

# A NEW SUBSPECIES OF DIPLOCARDIAN EARTHWORM FROM OKLAHOMA

(OLIGOCHAETA: MEGASCOLECIDAE)

W. R. MURCHIE

*Department of Zoology, The University of Michigan Flint College, Flint, Michigan*

Description of the taxon *Diplocardia verrucosa recta* ssp. n. has required re-examination of *D. verrucosa* Ude. For his original description (1895), Ude had three specimens; these had been collected near Omaha, Nebraska, by Mrs. C. W. Siemssen and shipped to Dr. Wilhem Michaelsen, Hamburg, Germany. He in turn sent them to Ude for study and description. It is probable that none of the worms was fully clitellate, nor in a particularly good state of preservation. After completion of his analysis, Ude returned the specimens to the Hamburg Museum where they were studied by Michaelsen in connection with his monograph on the Oligochaeta (1900). Therein, Michaelsen corrected Ude's interpretation of the openings of the spermathecal pores, noting their occurrence on segments VIII and IX rather than IX and X. He further corroborated Eisen's (1899) belief that the original description of *D. verrucosa* was in error with regard to the level at which the spermathecal and oviducal pores opened to the surface. Eisen had suggested that, inasmuch as Ude's figures were correct with regard to the oviducal pores, typographical rather than interpretative error was probably involved in both instances.

Unfortunately, in 1899, and again in 1900, Eisen presented diagnoses of *Diplocardia verrucosa* in which he perpetuated some of the errors in Ude's original description. Eisen was quite definite, for example, in placing the posterior spermathecal pore on X. He had examined worms sent to him by Frank Smith and, in 1899, he wrote: "Those received from Prof. Frank Smith from Havana, Illinois and labeled '*D. verrucosa* Ude (?)' belong undoubtedly to a new, not yet described species." Again, in 1900, Eisen wrote: "*D. verrucosa* as well as the species sent me by Dr. Smith, differs also from all of the *Diplocardia* in the position of the spermathecal pores in IX and X. In no other species is a spermathecal pore found in X. This may possibly be a characteristic of the subgenus *Omahania*." Eisen was obviously quite certain that he had never actually seen a specimen of *Diplocardia verrucosa*.

Some of the specimens from this collection were retained by Smith and later deposited in the U. S. National Museum. One of these (U. S. N. M. number 25554) was described by Smith, in his laboratory notes, as follows: "Same as mentioned by Eisen in his 1900 paper." I have used these specimens, among others, in my redescription of *D. verrucosa*. It is difficult to account for Eisen's interpretation of them, for in no instance was the posterior spermathecal pore located on segment X.

In view of Michaelsen's corrected definition, Smith was apparently unconvinced of Eisen's opinion. A letter of March, 1900, from Michaelsen, in obvious reply to an inquiry by Smith, reads as follows: "I have examined the original specimens of *Diplocardia verrucosa* and find that the statement on the spermathecal pores is in error. The spermathecal pores lie anteriorly on segments 8 and 9, somewhat above setal line *a* (between *a* and *b*). Ude erred either in his interpretation or his writing."

In 1905, Michaelsen sent one of the original type specimens of *D. verrucosa* to Smith. Laboratory notes by the latter read as follows: "*Diplocardia verrucosa* Ude. Orig! Specimen from Michaelsen. Examined April 5, 1914 with binoculars and found evidence of spermathecal pores being as described by Eisen (?) (Michaelsen?) and as found on my specimens. The papillae and grooves on

XVIII to XXII were as figured by Ude and it might easily be the specimen from which the drawing was made. Papillae on X and right side of IX as described by Ude. Clitellum but slightly developed and specimens very soft." The question marks and the name "Michaelsen" in parentheses indicate penciled notations added by Smith when he apparently recognized his own lapse in crediting Eisen with the correct description rather than Michaelsen. It is quite clear that both Michaelsen and Smith had seen and correctly understood *Diplocardia verrucosa*; the "new, and yet undescribed species," of Eisen cannot presently be determined and it is highly probable he erred in his analysis of Smith's material.

