

A NOTE ON THE MORPHOLOGY OF *CURA FOREMANII*
(GIRARD, 1852) FROM FOUR LOCALITIES, U. S. A.
(Turbellaria, Tricladida, Paludicola)

by

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INTRODUCTION

Cura foremanii (GIRARD, 1852) is a rather common species occurring in the eastern half of North America, from New Brunswick (Canada) to Louisiana and westward to Minnesota and Arkansas (U. S. A.) (KENK, 1972). According to BALL (1974b), this species is recorded in Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, and New Foundland in Canada. Photographs and sketches of live specimens are found in KENK (1935, pl. 45, fig. 1 and fig. 9 on the next page without pagination, 1944, pl. I, fig. 1). Descriptions, including figures of the copulatory apparatus, have been published by several authors (CURTIS, 1900; STEVENS, 1904; KENK, 1935, 1972; BALL, 1974b). ANDERSON (1951, 1952a, b) and ANDERSON & JOHNN (1958) reported on self-fertilization in this species. Synonyms and differential diagnoses (and geographical distribution) have been summarized by KENK (1972, p. 19, 1974, pp. 11-12) and BALL (1974b, pp. 12-13) (see also HYMAN, 1951, p. 160). The chromosome numbers of this species are $n = 6$ and $2n = 12$ (PENNYPACKER, 1938; see also BENAZZI & BENAZZI-LENTATI, 1976; GOURBAULT & BENAZZI, 1975).

The following description of *C. foremanii* is based on identified specimens from Illinois, North Carolina and Pennsylvania sent to the authors by Dr. R. KENK. This study has been done for comparative purposes in connection with the authors' several collections of materials of *Dugesia azteca* (BENAZZI et GIANNINI, 1971) from México¹⁾ and *Cura patagonica* (BORELLI, 1901) from Chile (the authors' unpublished data).

MATERIALS AND METHODS

The following materials, except for the Specimen Lot No. 1685, were embedded in Paraplast Plus when received. Serial sagittal sections (7-8 micrometers) were stained with Delafield's hematoxylin and erythrosin. The numbers designating each sample are those employed by KAWAKATSU in his permanent recording system.

1). KAWAKATSU's Specimen Lot. No. 1677. A single specimen collected from Midland

1) The authors have a number of fully sexually mature specimens of this species collected from the type-locality of "*Cura azteca*" (a spring-fed stream and a small pond at El Zarco, México, D. F., México; alt. 3100 m). In histological sections the dorsal testes are large in size, numerous, and distributed from the posterior level of ovaries to the level near the genital pore (KAWAKATSU & MITCHELL, ms.: Redescription of *Dugesia azteca* (BENAZZI et GIANNINI, 1971) from México and reconsideration of its taxonomy)

