenozoic left a geologic legacy of variably eroded lava flows and rugged topography known locally as the Scenic Rim (Cohen 2012).

The features that extend from the Mistake Mountains to Cunningham's Gap, as well as the Moogerah Peaks, are remnants of the Main Range shield volcano (Ewart & Grenfell 1985). The Focal Peak volcano, centred on Mt Barney, produced the Mt Lindsay, Mt Glennie and Levers Plateau prominences and the Lamington Group of the Tweed shield volcano forms the Border Ranges (Ewart et al. 1987). Following progressive erosion, a rich diversity of Gondwanan floristic and faunistic elements became established on the derived soils.

The Scenic Rim forms part of a dispersed UNESCO property, the Gondwana Rainforests of Australia World Heritage Area, formerly known as the Central Eastern Rainforest Reserves of Australia. The extant vegetation of this property is regarded as a secondary centre of endemism for primitive flowering plants originating in the Early Cretaceous, a unique record of the evolutionary history of Australian rainforests dating from the Miocene that would become the precursor of modern temperate rainforests in Australia. It also contains outstanding examples of relict vertebrate as well as invertebrate faunas from ancient lineages linked to the break-up of Gondwana (Hunter 2004, Kitching et al. 2010).

Earthworms have colonised the eroded volcanics from both north and south, with subsequent speciation of isolates occurring along the length of the Scenic Rim. To date, study of the earthworm fauna of the Scenic Rim has been largely focused on the Lamington and Springbrook plateaus where 13 species (an assemblage comprised of both widespread taxa such as *Fletcherodrilus unicus* (Fletcher, 1890), as well localised endemics) are currently recognised (Jamieson 2001).

The current study augments the known fauna and includes new records of previously described taxa. Some were collected as part of the IBISCA-Queensland project, an international research program studying the spatial and temporal distribution of arthropods and their interaction with plants and other organisms (Kitching et al. 2011).

Taxonomic methodology and descriptive terms follow that of Jamieson (2001). All type material and other specimens examined are lodged in the Australian National Insect Collection (ANIC), CSIRO Black Mountain, Canberra. The use of Indigenous names for new species was informed by consultation with the Yugambah Regional Aboriginal Corporation Alliance.

## SYSTEMATICS

### Order CRASSICLITELLATA Jamieson, 1988

#### Family MEGASCOLECIDAE Rosa, 1891

#### *Heteropodrilus* Jamieson, 1970

*Heteropodrilus julgeh* sp. nov.  
(Figs. 1, 2A)

**Material:** HOLOTYPE: -27°58'S 152°21'E, Mistake Mountains, track to Sylvester's lookout in rainforest. Collector G. Dyne 12 December 1981: a single mature specimen. ANIC 76-000157.

**Etymology:** *Julgeh* denotes earthworm in the Mibiyn dialect of Yugambah, the language used by the Traditional Custodians whose lands include the Mistake Mountains.

**Description:** Length = 93 mm; width (mid-clitellar) = 3.6 mm; segment count = 179. Body colouration buff-brown, forebody dorsum with more pigmentation; clitellum purplish.

Prostomium tanylobous. First perforate dorsal pore is at 9/10. Lumbricin setal arrangement, in uniform lines throughout. Inter-setal distance setal ratios in segment XII are  $aa:ab:bc:cd:dd = 2.3:1.0:2.3:1.9:5.76$ ;  $dd:u = 0.31$ . Nephropores clearly visible, especially on clitellum; alternate segmentally between a position slightly lateral of *b*-lines and *d*-lines after X. In the forebody, sequence of setal alignment (commencing at 2/3) is *d d c c d c b d*. Male pores small orifices that lie within darkish areolae in XVIII. Broad, swollen pad containing pair of depressed areas is present in X and extends slightly beyond *d*-lines. Similar genital marking is present in XX. Pad with depressed central area lies in XVII (Fig. 1).

Clitellum tumescent and complete, encompassing posterior half of XIII to anterior portion of XVII,

with distinct ventral gap in XVII. Single female pore in an oval patch of lighter colouration situated midventrally in XIV, slightly anterior to the setal arc. Two pairs of inconspicuous spermathecal pores present in 7/8 and 8/9, aligned with *b*-lines.

Septa thickened by musculature in the oesophageal segments, especially 5/6–9/10 though from 10/11 posteriorly, septa become diaphanous. Gizzard firm and robust, with a muscular sheen, in V. Oesophagus well vascularised and has three pairs of large, reniform, sessile calciferous glands in XI–XIII. Narrow oesophagus in XIV transitions to the intestine with abrupt expansion in XV. No typhlosole or caeca are present. Gut contents soil, little organic matter.

Last hearts in XIII. Dorsal blood vessel single throughout. Highly iridescent male funnels occur in X and XI, with flocculent whitish masses present in those segments. Two pairs of finely racemose seminal vesicles of roughly comparable size attached to septa in IX and XII. Prostatic glands tubulo-racemose and composed of two distinct lobes, broadly U-shaped, occupying segments XVII–XIX. Narrow duct executes a loop before entering body wall. Vasa deferentia not detected. No penial setae present.

Ovaries, consisting of membranous fan of small ovules, present in XIII, oviducal funnels not detected. Spermathecae (Fig. 2A) occur in VIII and IX, all approximately equal in size, each organ consisting of sacciform ampulla, thick duct and two small clavate diverticula. These are iridescent with sperm and attached on either side of the point where ampulla forms a shoulder, just below duct. Ampullae of all spermathecae bent at an angle below insertion of the diverticula and are reflexed anteriorly through septa into preceding segments.

At ureter, nephridia are large and their ducts alternate in discharging through body wall near *b*-lines and *d*-lines. Immediately above each exit point lies large, wrinkled spheroidal bladder.

**Remarks:** The genus *Heteropordrilus* consists of 26 previously known taxa with nephridial organs terminating in bladders, the external pores of which alternate between *b*- and *d*- setal lines. The genus is also characterised by the possession of three to five ventrolateral calciferous glands (Blakemore 2000).

The new species exhibits a combination of three pairs of calciferous glands and two pairs of spermathecae, each with two diverticula, a set of characteristics that is rare among other known members of the genus. The broad pad-like genital markings in X and XX are features unique to the new species.

*Heteropordrilus montiserratae* Jamieson, 1995

**Material examined:** Mistake Mountains; near old forestry camp. Collector G. Dyne 12 December 1981: one mature and two semi-mature specimens. ANIC GD.95.41.2.

**Description:** *Mature specimen:* Length = 98 mm; width (mid-clitellar) = 4.5 mm; segment count = over 204 (amputation of tip).

Prominent genital markings present in X and XI; in the former, consist of two separated mounds encompassing setae *a* and *b*; in the latter, continuous swollen midventral pad extends across *bb*, with scattering of small circular dimples over its length. Similar broad pad present in XVIII, male pores occurring at its lateral extremities. This tumescence extends across midsegment beyond *b*-lines a further distance equal to *ab*. This pad also possesses small dimples. Additional tumescence of approximately same width as marking in preceding segment occurs in XIX.

Last hearts in XIII; gizzard, in V, sufficiently large to deflect thickened septa posteriorly, but sheathed in delicate septum (5/6). Four pairs of sessile calciferous glands in X–XIII; intestine commences abruptly in XV. Iridescent sperm funnels in X and XI; seminal vesicles not detected. Spermathecae with ovoid ampulla, short slender duct and single clavate inseminated diverticulum that joins at junction of ampulla and duct.

Both the external and internal anatomy of this material aligns closely with the original description of the species by Jamieson (1995), based on two specimens that are lodged with the Queensland Museum (HOLOTYPE QMG211443 (EX G10311) PARATYPE QMG211444 (EX G10311)).

**Remarks:** *Heteropordrilus* is a widespread genus found in the catchments of the Murray–Darling system in New South Wales through to Victoria

and South Australia, the Wimmera River in Victoria, Tweed River in northern NSW and various tributaries in south-eastern Queensland (Blakemore 2000). The preponderance of *Heteropodrilus* species discovered in south-east Queensland may be an artefact of concentrated collecting effort in the region, but it has demonstrated that the ranges of different species may overlap. Blakemore (1994) notes that four species of the genus could be sampled together in one small area around Brisbane. The occurrence of *H. montiserratae* near *H. julgeh* is therefore unsurprising. *Heteropodrilus montiserratae* is readily distinguishable from *H. julgeh* by the configuration of the genital markings, the presence of four, rather than three, calciferous glands, and the possession of three pairs of spermathecae, each with a single diverticulum.

*Heteropodrilus lamingtonensis* Jamieson, 1970  
(Fig. 2B)

**Material examined:** -27°59'11"S 153°10'1"E, Lamington National Park, 1106 metres altitude in complex notophyll vine-forest; collector G Dyne 19 October 2006. Material held in the ANIC Earthworm collection, Canberra. Collected as part of the IBISCA-Queensland project.

**Description:** *Specimen 1:* length = 122 mm; width (mid-clitellar) = 3.3 mm; segment count = 132. *Specimen 2:* length = 119 mm; width (mid-clitellar) = 3.1 mm; segment count = 125.

Body uniform umber in colour, clitellum pale orange. Prostomium pro-epilobous. First perforate dorsal pore is at 5/6 (in Specimen 2). Two pairs of spermathecal pores appear as small slits intersegmentally in 7/8–8/9, in line with *ab*.

Lumbricin setal arrangement, in regular lines throughout. Male pores on low mounds in XVIII. Clitellum tumescent and complete, encompassing posterior half of XIII to anterior portion of XVII, with distinct ventral gap in XVII. Single female pore is faint slit in pale patch situated midventrally in XIV on clitellum, slightly anterior to setal arc.

