REDESCRIPTION OF TWO GULF COAST DIPLOCARDIANS (OLIGOCHAETA: MEGASCOLECIDAE)

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ABSTRACT

Redescription of two megascolecid earthworms, *Diplocardia eiseni* and *D. alba*, based upon extensive collections throughout the southern portions of the United States. Substantial structural differences occur in these species including spermathecal form, prostatic duct structure, (height and number of calciferous gland lamellae), pigmentation, and ecology. Both appear to belong to a group which share the following in varying degree:

(1) quadrithecate condition, (2) variable position of spermathecal pores, (3) vestigal prostatic setae, (4) anterior doubling of the dorsal vessel, and (5) internal lamellar edges of the calciferous gland not connected. These earthworms occur throughout the Gulf Coast area and Florida; *D. alba* is not now known to exist west of Louisiana. Both species tolerate very sandy soils but *D. eiseni* is more likely to be found in submerged, or very wet soils.

These descriptions are based upon extensive collections of two species of diplocardian earthworms, both widely distributed throughout Florida and the Gulf Coast region. For one of these, *Diplocardia alba* Gates, 1943, I have been able to examine the types; for the other, *D. eiseni* (Michaelsen, 1894) specimens collected near the type locality have been available.

Both species are variable in structure. Substantial differences have been noted among individuals from a single population. From present indications, *Diplocardia alba* is more common in the eastern Gulf Coast region, especially in Florida, while *D. eiseni* ranges at least from the northern Mexican border area into southern Florida and parts of eastern Georgia. These earthworms have not been collected together in the same habitats although their ranges overlap. For both, local population density may be quite high, depending upon prevailing soil conditions, essentially soil moisture.

Morphologically, *Diplocardia eiseni* and *alba* differ substantially; unfortunately, reliance upon a few characteristics which these and other diplocardian species have in common, has obscured the differences. Thus, both species are quadrithecate, possess vestigal prostatic setae, anterior doubling of the dorsal blood vessel, and a tendency for the spermathecal pores to vary in position. Among the more obvious differences are pigmentation, structure of the spermathecae, calciferous gland, prostate glands and ecology.

Diplocardia eiseni (Michaelsen, 1894)
Geodrilus eiseni (Michaelsen), 1894
Diplocardia eiseni Ude, 1895
D. eiseni Eisen, 1899
D. eiseni Eisen, 1900
D. eiseni Macnab and McKey-Fender, 1955

Specimens available for this study include:
Lake Eola, Florida March 1896 A Hempel 11 specimens
Lake Placid, Highlands County, Florida April 3, 1950 D. E. Beck 32 specimens
Lake Placid, Highlands County, Florida April 5, 1950 D. E. Beck 38 specimens
Suwanee River, Florida April 15, 1950 D. E. Beck 2 specimens
Bayou de Loutre, Union Parish, Louisiana June 14, 1959 W. R. Murchie 11 specimens
Encinal, Webb County, Texas October 13, 1962 W. R. Murchie 16 specimens

Nuttall Rise, Taylor County, Florida August 15, 1963 W. R. Murchie 58 specimens
El Campo, Wharton County, Texas August 20, 1964 W. R. Murchie 6 specimens
Sinton, San Patricio County, Texas August 20 1964 W. R. Murchie 46 specimens
Port Lavaca, Jackson County, Texas August 22, 1964 W. R. Murchie 1 specimen
Edna, Jackson County, Texas August 22, 1964 W. R. Murchie 13 specimens
Melville, Landry Parish, Louisiana March 24, 1965 R. Tandy 4 specimens
Campus, LSU, East Baton Rouge Parish, La. April 8, 1965 J. T. Tafare 16 specimens
Providence, Union County, Florida August 6, 1965 W. R. Murchie 4 specimens
Frost Proof, Polk County, Florida August 7, 1965 W. R. Murchie 9 specimens
Donaldsonville, Ascension Parish, La. April 28, 1966 R. E. Tandy 1 specimen
Springhill, Webster Parish, Louisiana August 22, 1966 R. E. Tandy 10 specimens
16 mi. west Holly Beach, Cameron Parish, La. September 20, 1966 R. E. Tandy 7 specimens
11 mi. west Holly Beach, Cameron Parish, La. September 20, 1966 R. E. Tandy 9 specimens
Grand Chenier, Cameron Parish, La. September 22, 1966 R. E. Tandy 12 specimens

The Lake Eola specimens, collected by A. Hempel in March, 1896, were apparently sent to Professor Frank Smith. It is likely that Smith separated these into two groups; one of these was kept at the University of Illinois and has been described by Macnab and McKey-Fender (1955). The other portion was stored in the University of Michigan Zoology Department, Ann Arbor, Michigan. It is these specimens, bearing Smith's accession numbers 845 and 847, which I report here.