I have examined earthworms collected or identified by Frank Smith as well as the syntypic specimen sent to Smith by Michaelsen; these appear to be conspecific. I have based my redescription of *D. verrucosa* on Michaelsen's 1900 diagnosis and the Illinois specimens deposited in the U. S. National Museum by Prof. Smith. These earthworms comprise ten lots, U. S. N. M. numbers 25816, 25817, and 25553 through 25560, including 26 preserved worms and seven series of microscopic preparations in the form of serial sections. Preserved specimens of numbers 2554 and slide series of catalogue number 25560 I designate plesio-types. The syntypic specimen, from the Smith collection, has been placed in the U. S. National Museum. Portions of the type material not seen by me are housed in the Zoologisches Staatsinstitut und Zoologisches Museum, Hamburg, Germany, under number V-382 (Dr. M. E. Thiel, personal communication).

*Diplocardia verrucosa verrucosa* Ude 1895

Elongate, anterior and posterior ends without swelling. Length 82 to 124 mm; diameter 2.0 to 3.0 mm, with averages of 101 mm by 2.5 mm respectively. Segments 103 to 129, average 117. Pigment lacking (alcoholic specimens). Clitellum VIX-XVIII, incomplete ventrally. Setal formula; aa:ab:bc:cd=2:7:2:1. Prostomium epilobic  $\frac{1}{2}$ . Dorsal pores from  $\frac{1}{8}$ - $\frac{3}{8}$ . Annulations varied; I-III simple, IV-V biannulate, VI-XIII triannulate; weakly multi-annulate in post-clitellar region. Tubercula pubertatis absent. Anus terminal. Nephropores at anterior edge of segments, in setal line *d*.

Genital tumescences present as distinct papillae in two or three rows, in, or median to setal lines *ab*, involving spermathecal and male fields. In the former, papillae are formed on segments VII through X; in the male field, papillae somewhat variable, generally including  $\frac{1}{8}$  and  $\frac{2}{8}$  in setal line *ab* and two pair of tumescences on XIX and XI, median to *a*. Supernummary tumescences may occur from XVII through XXII, usually medial to setal line *a*. Seminal gutters in setal lines *ab*, curved, space between gutters narrowest in XX, convexities on XIX and XXI. Setae *ab* of XIX and XXI modified as genital setae; curved at extremities; *ca* 0.6 mm in length; tip pointed, irregular, without distinct sculpture. Spermathecal setae not differentiated. Spermathecal pores in VIII and IX about  $\frac{1}{2}$  distance from equator to  $\frac{1}{8}$  and  $\frac{3}{8}$  in setal line *a*, each located on a distinct papilla. Oviducal pores widely paired antero-medial to *a* on XIV; female field is distinct transverse glandular area. Male pores located on small papillae at anterior margin of XX, in seminal gutter. Prostatic pores at ends of seminal gutters in XIX and XXI.

Pharyngeal gland masses ending in IV; gizzards in V and VI. Esophagus includes VII-XV in VII-XIII the walls are papillose becoming ridged in XIV and XV. No distinct calciferous gland development. Esophageal walls distinctly vascularized in IX-XIII. Intestine expands abruptly in XVI. Typhlosole a simple fold, about one-half inner diameter of intestine, beginning in XVIII and ending ca LXX-LXXX. Septa  $\frac{1}{8}$ ,  $\frac{3}{8}$ , and  $\frac{5}{8}$  considerably thickened, succeeding septa decreasing in thickness to  $\frac{1}{13}$  and following. Meganephridial, avesculate. Dorsal vessel single, last hearts in XII.

Two pair of small, digitate testes in X and XI, from antero-ventral wall of segment. Male funnels are small, auriculate, with some iridescence. Male gonoducts with slight post-septal looping; they extend posteriorly on coelomic wall of parietes, joining within body wall in XX; no atrium. Seminal vesicles in IX and XII, incised, with posterior pair largest. Ovaries one pair in XIII; multi-strand of ova; from antero-ventral wall of segment. Ovarian funnel is

