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Earthworms (Clitellata, Acanthodrilidae) of the mountains of Eastern Jamaica

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Abstract

Fourteen species new to science are described from material collected at several sites in the Blue Mountains and the John Crow Mountains of eastern Jamaica, doubling the known endemic Jamaican earthworm fauna. New data on *Dichogaster montecyanensis* (Sims) are provided. All species are placed in the genus *Dichogaster* Beddard, which is here treated sensu lato, i.e. including *Eutrigaster* Cognetti. Eight of the new species have lost the posterior pair of prostates and the seminal grooves of the male field. These are *D. bromeliocola*, *D. crossleyi*, *D. davidi*, *D. garciai*, *D. harperi*, *D. haruvi*, *D. hendrxi*, and *D. johnsoni*. *D. sydneyi* n. sp. has independently lost the posterior prostates but not the seminal grooves. The new species *D. altissima* and *D. manleyi* have the conventional dichogastrine prostatic battery and male field characteristics. Three species described here, *D. farri*, *D. garrawayi*, and *D. marleyi*, all have a third pair of prostates in the 20th segment, no seminal grooves, dorsal paired intestinal caeca in segment lxxv, and lack penial setae. © 2004 Elsevier GmbH. All rights reserved.

Keywords: *Dichogaster*; Oligochaeta; Clitellata; Jamaica; Earthworms

Introduction

Scattered over the last century one can find four primary sources on the earthworm fauna of Jamaica—Eisen (1900), Michaelsen (1908), Sims (1987), and Csuzdi and Zicsi (1991)—in each of which are described two or more species assigned to either of the megascolecid (sensu lato) genera *Dichogaster* Beddard, 1888 or *Eutrigaster* Cognetti, 1904. Sims (1987) cited an interest in Caribbean Basin biogeography as the stimulus for his short collecting expedition to Jamaica. The new species discovered and reported here are a result of my own interest in this subject. Jamaica was one of many Caribbean island locations I surveyed for earthworms (Fragoso et al. 1995), and it is one of the most species-rich.

It being my intent to find the native earthworms of Jamaica, I did not concern myself with making a complete inventory of all earthworms present, including exotics. Some information on exotic species present on Jamaica is in Sims (1987). I do not believe that all the species have been found, not even in the Blue Mountains, where I spent the most time. Only in a few cases did I find multiple locations for a particular species. The John Crow Mountains were largely untouched by my efforts, as I was only able to enter from the west at one point.

Methods and material

All material was collected either by digging and handsorting, or by searching bromeliad leaf tanks, mosses and root mats of other epiphytes, or rotting

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logs. Collection sites were mainly in remote areas of natural vegetation, in order to maximize the probability of finding native species. Earthworms were killed in 50% ethanol and transferred to 10% formalin for fixation. After at least 48 h in formalin the specimens were transferred to 70% ethanol. This resulted in significant color changes among those species naturally blue or green in hue. These gradually changed to a brown color, since the blue and green pigmentation is soluble in alcohol. Species naturally red or brown did not undergo any comparable change in color. Since it was not possible to distinguish all species in the field, notes on original color are not available except in a few cases, and those are noted in the descriptions.

Anatomical data were collected by dorsal dissections and from slides made of penial setae. Characteristics of the common or ambulatory setae are not given, as these are seldom different among closely related species, except in size. I have tried to characterize the circulatory systems, testis sacs and intestines in greater detail than has been the practice in the past. Measurements of the gizzard and proventriculus are given to allow comparison of the muscularity of the latter among species of different body sizes.

Systematics

Clitellata: Megascolecidae Rosa, 1891

Dichogaster haruvi n. sp. (Figs. 1A–C)

Etymology. The species name is derived from “Haruv,” the Hebrew name of Mr. Joseph Boxerman, in appreciation of Mr. Boxerman’s generous support of charitable causes.

Type material. Holotype (KUNHM Invertebrate Zoology 001907): soil in cloud forest on north side of summit of Blue Mountain Peak, 2250 m a.s.l., Jamaica, 11 September 1992, S.W. James. Paratypes (KUNHM Invertebrate Zoology 001908): two adults, two juveniles; same data as holotype.

Description. Dimensions 74–107 mm × 5.0 mm at segment x, 4.0 mm at xxx, 6.1 mm at clitellum; body cylindrical throughout, segments 131–146. Setae closely paired throughout; setal formula AA:AB:BC:CD = 2.8:1.2:3:1 at x, 4.3:1.1:4.7:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, completely divided by a mid-dorsal triangular depression with apex towards posterior; segments without secondary annulations. Brown pigmentation present dorsally to mid-laterally, formalin preservation. First dorsal pore

13/14, spermathecal pores in 7/8, 8/9 near A. Ovipores equatorial median to A in xiv; male pores on xvii near 17/18 in A; one pair prostatic pores in A in xvii, male grooves lacking; paired genital markings on AB in xix. Clitellum xiii–xx, saddle reaching to B (Fig. 1A).

Septa 10/11–13/14 muscular, 14/15 slightly so, greatest thickness at 11/12. Alimentary canal with proventriculus in v, two gizzards in vi, vii, these demarcated by collar-like ring. Gizzard diameter in vi 2.9 mm, proventriculus wall thickness 0.2–0.5 mm anterior to posterior; at posterior muscle thickness 0.3 mm with 0.2 mm folded inner non-muscular layer. Esophagus valvular in xviii, intestinal origin xix, full size in xx; low typhlosole one-fifth lumen diameter xxv–cix, with vertical flaps each side xxvi–xxxv, lateral typhlosoles 25/26–xxxvii. Calciferous glands dichogastrine, three pairs xv–xvii, increasing in size posteriorly. Micronephridia 12–14 per segment v–xviii, on muscular septa where possible; 14 per segment xix–end; postclitellate nephridia with dense cellular mantle containing oil droplets from xviii, ventralmost 2 rows per side stomate, less mantled; dense masses of micronephridia on body wall iii, iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in v(?), vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of vii to gizzard wall. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–viii, in viii entering dorsal esophagus wall. Supra-esophageal vessel visible in xi; efferent parieto-esophageal vessels from body wall of xiv–xx to dorsal-lateral esophageal wall of xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; equal size, each with spherical ampulla, moruloid diverticulum 8–9 lobed internally, sessile on duct near duct/ampulla junction (Fig. 1B).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 fused at body wall, lateral pockets of 9/10 contain coagulum; reniform seminal vesicles in xi, xii; vasa deferentia superficial, thick, with muscular sheen xv–xvii, enter body wall in xvii, diving diagonally towards 17/18; paired tubular prostates in xvii with large muscular ducts narrowing at body wall; penial setal follicles just median to ducts, penial setae very small, 8 μm × 440 μm (Fig. 1C); copulatory setae lacking.

Remarks. *D. haruvi* n. sp. and the next seven species below (through *D. johnsoni* n. sp.), all of which have one pair of prostates and no seminal grooves, can be distinguished from all other biprostatic Neotropical *Dichogaster* (s.l.) by the lack of seminal grooves and by having two pairs of spermathecae (vs. one) in vii and viii. *D. haruvi* n. sp. is unique among the similar Jamaican species in having the following combination of characters (see

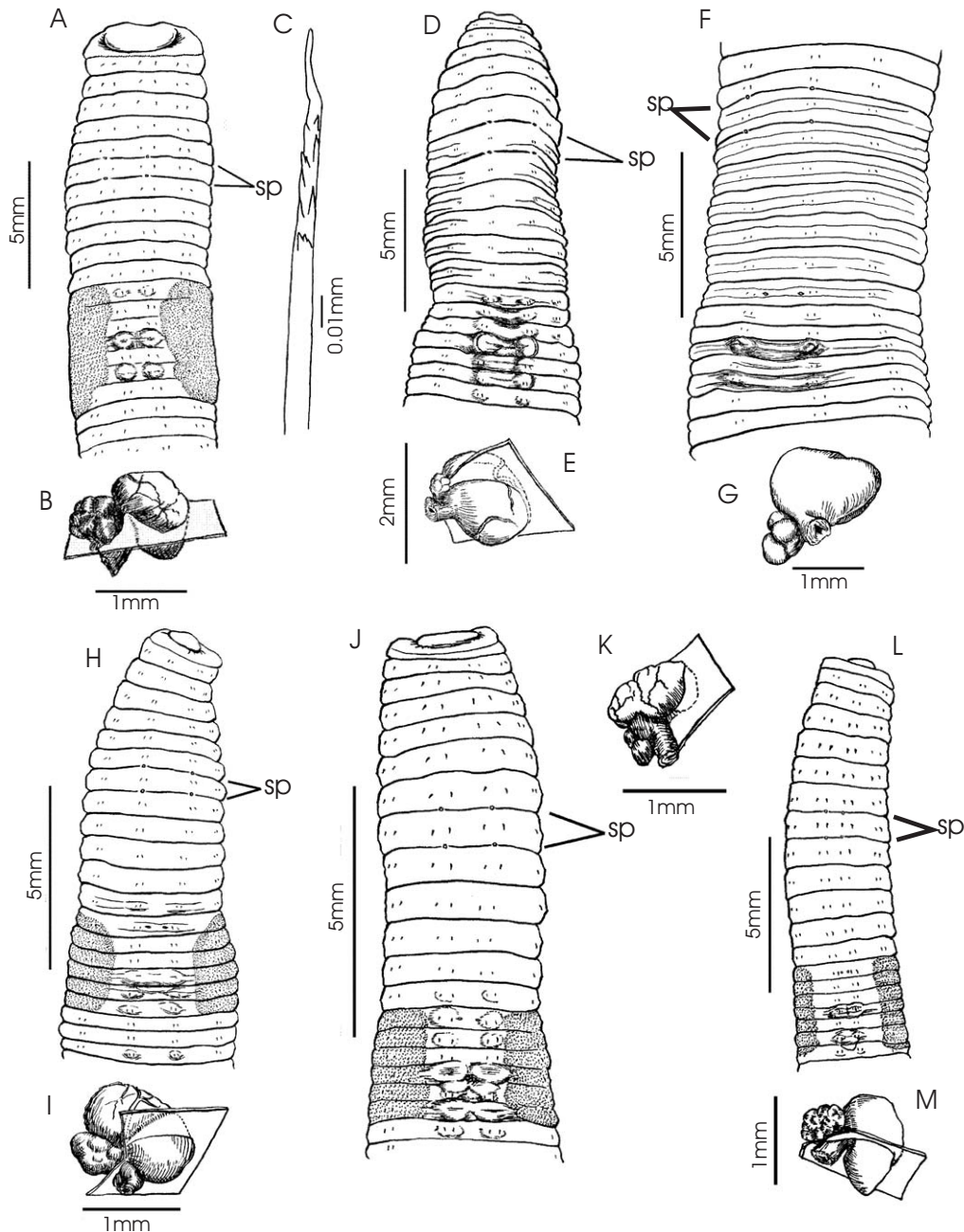


Fig. 1. Morphological structures of *Dichogaster* species; A, D, F, H, J, L: ventral views; B, E, G, I, K, M: spermathecae; C: penial seta. A–C, *D. haruvi* sp.n.; D and E, *D. harperi* sp.n.; F and G, *D. crossleyi* sp.n.; H and I, *D. hendrixi* sp.n.; J and K, *D. bromeliocola* sp.n.; L and M, *D. garciai* sp.n. Abbreviation: sp = spermathecal pores.