**Remarks:** The internal anatomy of the new material strongly agrees with the description given by Jamieson (1970) of the only known specimen and type of *H. lamingtonensis*. This includes the occurrence of three pairs of sessile calciferous glands,

disposition of the nephropores, and significantly, the presence of pericardiac testis–sacs in segments XI and XII. The prostatic glands and spermathecae also broadly correspond in morphology. The only detected difference (and this appears to be an uncommon aberration) occurs in the spermathecae: normally the diverticula numbers two, but it can include an additional member (Fig. 2B).

Externally, however, there is considerable divergence in the occurrence and appearance of genital markings. The new specimens, though mature, do not exhibit any of the distinctive markings described and illustrated for the type (*op. cit.*) The new material is, however, in a much-softened state, and this may have obscured the genital marking profiles. More material will be needed to determine if there is only a single species in this locality or two closely related sibling species.

**Spenceriella Michaelsen, 1907**

*Spenceriella erroremontes* sp. nov.  
(Figs. 3, 2C)

**Material examined:** -27°58' S 152°21' E, Mistake Mountains; track to Sylvester's lookout in damp decomposing log in rainforest. Collector G. Dyne 12 December 1981: several mature and semi-mature specimens. HOLOTYPE ANIC 76-000158, PARATYPE 1 ANIC 76-000159.

**Etymology:** *Erroremontes* is the Latinised name for the Mistake Mountains.

**Description:** *Holotype:* length = 65 mm; width (mid-clitellar) = 1.9 mm; segment count = 126. Body uniform grey-brown, clitellum pale pink. *Paratype 1:* length = 57 mm; width (mid-clitellar) = 1.4 mm; segment count = 124.

Prostomium's first perforate dorsal pore is at 5/6 (4/5 in P1). Two pairs of inconspicuous spermathecal pores in *b*-lines, intersegmentally, in 7/8–8/9. erichaetin has 19–21 setae per segment, in roughly regular lines throughout.

Male pores slightly elevated on puckered mounds that appear to lie within a depression in XVIII. Distinct genital markings occur in XVII and XIX, each consisting of conjoined oval depressions within glandular field, posterior of setal arc, roughly aligned with *a* setae (Fig. 1C). Pre-clitellar genital markings,

consisting of faint oval midventral patches of glandular appearance usually with small dimple-like markings, restricted to IX and XI, the latter usually more prominent.

Clitellum tumescent and complete, encompassing posterior half of XIII to anterior portion of XVII, with distinct ventral gap in XVII. Paired female pores are small slits situated in pale oval area midventrally in XIV on clitellum, slightly anterior to setal arc.

All septa are delicate, showing no appreciable thickening in oesophageal region. Single gizzard with muscular sheen occurs in VI; of moderate size, it does not push septa posteriorly. Oesophagus is narrow, lacking any lateral pouching or calciferous glands; intestine begins in XVI, but does not attain full dilation until XIX. Gut contents fine soil particles and some organic matter.

Last hearts in XII. Prostates racemose, bilobed, occupying XVIII and IX; duct is muscular, sinuous, and long, dilating slightly and gradually as it moves from gland towards body wall. Penial setae absent. Male funnels present in X and XI, with iridescence on those in X. Botryoidal seminal vesicle clusters occur in XI and XII.

Ovaries, consisting of membranous fan of small ovules, present in XIII, substantial oviducal funnels occur at ventral base of septum 13/14. Spermathecae occur in VIII and IX, of roughly equal size, each organ consisting of heart-shaped ampulla with distinct waist separating main body from smaller ectal portion; duct is very short and joined near its point of exit at body wall by sausage-shaped diverticulum that approaches ampulla in length (Fig. 2C).

Meronephric; nephridia consist of numerous small, compact tubules on body wall throughout most of the body, with large clusters of elongate tubules present in V–VII. Several large megameronephridia occur on each side of body (rather than single enlarged ventral nephridium), each consisting of tangle of tubules in the final 20 or so caudal segments. Occasional intrasegmental nephrostome is visible, but no pre-septal nephrostomes detected.

**Remarks:** A species-group based on the nominate species *Spenceriella cormieri* Jamieson & Wampler, 1979 was suggested by Dyne (1984) and accepted

by Jamieson (2001). This assemblage is especially diverse and commonly encountered in south-east Queensland and north-east New South Wales within a range of habitats. Many are epigeic, found in decaying organic material above or near the soil surface — in the case of this species, within decomposing wood. The assemblage is characterised by the absence of calciferous glands and enlarged caudal nephridia, usually with conspicuous pre-septal nephrostomes. The lack of these in the caudal region of *S. erroremontes* does not necessarily preclude it from the group, although this character is often encountered in other members. The unusual presence of seminal vesicles in XI and XII separates *S. erroremontes* from other members of the species group and all other known *Spenceriella* species excepting *S. cappoong* (described below), their differences noted in the remarks under the latter species.

*Spenceriella cappoong* sp. nov.

(Figs. 4, 2D)

**Material examined:** -28°03'S 152°23'E, Cunningham's Gap National Park, in dry rainforest soil towards Mt Cordeaux. Collectors G Dyne and D Lambert 10 Dec 1977: numerous mature and semi-mature specimens. HOLOTYPE ANIC 76-000160, PARATYPE 1 ANIC 76-000161, PARATYPE 2 ANIC 76-000162, PARATYPE 3 ANIC 76-000163.

**Additional material:** Near Cunningham's Gap under rocks on hillside 29 December 1974; collector unknown: Three mature specimens, held in the ANIC Earthworm Collection, Canberra.

**Etymology:** *Cap-po-ong* is the name given to Cunningham's Gap by the Traditional Custodians of the region.

**Description:** *Holotype:* length = 78 mm; width (mid-clitellar) = 3.2 mm; segment count = 100. Body colour is uniform umber, clitellum pale grey. *Paratype 1:* length = 77 mm; width (mid-clitellar) = 2.9 mm; segment count = 98.

Prostomium epilobous at 1/2. First perforate dorsal pore is at 5/6 (in P1). Female pores closely paired in small pale areola on clitellum, well ventral of a-lines and slightly above setal arc. Two pairs of spermathecal pores appear as small openings intersegmentally in 7/8–8/9, in line with *ab*.

Perichaetin has 16 setae on segment XII, in somewhat regular lines throughout.

Male genital field ovoid and includes slightly concave areas; male pores small slits located in XVIII on small mounds located within those areas. Dimple-like genital markings lie anterior and posterior to male pores, aligned with *ab* setae. Pre-clitellar genital markings, consisting of circular intra-segmental areolae with dimple-like centres, restricted to XI and XII, latter often more prominent. In XI, these markings span *ab* setal pair (though slightly posteriad in the segment), in XII markings more closely paired, aligned with *a* setae (Fig. 4).

Clitellum tumescent and annular, encompassing posterior half of XIII to anterior portion of XVII, with distinct ventral gap in XVII. Small paired female pores situated midventrally in XIV on clitellum, slightly anterior to setal arc.

All septa are delicate, lacking muscular thickening. Gizzard insubstantial and soft, in V. Oesophagus well vascularised, lacking any pouching or calciferous glands; intestine commences in XVI. Gut contents fine organic particles. No typhlosole present. Last hearts in XII.

Holandric; iridescent male funnels and associated flocculent sperm masses occur in X and XI. Botryoidal seminal vesicles consisting of large locules occur in XI and XII. Prostates racemose but simple and wafer-like, occupying XVIII; duct is long, shiny, and tortuous, paired vasa deferentia enter gland near emergence of the duct. No penial setae present.

Ovaries, consisting of membranous fan of small ovules, present in XIII, with presumed ovisacs attached to posterior wall of septum 12/13; small translucent oviducal funnels occur at ventral base of septum 13/14. Spermathecae occur in VIII and IX, of roughly equal size, each organ consisting of elongate broadly cylindrical ampulla with constricted waist producing bipartite appearance, and short, narrow duct and long digitiform diverticulum arising where ampulla meets duct (Fig. 2D).

Meronephric; rows of micromeronephridia cover body wall throughout, become enlarged in final caudal segments. No nephrostomes, either pre-septal or intrasegmental, can be detected on any nephridial tubules.

**Remarks:** As noted for *Spenceriella erroremontes* sp. nov., *S. cappoong* is placeable within the *S. cormieri* species-group. It shares with *S. erroremontes* the presence of seminal vesicles in XI and XII, unlike the more commonly encountered arrangement in IX and XII seen in other members of the species-group. *Spenceriella cappoong* is distinguishable from *S. erroremontes* in having a distinctly different spermathecal anatomy and disposition of the pre-clitellar genital markings (Figs. 3, 4).

*Spenceriella badia* sp. nov.  
(Figs. 5, 2E)

**Material examined:** -28°03'S 152°23'E, Cunningham's Gap National Park, in dry rainforest soil towards Mt Cordeaux; collectors G Dyne and D Lambert 10 Dec 1977: a single mature specimen. HOLOTYPE ANIC 76-000164.

**Etymology:** *Badia* in Latin means reddish-brown in colouration.

**Description:** Holotype: length = 137 mm (caudal tip amputated?); width (mid-clitellar) = 6.3 mm; segment count = 100. Body has uniform reddish-brown pigmentation, including clitellum.

Perichaetin has numerous setae with 49–52 setae per segment in irregular rows. No setae present between male pores. Prostomium epilobous at 1/2. First perforate dorsal pore is at 5/6.