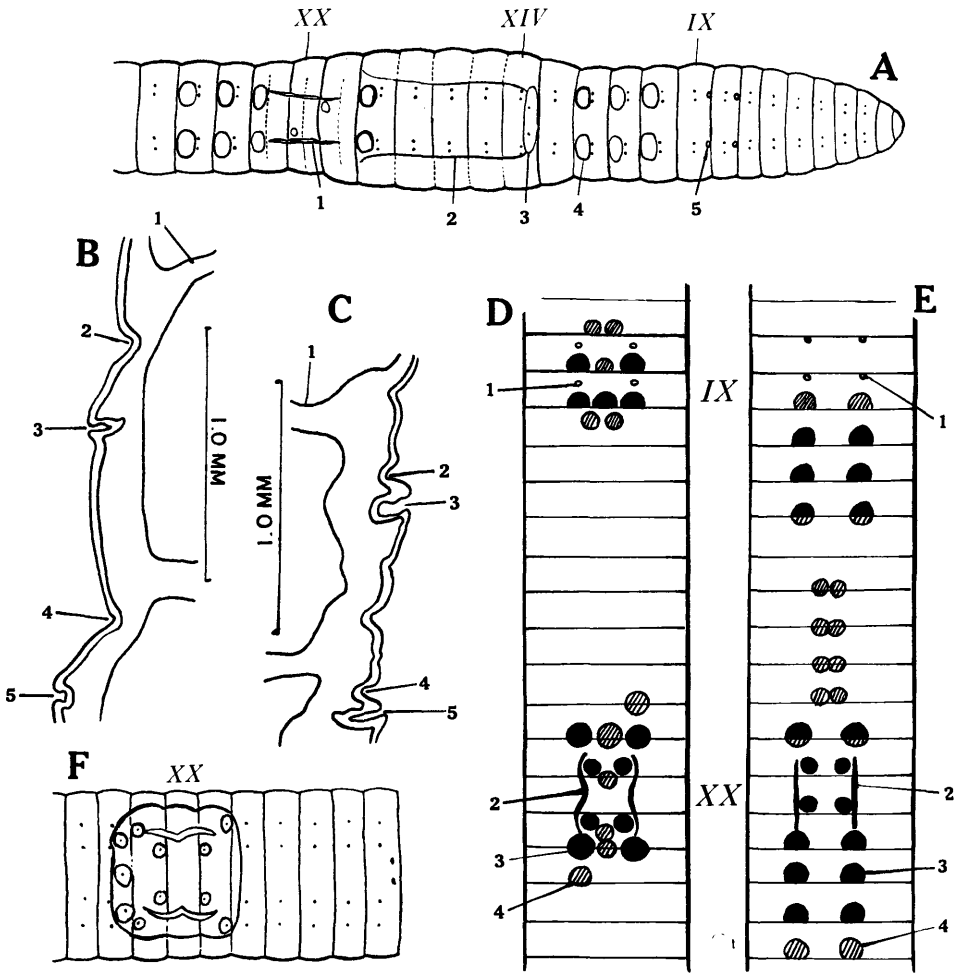


FIGURE 1

- A. Ventral aspect of *Diplocardia verrucosa recta*.
  - 1. Seminal gutter
  - 2. Ventral edge of clitellum
  - 3. Female field
  - 4. Glandular tumescence of XII
  - 5. Spermathecal pore of IX
- B. Body wall of *D. v. verrucosa*, showing spermathecal pores in VIII and IX.
  - 1. Septum  $\frac{1}{8}$
  - 2. Intersegmental groove  $\frac{1}{8}$
  - 3. Spermathecal pore in VIII
  - 4. Intersegmental groove  $\frac{5}{8}$
  - 5. Spermathecal pore in IX
- C. Body wall of *D. v. recta*, showing spermathecal pores in VIII and IX. Labels as for B.
- D. Diagram showing disposition of glandular tumescences in *D. v. verrucosa*. Regularly disposed tumescences in black; supernummary tumescences shaded.
  - 1. Spermathecal pore in IX
  - 2. Seminal gutter
  - 3. Regularly disposed tumescence of  $\frac{21}{22}$
  - 4. Supernummary tumescence of  $\frac{22}{23}$
- E. Diagram showing disposition of glandular tumescence in *D. v. recta*. Labels as in D.
- F. Ventral aspect of genital field of *D. v. verrucosa*; redrawn from Ude (1895a), figure 14.