Table 1): penial setae present, 14 nephridia per segment in the intestinal region, and prostatic ducts muscular.

***Dichogaster harperi* n. sp.**

(Figs. 1D and E)

Etymology. The species is named in honor of Steve Harper of Fairfield, Iowa, USA, in recognition of his generous support for charitable causes.

Type material. Holotype (KUNHM Invertebrate Zoology 001909): soil in forest at 1950 m a.s.l., 2.5 km by trail below summit of Blue Mountain Peak, Jamaica, 11 September 1992, S.W. James. Paratype (KUNHM Invertebrate Zoology 001910): same data as holotype.

Description. Dimensions 104, 112 mm × 3.4, 4.0 mm at segment xxx, 5.5, 6.0 mm at x; body cylindrical throughout, segments 158, 170. Setae closely paired

Table 1. Distinguishing features of *Dichogaster* species with prostates in segment xvii

Species	Segments	Length (mm)	Color	First dorsal pore	Female pores	Nephridia	Penial setae	Male pores	Prostate duct muscularity	Testis sacs	Seminal grooves
<i>D. harui</i> n.sp.	131–146	74–107	Brown	13/14	Paired	14	Present	xvii	Yes	Septal, subesophageal	Absent
<i>D. harperi</i> n.sp.	158–170	104–112	None	20/21	Paired	16	Absent	17/18	No	Septal, subesophageal	Absent
<i>D. crossleyi</i> n.sp.	215	116	Pale red	14/15	Paired	22–24	Absent	17/18?	Yes	Septal, subesophageal	Absent
<i>D. hendrixii</i> n.sp.	?	>78	Red-brown	12/13	Paired	20	Absent	xvii	Yes	Septal, subesophageal	Absent
<i>D. bromelicolola</i> n.sp.	139	62–73	Brown	12/13	Paired	10	Absent	xvii	Yes	Septal, subesophageal	Absent
<i>D. garciai</i> n.sp.	112–141	47–72	Red-brown	12/13	Paired	12	Absent	xvii	Yes	Septal only	Absent
<i>D. davidi</i> n.sp.	149	102	Tan	13/14	Paired	14	Absent	xvii	No	x subesoph., xi septal	Absent
<i>D. johnsoni</i> n.sp.	79	43	Green-brown	12/13	Paired	8	Present	xvii	Yes	Septal, subesophageal	Absent
<i>D. sydneyi</i> n.sp.	98–124	31–38	Red-brown	11/12	Paired	8	Present	xvii	No	Subesophageal	Present
<i>D. grandis</i> (Sims)	439–459	330–347	?	12/13	Paired	50	Absent	xviii	?	Septal and ?	Present
<i>D. hartmeyeri</i> (Michaelsen)	123	30	Brown	11/12	Paired	8–10	Present	xvii	No	?	Present
<i>D. reichardtii</i> (Michaelsen)	425	230	?	12/13	?	30	Present	xvii?	No?	Septal?	Absent?

Data on species not examined in the present study are from Michaelsen (1908) and Sims (1987), respectively. Question marks indicate missing or doubtful data.

throughout; setal formula AA:AB:BC:CD = 4.3:1.4:1 at x, 6:1.3:8:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, divided by mid-dorsal groove reaching 1/2 ii; presetal secondary annulations vi–xv, postsetal secondary annulations vi–ix. Pigmentation absent, formalin preservation. First dorsal pore 20/21, though 13/14 almost open, spermathecal pores in 7/8, 8/9 near B in AB. Ovipores equatorial median to A in xiv; male pores in 17/18 in A; one pair prostatic pores in A in xvii, male grooves lacking. Clitellum xiv–xix, saddle reaching to B, paired papillae on AB in xix, no other genital markings (Fig. 1D).

Septa 10/11–14/15 muscular, maximum at 11/12–13/14; septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii, separated by thin-walled section. Gizzard vi diameter 2.5, 3.6 mm, proventriculus wall thickness 0.1–0.3 mm anterior to posterior including inner non-muscular layer. Esophagus valvular in xviii, intestinal origin xix, full size in xx; low typhlosole one quarter lumen diameter xxiv–cxi, cxv, with vertical flaps each side xxv, xxvi–xxx, xxxii; lateral typhlosoles xxv, xxvi–xxx. Calciferous glands dichogastrine, three pairs xv–xvii, separate ducts. Micronephridia 16–20 per segment vi–xviii, on muscular septa xi–xiii; 16 per segment xix–end; postclitellate nephridia with thin mantle xvii–xxv, dense cellular mantle containing oil droplets from xxvi, ventralmost row per side stomate, less mantled; dense masses of micronephridia on body wall iii–v; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of vi with branch to gizzard, commisural vessel of vii only to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix entering dorsal esophagus wall. Supra-esophageal vessel visible x–xi, connections to hearts visible in xii; efferent parieto-esophageal vessels from body wall of xiv–xx to dorsal-lateral esophageal wall in of xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae mainly in vii, viii; embedded in septa 7/8, 8/9, respectively; equal size, each with spherical ampulla, small diverticulum 2–3 lobed internally, sessile on duct near duct/ampulla junction, diverticulum on anterior side of corresponding septum (Fig. 1E).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 fused at body wall, lateral pockets of 9/10 contain coagulum; reniform seminal vesicles in xi, xii; vasa deferentia superficial, lacking muscular sheen, enter body wall in xvii, posterior to prostatic ducts, diving diagonally towards 17/18; paired tubular prostates in xvii with slender, non-muscular ducts; penial and copulatory setae lacking.

Remarks. Following the pattern established in the remarks on *D. haruvi* n. sp. above, *D. harperi* n. sp. can be distinguished by the following: penial setae absent, 16 nephridia in intestinal segments, prostatic ducts non-muscular.

***Dichogaster crossleyi* n. sp.**

(Figs. 1F and G)

Etymology. D.A. Crossley is an eminent soil ecologist whose work and wit has always been a source of inspiration to the author.

Type material. Holotype (KUNHM Invertebrate Zoology 001911): soil in forest at 1950 m a.s.l. 2.5 km by trail below summit of Blue Mountain Peak, Jamaica, 11 September 1992, S.W. James. Paratype (KUNHM Invertebrate Zoology 001912): same data as holotype.

Description. Dimensions of only complete adult 116 mm × 7.5 mm at segment xxx, 6.0 mm at viii; body cylindrical throughout, segments 215. Setae closely paired throughout; setal formula AA:AB:BC:CD = 8:1:9.5:1 at x, 11:1:10.5:1 at xxx, DD > 1/2 circumference, body cylindrical throughout. Prostomium tanylobous, divided by two furrows; presetal secondary annulations viii–xiii, postsetal secondary annulations viii–xiii. Faint dorsal red-brown pigmentation, formalin preservation; pink in life. First dorsal pore 14/15, spermathecal pores in 7/8, 8/9 near B in AB. Ovipores equatorial median to A; male pores not seen; paired papillae over AB in xvii, each with transverse slit; setae ab of xviii present, ab of xix present surrounded by small papillae; male grooves lacking; clitellum not developed (Fig. 1F).

Septa 10/11–13/14 muscular; septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii, separated by thin-walled section. Gizzard vi diameter 3.7 mm, proventriculus wall thickness 0.05 mm, but proventriculus distended with soil. Esophagus valvular in xviii, intestinal origin xix, full size in xx; low typhlosole one quarter lumen diameter xxiv–cxliv, with vertical flaps each side xxv–xxx; lateral typhlosoles xxv–xxx. Calciferous glands dichogastrine, three pairs xv–xvii, increasing in size posteriorly, ducts separate. Micronephridia 20 per segment vi–xviii, on muscular septa xi–xiii; 22–24 per segment xix–end; postclitellate nephridia with dense cellular mantle containing oil droplets from xxvi, ventralmost row per side stomate, less mantled; nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commissural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commissural vessel of vi with branch to gizzard, lateral of vii only to gizzard. Extra-esophageal vessel from pharyngeal

glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix entering dorsal esophagus wall. Supra-esophageal vessel visible only at connections to hearts visible x–xii; efferent parieto-esophageal vessels from body wall of xiv–xx to dorsal-lateral esophageal wall in of xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; equal size, each with ovate ampulla, diverticulum 3 lobed internally, sessile on duct near duct/ampulla junction; ampulla of viii embedded in septum 8/9; duct, diverticulum in viii (Fig. 1G).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 fused at body wall, lateral pockets of 9/10 contain coagulum; seminal vesicles in xi, xii; vasa deferentia superficial, muscular xv–xvii, enter body wall near 17/18 posterior to prostatic ducts; paired large coiled tubular prostates in xvii with slender, kinked muscular ducts; penial setal follicles just median to ducts, penial setae lacking.