Clitellum annular, encompassing segments XIV–XVI, only slightly swollen, but more obviously so dorsally. Female pores tiny, indistinct, slightly anterior to setal arc and just ventral of setal *a*-lines. Two pairs of spermathecal pores are small slits slightly behind 7/8 and 8/9 intersegments, in line with setal line *bc* (although setal lines variable).

Male pores, in alignment with *ab*, small slits lying within broad, dark glandular band that extends both anteriorly and posteriorly into preceding and succeeding segments, united by bridge across the midventrum in XVII to produce  $\pi$ -shaped appearance overall. Within this band, ovoid sucker-like markings occur in XVII and XIX, latter more widely spaced (Fig. 5).

No pre-clitellar genital markings present. Gizzard is enveloped in thin septum, septa thickening posteriorly from this, attaining maximum muscularity

in 8/9–12/13, thinning progressively after that. Last hearts in XII.

Single globose muscular gizzard in VI; oesophagus is well vascularised, lacking pouching or calciferous glands. Intestine commences in XV; no intestinal pouching or typhlosole present.

Nephridia consist of dense bands of tubules that run across body wall immediately behind preceding septum; no nephridial funnels detected. Caudally, slight enlargement of nephridial bodies, but no enlarged median megameronephridia or nephrostomes. No prominent tufting detected in pharyngeal segments.

Iridescent sperm funnels present in X and XI, with adherent flocculent sperm masses. Small, finely loculate seminal vesicles occur in IX, adherent to anterior face of septum 9/10 and in XII, on posterior face of 11/12. Prostatic glands small, solid racemose organs with very short duct. Ovaries, in form of sheaf of ovules on both sides of oesophagus, present in XIII.

Large spermathecae occur in VIII and IX, their ducts opening near bases of respective preceding septa. Each organ consists of elongate-ovoid ampulla, straight, broad duct approximately 2/3 length of ampulla, and single fusiform diverticulum that joins duct close to its exit through body wall (Fig. 2E).

**Remarks:** This taxon lacks the pre-clitellar genital markings that characterise many other *Spenceriella* species. The location of the last hearts in XII, together with the lack of calciferous glands and its spermathecal anatomy, characterise this species.

***Digaster* Perrier, 1872**

*Digaster longitheca* sp. nov.  
(Figs. 6, 2F)

**Material examined:** -28°15'36"S 153°10'1"E, Lamington National Park, 1106 metres altitude in complex notophyll vine-forest; collector G Dyne 19 October 2006 as part of the IBISCA-Queensland project. A single mature (Holotype) and one semi-mature specimen (Paratype 1). HOLOTYPE ANIC 76-000165, PARATYPE 1 ANIC 76-000166.

**Etymology:** Longitheca refers to the greatly elongate spermathecal ampulla.

**Description:** *Holotype:* length = 87 mm (posterior amputee); width (mid-clitellar) = 8.3 mm. Body pale biscuit, clitellum orange.

Prostomium prolobous. First perforate dorsal pore is at 5/6. Two pairs of inconspicuous spermathecal pores (in *ab* setal lines) intersegmentally in 7/8–8/9.

Lumbricin setal arrangement, in uniform lines throughout. Intersetal distance ratios are  $aa:ab:bc:cd:dd = 3.8:1.0:3.9:3.3:13.7$ ;  $dd:u = 0.7$ .

Male pores small orifices that lie within darkish areolae in XVIII. Broad, swollen pad containing pair of depressed areas is present in X and extends slightly beyond *d*-lines. Similar genital marking present in XIX. Pad with depressed central area lies in XVII (Fig. 6).

Clitellum well developed, encompassing XIV–XVIII, annular save for ventral gap in XVIII associated with male field. Single prominent female pore situated midventrally in XIV, slightly anterior to setal arc.

Last hearts in XII. Septa 6/7–10/11 thickened with musculature, 6/7–8/9 the most robust; septum 11/12 only partially thickened and in subsequent segments, septa become diaphanous.

Large pair of gizzards occur in VI and VII, former the longer and more muscular; organ in VII more compact, but also has muscular sheen. Oesophagus is shortened by protrusion of gizzards posteriorly, lacking any pouching or calciferous glands. Intestine commences abruptly in XIV–XV. No typhlosole present.

Metandric; iridescent sperm funnels observed in XI only and seminal vesicle masses restricted to XII. Prostates small single-lobed organs restricted to XVIII. Ovaries not detected, although pair of tiny translucent ovarian funnels located close to midventral line on anterior face of 13/14, oviducts not detected.

Two pairs of spermathecae occur in VIII and IX, each consisting of ampulla (usually reflected forwards through septum into respective preceding segment) very short duct and small sessile diverticulum at junction of duct and ampulla that contains conspicuous iridescent spermatic chambers. Ampulla considerably longer than that observed in other members of genus. (Fig. 2F).

Meronephric; small tubules present on body wall and septa throughout.

**Remarks:** Over 30 species of *Digaster* are known from south-east Queensland and northern New South Wales, occupying a wide range of habitats (Jamieson 2001, Blakemore 2000). The new species is differentiated by the exceedingly long spermathecal ampulla, the presence of metandry in the male reproductive system and the occurrence of a single female pore, rather than the more commonly encountered paired configuration.

Metandry is also seen in *Digaster brunneus* Spencer, 1900, *D. conforma* Blakemore, 1997 and *D. longmani* Boardman, 1932 and may be the result of convergence rather than denoting a close relationship between the species exhibiting this character.

*Digaster meeborrum* sp. nov.  
(Figs. 2G–H, 7)

**Material examined:** -27°59'10"S, 152°37'25"E, near summit of Mt French (northern peak), 480 metres, in dry black soil; collector G Dyne 19 May 1980, three mature specimens. HOLOTYPE ANIC 76-000167, PARATYPE 1 ANIC 76-000168.

**Etymology:** *Me-ebor-rum* is the name given to the northern peak of Mt French by the Ugarapul people, the Traditional Custodians of the mountain.

**Description:** Length = 55 mm (*Holotype*), 51 mm (*Paratype 1*); width (mid-clitellar) = 6.7, 6.5 mm; segment count = 124, 119. Body dun colour, clitellum with pale orange tint.

Prostomium prolobous. Segment I setigerous, indicating fusion of first two segments. First perforate dorsal pore is at 4/5 (all specimens). Lumbricin setal arrangement, the eight setae per segment in uniform lines throughout. Intersetal distance ratios are  $aa:ab:bc:cd:dd = 3.8:1.0:3.9:3.3:13.7$ ;  $dd:u = 0.7$ .

Clitellum well-developed and swollen over XIII–XVII, pigmentation extending into posterior portion of XII. Male pores small slits atop slightly elevated mounds in XVII, in line with *ab*. Female pores in XIII indistinct, slightly presetal (and ventral to *a*-lines) in paler areola. Two pairs of inconspicuous spermathecal pores intersegmental in 6/7–7/8, roughly aligned with *a* setae (Fig. 7).

Genital markings consist of slightly raised ventral pads that extend across intersegments 18/19 to 20/21 (*Holotype*, *Paratype 2*) or 18/19 and 19/20 only (*Paratype 1*). These markings usually encompass area between the *b*-setal lines. No pre-clitellar markings present.

Septa generally delicate, but thicker in forebody. Last hearts narrow tubes in XII. Pair of robust gizzards of equal size occur in V and VI. Oesophagus narrow, unelaborated. Intestine commences abruptly in XVI, no typhlosole or caeca present.

Meronephric, small tubules lining body wall. Caudally, median-most nephridium on each size enlarged as a megameronephridium with distinct pre-septal funnel. No other nephrostomes detected elsewhere in the body. In II, adjacent to pharyngeal mass, there are tufted nephridia with numerous tubules that have consolidated duct, leading to buccal cavity.

Iridescent male funnels occur in IX and X; botryoidal seminal vesicles consisting of large locules occur in VIII and XI. Prostates racemose (Fig. 2G), are deeply dissected (almost to duct) into two lobes and restricted to XVII. Iridescent vasa deferentia join with muscular duct at point of exit from gland. Ovaries, consisting of loose fan of oocytes, present in XII; oviducal funnels, ventrally located at posterior face of septum 11/12, present, no ovisacs detected.

Spermathecae occur in VI and VII, diverticulum often reflexed through septum into succeeding segment. Each spermatheca (Fig. 2H) consists of globose ampulla, duct of moderate length and digitiform diverticulum, often iridescent with sperm, inserted midway along the duct.

**Remarks:** The new species closely resembles *D. anomala* Jamieson, 1975, while being geographically distant from other known records of the species, which is relatively widespread. Principal points of agreement include the unusual fusion of the first and second segments (resulting in the anterior displacement of other anatomical features), transverse genital markings behind the male pores and bipartite prostate glands. Points of divergence include a smaller body size, the absence of pre-clitellar genital markings (although this is not a consistent feature in all known *D. anomala*

specimens), a different spermathecal construction, and the locations of the intestinal commencement and tufted pharyngeal nephridia.

Jamieson (1975) proposed a *D. anomala* complex for taxa exhibiting the apomorphic segmental fusion character, members of which would now include *D. conforma* Blakemore, 1997, *D. rosea* Dyne, 2000, *D. segnitatis* Dyne, 2000 as well as the newly described species. The occurrence of this character in geographically disconnected species within *Digaster* may, however, be the result of homoplasy in separate lineages within the genus, rather than signalling close relatedness.

While genetic analysis may later result in the inclusion of *D. meeborrum* as a geographical variant within a broader definition of *D. anomala*, for the present it is retained as a distinct species.