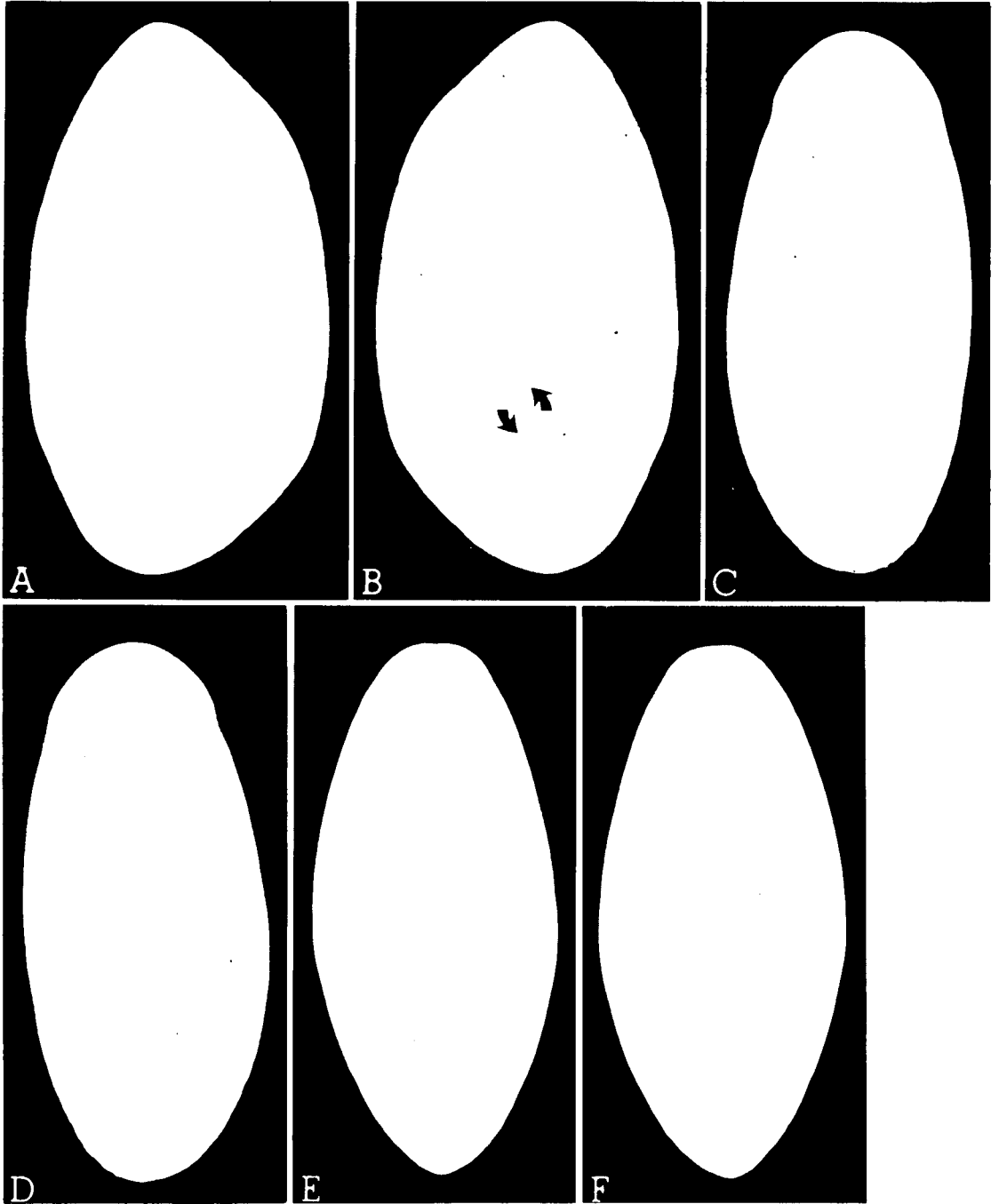


Fig. 1. *Cura foremanii*, photographs of three preserved specimens from the vicinity of Chicago, Illinois, U. S. A. (Specimen Lot No. 1685). A, C and E, dorsal views; B, D and F, ventral views. Top arrow indicates mouth; bottom arrow, genital pore. Note the position of genital pore.

Hills Country Club, Jackson County, Illinois, on 21 July 1968; fixed in hot solution of mercuric chloride and then acidulated. Dr. KENK's Specimen Lot No. 1145.

2). KAWAKATSU's Specimen Lot No. 1678. Two specimens collected from Elon College, Alamance County, North Carolina, in 1966; killed in 1% solution of nitric acid and then fixed in a solution of mercuric chloride with a small quantity of acetic acid. Dr. KENK's Specimen Lot No. 1056.

3). KAWAKATSU's Specimen Lot No. 1679. A single specimen collected from Spout Run, at Hopewell Village, Berks County, Pennsylvania, on 20 April 1969; fixed in hot solution of mercuric chloride and then acidulated. Dr. KENK's Specimen Lot No. 1208.

4). KAWAKATSU's Specimen Lot No. 1685. Five sexually mature specimens collected in the vicinity of Chicago, Illinois, in 1963; fixed in Bouin's fluid (received from Dr. E. K. MACRAE). Only used for the examination of general appearance.

Order TRICLADIDA
Suborder PALUDICOLA or PROBURSALIA
Family Dugesiidae BALL, 1974
Genus *Cura* STRAND, 1942

***Cura foremanii* (GIRARD, 1852)**

The principal literature for this species is as follows: CHANDLER, 1966; GIRARD, 1852; CURTIS, 1900; STEVENS, 1904; HYMAN, 1931, 1951; KENK, 1930, 1935, 1944, 1972, 1974; MARCUS, 1955; BALL, 1974a, 1974b, 1975, 1977.

External features. — The general appearance of *C. foremanii* is well described by KENK (1935, 1944) and some other investigators. The authors wish only to refer to photographs of Figure 1 (A-F) taken from the preserved specimens from the vicinity of Chicago. The largest specimen