Remarks. *D. crossleyi* n. sp. can be distinguished by the following: penial setae absent, 22–24 nephridia in intestinal segments, prostatic ducts muscular.

***Dichogaster hendrixii* n. sp.**

(Figs. 1H and I)

Etymology. This species is named after my friend and colleague Paul Hendrix, who is active in the field of earthworm ecology.

Type material. Holotype (KUNHM Invertebrate Zoology 001913): soil in forest at 1100 m a.s.l. on Vinegar Hill trail, Portland Parish, north slope of Blue Mountains, Jamaica, 22 September 1992, S.W. James and R. Calderon. Paratype (KUNHM Invertebrate Zoology 001914): same data as holotype.

Description. Dimensions of tail-autotomized specimens, 74, 75 mm × 7.0, 7.3 mm wide at segment xxx, 5 mm thick; body dorso-ventrally flattened throughout, segments not counted. Setae closely paired throughout; setal formula AA:AB:BC:CD = 7.2:1.2:7.6:1 at x, 7:1.2:7:1 at xxx, DD > 1/2 circumference throughout. Prostomium epilobous, divided by one furrow; pre- and post-setal secondary annulations ix–xiv. Dark dorsal red-brown pigmentation, formalin preservation. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 in AB. Ovipores equatorial, median to A in xiv; male pores at posterior edge of paired papillae over AB in xvii; setae ab of xviii present (1) setae b of xviii present (1), ab of xix present but reduced, surrounded by small papillae; male grooves lacking; clitellum 1/2 xiii–1/2 xx (Fig. 1H).

Septa 10/11–13/14 increasingly muscular, 14/15 much thinner; septa 9/10–11/12 fused at body wall at external

furrow 11/12. Alimentary canal with proventriculus in v, two gizzards in vi, vii, separated by thin-walled section of lesser diameter. Gizzard vi diameter 3.6 mm, proventriculus wall thickness 0.1–0.2 mm anterior to posterior. Esophagus valvular in xviii, intestinal origin xix; typhlosolar origin 24/25, height one-fourth lumen diameter with vertical flaps each side xxv–xxxii; lateral typhlosoles xxvi–30/31. Calciferous glands dichogastrine, three pairs xv–xvii, glands of xv smaller, ducts separate. Micronephridia up to 14 per segment vi–xviii, on muscular septa x–xiii; 20 per segment xix–end; from xxv nephridia with cellular mantle, ventralmost two rows per side stomate, less mantled; dense masses of micronephridia on body wall iii–v; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of vi with branches to gizzards, commisure of vii only to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix entering dorsal esophagus wall. Supra-esophageal vessel only visible at connections to hearts x–xii; efferent parieto-esophageal vessels from body wall to dorsal-lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; that of viii much larger, each with ovate ampulla, diverticulum 6 lobed internally, sessile on duct near duct/ampulla junction (Fig. 1I).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 fused at body wall, lateral pockets of 9/10 contain coagulum; seminal vesicles in xi, xii; vasa deferentia superficial, muscular xv–xvii, enter body wall near 17/18 posterior to prostatic ducts; paired very long coiled tubular prostates in xvii with slender, tightly kinked muscular ducts; penial setae lacking.

Remarks. *D. hendrixi* n. sp. can be distinguished by the following: penial setae absent, 20 nephridia in intestinal segments, prostatic ducts muscular, dark pigmentation.

***Dichogaster bromeliocola* n. sp.**
(Figs. 1J and K)

Etymology. The species is named for its habitat preference, the leaf tanks of bromeliads.

Type material. Holotype (KUNHM Invertebrate Zoology 001915): bromeliad plant leaf tanks in forest at 1100 m a.s.l. on Vinegar Hill trail, Portland Parish, north slope of Blue Mountains, Jamaica, 22 September 1992, S.W. James. Five paratypes (KUNHM Invertebrate Zoology 001916): same data as holotype.

Description. Dimensions 62–73 mm × 3.2–4.0 mm at x, 3.5–4.0 mm at xxx, body slightly dorso-ventrally flattened throughout, 139 segments. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3:1.5:3.5:1 at x, 4:1:5:1 at xxx, DD > 1/2 circumference throughout. Setae ab of iv–ix larger than other setae. Prostomium tanylobous, divided by one furrow; pre- and post-setal secondary annulations present ix–xii. Dark dorsal brown pigmentation, formalin preservation. First dorsal pore 12/13, 13/14; spermathecal pores in 7/8, 8/9 near a in AB. Ovipores equatorial, median to A in xiv; male pores at posterior edge of xvii; paired papillae over AB in xvii, xix, paired papillae anterior to setae ab of xviii, ab of xix absent; male grooves lacking; clitellum saddle to B, xiii–xix (Fig. 1J).

Septa 10/11–13/14 increasingly muscular, 14/15 much thinner; septa 9/10–11/12 fused at body wall at external furrow 11/12. Alimentary canal with proventriculus in v, two gizzards in vi, vii. Gizzard vi diameter 1.5 mm, proventriculus wall thickness 0.12–0.16 mm. Esophagus valvular in xviii, intestinal origin xix; typhlosole xxiv–ci, with vertical flaps each side xxiv–xxxii; lateral typhlosoles 24/25–34/35. Calciferous glands dichogastrine, three pairs xv–xvii, glands increasing in size posteriorly, ducts separate. Micronephridia up to 10 per segment vi–xviii, on muscular septa x–xiii; 10 per segment xix–end; from xxii nephridia with cellular mantle, ventralmost two rows per side stomate, less mantled; dense masses of micronephridia on body wall iii–iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of v to proventriculus, commisure of vii to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix entering supra-esophageal vessel; efferent parieto-esophageal vessels from body wall to dorsal-lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; ducts pass through septa to posterior, enter body wall just posterior to 7/8, 8/9, respectively; spermatheca of viii much larger, each with lenticular to spherical ampulla, diverticulum 5-lobed externally, sessile on duct near duct/ampulla junction (Fig. 1K).

Male sexual system holandric, testes and funnels in subesophageal paired sacs in x, xi; septa 9/10–11/12 fused at body wall; seminal vesicles in xi, xii; vasa deferentia superficial, muscular xiv–xvii, enter body wall in xvii just posterior to prostatic ducts; tubular prostates in xvii with thick muscular ducts; penial setae lacking.

Remarks. *D. bromeliocola* n. sp. can be distinguished by the following unique combination of characters: penial setae absent, 10 nephridia in intestinal segments,

prostatic ducts muscular, testis sacs subesophageal, septa 9/10–11/12 fused at body wall.

***Dichogaster garciai* n. sp.**

(Figs. 1L and M)

Etymology. This species is named in honor of the late American musician Jerry Garcia.

Type material. Holotype (KUNHM Invertebrate Zoology 001917): limestone-derived soil of west slope of John Crow Mountains above Millbanks, Portland Parish, 600 m a.s.l., Jamaica, 20 September 1992, S.W. James. Paratypes: 10 specimens (KUNHM Invertebrate Zoology 001918) with same data as holotype; 2 individuals (KUNHM Invertebrate Zoology 001919) from soil in forest at 1110 m a.s.l. on Vinegar Hill Trail, north slope of Blue Mountains, Portland Parish, Jamaica, 22 September 1992, S.W. James and R. Calderon; uncounted adults (KUNHM Invertebrate Zoology 001946) from limestone-derived soil, west slope of John Crow mountains just north of Cornpass Gap, 18°00.37'N, 76°21.82'W, 550 m a.s.l., Jamaica, 14 February 2000, S.W. James.

Description. Dimensions 47–72 mm × 3.9 mm at segment ix, 2.8 mm at xxx; body cylindrical throughout, segments 112–141. Setae closely paired throughout; setal formula AA:AB:BC:CD = 2.5:1.2:3:1 at x, 6.7:1:5.3:1 at xxx (Vinegar Hill material; John Crow worms more widely paired: 3.5:1:4.5:1 at xxx), DD > 1/2 circumference throughout. Prostomium epilobous, divided by one furrow or broad triangular depression. Dorsal red-brown pigmentation, formalin preservation, brighter red in life. First dorsal pore 12/13 (4) or 13/14 (3), spermathecal pores in 7/8, 8/9 in AB lateral to A. Ovipores equatorial, median to A in xiv; unpaired papilla over BB in xvii, slight thickening over same region in xix; male pores at posterior edge of papilla in xvii; setae ab of xviii present, ab of xix present but smaller and closer together than ab of adjoining segments; male grooves lacking; clitellum saddle 1/2 xiii–xx (Fig. 1L).

Septa 10/11–13/14 increasingly muscular, 14/15 much thinner; septa 9/10–11/12 partly fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii, separated by thin-walled section of lesser diameter. Gizzard vi diameter 1.2–2.0 mm, proventriculus wall thickness 0.1–0.2 mm anterior to posterior. Esophagus valvular in xviii, intestinal origin xix, full size in xx, with deep lateral pouches xix–xxiv, xxv; typhlosole xxiv–lxxxvi, xciii, xcv, cxiii, cvi; simple fold one quarter to one third lumen diameter; continuous lateral typhlosoles xxv–xxxiv, xxxv. Calciferous glands dichogastrine, three pairs xv–xvii, glands increasing in size posteriorly, ducts separate. Micronephridia 4–10 per segment vi–xvii, on muscular septa x–xiii; 12 per

segment xviii–end; from xx nephridia with cellular mantle, ventralmost two rows per side stomate, less mantled to simply tubular; dense masses of micronephridia on body wall iii–v; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts x–xii. Commisural vessel of v to proventriculus, commisure of vii only to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix entering dorsal esophagus wall. Supraesophageal vessel visible ix–xiii; efferent parieto-esophageal vessels from body wall to dorsal-lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii (according to septa, but viii, ix according to commissures); that of viii much larger, each with ovate ampulla, diverticulum 2–4 lobed internally, sessile on duct near duct/ampulla junction (Fig. 1M).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; small dense seminal vesicles in xi, xii; vasa deferentia superficial, muscular xiv–xvii, enter body wall anterior or posterior to prostatic ducts, in either case reaching external pore posterior to prostatic pore; paired long coiled tubular prostates in xvii with muscular ducts with diameter greater than or equal to glandular portion; penial setae lacking.