*Digaster gwongorellae* Jamieson, 1972  
(Fig. 8)

**Material examined:** -28°14'2"S 153°8'28"E: Lamington National Park, 904 metres altitude in complex notophyll vine-forest; collector G. Dyne 17 October 2006: several semi-mature specimens. Collected as part of the IBISCA-Queensland project. Material held in the ANIC Earthworm Collection, Canberra.

**Description:** Length (selected specimen) = 82 mm; width = 4.4 mm. A large genital protuberance occupies a prominent central position in segment XVIII, with the male pores on its margins (Fig. 8). This configuration is diagnostic of the species and establishes this occurrence as a new record.

**Remarks:** *Digaster gwongorellae* was described by Jamieson (1972) from Gwongorella National Park on the Springbrook Plateau and subsequently identified near Binna Burra in Lamington National Park. The new material expands the previously recorded range of the species within the latter protected area, which confirms its status as a relatively widespread species in Border Ranges rainforest habitats.

*Digaster jamiesoni* sp. nov.  
(Figs. 9, 21)

**Material examined:** -28°11'16.8"S 153° 7'15.6"E, Lamington National Park, 746 metres altitude in complex notophyll vine-forest; collector G Monteith 16 October 2006, collected as part of the IBISCA-

Queensland project: a single specimen. HOLOTYPE ANIC 76-000169.

**Etymology:** Named for Professor Barrie Jamieson, a pre-eminent researcher of Australian Oligochaetes.

**Description:** Length = 188 mm (approximate, as specimen is bisected mid-body); width (mid-clitellar) = 6.5 mm. Colour pale straw colour, clitellum light pink.

Prostomium tanylobous. First perforate dorsal pore is at 5/6. Two pairs of spermathecal pores appear as small slits intersegmentally in 7/8–8/9, in line with a setae. Lumbricin setal arrangement, distance ratios  $aa:ab:bc:cd = 2.1:1.0:2.6:2.1$ .

Male field, encompassing segments 17/18–18/19, in form of bipartite concavity, 17/18 depression having larger area. Male pores atop incomplete raised ridge in XVIII that partially separates these two concavities.

Clitellum tumescent and complete, encompassing posterior half of XIII to anterior portion of XVII, with distinct ventral gap in XVII. Female pores tiny slits situated in pale patch midventrally in XIV on clitellum, slightly anterior to setal arc. Pre-clitellar genital markings absent.

Anterior septa, especially those in 5/6–13/14 clearly thickened and muscularised, with remainder diaphanous. Last hearts in XII; two shortly cylindrical gizzards of equal size with muscular sheen in VI and VII. Oesophagus unelaborated, with expansion to intestine in XVIII.

Meronephric; rows of numerous nephridial tubules of roughly uniform size line body wall but not present on septa. Nephridial tubules conspicuously larger in forebody, intestinal segments having much smaller bodies. In III, dense cluster of much enlarged and thickened nephridial elements present, possibly ducted to buccal cavity. No obvious enlargement of the median-most nephridium compared with other tubules except caudally, where median-most nephridium more substantial than others in segment. Nephrostomes not detected.

Plicate seminal funnels present in X and XI, without conspicuous iridescence. Large, finely locular seminal vesicle masses occur in IX and XII, adherent to anterior wall of septum 9/10 and posterior wall

of septum 11/12 respectively. Prostates confined to XVIII, each consisting of two lobes, one notably larger than other. Short, stout, muscular duct, vasa deferentia not detected.

No substantial ovarian masses detected, but some loose ovules present in XIII; conspicuous oviducal funnels occur at ventral base of septum 13/14. Spermathecae occur in VIII and IX, each consisting of large sac-like ampulla, narrow duct and broad, multi-chambered and inseminated diverticulum that arises from duct halfway along latter's length (Fig. 21).

**Remarks:** The anatomy of this species is close to that of *Digaster lamingtonensis*, originally described by Michaelsen (1916) with an expanded description by Jamieson (1963) based on new material. The main point of difference is the symmetrical nature of the male field, which differs from the unilateral absence of the sucker-like concavity of the male field in 18/19 (developed on the left side only) observed in *D. lamingtonensis*. There are also some anatomical discrepancies in the spermathecal construction, as well as the bilobed nature of the prostatic glands, which was not noted in the latter species. Jamieson (1963) further remarked that the material he examined from the Tweed River had paired female pores (as seen in the current specimen), rather than the single pore noted by Michelsen in the type.

The new species brings the number of *Digaster* species now recorded within Lamington National Park to nine. As well as rainforest, the genus is found in a range of habitats in south-eastern Queensland including open eucalyptus woodland, heath and coastal sand masses.

## DISCUSSION

There is relatively good documentation of diversity, as well as exemplars of endemism, within the floristic and vertebrate elements of the World Heritage property of the Scenic Rim, and this knowledge continues to expand (e.g. Mahoney et al. 2022). The invertebrate fauna is less well characterised, although there are individual accounts of localised invertebrate endemics. For example, the freshwater crayfish *Euastacus jagara* Morgan, 1988 appears to be restricted to the Mistake Mountains and Goombarra section of the Main Range (Morgan,

1988) and *E. binzayedi* Coughran & Furse, 2013 to a small area of Lamington National Park (Furse et al. 2013).

A compilation of collection records within the whole World Heritage property by Williams (2002) indicates high levels of endemism and Gondwanic affinities for other invertebrate groups (e.g. terrestrial snails Charopidae). The latter family includes the very small pinwheel snails, some of which have a broad distribution, while others are highly restricted, known from single sites (Stanisic 1990, Stanisic et al. 2010). The records of other invertebrate groups suggest a complex history that includes waves of colonisation and radiation.

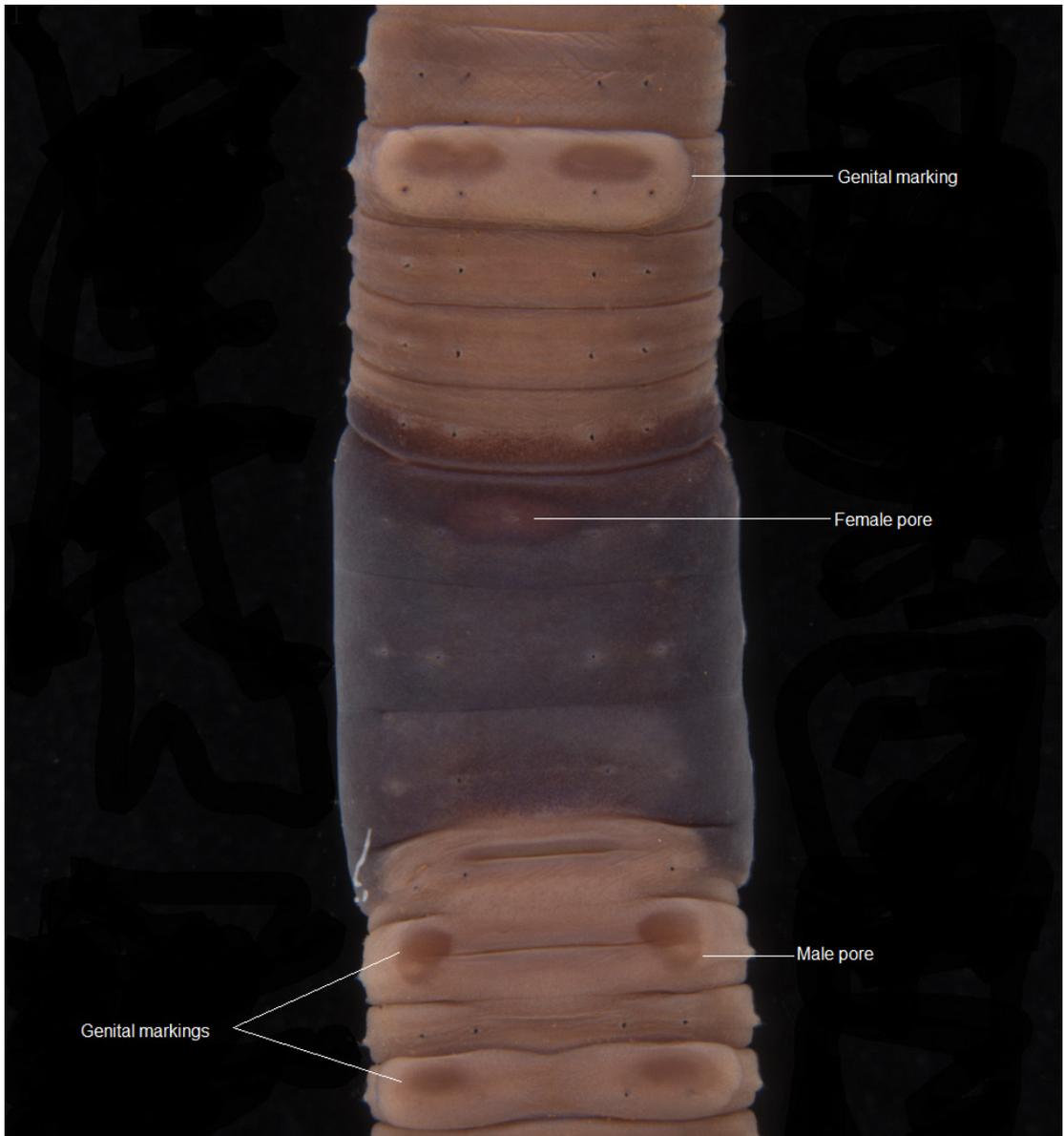
Some native earthworms seem to be able tolerate profound habitat alteration (e.g. *Digaster longmani* Boardman, 1932 is occasionally encountered in cleared land given over to pasture, as is the giant Gippsland species, *Megascolides australis*), but many stenotopic species are also known. Small epigeic earthworms such as *Spenceriella* species, which rely on a humic compost layer at the soil interface, would have been particularly vulnerable to the climatic and vegetation fluctuations that occurred within the Pliocene/Pleistocene (Harle 1997). Stanisic et al. (2007) proposed a similar scenario for those land snails that have narrow environmental tolerances.