Professor W. Michaelsen (1894) appears to have had specimens from at least nine populations available when he wrote the original description. Some of this material still exists in the collections of the Hamburg Museum, East Germany (Dr. M. E. Thiel, personal communication). Unfortunately, anterior ends of these worms were sectioned; these slides were destroyed by fire (1943). Designation of a lectotype from this material is not presently feasible; the following specimens of the Hamburg Museum collections are designated as syntypes inasmuch as all were available at the time Michaelsen prepared his description but none was singled out as the type:

V. 377 Arcadia, DeSoto County, Florida E. Lönnberg
V. 378 Lake Leonore, Orange County, Florida September 5, 1892 E. Lönnberg
V. 379 Lake Eola, Florida February 20, 1893 E. Lönnberg
V. 380 Sanford, Seminole County, Florida March 31, 1893 E. Lönnberg
V. 381 Savannah, Chatham County, Georgia March 1889 E. Lönnberg

The following collection, also deposited in the Hamburg Museum, was used by Ude (1895) in his emendation of the original description:

V. 5022 Lake Gatlin, Orange County, Florida 1892/93 E. Lönnberg

Description

Elongate, often robust, normally tapering over the posterior 50 somites so that the diameter of the penultimate segment does not exceed one-half the greatest diameter of the worm. Pigmented, reddish brown to brown or dark amber, darkest in posterior fifth of the body, lightest in color in middle portion of the body. Clitellum yellowish to flesh-colored. Size 112 mm (average of 203 measurable specimens) with expected range from 63 to 157 mm in length and 1.8 to 3.0 mm (average 2.5 mm) in width. Average segment number 135 (193 specimens) with range from 111 to 190.

Prostomium pro-epilobic one half length of first segment, tongue narrow. Annulations, simple in I through V, multiannulate VI to clitellum. First dorsal pore in 10/11. Setal formula: $aa:ab:bc:cd = 20:8:15:11$ (post-clitellar). Clitellum XIII-XVII, XVIII; cingulum, absent ventrally posterior to 16/17. Tubercula pubertatis absent. Seminal gutters nearly straight to convex from ½XVIII to ½XX; edges of gutters glandu-

lar. Male field flat with supernummary annulations. Male pore on anterior ½ of XIX, on small papilla in gutter. Prostatic pores equatorial in XVIII and XX, at ends of gutters. Female field slightly developed elliptical zone of XIV anterior to equator; female pores closely paired (♀♀ = *ab*) antero-median to *ab*. Genital tumescences occur as papillae at *ab* on VIII and IX and often appearing in ventral area (*a-a*) of XXI; normally post-setal or nearly intersegmental. Prostatic setae small (0.15 mm), modified, hidden in body wall of XVIII and XX. Setae *a* and *b* of segment XIX are present and normal in size. Spermathecal pores two pair in VIII and IX; variable in position, most commonly in anterior part of VIII and at equator in IX or equatorial to post-equatorial in VIII and post-equatorial in IX. Spermathecal setae *a* and *b* modified; distal one-third of shaft with fine spines (*ca* 10 rows); arcuate, about 0.4 mm in length. Somatic setae *ca.* 0.35 mm in length. Nephridiopores on anterior edge of somite in setal line *d*.

Pharyngeal gland masses end in IV. Gizzard in V and VI, strongly developed. Esophagus VII through XIII, straight with internal lining papillose. Esophagus of XIV and XV expanded to form calciferous gland with approximately 20 free lamellae. Gland-like ridges may extend into XIII or XIV. Intestine begins abruptly in XVII. Typhlosole begins in XX; simple fold, diminishes gradually posteriorly, disappearing in XCV. Last hearts in XIII. Dorsal vessel doubled intrasegmentally from XVII forward into VIII. Supra-esophageal vessel free and visible X-XII. Parieto-esophageal vessel joins esophageal wall in XIII; passes into esophageal wall from which it emerges in XI, passing forward to disappear in VII.

Testes two pair on ventro-anterior wall of X and XI, small to medium in size, maniculate. Male funnels rather box-like, folded, with iridescence. Sperm duct direct, passing posteriorly on inner parietal wall at setal line *b;* ducts of each side contiguous, join in XIX. No atrium. One pair of ovaries in XIII; multiple strand. Ovarian funnel rather simple, auriculate. Oviduct direct, enter parietes immediately anterior to seta *a*. Ovisac very small, from 13/14, dorso-median to funnel. Seminal vesicles two pair in IX, from 9/10, and in XII from 11/12; larger pair in XII. Prostate glands two pair, elongate to U-shaped; duct shorter than gland proper. Prostate glands of XVIII extend into XIX, those of XX extend into XXI. Prostatic setae of XVIII and XX very small, embedded in ectal portion of duct wall. Spermathecae two pair in VIII and IX, duct as long as large ampulla; finger-like diverticulum from extreme ental end of duct near junction of duct and ampulla; duct narrow and of uniform width. Meganephridial, avesiculate. Septa 7/8, 8/9, and 9/10 thickened; 10/11 somewhat thickened.