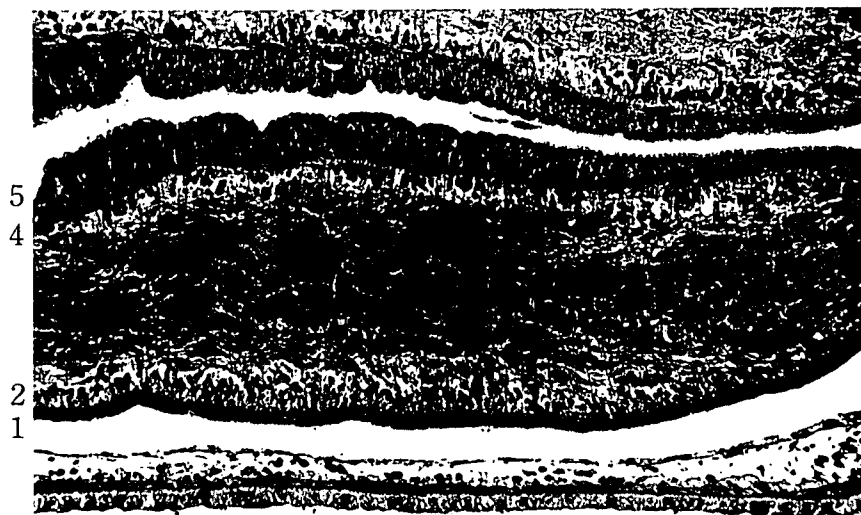


Fig. 2. Sagittal pharyngeal section of *Cura foremanii* from the Pennsylvania locality, U. S. A. (1679 a). 1, longitudinal fibers of outer muscle zone; 2, circular fibers of outer muscle zone; 4, longitudinal fibers of inner muscle zone; 5, circular fibers of inner muscle zone.

measured 8 mm in length and 4 mm in width; smaller specimens are 6 mm long and 3 mm wide. The non-pigmented pharynx is rather short. The genital pore opens at rather anterior position in the postpharyngeal region.

Redescription of histology and genital anatomy. — The marginal adhesive glands are well developed in this species, and are characterized by their coarse granules stained heavily red with erythrosin (Fig. 3 A and B).

Inner pharyngeal musculature is typical of the family Dugesiidae. The outer pharyngeal musculature consists of two layers, a thin outer one of longitudinal fibers and a slightly thick inner one of circular fibers (Fig. 2).

A pair of rounded ovaries is situated in the usual ventral space (each of them is approximately one-third of the dorso-ventral thickness in diameter). Yolk glands (or vitellaria) occur throughout the length of the body (Fig. 3 C). The dorsal testes are small in size (each of them is one-fifth to one-fourth of the dorso-ventral thickness at the prepharyngeal region) and scattered irregularly on either side of the midline from the posterior level of ovaries to that of the mouth (Fig. 4).

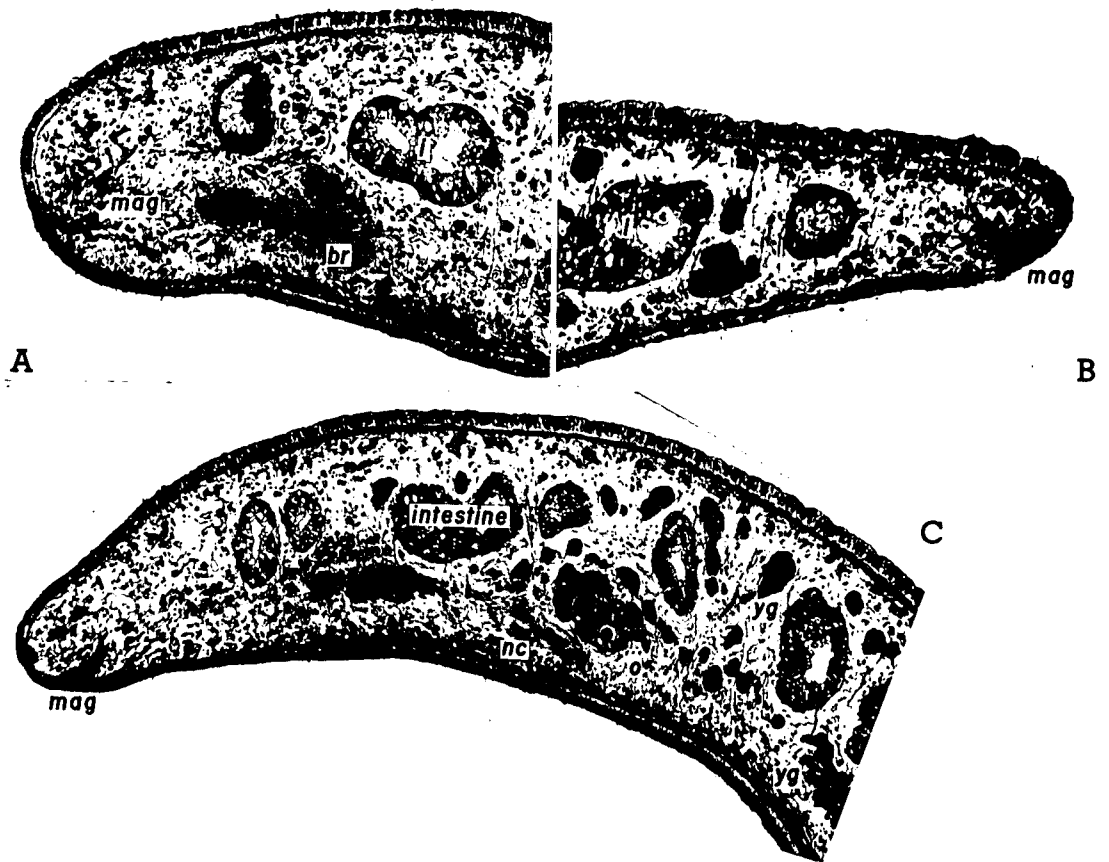


Fig. 3. *Cura foremanii*, sagittal sections of a specimen from the Pennsylvania locality, U. S. A. (1679 a). A: Near midsagittal section of the anterior portion. B: Near midsagittal section of the posterior portion. C: Near midsagittal section of the anterior region. br, brain; e, eye; mag, marginal adhesive gland; nc, nerve cord; o, ovary; yg, yolk gland.