flattish, trumpet-shaped; oviduct direct. An ovisac is present, medial to funnel. Seminal receptacles two pair in VIII and IX, with distinct ampulla and a smaller, incised diverticulum opening below ampulla on antero-lateral wall of duct. Spermathecal duct and ampulla nearly equal in length; opening of diverticulum above middle of duct. Two pair of prostate glands in XIX and XXI; strongly folded with the glandular portion at least twice the diameter and from four to five times the length of the duct. Prostatic duct passes through parietes immediately lateral to setal line *b*. Setae *a* and *b* of XIX and XXI with elongate setal follicles confined to their respective segments. Setal follicles in contact with ectal portion of prostatic duct for about one half of its length.

Material available for the description of the subspecies *Diplocardia verrucosa recta* included the following: (1) six specimens from the bank of the Verdigris River at route 28, six miles north of Nowata, Nowata County, Oklahoma; collected June 15, 1960, and (2) twenty-two specimens from the bank of the Salt Fork of the Arkansas River at route 77, Kay County, Oklahoma; collected June 17, 1960. The Nowata County specimens are designated as types; syntypes have been deposited in the U. S. National Museum.

#### *Diplocardia verrucosa recta* ssp. n.

Glandular tumescences of setal lines *ab* occurring normally on X–XII and XVIII–XXIII. Supernummary tumescences, when present, on IX,  $\frac{1}{16}$ – $\frac{1}{19}$ , and XXIV in various combinations. Spermathecal pores near intersegmental furrows  $\frac{3}{8}$  and  $\frac{5}{8}$ , on anterior margin of VIII and IX. Seminal gutter nearly straight. Ventral margins of clitellum lateral to setal line *b*.

#### DISCUSSION

The present state of oligochaete taxonomy is far too uncertain to permit speculation on the precise limits which should characterize subspecies. The presence of the male pore on segment XX is unique for the genus *Diplocardia* and is perhaps the strongest indication of close relationship of the populations from which the samples were drawn. Beyond the general similarity of these subspecies, they are virtually identical in: (1) the structure of the penial setae (fig. 2D and 2G), (2) the prostate gland (fig. 2F), (3) the spermathecae (fig. 2E), (4) the typhlosole (fig. 2B), (5) the nature of the esophageal wall (fig. 2C), and (6)

#### EXPLANATION OF FIGURE 2

- A. Ventral aspect of *Diplocardia verrucosa verrucosa*.
  1. Tumescence of  $\frac{2}{32}$
  2. Seminal gutter
  3. Spermiducal pore
  4. Ventral margin of clitellum
  5. Female field
  6. Spermathecal pores
  7. Tumescence of VII
- B. Cross section of typhlosole in *D. v. verrucosa*
  1. Blood sinus
  2. Epithelial layer
  3. Typhlosolar sinus
- C. Esophageal wall of XIII
  1. Chloragogue layer
  2. Blood sinus
  3. Epithelial layer
- D. Tip of prostatic setae of XXI, *D. v. verrucosa*
- E. Spermatheca of VIII, *D. v. verrucosa*
  1. Ampulla
  2. Diverticulum
  3. Ectal portion of duct
- F. Prostate gland of XXI, *D. v. verrucosa*
  1. Body of gland
  2. Prostatic duct
- G. Prostatic seta of XXI, *D. v. verrucosa*