Remarks

In the most recent emendation of Michaelsen's description, Macnab and McKey-Fender (1955) make the following observations:

"There are indications that Michaelsen may have had more than one species or subspecies in his material. The fact that *D. eiseni,* judging from the Lake Eola material, actually must be a variable species complicates matters." Whether Michaelsen did or did not have a mixed collection before him may never be known. The work of Ude (1895) does confirm that some of Michaelsen's worms most certainly were *D. eiseni* as we know it.

Because of the substantial variation in some characters, the present analysis had as one of its primary objectives, the identification of somatic features showing structural constancy. The following characters appear to have the greatest stability in *Diplocardia eiseni:* (1) vestigal condition of the prostatic setae, (2) constant occurrence of setal couple *a-b* in segment XIX, (3) quadrithecate condition, (4) form of the spermathecae, (5) modification of the spermathecal setae (setae *a* and *b* of VIII and IX), (6) intrasegmental doubling of the dorsal blood vessel, (7) last hearts in XIII, (8) very sharp postero-ventral clitellar margin, and (9) free internal lamellar edges of the calciferous gland.

The prostatic setae (Figure 1-D) do vary somewhat in shape from one population to the next but are characteristically so small that they do not normally extend into the coelomic cavity. Instead, they are closely applied to the terminal portion of the prostatic duct and with it, are embedded in the body wall. An exception was found in *one* aprostatic population in which instance the setae, while vestigal, did extend into the

body cavity, although slightly. The spermathecae (Figure 1-F) are characterized by a distinct ampulla and a diverticulum that arises at the junction of the ampulla and duct. The posterior boundary of the clitellum is decidedly sharper than frequently obtains for diplocardian species. The rather flat male field is bound by seminal gutters with strongly glandular lips (Figure 1-A); this glandular development does not extend anteriorly beyond intersegmental furrow 17/18. The nine characters listed in the previous paragraph, provide the most adequate basis for recognition of this species.

The more important areas of variation in *D. eiseni* include: (1) size, (2) disposition of the spermathecal pores, (3) pigmentation, and (4) condition of the prostate gland. A sample obtained by Dr. D. E. Beck at Lake Placid, Highlands County, Florida, April 5, 1950, contained eight exceedingly small specimens in a collection of 38 worms. The larger individuals average 104 by 3.0 mm in length and width with 157 segments (average of 30 specimens); the eight smaller animals averaged 39 by 1.2 mm, length and width, and 81 segments. The clitellum, as well as the internal reproductive structures showed full sexual development in each specimen. In every particular, except dimension, they answered the description of *Diplocardia eiseni.* It must be recognized that size *per se* is not a reliable feature of earthworm anatomy inasmuch as a variety of environmental conditions can act to change body size. Thus, while the averages and ranges given in the diagnosis may be considered as probable values, populations do vary with respect to size. Causal mechanisms cannot be assigned as yet; genetic factors might be suggested but parthenogenecity is a strong probability for *D. eiseni.* An amber or dark brown pigmentation is normal for most of the populations seen, but it is not an invariable attribute of *D. eiseni.* Of the North American representatives of the family Lumbricidae, the species *Eiseniella tetraedra* (Savigny), 1826, is very close in pigmentation to *D. eiseni* and it is interesting to note that these two species are very similar in habitat preference.

Disposition of the spermathecal pores has been given considerable weight in diplocardian systematics. For *D. eiseni,* the pattern is generally regular, but variable between populations, sometimes even within a single population. The pores in segment VIII may be close to the setal arc (equatorial), in line with seta *b,* or slightly median to same, or the pores may be found at varying distances anterior to the equator, shifting at times to the extreme anterior edge of the segment, nearly in 7/8. In IX, the pore may be similarly nearly equatorial but more often is shifted posteriorly in varying degree, sometimes to the extreme posterior edge of the segment at 9/10. One pattern is shown in Figure 1-A. The precise position of the spermathecal pores is so variable as to be of little value in identification; the variability itself is undoubtedly of greater phylogenetic significance than the patterns expressed.

Another collection made by Dr. D. E. Beck at Lake Placid, Florida, on April 3, 1950, contained 32 specimens of *D. eiseni,* unique in that every specimen lacked the entire battery of prostate glands. In all other particulars these worms agree with descriptions of *D. eiseni.* The aprostatic condition has been recorded for this genus previously (*Diplocardia egglestoni* Murchie, 1958). It should be noted that while the prostatic battery as described and figured (Figure 1-C) is to be expected, populations may be encountered in which the prostate glands are missing.