The upland areas of the Scenic Rim have been regarded as relatively stable refugia (Bryant & Krosch 2016) and the episodic ebb and flow of favourable habitat would have resulted in periodic isolation and speciation in invertebrates of low vagility, such as earthworms. Similarly, flightless carabid beetles, which also favour stable upland environments, were likely more widely distributed when rainforest coverage was more extensive, with subsequent contraction leading to isolation and speciation. While some carabid species have broader distributions in south-east Queensland, localised endemism is also prevalent (Hunter 2004). As an added complexity, molecular analysis of the earthworm genus *Terrisswalkerius* Jamieson, 1994 in northern Queensland (Moreau et al. 2015) suggests that intrageneric diversification predates the mid-Miocene aridification model, so that while the latter may explain more recent speciation events, it likely overlies a much deeper zoogeographic history.

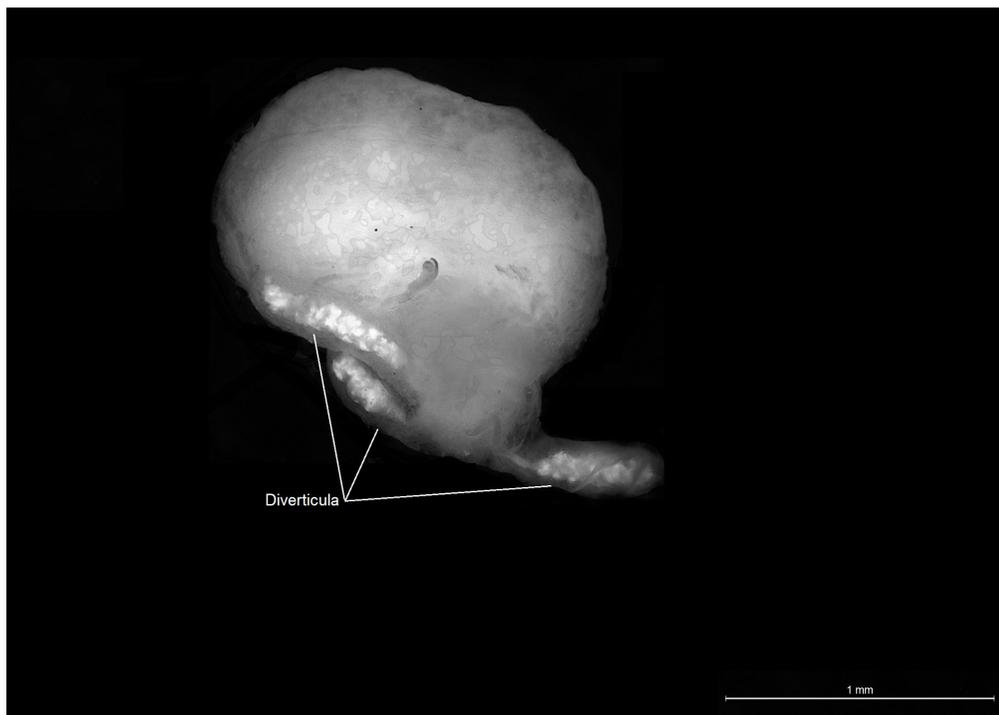
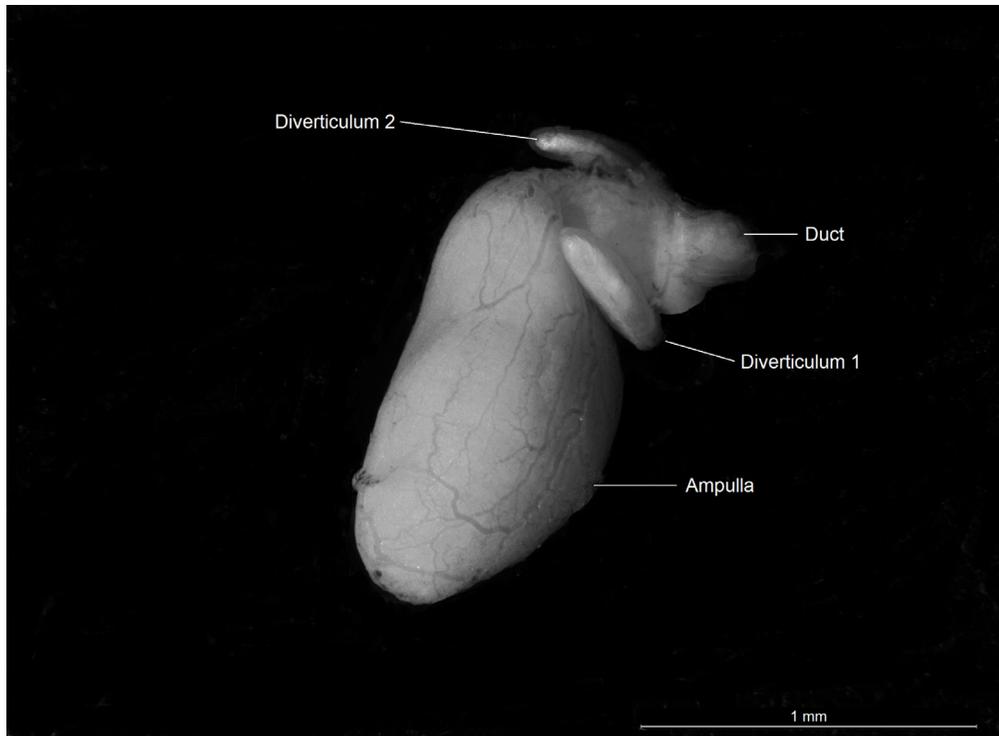
It is probable that species richness of earthworms across the Scenic Rim is much higher than current records might suggest, as there has been sufficient time for vicariance within spatially separated geologic elements. Targeted collections of earthworms have been undertaken since the early 1970s, with a preponderance of these centring on rainforest habitats within Lamington and Springbrook National Parks. Additional material, though scant, exists largely because of the serendipitous nature of terrestrial invertebrate collections, whereby earthworm specimens may be a collateral by-product of other faunal surveys. Significant collecting gaps remain within the Scenic Rim (such as the Mt Barney sector) and certain habitats, such as the montane heaths, remain completely unsampled.

## ACKNOWLEDGEMENTS

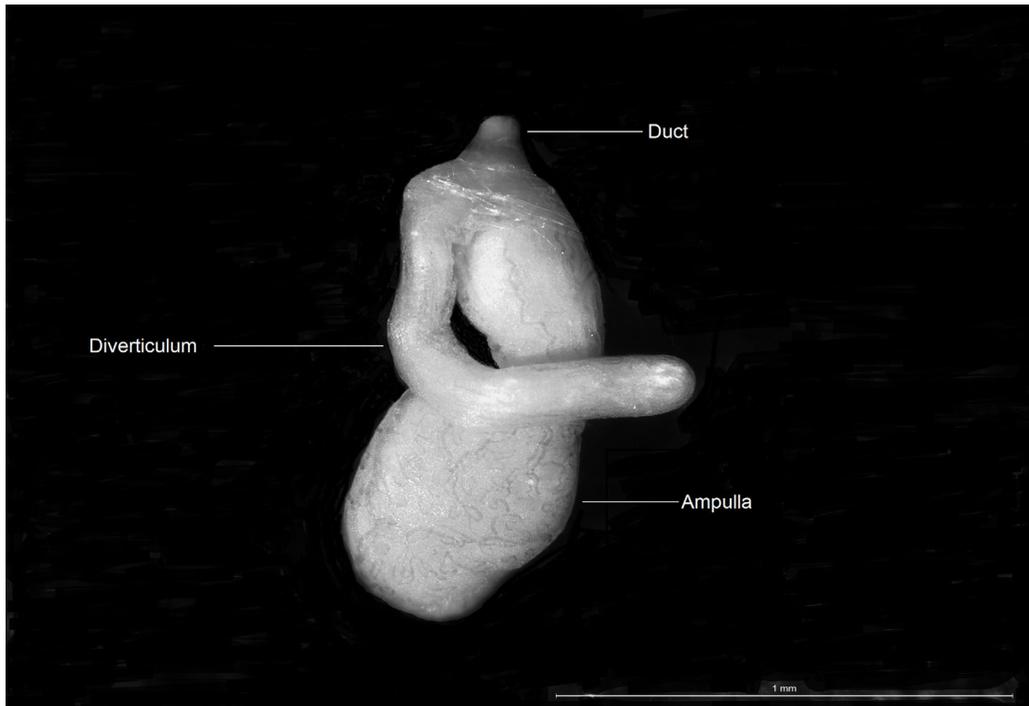
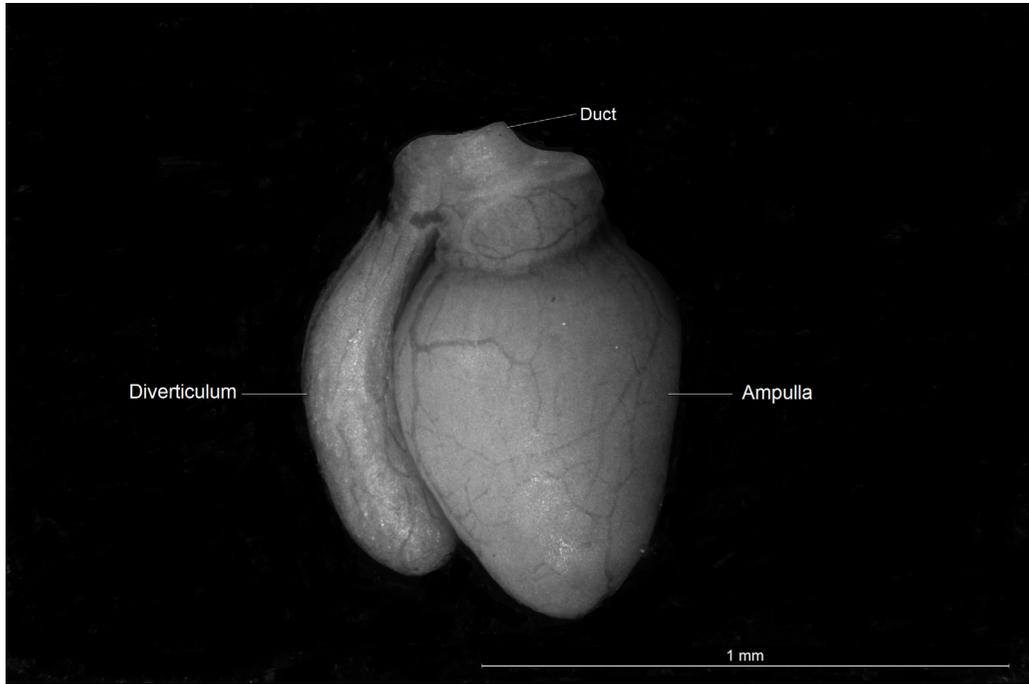
I am indebted to Dr Margaret Sharpe and Dr Sylvia Haworth for their valuable assistance, under the auspices of the Yugambeh Regional Aboriginal Corporation Alliance, in determining the accuracy of the Indigenous names used in this paper. I also wish to thank Prof. Roger Kitching for encouraging participation in the IBISCA survey in Lamington National Park and Prof. Barrie Jamieson for constructive comments on the draft of this paper.