Total number of testes is estimated to be between 8 and 14.

Sagittal views of the copulatory apparatus of specimens from three localities are shown in Figure 5 (A-C), and pertinent photomicrographs of the apparatus are shown in Figure 6 (A-E).

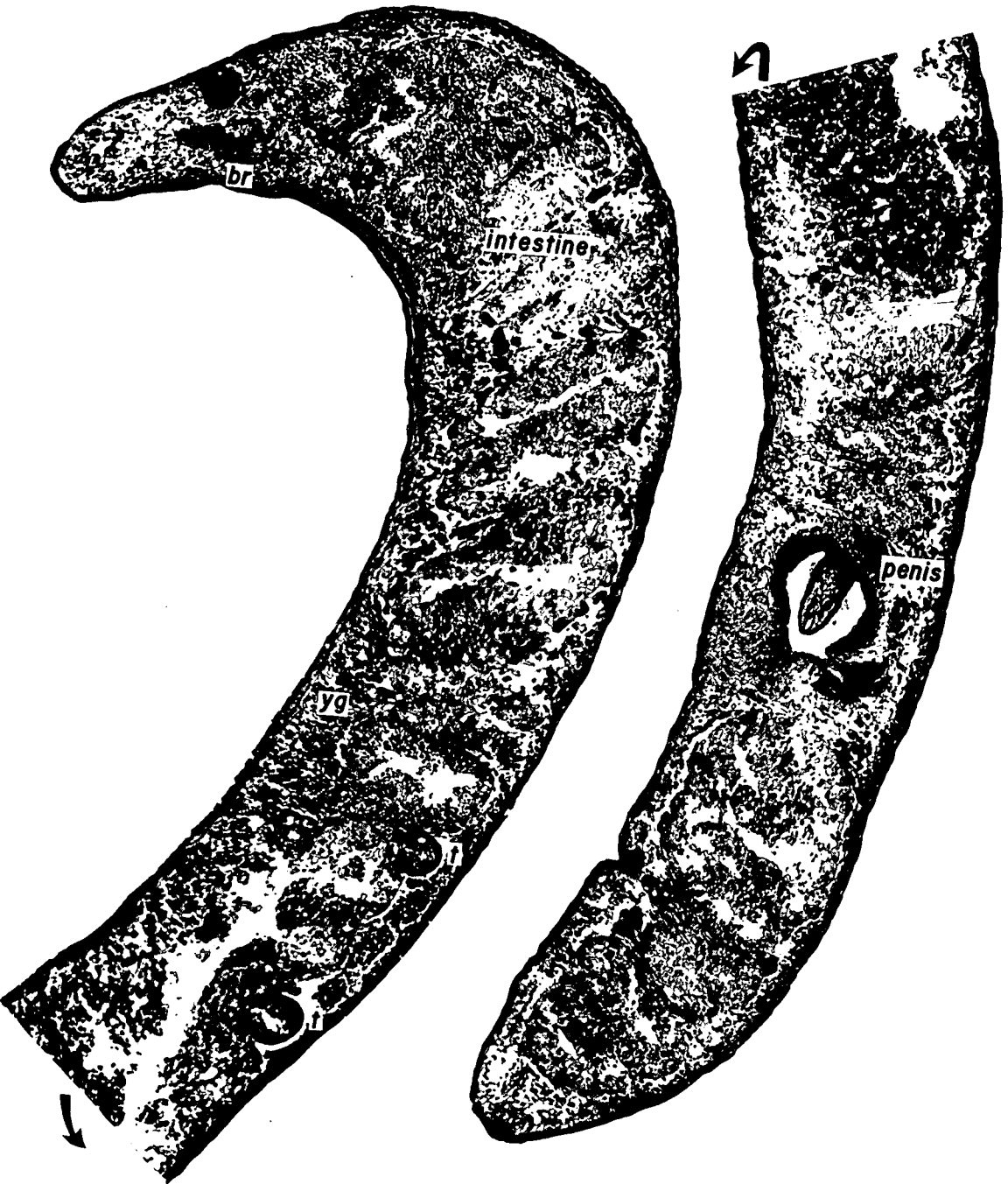
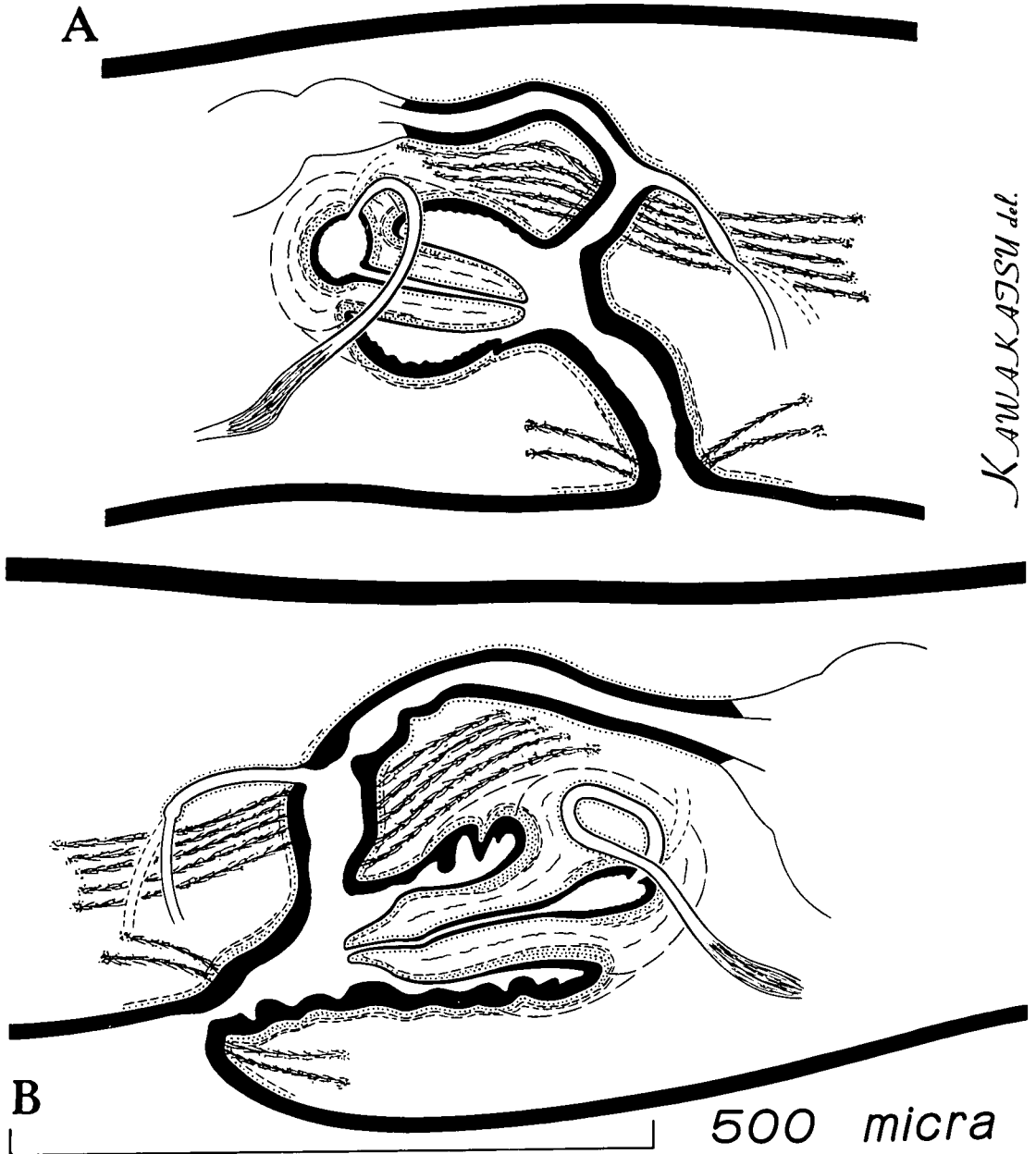