In habitat preference, *D. eiseni* is the most nearly limnic of the known diplocardians. The heaviest populations were encountered in poorly drained situations. In several instances, great numbers were collected from water-covered soils, in ditches, or the margins of lakes or streams. Throughout much of the region inhabited by *D. eiseni* the water table is quite high; in addition, soils are often very sandy so that free water is readily available. Wherever these is sufficient moisture, soil type is of little consequence in controlling population density; equally large numbers of *D. eiseni* have been found in such diverse soil types as sand, loam, or heavy mucky clay. Similarly, vegetational type is not a limiting factor in determining habitat occupancy by diplocardians. In view of the preference of *D. eiseni* for low, wet areas, considerable similarity is to be expected in tree and shrub cover.

Present distributional evidence for *D. eiseni* would suggest a coastal species, with

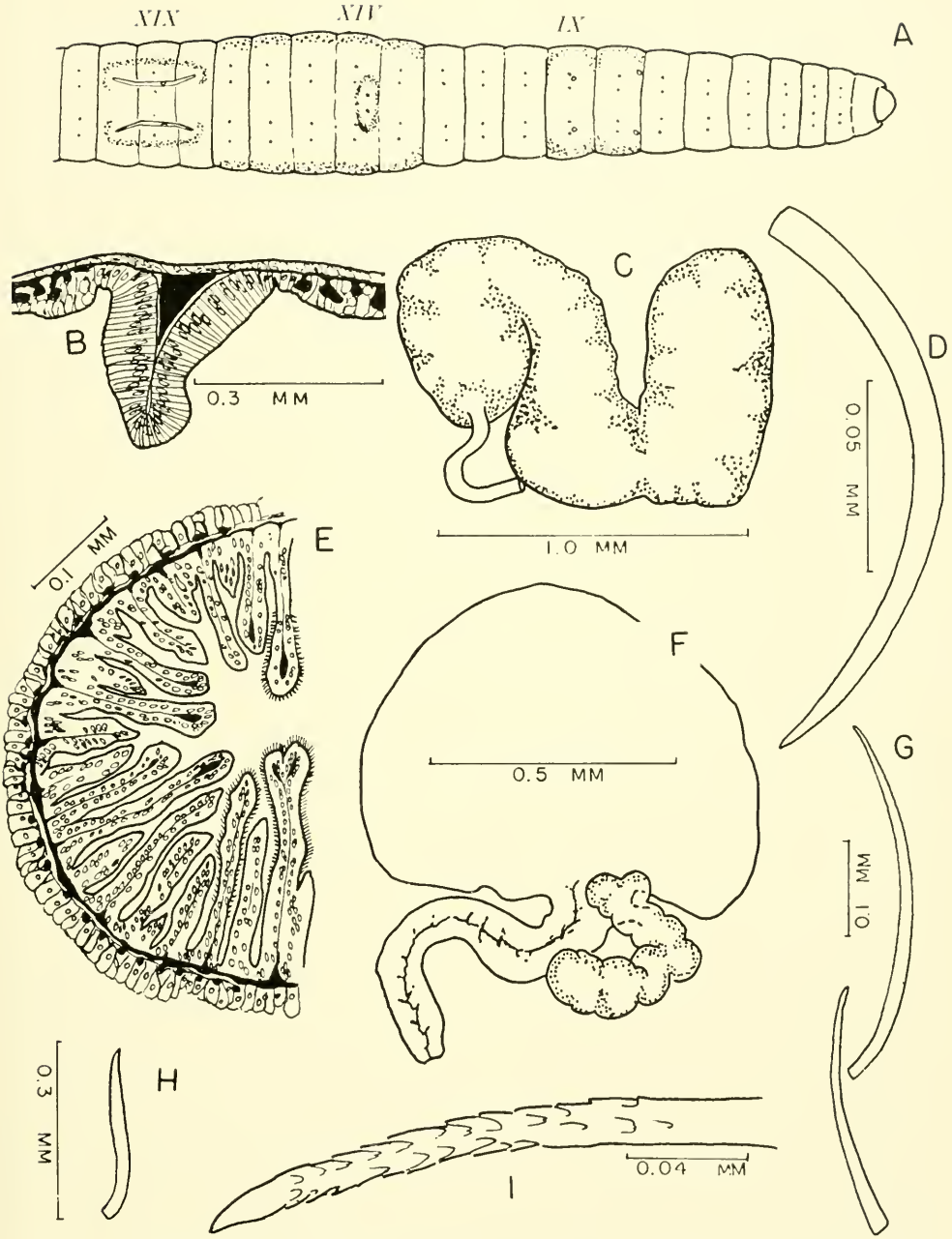

Figure 1. Anatomical features of *Diplocardia eiseni*. **A.** Ventral view of anterior 21 segments. **B.** Cross section of typhlosole, segment XXI. **C.** Prostate gland of XX. **D.** Prostate seta of XVIII. **E.** Cross section of calciferous gland of XIV. **F.** Spermatheca of VIII. **G.** Spermathecal seta *a* of VIII; normal and reserve. **H.** Seta *b* of segment XIX. **I.** Tip of spermathecal seta of VIII.