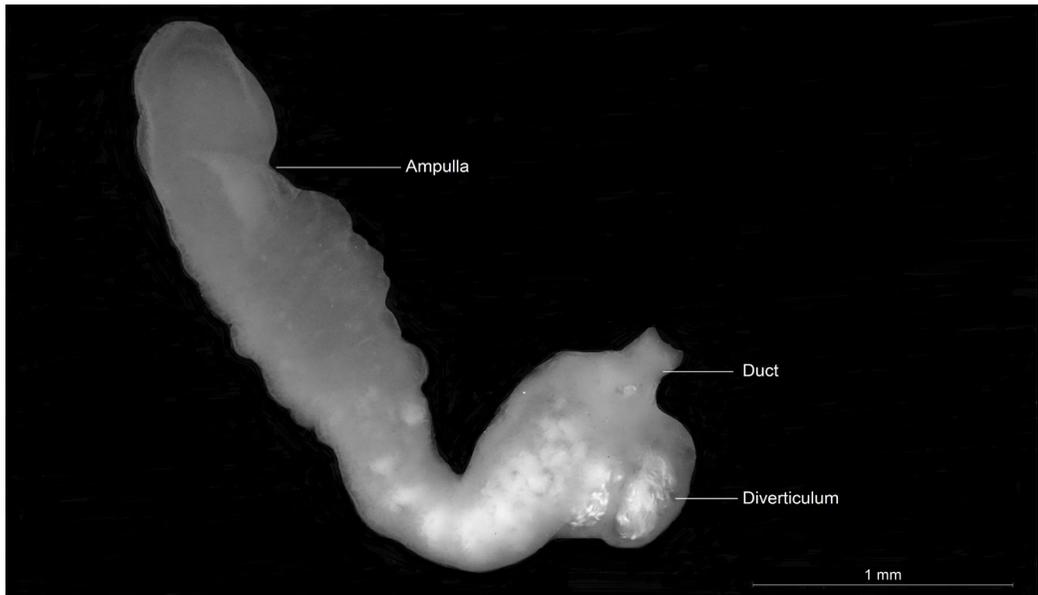
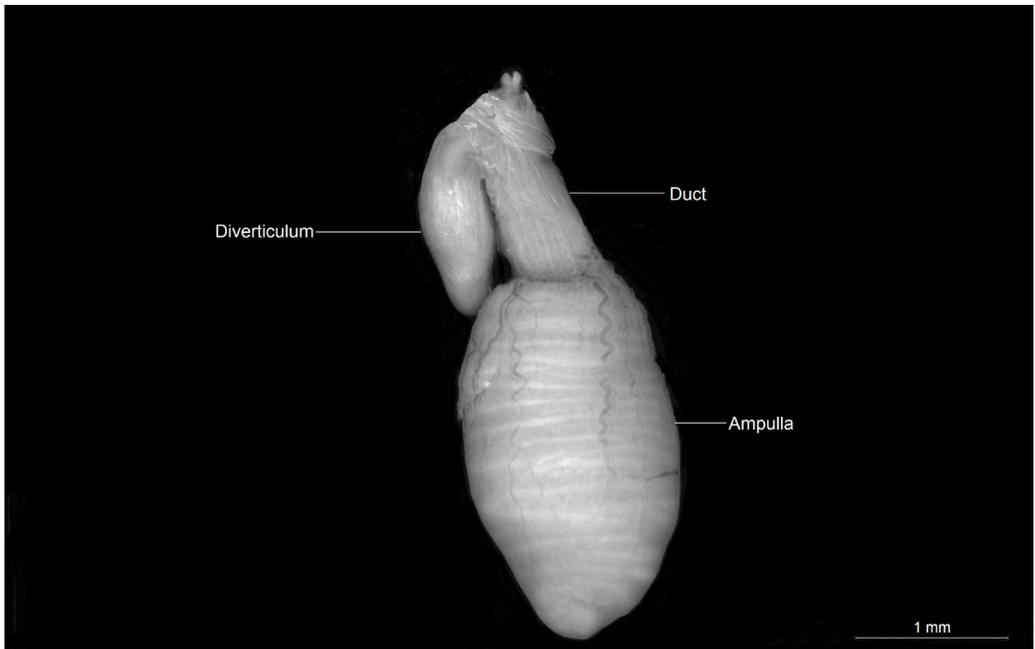
**Figure 1.** *Heteroporodrilus julgeh* sp. nov. genital field



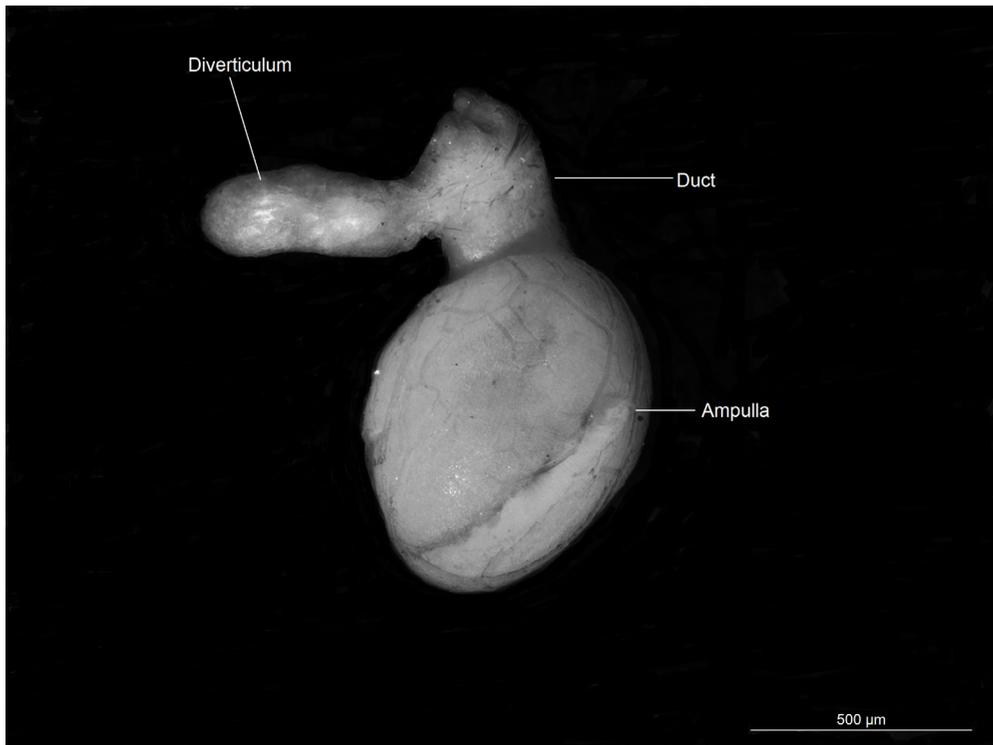
**Figure 2A (above).** *Heteroporodrilus julgeh* sp. nov. spermatheca. **Figure 2B (below).** *Heteroporodrilus lamingtonensis* Jamieson, 1970 spermatheca