Fig. 4. *Cura foremanii*, near midsagittal section of the body of a specimen from the Illinois locality, U. S. A. (1677 a). br, brain; e, eye; t, testis; yg, yolk gland.

The penis has a rather small, rounded bulb and an elongated, conical shaped or finger-shaped papilla of a symmetrical form (Figs. 5 A and C, 6 A, D and E). In two specimens from North Carolina, the tip of the papilla shows a slightly pointed form (Figs. 5 B, 6 B and C). Both the bulb and papilla are feebly muscular in nature. The papilla is covered with a thin, nucleate epithelium and has a well-developed subepithelial muscular coat consisting of a thick layer of outer circular fibers and a thin layer of inner longitudinal fibers. This muscular coat becomes thicker toward the basal



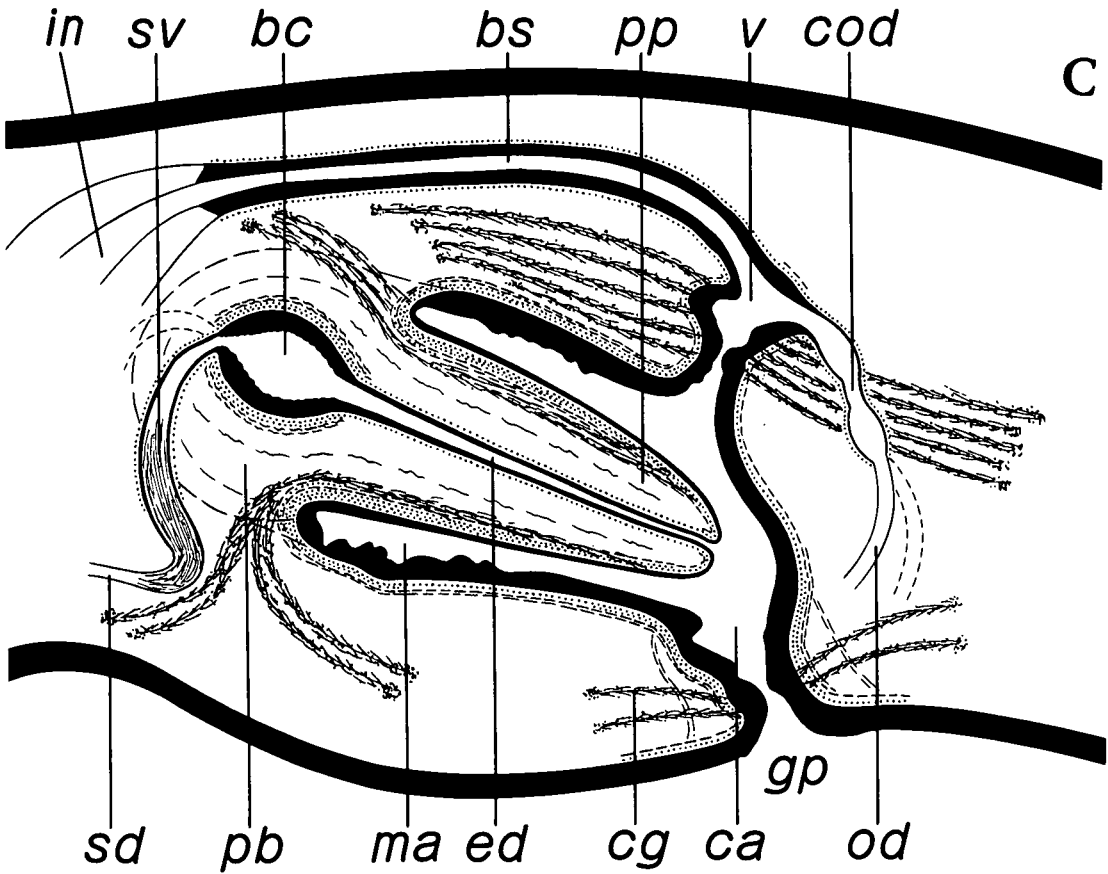


Fig. 5 (on pages 96-97). *Cura foremanii*, semidiagrammatic sagittal views of the copulatory apparatus of specimens from three localities in the U. S. A. A: Illinois (1677 a). B: North Carolina (1678 a). C: Pennsylvania (1679 a). **bc**, bulbar cavity; **bs**, bursa stalk; **ca**, common genital antrum; **cg**, cement gland; **cod**, common ovovitelline duct; **ed**, ejaculatory duct; **gp**, genital pore; **ma**, male genital antrum; **od**, ovovitelline duct; **pb**, penis bulb; **pp**, penis papilla; **sd**, sperm duct; **v**, vagina.

part of the papilla. In the specimen from the Pennsylvania locality, two layers of muscle fibers are slightly intermingled in the papilla.

The penis bulb contains a rounded (Illinois) or elliptical (Pennsylvania) or linear-oblong (North Carolina) bulbar cavity into which the two sperm ducts open separately from both lateral sides of its posterior region (Figs. 5 A-C, 6 A-E). The cavity is lined with a thick, glandular, nucleate epithelium. Below this epithelium there are two layers of muscle fibers, one thick circular and the other thin longitudinal. The sperm ducts form less-developed spermiducal vesicles at the lateral sides of the bulb (Fig. 5 A-C). The ejaculatory duct, a narrow and tubular cavity, opens at the tip of the papilla (Figs. 5 A-C, 6 A-E). A nucleate epithelium is found in the duct. The duct is surrounded by a thin layer of circular muscle fibers.