a range from an unknown point along the Mexican east coast, into the entire peninsular Florida region, and northward at least to South Carolina. Insofar as currently known, the species has not extended its range very far up the Mississippi Valley; it can be expected that scattered populations may be encountered in poorly drained soils adjoining any of the major rivers draining south and eastward across the Gulf and Atlantic coastal plains.

Diplocardia alba Gates, 1943

Specimens available for this study include:

Gainesville, Alachua County, Florida April 14, 1950 D. E. Beck 1 specimen
Tallahassee, Leon County, Florida July 23, 1959 W. R. Murchie 17 specimens
Naples, Collier County, Florida August 9, 1963 W. R. Murchie 27 specimens
Naples, Collier County, Florida August 9, 1963 W. R. Murchie 11 specimens
Naples, Collier County, Florida August 10, 1963 W. R. Murchie 14 specimens
Tice, Charlotte County, Florida August 11, 1963 W. R. Murchie 5 specimens
La Belle, Glades County, Florida August 11, 1963 W. R. Murchie 9 specimens
Lake Wales, Polk County, Florida August 12, 1963 W. R. Murchie 16 specimens
Clyo, Effingham County, Georgia August 18, 1963 W. R. Murchie 20 specimens
West of El Campo, Wharton County, Texas August 20, 1964 W. R. Murchie 8 specimens
Bogalusa, Washington Parish, Louisiana January 21, 1965 R. E. Tandy 2 specimens
Torrey State Park, Liberty County, Florida January 25, 1965 R. E. Tandy 3 specimens
Bonita Springs, Collier County, Florida August 8, 1965 W. R. Murchie 17 specimens
Bowling Green, Hardee County, Florida August 7, 1965 W. R. Murchie 21 specimens
20 miles north of Okeechobee, Okeechobee County, Florida August 10, 1965 W. R. Murchie 56 specimens
Newberry, Alachua County, Florida August 11, 1965 W. R. Murchie 21 specimens
Camp Blanding, Clay County, Florida August 12, 1965 W. R. Murchie 21 specimens

Specimens were placed in the U. S. National Museum by Professor G. E. Gates and designated co-types as follows:

Yellow Fern Creek, Fort Myers, Lee County, Florida January 21, 1941 W. M. Barrows USNM 20967 1 specimen
Fort Myers, Lee County, Florida February 19, 1941 W. M. Barrows USNM 20630 72 specimens

I designate the Yellow Fern Creek specimen (USNM 20967) as the lectotype for this species.

A subspecies *Diplocardia alba mexicana* was described by Gates (1955) on the basis of a single specimen intercepted at the Mexican border (Brownsville, Texas), February 20, 1950; the description is somewhat incomplete.

Description

Elongate, slender, without noticeable swelling of extremities. Unpigmented, clitellum yellowish to brown (formalin fixation). Size 26 to 160 mm with averages of 67 by 2.0 mm in length and width respectively (204 specimens). Somite numbers, 96 to 199; average 145 (205 clitellate specimens). Prostomium epilobic one-half, tongue broad. First dorsal pore at 9/10. Annulations simple in I through V, multiannulate VI to clitellum, weakly multiannulate posterior to clitellum. Setal formula *aa:ab:bc:cd* = 12:3:9:6 (posterior to clitellum). Tubercula pubertatis absent. Clitellum XIII, XIV, to XVI and dorsally on XVII; cingulum. Genital tumescences weakly developed, may involve combinations of VII, VIII, IX, possibly X, and sometimes XXI in *ab*, usually paired or may include the entire ventral area *b* - *b*. Spermathecal pores on VIII, and IX, variable in terms of antero-posterior position; most commonly in anterior VIII and equatorial in IX, usually midway between *a* and *b* regardless of other variations. Spermathecal setae modified, 0.53 by 0.02 mm in length and width respectively; distal one third of shaft with *ca.* eight rows of fine sculpturing; sometimes setae of IX are unmodified. Male field strongly glandular. Seminal grooves straight or curved from ½XVIII to ½XX, often with convexity directed mesiad. Male pore equatorial or immediately anterior to equator on XIX, in groove. Prostatic pores at ends of gutters in XVIII and XX. Prostatic setae modified, virtually confined to

body wall adjacent to prostatic duct, involve setae *a* and *b;* primary setae of couple are 0.25 by 0.005 mm in length and width, variously bent, without sculpturing. Female field slightly developed elliptical area antero-median to *a.* Nephropores at anterior edge of somite in *d.*