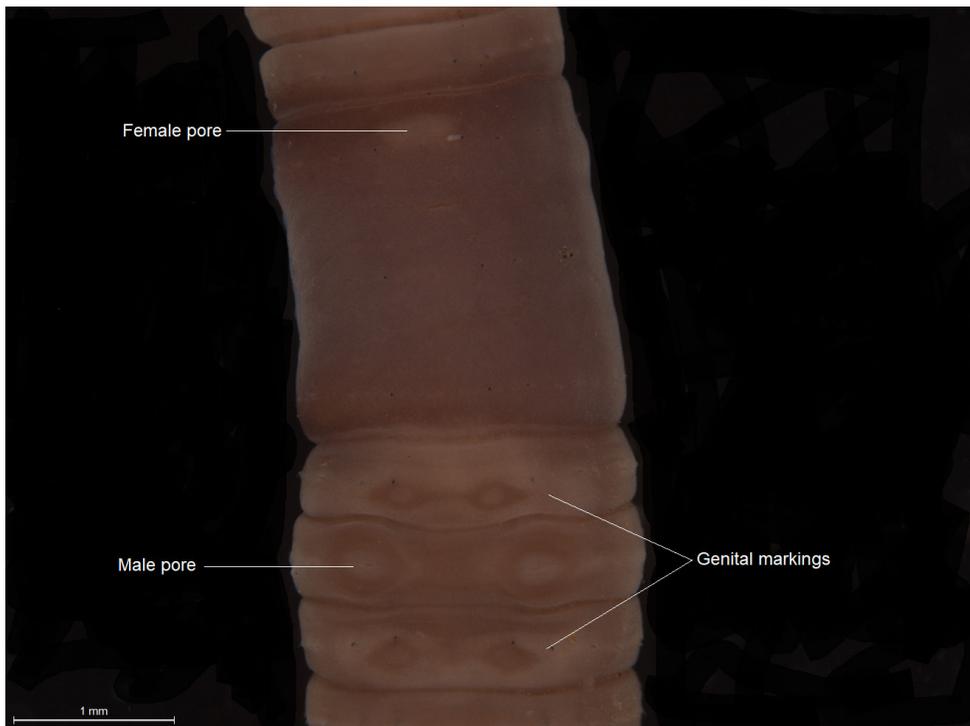
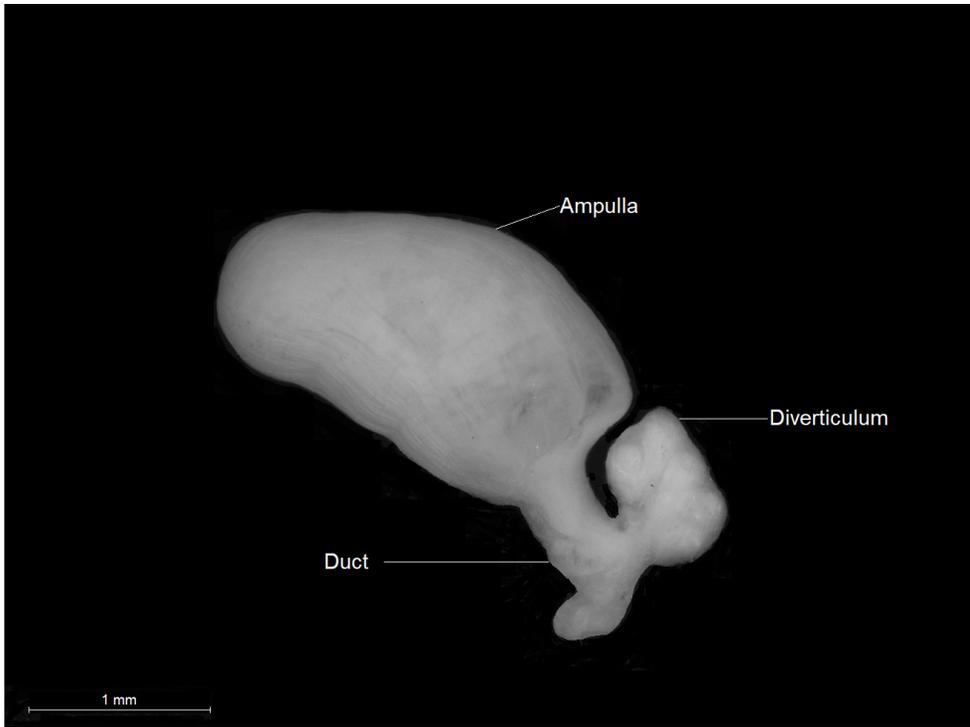
**Figure 2C (above).** *Spenceriella erroremontes* sp. nov. spermatheca **Figure 2D (below).** *Spenceriella cappoong* sp. nov. left IX spermatheca



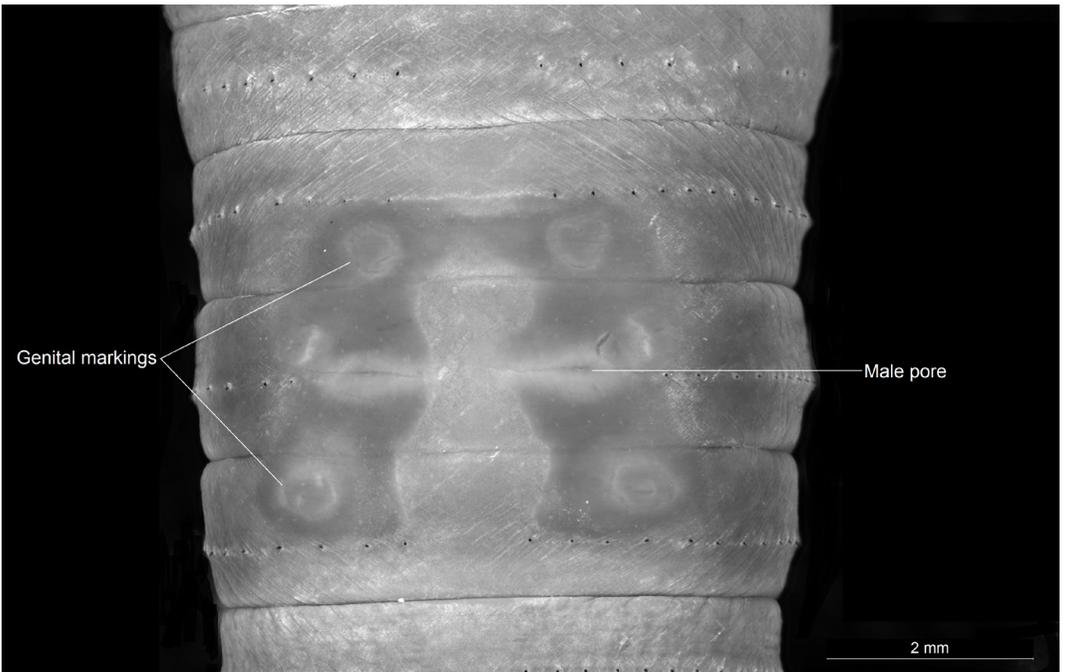
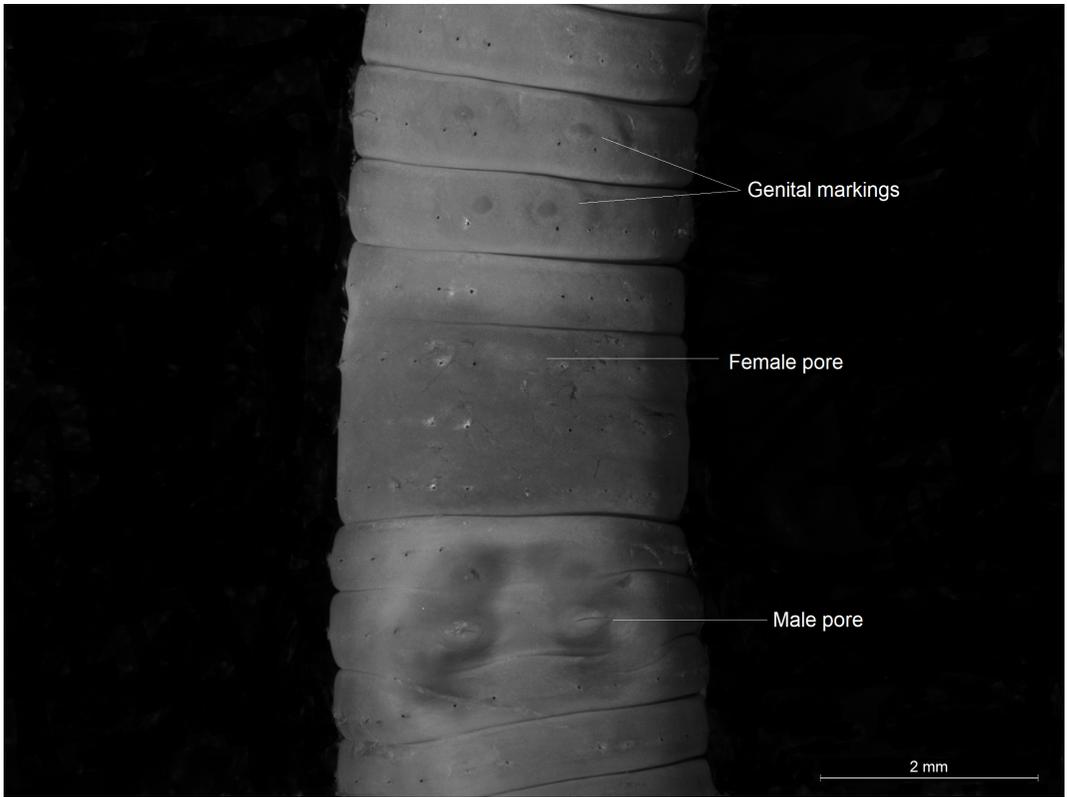
**Figure 2E (above).** *Spenceriella badia* sp. nov. left VIII spermatheca **Figure 2F (below).** *Digaster longitheca* sp. nov. left VIII spermatheca