The male and common genital antra and a poorly-developed vagina (or a slightly widened portion of the posterior part of the bursa stalk) are covered with a thick, highly glandular, nucleate

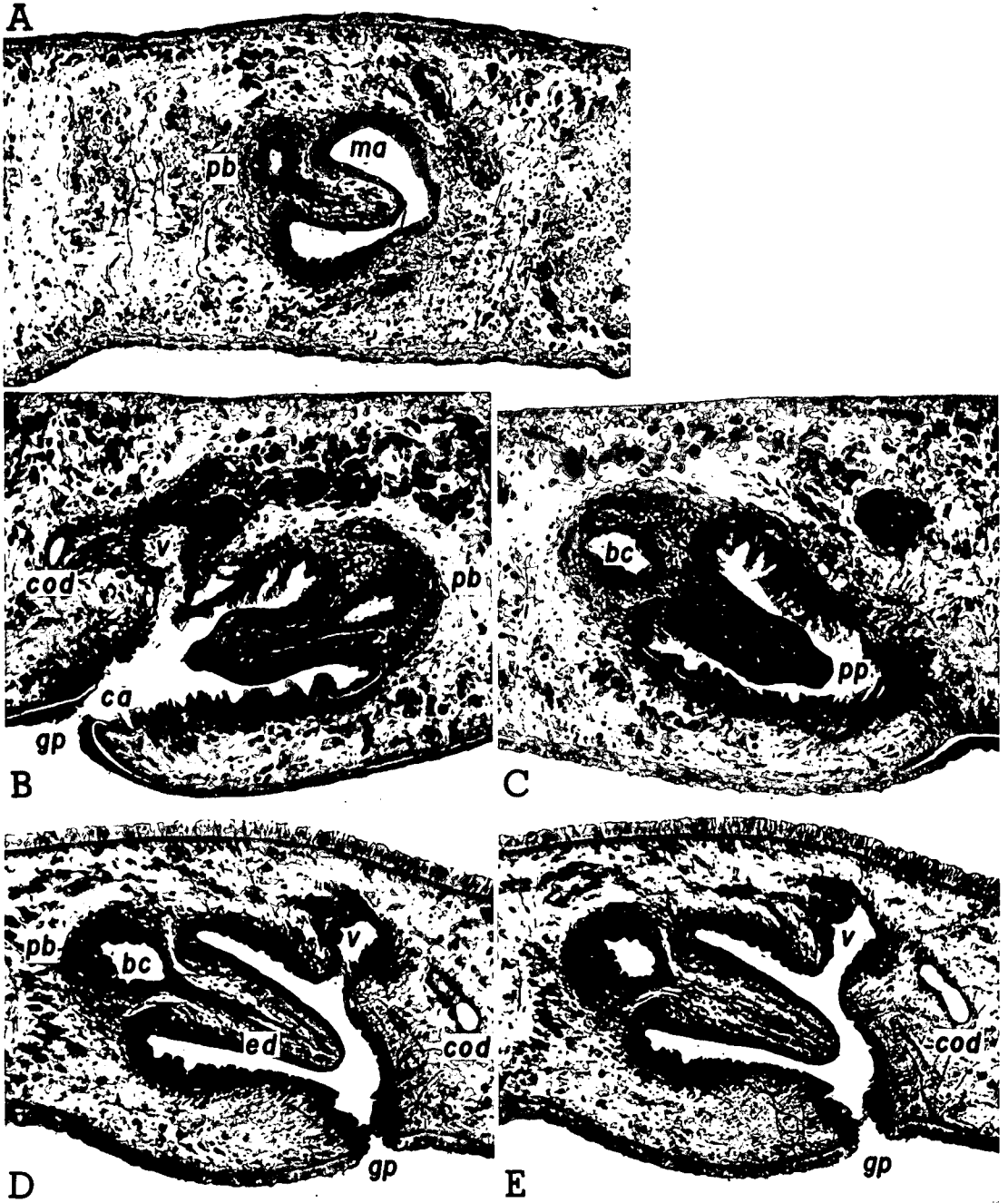


Fig. 6. *Cura foremanii*, sagittal sections of copulatory apparatus of specimens from three localities in the U.S.A. A: Illinois (1676 a). B: North Carolina (1678 a). C: North Carolina (1678 b) D and E: Pennsylvania (1979 a). bc, bulbar cavity; ca, common genital antrum; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; ma, male genital antrum; pb, penis bulb; pp, penis papilla; v, vagina.

epithelium. Below this epithelium, there are two layers of muscle fibers, one circular and the other longitudinal. The bursa stalk is a rather narrow cavity and connects with the intestine at the dorsal position of the penis bulb (Figs. 5 A-C). The bursal canal has a glandular, nucleate epithelium. Its muscular coat consists of a single, thin layer of circular fibers. A rather long, common ovovitelline duct accompanied by a thin muscular coat of circular fibers opens into the posterior, widened portion of the bursa stalk. It is a narrow tube in the specimens from the localities of Illinois and North Carolina localities (Figs. 5 A and B, 6 A-C), but in the specimen from the Pennsylvania locality, the common ovovitelline duct forms a rather wide tube (Figs. 5 C, 6 D). The walls of the vagina receive numerous outlets of erythrophilic shell glands.