Remarks. *D. garciai* n. sp. can be distinguished by the following: penial setae absent, 12 nephridia in intestinal segments, prostatic ducts muscular, testis sacs not subesophageal, formed from partial fusion of septa 9/10–11/12 at body wall. It is most similar to *D. bromeliocola* n. sp., from which it also differs in coloration and habitat, the latter species living in bromeliad leaf tanks.

***Dichogaster davidi* n. sp.**

(Figs. 2A and B)

Etymology. The species is named after the author's son, David T. James.

Type material. Holotype (KUNHM Invertebrate Zoology 001920): from soil in elfin forest at 2250 m a.s.l. near summit of Blue Mountain Peak, Jamaica, 11 September 1992, S.W. James. Paratype (KUNHM Invertebrate Zoology 001921): same data as holotype.

Description. Dimensions 102 mm × 5.4 mm at viii, clitellum, 6.5 mm at xxx; body cylindrical, segments 149. Setae closely paired throughout; setal formula AA:AB:BC:CD = 4:1:3:1 at x, 7:1:9:1 at xxx, DD > 1/2 circumference throughout. Setae ab xviii present, xix

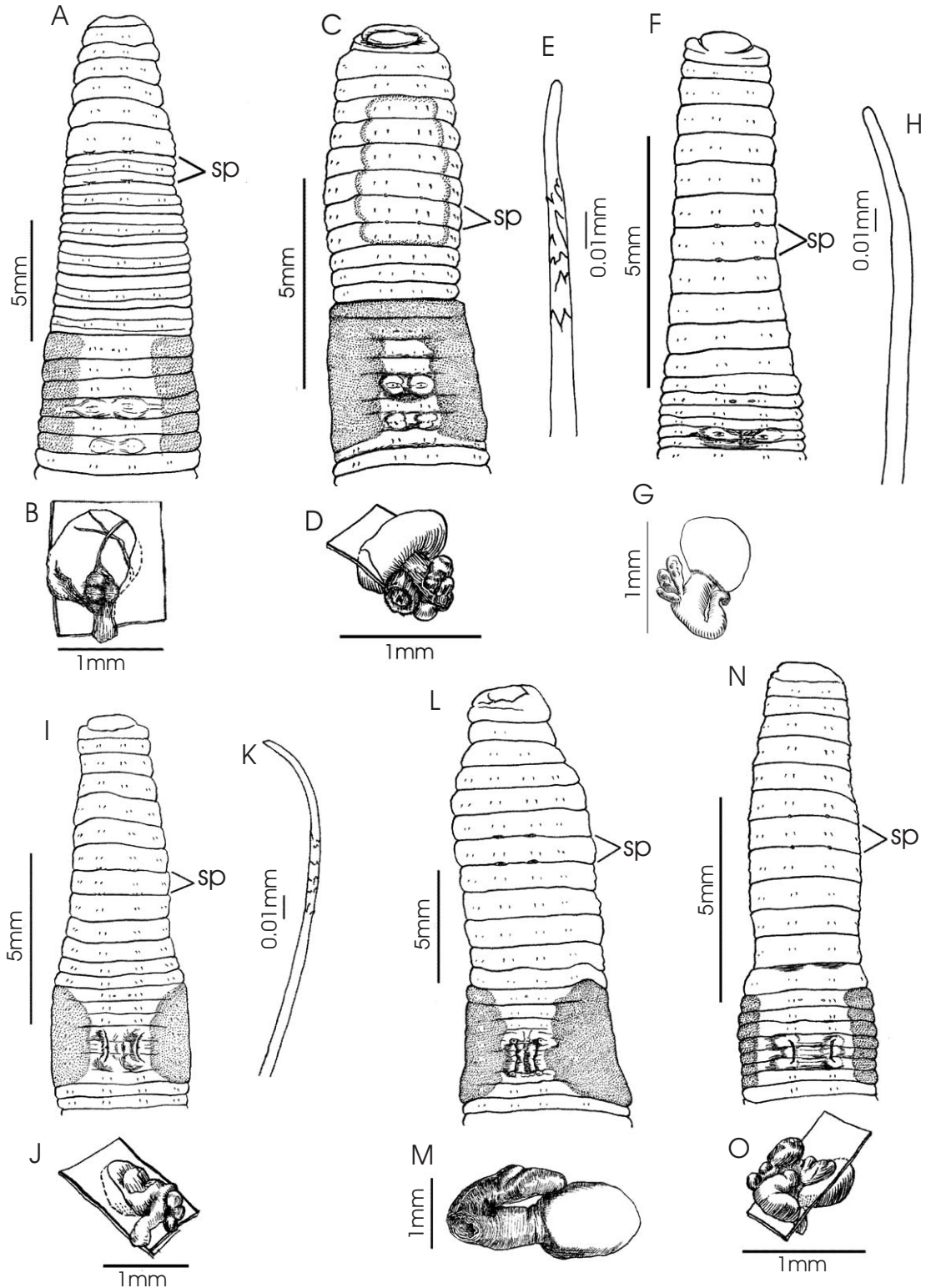


Fig. 2. Morphological structures of *Dichogaster* species; A, C, F, I, L, N: ventral views; B, D, G, J, M, O: spermathecae; E, H, K: penial setae. A and B, *D. davidi* sp.n.; C–E, *D. johnsoni* sp.n.; F–H, *D. sydneyi* sp.n.; I–K, *D. manleyi* sp.n.; L and M, *D. montecyanensis*; N and O, *D. altissima* sp.n. Abbreviation: sp = spermathecal pores.

absent. Prostomium tanylobous, divided by one furrow, segments viii–xiii triannulate. Faint tan pigmentation present dorsally to mid-laterally, formalin preservation. First dorsal pore 13/14, spermathecal pores in 7/8, 8/9 near A. Ovipores paired, equatorial median to A in xiv; male pores posterior edge of xvii; one pair prostatic pores in A in xvii, paired papillae in xix with apparent pore, male grooves lacking. Clitellum not developed, no other genital markings (Fig. 2A).

Septa 10/11–13/14 muscular, greatest thickness at 11/12. Alimentary canal with proventriculus in v, gizzards in vi, vii, nearly continuous. Gizzard diameter 3.5 mm, proventriculus wall thickness 0.2–0.4 mm anterior to posterior; proventriculus lined with longitudinal and pebbly textured layer. Esophagus valvular in xviii, intestinal origin 1/2xix, full size in xx, constricted at 24/25; low typhlosole from xx a mere wrinkle, expanding abruptly in xxv to one fourth lumen diameter, simple fold, ends cviii, lateral typhlosoles xxv–xxxi. Paired dorsal caeca xlv. Calciferous glands dichogastrine, ducts separate, three pairs xv–xvii, increasing in size posteriorly. Micronephridia 8–10 per segment v–ix, 18–20 x–xiii and on muscular septa in those segments; 16–18 per segment xiv–xix, 14 per segment xx–end; postclitellate nephridia with dense cellular mantle from xxiii, ventralmost row per side unmantled, stomate; dense masses of micronephridia on body wall iii, iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of vii to gizzard wall only, of vi with branch to gizzard wall. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–viii, in ix entering dorsal esophagus wall. Supra-esophageal vessel not seen, though hearts x–xii have connections to usual location of supra-esophageal vessel; efferent parieto-esophageal vessels from body wall of xiv–xx to dorsal-lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; each with sac-shaped ampulla, moruloid diverticulum sessile on duct near duct/ampulla junction (Fig. 2B); spermathecae of viii have ampulla penetrating septum 8/9.

Male sexual system holandric, testes and funnels in ventral paired sacs in x, in sac formed by septal fusion in xi; septa 9/10–11/12 fused at body wall, lateral pockets of 9/10 contain coagulum; reniform seminal vesicles in xi, xii; vasa deferentia superficial, thin, with slight muscularity xiv–xvii, enter body wall in xvii, diving diagonally towards 17/18; paired tubular prostates in xvii with slender non-muscular ducts; penial setae lacking.

Remarks. *D. davidi* n. sp. can be distinguished by the following: penial setae absent, 14 nephridia in intestinal

segments, prostatic ducts non-muscular, testis sacs of xi not subesophageal, only from fusion of septa 10/11, 11/12 at body wall.

***Dichogaster johnsoni* n. sp.**

(Figs. 2C–E)

Etymology. The species is given the family name of the author's wife.

Type material. Holotype (KUNHM Invertebrate Zoology 001922): from bromeliad in montane forest at 1280 m a.s.l. along waterfall trail at Hollywell Park above Newcastle, Blue Mountains, St. Andrews Parish, Jamaica, 10 September 1992, S.W. James.

Description. Dimensions 43 mm × 3.8 mm at segment xxx, 3.3 mm at xx, 3.6 mm at clitellum; body elliptical in cross-section throughout, segments 79. Setae closely paired throughout; setal formula AA:AB:BC:CD = 2:1:3:1 at x, 4:1.2:6:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, completely divided by a single mid-dorsal groove. Greenish-brown pigmentation present dorsally to mid-laterally, formalin preservation. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 near A. Ovipores equatorial median to A in xiv; male pores posterior part of xvii; one pair prostatic pores in A in xvii, paired papillae in xix on AB, male grooves lacking. Clitellum xviii–1/2xx, annular in xviii, xiv (Fig. 2C).

Septa 10/11–13/14 slightly muscular, greatest thickness at 11/12. Alimentary canal with proventriculus in v, gizzards in vi, vii, nearly continuous. Gizzard diameter vi 1.5 mm, proventriculus wall thickness 0.15 mm; proventriculus lined with longitudinal furrows. Esophagus valvular in xviii, intestinal origin xix; low typhlosole from xxiii one-fifth lumen diameter, simple fold, ends lxv, lateral typhlosoles xxiv–xxxiv. Calciferous glands dichogastrine, ducts separate, three pairs xv–xvii, increasing in size posteriorly. Micronephridia 6–10 per segment v–xvii, 8 per segment xviii–end; postclitellate nephridia with dense cellular mantle from xxii, ventralmost row per side unmantled, stomate; dense masses of micronephridia on body wall iii, iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts in x–xii. Commisural vessel of vii to gizzard wall only. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–viii, in viii entering dorsal esophagus wall. Supra-esophageal vessel not seen; efferent parieto-esophageal vessels from body wall of xiv–xx to dorsal-lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; each with

sac-shaped ampulla, 3–4 chambered diverticulum sessile on duct near duct/ampulla junction (Fig. 2D); spermathecae of viii have ampulla penetrating septum 8/9.