Pharyngeal glands end in IV. Gizzards in V and VI. Esophagus straight, narrow, without diverticula, from VII; walls papillose and ridged. Calciferous gland development in XIV, XV - XVI; about 18-20 lamellae, without fusion of lamellar ends internally. Intestine begins in XVII or XVIII. Typhlosole a simple fold, beginning in XX, ends LXX. Last hearts in XIII. Dorsal vessel intrasegmentally doubled from XVIII forward into VIII. Supra-esophageal vessel free in X - XII. Parieto-esophageal joins esophagus in XIII.

Testes two pair from 9/10 and 10/11 into X and XI; maniculate, male funnels moderately large, folded, with iridescence. Sperm ducts of each side on internal parietes, highly convoluted, especially from XIV through XVII; ducts of each side contiguous, joining in XIX. Prostatic glands two pair in XVIII and XX; U-shaped with free limbs directed dorsad. Prostatic ducts as long as gland proper, strongly coiled, first coil often contiguous with ectal limb of gland proper; anterior or posterior limb of the gland may penetrate adjacent segments. Seminal vesicles acinous, in IX and XII, from 9/10 and 11/12; those of XII the larger pair. Ovaries one pair, mutiple strands of ova, from 12/13 in ventral portion of XIII. Ovarian funnel simple, oviduct direct. Ovisac in XIV, small, dorsal to oviduct on 13/14. Spermathecae two pair, in VIII and IX; ampulla oval to cordate and nearly as long as the stout duct; diverticulum pear-shaped to digitiform, on narrow, folded stalk arising from the antero-lateral aspect of the main spermathecal duct, usually near center of latter. Holonephric, avesiculate. Septa 7/8 and 8/9 thickened; 6/7 and 9/10 somewhat thickened.

Remarks

The following are the specific anatomical features which, when correctly analyzed and considered in combination with all others in this list, provide the pattern with least variability in describing *D. alba:* (1) shape of the prostatic duct, (2) vestigal prostatic setae, (3) last hearts in segment XIII, (4) intrasegmental doubling of the dorsal blood vessel, (5) internal edges of the calciferous gland lamellae are free, and (6) structure of the spermathecae.

The prostatic duct is at least as long as the gland itself, but is characteristically coiled (Figure 2-H). This condition was found to obtain in co-typic specimens. The prostatic setae as in *D. eiseni* are very small (Figure 2-I) and can only be isolated with difficulty. They are appressed to the ectal portion of the prostatic duct, within the body wall. Spermathecal structure is reasonably constant (Figure 2-G). An expanded ampulla is set apart in size from the duct; the diverticulum arises by means of a narrow stalk about midway along the length of the duct proper. The diverticulum itself is rather pear-shaped, or may be generously expanded, and in one instance, was bifurcated.

While these characters are constant, there are several other features which are useful but subject to variation. The spermathecal setae (*a* and *b* of segments VIII and IX) of segment VIII, for example are invariably modified (Figure 2-C and D). Similar setae in segment IX may or may not be modified (Figure 2-E). In like fashion, the opening of the spermathecal pores is not constant. The pattern figured (Figure 2-A) is common but the pores in VIII may be closer to or on the equator; those of IX may be closer to the posterior edge of the segment, near 9/10.

In writing of the male field, Gates (1943) states:

> "A male genital shield is not definitely marked off but an area between the setal arcs of XIII (= XVIII) and XX may be very slightly protuberant. Seminal grooves are nearly straight, fairly deep—the median margins especially tumescent, in *ab,* between setal arcs of XVIII and XX."

In some populations of *D. alba* I have examined, the male field is very strongly developed. In the specimen figured (Figure 2-A), the mid-ventral portion of XVIII - XX is quite glandular, forming a flat shield between the seminal grooves which are then forced outward at the center instead of remaining straight as described by Gates. This condition is not constant, even among members of a single population; both patterns have been studied during this investi-