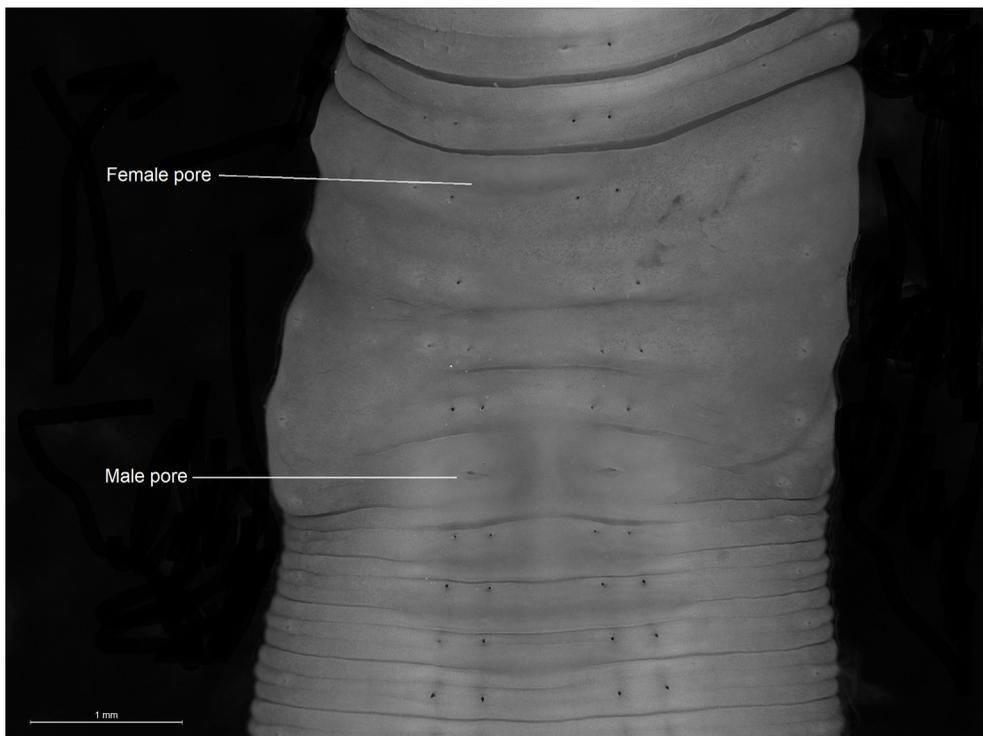
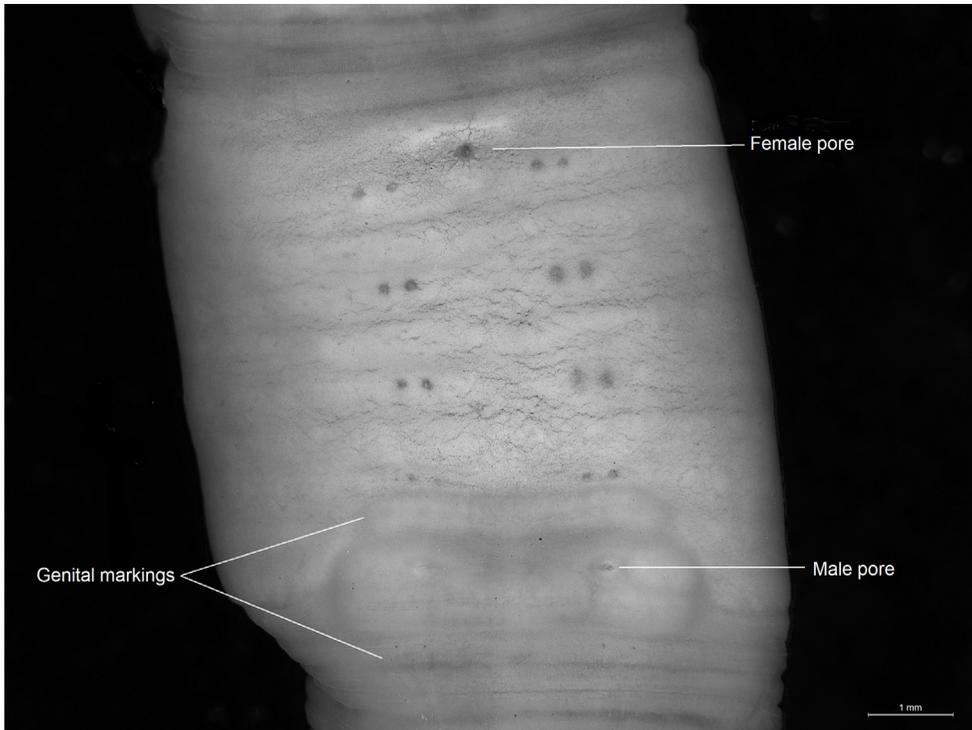
**Figure 2G (above).** *Digaster meeborrum* sp. nov. prostatic gland **Figure 2H (below).** *Digaster meeborrum* sp. nov. spermatheca



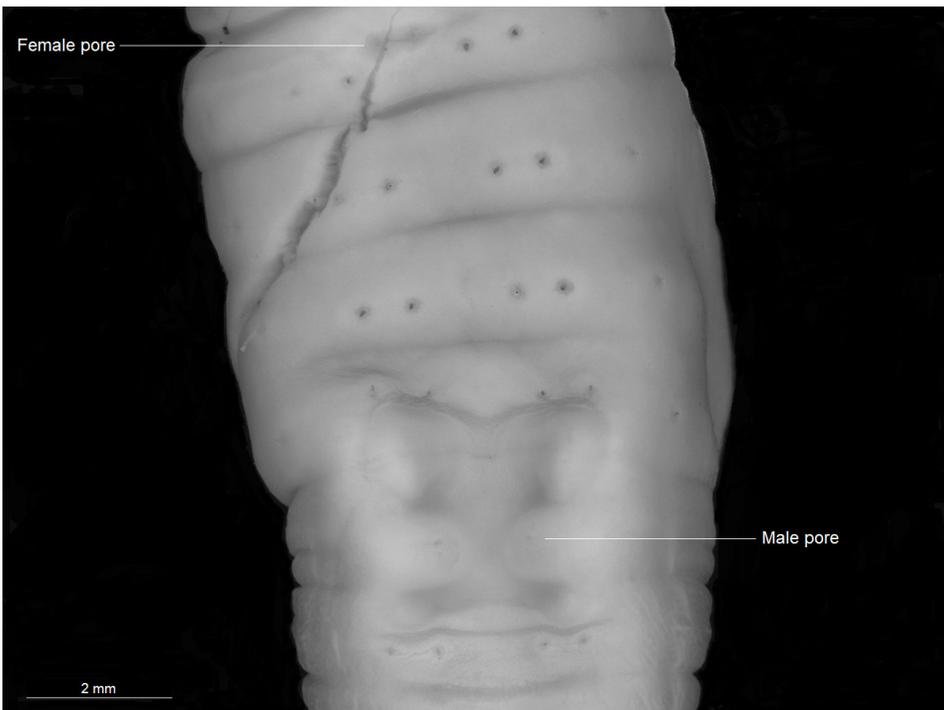
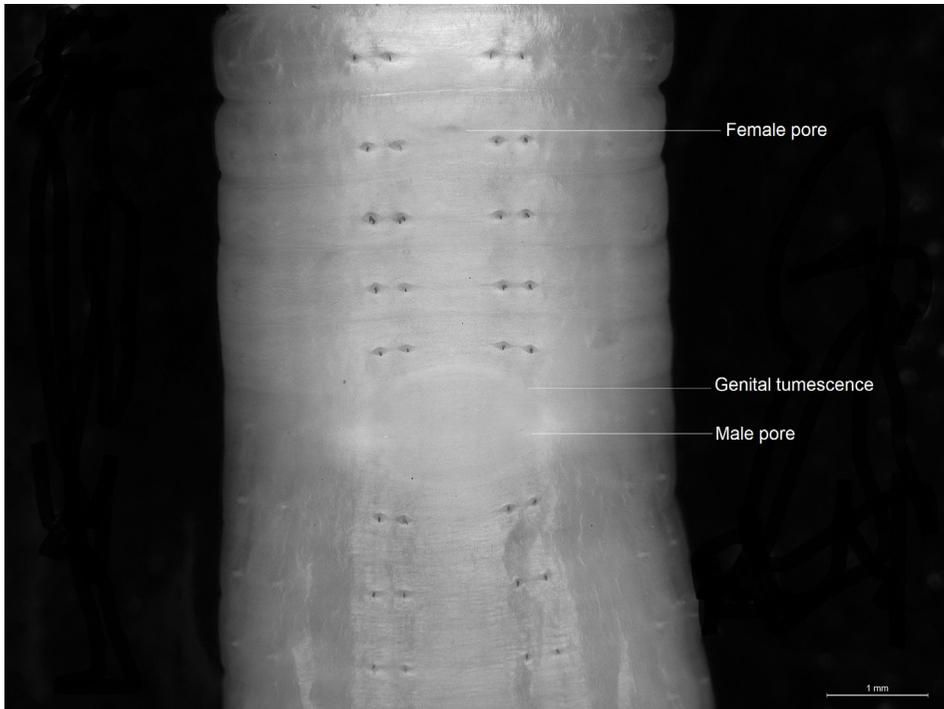
**Figure 21 (above).** *Digaster jamiesoni* sp. nov. spermatheca **Figure 3 (below).** *Spenceriella erroremones* sp. nov. genital field



**Figure 4 (above).** *Spenceriella cappoong* sp. nov. genital field **Figure 5 (below).** *Spenceriella badia* sp. nov. genital field



**Figure 6 (above).** *Digaster longithecus* sp. nov. genital field **Figure 7 (below).** *Digaster meeborum* sp. nov. genital field



**Figure 8 (above).** *Digaster gwongorellae* Jamieson, 1972 **Figure 9 (below).** *Digaster jamiesoni* sp. nov. genital field

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