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 fused at body wall; reniform seminal vesicles in xi, xii; vasa deferentia superficial, muscular xiv–xvii, enter body wall in xvii; paired tubular prostates in xvii with slender muscular ducts; penial setae $460\ \mu\text{m} \times 12\ \mu\text{m}$, shaft gently curved, tip blunt, unornamented, some small scale-like teeth just ental to the tip (Fig. 2E).

Remarks. *D. johnsoni* n. sp. can be distinguished by the following: penial setae present, 8 nephridia in intestinal segments, prostatic ducts muscular, green pigmentation.

The preceding 8 species, including *D. johnsoni*, share the distinctive characteristics of having one pair of prostatic glands in xvii and of lacking any trace of seminal grooves in the male field. The spermathecal diverticula are all attached very close to the duct–ampulla junction. The previously known biprostatic Neotropical *Dichogaster* are all from Jamaica. Additional undescribed biprostatic species are present on Martinique (James, unpublished). There is some doubt whether biprostatic Jamaican worms constitute a clade, with or without the Martinique species. Some lack penial setae, some have them; some lack seminal grooves and some do not, *D. grandis* (Sims) has male pores in xviii while the others have male pores in xvii, and some have spermathecal diverticula that are clearly sessile, while others have diverticula with distinct stalks. Any decision to elevate this collection of species to a formal rank would involve seemingly arbitrary hypotheses about character evolution. Dividing them among the proposed subgenera of *Eutrigaster* (Csuzdi and Zicsi 1991; Csuzdi 1995) also makes questionable statements about character evolution in this assemblage. Complicating the situation further is the next species in the present paper, which has prostates in xvii only, but does have seminal grooves. Table 1 provides characteristics of the species discussed here.

***Dichogaster sydneyi* n. sp.**
(Figs. 2F–H)

Etymology. The species is named after the author's late father.

Type material. Holotype (KUNHM Invertebrate Zoology 001923): under moss on fallen logs and prostrate tree limbs in elfin forest at summit of Blue Mountain Peak, 2250 m a.s.l., St Andrews Parish, Jamaica, 11 September 1992, S.W. James. Paratypes: 5 specimens (KUNHM Invertebrate Zoology 001924) with same data as holotype; uncounted specimens

(KUNHM Invertebrate Zoology 001925) from bromeliad leaf tanks about 2.5 km by trail below Blue Mountain Peak, 1950 m a.s.l., St. Andrews Parish, Jamaica, 11 September 1992, S.W. James.

Description. Dimensions 31–38 mm \times 3.1 mm at segment xxx, 2.5 mm at x; body elliptical in cross-section throughout, segments 98–124. Setae closely paired throughout; setal formula AA:AB:BC:CD = 5:1.3:4:1 at x, 6:1:4:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, completely divided by a single mid-dorsal groove sometimes extending into ii. Faint red-brown pigmentation present dorsally to mid-laterally, formalin preservation. First dorsal pore 11/12 (type locality material), 12/13, spermathecal pores in 7/8, 8/9 near A. Ovipores equatorial median to A in xiv; male grooves within xvii, prostatic pores at anterior end of grooves, male pores at posterior end of grooves. Clitellum 1/2xiii–xix, saddle (Fig. 2F).

Septa 10/11–13/14 slightly muscular, greatest thickness at 11/12. Alimentary canal with proventriculus in v, gizzards in vi, vii, nearly continuous. Gizzard diameter 1.1–1.3 mm, proventriculus wall thickness 0.08–0.1 mm; proventriculus lined with longitudinal furrows. Esophagus valvular in xviii, intestinal origin xix; low typhlosole from xxi, full size 25/26, one-sixth lumen diameter, simple thick fold becoming ribbon-like posteriorly, ends ci, c, lxxxii, xcii, lateral typhlosoles xxiii, xxiv–xxxi, xxxii. Calciferous glands dichogastrine, ducts separate, three pairs xv–xvii, increasing in size posteriorly. Micronephridia 6–8 per segment v–xvii, 8 per segment xviii–end; ventralmost rows stomate; postclitellate nephridia with dense cellular mantle from xviii, dense masses of micronephridia on body wall iii, iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in viii, ix, latero-esophageal hearts in x–xii. Commisural vessels of vi, vii to gizzard wall only; those of v to proventriculus wall. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–viii, in ix entering dorsal esophagus wall. Supra-esophageal vessel visible at points of attachment to hearts, with small ventrally directed vessels on esophageal wall from these points; efferent parieto-esophageal vessels from body wall of xiv–xviii to lateral esophageal wall in xiv (in material from 1950 m these connect to supra-esophageal vessel directly). Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; each with sac-shaped ampulla, bi- or trifurcate stalked diverticulum on enlarged portion of duct just ectal to duct/ampulla junction (Fig. 2G).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; septa 9/10–11/12 nearly fused at body wall; seminal vesicles in xi, xii, each an elongate arc attached ventrally; vasa deferentia superficial, enter

body wall in xvii; paired tubular prostates in xvii with slender non-muscular ducts; penial setae $359\ \mu\text{m} \times 11\ \mu\text{m}$, shaft smooth, tip blunt, unornamented (Fig. 2H), some individuals with empty penial setal follicles.

Remarks. *D. sydneyi* n. sp. can be distinguished by the following: penial setae present, 8 nephridia in intestinal segments, seminal grooves present, biprostatic, spermathecae in vii, viii, prostatic ducts non-muscular. Were it not for the presence of seminal grooves, this species would greatly resemble *D. johnsoni* n. sp., which also inhabits bromeliads. However, there are additional distinguishing features, including the form of the spermathecal diverticulum and several somatic characters.

***Dichogaster manleyi* n. sp.**
(Figs. 2I–K)

Etymology. The species is named in honor of the late former Prime Minister of Jamaica, Michael Manley.

Type material. Holotype (KUNHM Invertebrate Zoology 001926): from moss growing on prostrate tree limbs and fallen logs in elfin forest at summit of Blue Mountain Peak, 2250 m a.s.l., St. Andrews Parish, Jamaica, 11 September 1992, S.W. James. Five paratypes (KUNHM Invertebrate Zoology 001927): same data as holotype.

Description. Dimensions $38\text{--}44\ \text{mm} \times 2.5\text{--}3.2\ \text{mm}$ at x, $3.1\text{--}3.5\ \text{mm}$ at xxx; body cylindrical anteriorly, cylindrical to ovate posteriorly, segments 144–149. Setae closely paired throughout; setal formula AA:AB:BC:CD = 4:1:4:1 at x, 5:1:4.8:1 at xxx, $DD > 1/2$ circumference throughout. Prostomium tanylobous, divided by two furrows. Pigmentation faint red-brown dorsally in formalin preservation. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 in AB closer to B. Ovipores equatorial, paired in xiv median to A; male pores xviii in seminal grooves. Seminal grooves in raised male field; clitellum xiii–xix, only slightly developed (Fig. 2I).

Septa 11/12–13/14 muscular, septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii; gizzard vi diameter 1.6 mm, proventriculus wall thickness 0.1–0.2 mm. Esophagus valvular in xviii, intestinal origin xix, constriction at 22/23, small paired dorsal caeca xliii or xlv; typhlosole xxii–cxii, simple fold one-third lumen diameter; continuous lateral typhlosoles xxiii–xxx. Calciferous glands dichogastrine, three pairs xv–xvii, glands increasing in size posteriorly, ducts separate. Micronephridia 8–10 per segment v–xviii, on muscular septa in segments with muscular septa; 10 per segment xix–end; from xix nephridia with dense cellular mantle, ventralmost rows stomate; dense masses of micronephridia on body wall iii–iv; otherwise nephridia distributed AB- dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in v, viii, ix, latero-esophageal hearts x–xii. Commisural vessels vi, vii only to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Supra-esophageal vessel visible only at attachments to hearts; efferent parieto-esophageal vessels from body wall of xiv–xviii to lateral esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii, that of viii larger, each with ovate ampulla, 3–4 chambered diverticulum sessile on duct close to middle of duct (Fig. 2J).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; small dense seminal vesicles in xi, xii; vasa deferentia superficial, non-muscular, union with body wall at 1/2 xviii; paired folded tubular prostates in xvii, xix, those of xvii larger than in xix; prostatic ducts slender, non-muscular, short, nearly straight; penial setae $550\text{--}675\ \mu\text{m} \times 12\ \mu\text{m}$, shaft nearly straight, ectalmost portion curved, tip blunt, 4–5 rows of small, scale-like teeth just ental to curved portion (Fig. 2K).

Remarks. *D. manleyi* n. sp. can be distinguished from most other Neotropical *Dichogaster* with prostates in xvii, xix and spermathecae in vii, viii by the following: penial setae present, 10 nephridia in intestinal segments, gizzards in vi, vii, prostatic ducts non-muscular. It is similar to *D. sporadonephra* Cognetti, from which it can be distinguished by the following characteristics: lateral typhlosoles xxiii–xxx, non-muscular prostatic ducts, penial setae bent at the tips, nephridia arranged regularly. *D. sporadonephra disa* Righi has a greater number of nephridia, gizzards in v and vi, lateral typhlosoles from xxx–xlvi, a greater extent of septal muscularization, and hearts in xi and xii only (Righi, 1972). Table 2 summarizes the characteristics of the Jamaican species with prostates in xvii and xix or xvii, xix and xx.