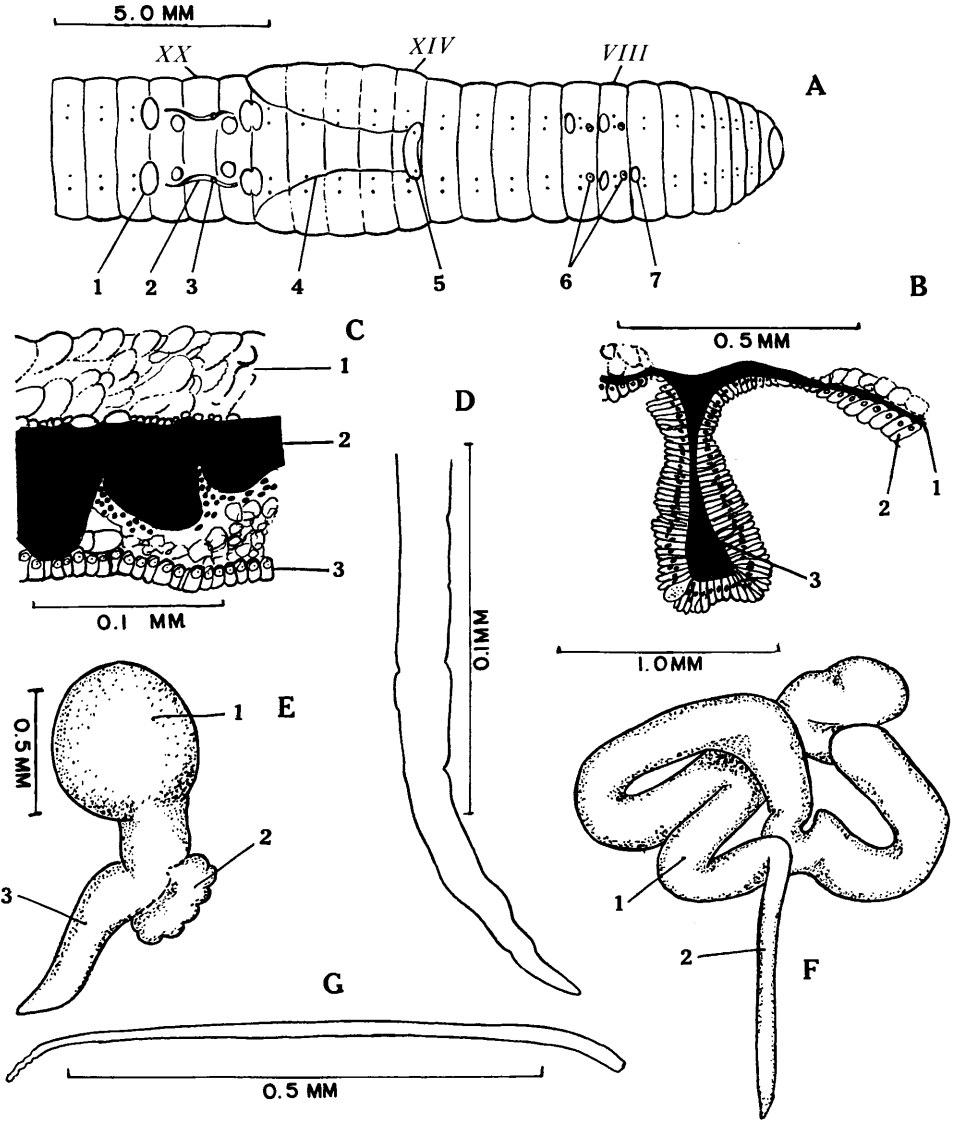


FIGURE 2

the lack of modified spermathecal setae. All of these structures have been found useful in diplocardian taxonomy. Observed differences in these subspecies, constant in the material at hand, include: (1) greater development ventro-medially of the clitellum in *D. verrucosa verrucosa* (fig. 1A and 2A), (2) the forward placement of the spermathecal pores in *D. v. recta* (fig. 1B and 1C), and (3) the difference in location of glandular tumescences (fig. 1D and 1E). The glandular pattern as figured by Ude (fig. 2F) is quite typical of *D. verrucosa verrucosa* and the specimen which I have figured (fig. 1A) is unusually simple in form with the tumescences reduced to a minimum. It can be stated that, as a general rule, *D. v. verrucosa* will tend to show irregularities in the number and disposition of glandular tumescences while *D. v. recta* has a distinctly linear and symmetrical pattern.

As presently known, these subspecies show no intergrades. *Diplocardia verrucosa verrucosa* had been collected from Illinois and Nebraska; *D. v. recta* from two locations in northern Oklahoma. Moreover, for the moment, they are characterized as subspecies on strictly morphological bases. Ecologically, nothing is known of Ude's specimens. Illinois material, collected by Smith, was apparently found in river bank soils. The Oklahoma collections were from heavy, alluvial soils, associated with large streams.

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