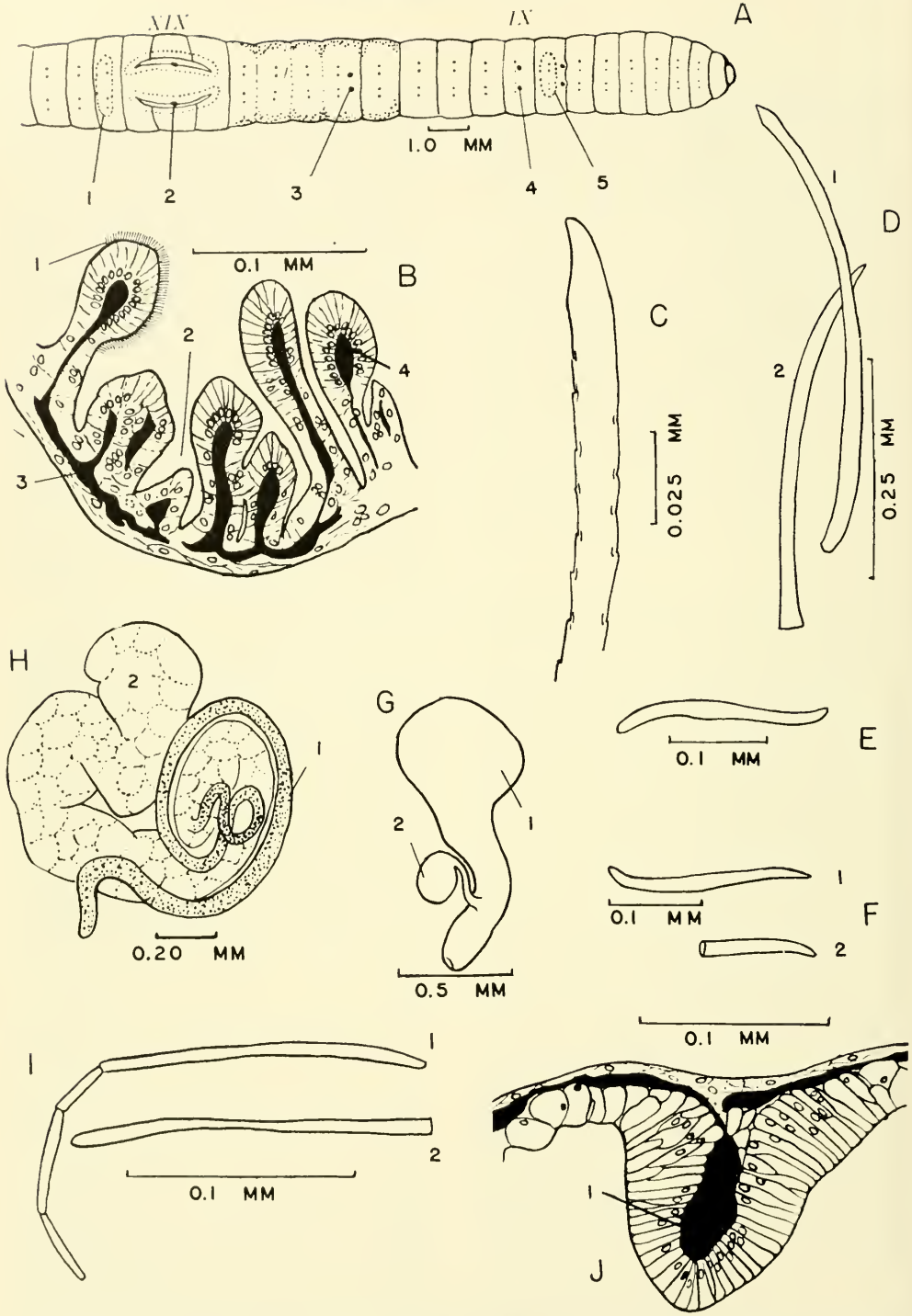

Figure 2. Anatomical features of *Diplocardia alba*. **A.** Ventral view of anterior 23 segments, 1. Glandular tumescence of XXI, 2. Male pore, 3. Female pore, 4. Spermathecal pore, 5. Glandular tumescence of VIII. **B.** Cross section of calciferous gland in XIV: 1. Ciliated border of lumen, 2. Lumen of esophagus, 3. Peripheral blood sinus, 4. Intralamellar blood sinus. **C.** Tip of spermathecal seta *b* of VIII. **D.** Spermathecal seta *b* in VIII: 1. Normal seta, 2. Reserve seta. **E.** Unmodified spermathecal seta of IX. **F.** Somatic seta of XIII: 1. Regular seta, 2. Reserve seta. **G.** Spermatheca of VIII: 1. Ampulla, 2. Diverticulum. **H.** Prostate gland of XVIII: 1. Duct, 2. Gland. **I.** Prostatic seta of XX: 1. Regular seta, 2. Reserve seta. **J.** Typhlosole of segment XXIII: 1. Typhlosolar blood sinus.

gation. It can be considered as one of the anatomical variables in *D. alba.*

Size is known to be an inconstant feature, even within a single population of earthworms. In this instance, three populations showed striking differences from what might be considered "average": animals from Effingham County, Georgia (20 specimens), Newberry, Alachua County, Florida (21 specimens), and Washington Parish, Louisiana (2 specimens) had average lengths of 38, 32, and 41 mm respectively. Segment numbers in like order were 130, 110, and 106. Dimensions in *D. alba,* as with *D. eiseni,* must be used with caution in describing the species.