***Dichogaster montecyanensis* (Sims)**
(Figs. 2L and M)

Eutrigaster montecyanensis Sims 1987: 435

Eutrigaster franzi Csuzdi & Zicsi, 1991: 183; Csuzdi (1995, p. 104)

Eutrigaster montecyanensis (Sims); Csuzdi (1995, p. 107)

Eutrigaster (Eutrigaster) montecyanensis (Sims); Csuzdi (2000, p. 73)

Material examined. Jamaica: three adults (KUNHM Invertebrate Zoology 001928) from soil in forest at 1950 m a.s.l., 2.5 km by trail below summit of Blue Mountain Peak, St. Andrews Parish, 11 September

Table 2. Distinguishing features of *Dichogaster* species with prostates in segments xvii and xix or more

Species	Segments	Length (mm)	Color	First dorsal pore	Penial setae	Nephridia	Spermathecal location	Prostate duct muscularity	Prostate locations	Testis sacs	Intestinal caeca	Seminal grooves
<i>D. mantleyi</i> n.sp.	144–149	38–44	Red-brown	12/13	Present	10	vii, viii	None	xvii, xix	Subesophageal	None	Present
<i>D. montecyanensis</i> (Sims)	164–209	78–134	Gray, striped	12/13	Absent	16–20	viii, ix	Present	xvii, xix	Subesophageal	Single pair in xliii or xlv	Present
<i>D. altissima</i> n.sp.	158–179	55–64	Unpigmented	13/14	Absent	8–10	vii, viii	xvii only	xvii, xix	x subesoph., xi septal	None	Present
<i>D. orobia</i> (Graff)	101–168	36–57	Green	11/12	Absent	6	viii, ix	?	xvii, xix	Present	None	Present
<i>D. montana</i> (Csuzdi & Zicsi)	112	70	Brown	11/12	Present	20–22	viii, ix	Present	xvii, xix	Present	None	Present
<i>D. jamaicae</i> (Eisen)	130	40	Reddish	6/7	Present	?	viii, ix	?	xvii, xix	?	None ?	Present ?
<i>D. townsendi</i> (Eisen)	165	90	Brown	?	Absent	2	viii, ix	Present	xvii, xviii, xix	?	?	?
<i>D. marleyi</i> n.sp.	286	190	Bluegreen	13/14	Absent	28–30	viii, ix	Present	xvii, xix, xx	x septal, xi none	Single pair lxx	Absent
<i>D. farri</i> n.sp.	>194	>135	Pale red brown	12/13	Absent	28	vii, viii	Present	xvii, xix, xx	x, xi septal, x subesoph.	Single pair lxx	Absent
<i>D. garrawayi</i> n.sp.	214	129–160	Red-brown	12/13	Absent	22	vii, viii	Present	xvii, xix, xx	x, xi septal, x subesoph.	Single pair lxx	Absent

Data on species not examined in the present study are from Eisen (1900), Graff (1957) and Csuzdi and Zicsi (1991), respectively. Question marks indicate missing or doubtful data.

1992, S.W. James; two adults (KUNHM Invertebrate Zoology 001929) from soil in forest at 1100 m a.s.l. on Vinegar Hill trail, Portland Parish, north slope of Blue Mountains, 22 September 1992, S.W. James and R. Calderon; one adult (KUNHM Invertebrate Zoology 001947) from stony topsoil of forested ravine near water system intake about 5 km by road below Newcastle, 880 m a.s.l., St. Andrews Parish, 10 September 1992, S.W. James; two adults (KUNHM Invertebrate Zoology 001930) from limestone-derived soil of west slope of John Crow Mountains above Millbanks, Portland Parish, 600 m a.s.l., 20 September 1992, S.W. James.

Description. Dimensions 78–134 mm × 4.4–7.5 mm at ix, 3–5 mm at xxx; body cylindrical anteriorly, cylindrical to ovate posteriorly, segments 164–209. Setae closely paired throughout; setal formula AA:AB:BC:CD = 2.5:1:3:1 at x, 5.5:1.5:6.5:1 at xxx, DD > 1/2 circumference throughout. Prostomium epilobous, divided by one furrow (Newcastle, John Crow Mtns.) or broad depression approximating two furrows. Pigmentation densest in circumferential stripes centered on intersegmental furrows, pale at segmental equators, color blue-gray in life, red-brown in formalin preservation. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 in AB lateral to A. Ovipore single, midventral, in xiv; male pores xviii in seminal grooves. Seminal grooves in raised male field, ends of grooves often raised into porophores of prostatic pores; single midventral genital marking over AA of xxi (Blue Mtn. only); clitellum 1/2 xliii–xx, saddle (Fig. 2L).

Septa 10/11–13/14 increasingly muscular, 14/15 much thinner; septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii; gizzard vi diameter 1.8–3.3 mm, proventriculus wall thickness 0.15–0.2 mm. Esophagus valvular in xviii, intestinal origin 1/2xix, full size in xx, with deep lateral pouches xix–xxiv, small paired dorsal caeca xliii (Millbanks only) or xlv; typhlosole xxv–cxxi (1), cxxv (1), cxlv (1), cxli (1), simple fold one-quarter to one-third lumen diameter; continuous lateral typhlosoles xxv or xxvi–xxxiv, xxxiii, xxxiv, xxxv. Calciferous glands dichogastrine, three pairs xv–xvii, glands increasing in size posteriorly, ducts separate. Micronephridia 12–24 per segment v–xvii, on muscular septa in segments with muscular septa; 16–20 per segment xviii–end (constant within individuals, variable among them); from xx nephridia with thin cellular mantle, ventralmost row each side stomate, tubular; dense masses of micronephridia on body wall iii–iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commissural vessels in vi (connection to ventral vessel lacking for commisure vi of Millbanks and Newcastle material; here vi to gizzard), viii, ix, latero-esophageal hearts x–xii. Commissural

vessel of v to proventriculus, commisure of vii only to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Supra-esophageal vessel ix–xiv; in xiv efferent parieto-esophageal vessels from body wall to lateral esophageal wall.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in viii, ix; that of ix much larger, each with ovate ampulla, elongate diverticulum 1–2 lobed internally, on duct near duct/body wall junction (Fig. 2M).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi; some coagulum in lateral pouches of septa 9/10, 10/11; small dense seminal vesicles in xi, xii; vasa deferentia superficial, beginning of muscularity variable xii–xvi, muscular until union with body wall at 1/2 xviii; paired long coiled tubular prostates in xvii, xix, those of xvii much larger than in xix; prostatic ducts muscular, widening ectally with ectal diameter approximately equal to glandular portion; penial setae lacking.

Remarks. The Newcastle specimens carried flattened enchytraeid commensals, probably *Pelmatodrilus* sp. of Moore (1943; see Coates 1989). When alive, the enchytraeids are translucent and appear to glide smoothly, without contraction or extension, over the surfaces of their earthworm hosts. These tiny ghostly presences were not dislodged by the violent thrashing of the newly captured worms, but only released their hold when all were killed in alcohol.

The specimens collected and described here differ only in slight degrees from descriptions in Sims (1987) and Csuzdi and Zicsi (1991). Csuzdi (pers. comm.) has verified the presence of the small intestinal caeca in specimens he originally described as *Eutrigaster franzi*, helping to confirm that our two lots of material are conspecific. Csuzdi also examined Sims' syntypes of *D. montecyanensis*, correcting the original description and causing him to subsume his *E. franzi* as a junior synonym (Csuzdi 2000). Although I have not examined the type specimens for either above name, I am confident that we have indirectly established the correct identity of my *D. montecyanensis* material. To date, this species is the most widely distributed and frequently encountered of all endemic earthworms in eastern Jamaica.

Dichogaster altissima n. sp.

(Figs. 2N and O)

Etymology. The name refers to the high elevation of the type locality.

Type material. Holotype (KUNHM Invertebrate Zoology 001931): from soil in elfin forest at 2250 m a.s.l. near summit of Blue Mountain Peak, Jamaica, 11 September 1992, S.W. James. Five paratypes (KUNHM Invertebrate Zoology 001932): same data as holotype.

Description. Dimensions 55–64 mm × 3.3 mm at ix, 2.6 mm at xxx; body cylindrical, segments 158–179. Setae closely paired throughout; setal formula AA:AB:BC:CD = 4.5:1.3:7:1 at x, 5.5:1.3:6:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, divided by one furrow, segments i and ii nearly fused. Pigmentation lacking. First dorsal pore 13/14, spermathecal pores in 7/8, 8/9 in AB. Ovipores paired, equatorial, just median to A in xiv; male pores xviii. Seminal grooves xvii–xix, grooves straight; clitellum xiv–xx, saddle (Fig. 2N).

Septa 9/10–13/14 increasingly muscular, 14/15 much thinner; septa 10/11, 11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii; with slight constriction and thin-walled at 6/7; gizzard vi diameter 1.7 mm, proventriculus well vascularized, wall thickness 0.2 mm. Esophagus valvular in xviii, intestinal origin xix, texture changes at xxiv, chloragogen coating begins in xxv; typhlosole xxiii–cxxi, simple fold one quarter to one third lumen diameter, with vertical flaps xxiv–xxx; continuous lateral typhlosoles xxiii, xxiv–xxix, xxxi; calciferous glands dichogastri- three pairs xv–xvii, glands increasing in size posteriorly, ducts separate. Caeca lacking. Micronephridia 8–10 per segment v–xvii, on muscular septa in segments with muscular septa; 8–10 per segment xviii–end; from xix nephridia with thin cellular mantle, ventralmost row each side stomate, tubular; dense masses of micronephridia on body wall iii–v; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in v, vi, viii, ix, latero-esophageal hearts xi, xii. Hearts lacking in x. Commisural vessel of vii to gizzard, of vi with branch to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Supra-esophageal vessel ix–xii; efferent parieto-esophageal vessels from body wall of xiv–xviii to dorsal esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; composed of pyriform ampulla poorly demarcated from duct, 3–4 sessile knob-shaped diverticula in single row on duct, decreasing in size ectally (Fig. 2O).

Male sexual system holandric, testes and funnels in ventral paired sacs in x, sac formed by fusion of septa in xi; coagulum in ventral sac of x, entire segment xi; small dense seminal vesicles in xi, xii; vasa deferentia superficial, looped, muscular xiv until union with body wall in

xviii; paired long coiled tubular prostates in xvii, xix, those of xvii much larger than in xix; prostatic ducts muscular but slender xvii, non-muscular xix; penial setae lacking.