One population of *D. alba* from Okeechobee County, Florida, collected August 10, 1965, resembled Beck's Lake Placid specimens of *D. eiseni* in having no prostate glands. As noted for that species, aprostatic populations are to be expected for *D. alba* if not, indeed, for many other diplocardian earthworms.

Ecologically, *Diplocardia alba* has been collected only from sandy soils in what could be considered well-drained situations. Most often, grass, pine, and palmetto were the dominant vegetational forms. The species is highly tolerant of open, sunny situations such as roadside fill areas, trails, and old roadways. Soil temperatures at the depth occupied by these worms were measured as high as 32°C and commonly at 30°C. This species casts freely on the soil surface and normally lives in the upper five to ten centimeters of soil.

Diplocardia alba ranges throughout the Florida peninsula and along the Gulf Coast; limits of distribtuion are unknown as yet. The species is certainly to be expected on lighter (sandy) soils along the entire Gulf Coast. Greater structural variance than that described here can also be expected for *D. alba;* in view of the current lack of knowledge of genetic mechanisms in most oligochaetes, the significance of this variance cannot be fully evaluated.

Discussion

The affinities of *Diplocardia alba* and *D. eiseni* with each other, and with *D. mississippiensis,* Smith, 1924, *D. floridana,* Smith, 1924 and *D. michaelseni,* Eisen, 1899 have been noted by Gates (1943) and Macnab and McKey-Fender (1955). As pointed out by these authors, *D. mississippiensis* and *floridana* are characterized by a large T-shaped typhlosole and by the fact that the lamellae of the calciferous gland are joined internally. Neither *D. eiseni* nor *D. alba* would be confused with those species if typhlosole and calciferous gland characteristics alone were considered. With respect to *D. michaelseni,* Macnab and McKey-Fender have contrasted it with *D. eiseni* as follows (1955):

> "It follows that if the Smith material is *D. eiseni, D. michaelseni* may be no more than subspecifically distinct from *D. eiseni* and in any case the two species are very close".

Smith (1923) and Stephenson (1937) have reviewed and revised the description of *Diplocardia michaelseni.* I have examined several collections of what I recognize as *D. michaelseni;* from these sources and observations, it is clear that *D. eiseni* and *D. michaelseni,* while similar, are distinct species. The following conditions in *D. michaelseni* are substantially different from the situation obtaining in *D. eiseni:* (1) tanylobic prostomium, (2) absence of setae *a* and *b* in XIX, and (3) the location of the last hearts in XII.

The simplex condition of the dorsal vessel in *D. udei* Eisen, 1899 and *D. gracilis* Gates, 1943, has been cited as clear evidence of the distinctness of *D. eiseni* from these two species (Macnab and McKey-Fender, 1955). The points of similarity and difference between *D. alba* and *D. eiseni* have been reviewed earlier in this paper. The differences are constant and by no means obscure; there can be no doubt about the distinctness of both species.

Variability in earthworm species, particularly among members of the family Lumbricidae, has long been recognized. By designating these variants as morphs, forms, subspecies, and the like, a cluster of "kinds" has been created in some instances. Subsequent systematic treatment has tended either to bind these variants together by enlarging the species definition, or at the other extreme, the diverse elements have been formalized as distinct species. In at least one diplocardian species, *D. singularis,* some of these variants have been given subspecific names (*D. singularis fluviatilus* Smith, 1915 and *D. s. caroliniana* Eisen, 1899); another variant, *Diplocardia eggles-*

toni Murchie, 1958, has been established as a species but may prove to be an aprostatic morph of *D. singularis*.

Among the several populations of *Diplocardia eiseni* examined, several were evidently male-sterile because parasitism had removed most of the contents of the seminal vesicles and quite often virtually destroyed the testes. This situation, or natural parthenogenecity in the genus, means that those diplocardian species with significant geographic distribution are likely to show a degree of clonal structure in the total population. In the absence of selection based upon bisexual reproduction, variations in structure, or disposition of such structures as prostate glands, spermathecal pores, and genital setae can scarcely be treated in a formal taxonomic fashion. This approach must prevail even when populations rather than single individuals are involved until such time as earthworm reproduction is more adequately understood. Accordingly, the descriptions of *Diplocardia eiseni* and *D. alba* need not be expanded beyond the point of usefulness by itemizing all probable points of difference likely to be encountered from place to place. It must be recognized, however, that certain nonadaptive features can be variable, or missing, in these species. It can be hoped that laboratory experimentation will eventually prove the significance as well as the causes of this variation.

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