Remarks. *D. altissima* n. sp. can be distinguished from other Neotropical *Dichogaster* with prostates in xvii, xix and spermathecae in vii, viii by the following: penial setae absent, 8–10 nephridia in intestinal segments, gizzards in vi, vii, pigmentation lacking, prostatic ducts of xvii muscular, of xix non-muscular.

***Dichogaster marleyi* n. sp.**
(Figs. 3A and B)

Etymology. This large species is named in honor of the late Jamaican musician Bob Marley.

Type material. Holotype (KUNHM Invertebrate Zoology 001933): from soil in montane forest at 1280 m a.s.l. along waterfall trail at Hollywell Park above Newcastle, Blue Mountains, St. Andrews Parish,

Jamaica, 10 September 1992, S.W. James. Paratype (KUNHM Invertebrate Zoology 001934): same data as holotype.

Description. Dimensions 190 mm × 7.5 mm at ix, 7 mm at xxx; body ovate in cross-section, gradually tapering towards posterior, segments 286. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3:1:3.5:1 at x, 4.3:1:4.3:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, divided by one furrow. Pigmentation blue-green to slate blue in life, reddish brown preserved, darker dorsally. First dorsal pore 13/14, spermathecal pores in 7/8, 8/9 in AB. Ovipore single mid-ventral in xiv; male pores 17/18 (1), xviii (1). Male grooves lacking, prostatic pores three pairs xvii, xix, xx; those of xix, xx surrounded by genital markings over BB, pores of xvii on small porophores with faint grooves extending posteriorly from pores to 17/18; setae ab xvii–xx lacking; clitellum xiv–xxi, saddle (Fig. 3A).

Septa 8/9, 9/10 thinly muscled, 10/11–13/14 very muscular, 14/15 much thinner; septa 9/10, 10/11 fused at body wall. Alimentary canal with proventriculus in v,

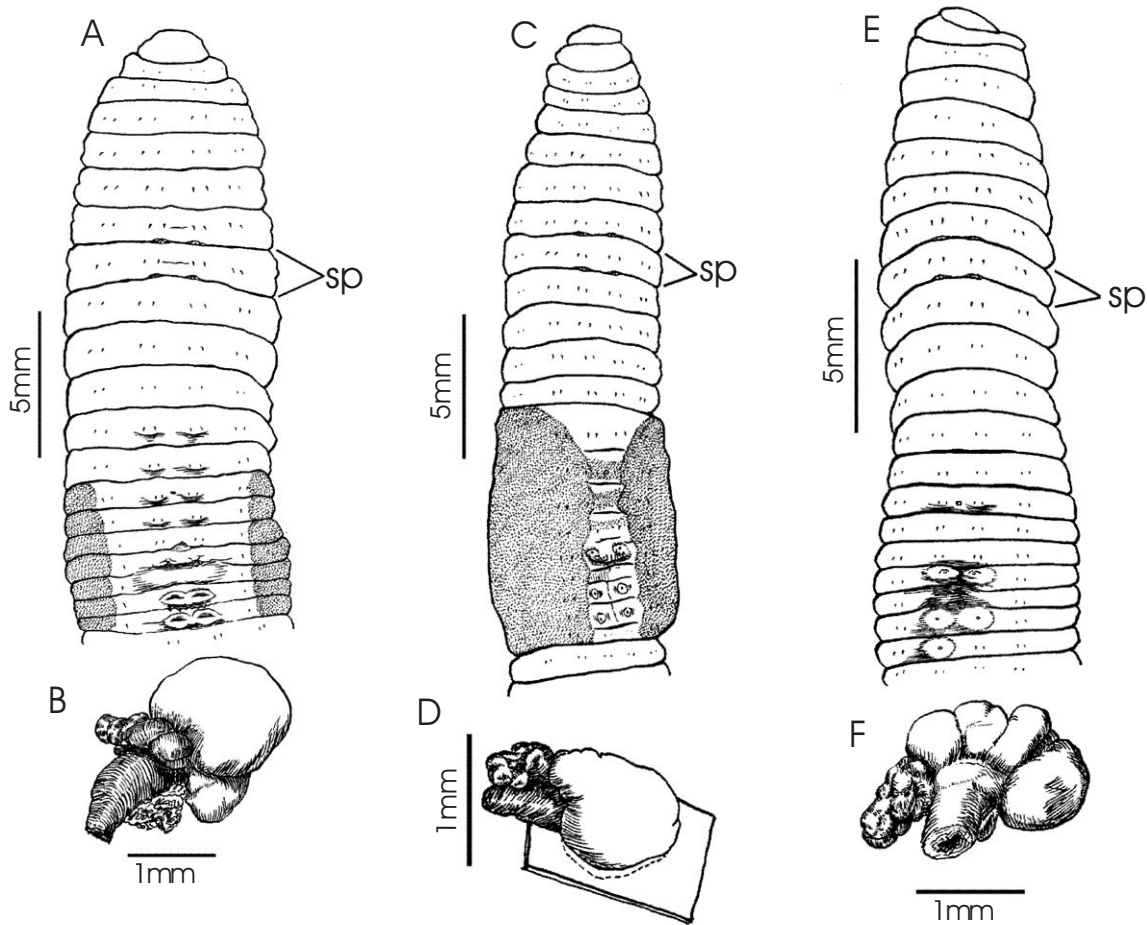


Fig. 3. Morphological structures of *Dichogaster* species; A, C, E: ventral views; B, D, F: spermathecae. A and B, *D. marleyi* sp.n.; C and D, *D. garrawayi* sp.n.; E and F, *D. farri* sp.n. Abbreviation: sp = spermathecal pores.

two gizzards in vi, vii; continuous with slight constriction at 6/7; gizzard vi diameter 3.0 mm, proventriculus well vascularized, wall thickness 0.2 mm at troughs of internal longitudinal ridges, 0.5 mm at peaks of ridges. Esophagus valvular in xviii, intestinal origin xix, full size in xx, slight constriction xviii, dorsal paired caeca lxxv; typhlosolar origin xix (1) or xxviii (1), in both cases full sized at 28/29, simple fold one tenth lumen diameter, some vertical flaps anteriorly; continuous lateral typhlosoles xxviii–l, li; calciferous glands dichogastrine, ducts separate, three pairs xv–xvii. Micronephridia 20–30 per segment v–xix, on muscular septa in segments with muscular septa; 28–30 per segment xx–end; from xx nephridia with thin cellular mantle, thickness greater from l posteriorly, ventralmost row each side stomate, tubular; dense masses of micronephridia on body wall iii, iv; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in v, vi, viii, ix, latero-esophageal hearts x–xii. Commisural vessel of vii to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Extra-esophageal vessel with branches to body wall v–viii, to gizzard in vi, to proventriculus in v. Supra-esophageal vessel ix–xiii; efferent parieto-esophageal vessels from body wall xiv–xviii to dorsal esophageal wall in xiv.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in viii, ix; hemispherical ampulla clearly distinct from duct, diverticulum attached at duct/ampulla junction, diverticulum branched to form 4–6 chambers in ix, 2–3 in viii (Fig. 3B).

Male sexual system holandric, testes and funnels in sac formed by fusion of septa in x, free in xi; small finely acinous to bushy seminal vesicles in xi, xii; vasa deferentia superficial, looped, muscular from xv until union with body wall in xvii (1), xviii (1); paired large coiled tubular prostates in xvii, small tubular prostates xix, xx; prostatic ducts muscular but slender xix, xx; thickly muscular xvii, diameter greater than glandular portion; penial setae lacking.

Remarks. These specimens also had flattened enchytraeid commensals on them at the time of collection, probably *Pelmatodrilus* as mentioned in the remarks on *D. montecyanensis*.

For differential diagnosis, see the Remarks under *D. farri* n. sp. below.

***Dichogaster garrawayi* n. sp.**

(Figs. 3C and D)

Etymology. The species is named in honor of Eric Garraway, lepidopterist and professor at The University of the West Indies, Kingston, Jamaica.

Type material. Holotype (KUNHM Invertebrate Zoology 001935): clitellate from limestone talus/organic matter mix, west slope of John Crow mountains just north of Cornpuss Gap, 18°00.37'N, 76°21.82'W, 550 m a.s.l., Jamaica, 14 February 2000, S.W. James. Paratypes: one specimen (KUNHM Invertebrate Zoology 001936) with same data as holotype; two pre-clitellates (KUNHM Invertebrate Zoology 001937) from limestone-derived soil of west slope of John Crow Mountains above Millbanks, 600 m a.s.l., Jamaica, 20 September 1992, S.W. James.

Description. Dimensions 129, 160 mm × 5.0, 6.0 mm at ix, 5.1, 6.0 mm wide, 3.5 mm thick at xxx; body ovate in cross-section, segments 154 + 146 regenerates, 214. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3.3:1.3:1 at x, 7:1.6:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, divided by one furrow into ii. Pigmentation light reddish brown dorsally. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 in AB. Ovipore single in xiv; male pores 17/18; male grooves lacking, prostatic pores three pairs xvii, xix, xx; those of xix, xx surrounded by paired papillae, pores of xvii surrounded by genital marking over BB; setae ab xvii–xx lacking; clitellum not developed (Fig. 3C).

Septum 9/10 thinly muscled, 10/11–13/14 very muscular, 14/15 much thinner; septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii; continuous with slight constriction at 6/7; gizzard vi diameter 2.6 mm, proventriculus wall maximum thickness 0.2 mm. Esophagus valvular in xviii, intestinal origin xix, dorsal paired caeca lxxv; lateral pouches of intestine xlix–lii; typhlosole xxvii–clxi, simple fold one-eighth lumen diameter; continuous lateral typhlosoles xxviii–lii; calciferous glands dichogastrine, ducts separate, three pairs xv–xvii. Micronephridia 20–28 per segment vi–xix, on muscular septa in segments with muscular septa; 22 per segment xx–end; from xx dorsal five ranks of nephridia with cellular mantle, all but ventral two ranks mantled from l posteriorly, ventralmost row each side stomate, tubular; dense masses of micronephridia on body wall iii–v; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in v (?), vi, viii, ix, latero-esophageal hearts x–xii. Commisural vessel of vii to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Extra-esophageal vessel with branches to body wall v–viii, to gizzard in vi, to proventriculus in v. Supra-esophageal vessel visible ix, at points of attachment to hearts x–xii; in xi, xii supra-esophageal vessel connected to paired small vessels arising low on esophageal wall; efferent parieto-esophageal vessels not seen.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; ovate ampulla clearly distinct from duct, diverticulum attached to ectal portion of duct, diverticulum with central canal pinnately branched to several small chambers on margins (Fig. 3D).

Male sexual system holandric, testes and funnels in sacs formed by fusion of septa, in x sacs extend anteriorly under esophagus; small elongate seminal vesicles in xi, xii; vasa deferentia superficial, looped, muscular from xv until union with body wall in xvii; paired large coiled tubular prostates in xvii, small tubular prostates xix, xx; prostatic ducts muscular but slender xix, xx; muscular xvii, diameter greater than glandular portion; penial setae lacking.

Remarks. For differential diagnosis see the Remarks under *D. farri* n. sp. below.

***Dichogaster farri* n. sp.**

(Figs. 3E and F)

Etymology. The species is named after an eminent Jamaican naturalist, Thomas Farr of the Institute of Jamaica.

Type material. Holotype (KUNHM Invertebrate Zoology 001938): soil in montane forest at 1100 m a.s.l. on Vinegar Hill trail, Portland Parish, north slope of Blue Mountains, Jamaica, 22 September 1992, S.W. James and R. Calderon.

Description. Dimensions > 135 mm (amputee) × 6 mm at ix, 6 mm wide, 5 mm thick at xxx; body ovate in cross-section, segments > 194. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3.3:1.4:1.5 at x, 4.7:1.4.3:1 at xxx, DD > 1/2 circumference throughout. Prostomium tanylobous, divided by one furrow. Pigmentation light reddish brown dorsally. First dorsal pore 12/13, spermathecal pores in 7/8, 8/9 in A. Ovipore single mid-ventral in xiv; male pores xviii; seminal grooves lacking, prostatic pores three pairs xvii, xix, xx (left xx pore lacking); surrounded by paired papillae, left pore and papilla of xx absent; setae ab xvii, xix, right xx lacking; clitellum xiv–xxii, saddle (Fig. 3E).

Septa 10/11–13/14 slightly muscular; septa 9/10–11/12 fused at body wall. Alimentary canal with proventriculus in v, two gizzards in vi, vii; continuous with slight constriction at 6/7; gizzard vi diameter 2.9 mm, proventriculus wall maximum thickness 0.4 mm on longitudinal folds. Esophagus valvular in xviii, intestinal origin 1/2 xix, constriction at 27/28, dorsal paired caeca lxxv; lateral pouches of intestine xlvi–li left, xlviii–li right; typhlosole 19/20–clxviii, one fourth lumen diameter, some vertical flaps anteriorly, otherwise a simple fold; continuous lateral typhlosoles xxix–li; calciferous glands dichogastri, three pairs xv–xvii. Micronephridia 20–26 per

segment viii–xxii, on muscular septa in segments with muscular septa; 28 per segment xx–end; from xxxiii dorsal 3–4 ranks of nephridia large, with cellular mantle, gradually decreasing in size and thickness of covering ventrally, ventral two ranks simple tubules; all but ventral two ranks mantled from l posteriorly, ventral-most row each side stomate, tubular; dense masses of micronephridia on body wall iii–vii; otherwise nephridia distributed AB-dorsum.

Vascular system with ventral trunk, single dorsal trunk, these connected by commisural vessels in vi, viii, ix, latero-esophageal hearts x–xii. Commisural vessel of v to proventriculus, vii to gizzard. Extra-esophageal vessel from pharyngeal glands, along ventral-lateral face of gizzard, ventral face of esophagus iv–ix, in ix ascending to dorsal esophagus wall to form supra-esophageal vessel. Extra-esophageal vessel with branches to body wall v–viii, to gizzard in vi, to proventriculus in v. Supra-esophageal vessel only visible at points of attachment to hearts in x–xii; in xi, xii supra-esophageal vessel connected to paired small vessels arising low on esophageal wall; efferent parieto-esophageal vessels not seen.

Fan-shaped ovaries composed of long strings, with funnels in xiii; paired spermathecae in vii, viii; hemispherical ampulla clearly distinct from duct, diverticulum attached to ectal portion of duct, diverticulum branched to form 2–3 chambers (Fig. 3F).

Male sexual system holandric, testes and funnels in sacs formed by fusion of septa, in x sacs extend anteriorly under esophagus; small elongate seminal vesicles in xi, xii; vasa deferentia superficial, looped, muscular from xv until union with body wall in xviii; paired large coiled tubular prostates in xvii, small tubular prostates xix, R xx; prostatic ducts muscular but slender xix, xx; ducts muscular xvii, widening ectally then narrowing close to body wall; penial setae lacking.

Remarks. *D. marleyi* n. sp. differs from *D. garrawayi* n. sp. and *D. farri* n. sp. in having green to blue pigmentation in life, spermathecae in viii, ix, and no lateral intestinal pouches in the region of the fiftieth segment. *D. garrawayi* is diagnosed as having spermathecae in vii and viii, 22 nephridia in the intestinal segments, and a typhlosolar origin in xxvii, whereas *D. farri* has 28 nephridia in the intestinal segments, and a typhlosolar origin in xx.

The green and blue coloration of *D. marleyi* and other *Dichogaster* is soluble in alcohol even after fixation in formalin. Consequently the specimens are now a slightly reddish brown, showing no trace of their original distinctive hues. For this reason collectors and curators should take care to preserve the worms properly or to make detailed notes and take photographs of the live or freshly preserved material.

The three *Dichogaster* species discussed here may have lost the seminal grooves independently of the eight

biprostatic species first described above. Otherwise, a rather more complicated hypothesis of evolution must be formulated in order to derive these worms from a biprostatic ancestor.

Discussion

See also the Remarks under *D. johnsoni* n. sp. and *D. farri* n. sp.

The present paper accounts for what I found in eastern Jamaica, but the John Crow Mountains were not adequately covered. More species were found in central and western parts of the island, and I recently made extensive collections in the John Crow Mountains. These will be the subject of another paper.

Sims (1987) reviewed the reasons for retrieving *Eutrigaster* from synonymy with *Dichogaster*, where it had lain since Omodeo (1955). Csuzdi and Zicsi (1991) followed this line of reasoning and expanded the definition of *Eutrigaster* to include virtually all Neotropical *Dichogaster*. Elsewhere I have presented evidence that the primary character used to define *Eutrigaster*, the presence of a muscularized proventriculus (Cognetti de Martiis 1904; Csuzdi and Zicsi 1991), is size-related and unlikely to be a reliable indicator of phylogenetic affinity (James 1996). Consequently *Eutrigaster* is now distinguished from many, but not all, African *Dichogaster* only by the more posterior location of the first dorsal pore in the former. In my collection I have an unidentified *Dichogaster* from Ghana with first dorsal pore in 12/13 in all specimens. Sims' (1987) statement that other characters of the type species of *Eutrigaster* need to be evaluated is true, but this affects both retention and rejection of *Eutrigaster* as a separate taxon. Subsequent work has followed the pattern of past descriptions of *Dichogaster* species, adding nothing new, neither in descriptions of new taxa nor in revisions of old ones.

The new species described here do little to clarify the phylogenetic relationships within Neotropical *Dichogaster* or between these and other members of this complex genus. In the above species we see further evidence of parallel evolution or character state reversals, most obviously in the numbers of prostate glands, the presence or absence of penial setae, and the presence or absence of seminal grooves. Other characters with apparent homoplasies are the condition of the female pores (paired or single), and muscularity of the prostatic ducts. Number of nephridia in the intestinal segments (they are easiest to count there) may be size related, at least in the extreme cases, as larger-bodied species tend to have 20 or more per segment.

I hypothesize that the eight biprostatic species lacking male grooves evolved these characters states (bipro-

static, lack male grooves) independently of other species that either had one pair of prostates in xvii with male grooves or had more than one pair of prostates but lacked male grooves.

The four species with intestinal pouches (*D. farri*, *D. garrawayi*, *D. marleyi*, *D. montecyanensis*) are also those on which I found ectocommensal *Pelmatodrilus* sp. (Clitellata: Enchytraeidae). This group is probably a clade defined by at least two synapomorphies, within which there is a sub-clade of species (the first three) with more than four prostates.

The diversity of Jamaican species suggests that the earthworm colonization history of the Caribbean is complex. The *Dichogaster* of Jamaica appear to be derived from more than one *Dichogaster* ancestor, and the sources of these ancestors are not yet clear. The earthworm fauna of Jamaica could be either the result of a lengthy and continuous occupation by more than one lineage, or the consequence of over-water dispersal from other land areas.

Geological models of the history of Jamaica generally state that Jamaica was totally submerged at some point during its movement from west to east (Buskirk 1985). If this is true, all terrestrial life on Jamaica arrived following the island's emergence. The thick limestone deposits evident in the karst regions (the western and eastern extremities, for example) of Jamaica leave no doubt of a prolonged period of subsidence, but it is possible that the earthworm fauna survived on the highest points of the modern island, perhaps when the island was reduced to a small archipelago of sub-aerial mountaintops. Otherwise there must have been multiple over-water dispersals to account for the diverse earthworm fauna.

At this point in the study of Neotropical *Dichogaster* there is no analytical support for removing species to other genera, either previously proposed or new ones yet to be defined. At times during the preparation of this manuscript I was tempted to do just this, but the inevitable consequence would be to create an apparently paraphyletic residue called *Dichogaster*. The morphological unity of *Dichogaster* has not been further strained by the description of the present new species, so I am advocating restraint until more can be learned about the other Neotropical and South Pacific members of the genus.

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