Specimens examined. — Specimen Lot Nos. 1677, 1678 and 1679 (4 sets of serial sagittal sections); Lot No. 1685 (5 preserved specimens in alcohol; 2 of them broken) (see the section "Materials and Methods"). All are retained in KAWAKATSU's laboratory, Fuji Women's College, Sapporo, Japan.

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REFERENCES

- ANDERSON, J. M., 1951. Evidence for the occurrence of self-fertilization in the fresh-water triclad Turbellarian, *Curtisia foremanii*. *Anat. Rec.*, 111 (3): one page. 1952 a. Sexual reproduction without cross-copulation in the fresh-water triclad Turbellarian, *Curtisia foremanii*. *Biol. Bull.*, 102: 1-8. 1952 b. A further report on sexual reproduction without cross-copulation in the freshwater triclad Turbellarian, *Curtisia foremanii*. *Anat. Rec.*, 113 (4): one page.
- ANDERSON, J. M. & JOHANN, J. C., 1958. Some aspects of reproductive biology in the fresh-water triclad Turbellarian, *Cura foremanii*. *Biol. Bull.*, 115: 375-383.
- BALL, I. R., 1974 a. A contribution to the phylogeny and biogeography of the freshwater triclads (Platyhelminthes: Turbellaria). In: N. W. RISER & M. P. MORSE (ed.), *The HYMAN Memorial Volume — Biology of the Turbellaria*, pp. 339-401. McGraw-Hill Book Co., New York, etc. 1974 b. A new genus of freshwater triclad from Tasmania, with reviews of the related genera *Cura* and *Neppia* (Turbellaria, Tricladida). *Life Sci. Contrib., Royal Ontario Mus.*, (99): i-iv + 1-48. 1975. Nature and formulation of biogeographical hypotheses. *Syst. Zool.*, 24: 407-430. 1977. On the phylogenetic classification of aquatic planarians. In: T. G. KARLING & M. MEINANDER (ed.), *The Alex. LUTHER Centennial Symposium on Turbellaria*, *Acta Zool. Fennica*, 154: 21-35.
- BENAZZI, M. & BENAZZI-LENTATI, G., 1976. Platyhelminthes. In: B. JOHN (ed.), *Animal Cytogenetics*, 1, pp. i-vi + 1-182. Gebrüder Borntraeger, Berlin und Stuttgart.
- BENAZZI, M. & GIANNINI, E., 1971. *Cura azteca*, nuova specie di planaria del Messico. *Atti Accad. Naz. Lincei, Rend. Cl. Sci. fis., matem. e natur., Ser. VIII*, 50: 477-481 + pls. I-II.
- BORELLI, A., 1901. Di una nuova Planaria d'acqua dolce della Repubblica Argentina. *Boll. Mus. Zool. Anat. comp. R. Univ. Torino*, 16 (400): 1-5.
- CHANDLER, C. M., 1966. Environmental factors affecting the local distribution and abundance of four species of stream-dwelling triclads. *Invest. Indiana Lakes & Streams*, 7 (1): 1-56.
- CURTIS, W. C., 1900. On the reproductive system of *Planaria simplissima*, a new species.

Zool. Jahrb., Abt. Anat. Ontog. Thiere, 13: 447-466 + pls. 31-32.

GIRARD, C., 1852. Descriptions of two new genera and two new species of Planaria. Proc. Boston Soc. Nat. Hist., 4: 210-212.

GOURBAULT, N. & BENAZZI, M., 1975. Karyological data on some species of the genus *Cura* (Tricladida, Paludicola). Can. Jour. Genet. Cytol., 17: 345-354.

HYMAN, L. H., 1931. Studies on the morphology, taxonomy, and distribution of North American triclad Turbellaria. IV. Recent European revisions of the triclads, and their application to the American forms, with a key to the latter and new notes on distribution. Trans. Amer. micros. Soc., 50: 316-335 (+ pl. XXXIII). **1951.** North American triclad Turbellaria. XII. Synopsis of the known species of fresh-water planarians of North America. Trans. Amer. micros. Soc., 70: 154-167.

KAWAKATSU, M. & MITCHELL, R. W., Ms. Redescription of *Dugesia azteca* (BENZAZZI et GIANNINI, 1971) from México and reconsideration of its taxonomy. (Bull. Biogeogr. Soc. Jap. for 1983.)

KENK, R., 1930. Beiträge zum System der Probursalier (Tricladida Paludicola). Zool. Anz., 89: 145-162, 289-302. **1935.** Studies on Virginia Triclads. Jour. Elisha Mitchell Sci. Soc., 51: 79-125 + pl. 45 + 7 unnumbered plates. **1944.** The fresh-water Triclads of Michigan. Misc. Publ., Mus. Zool., Univ. Michigan, (60): 1-44 + pls. I-VII. **1972.** Freshwater Planarians (Turbellaria) of North America. *Biota of Freshwater Ecosystems, Identification Manual*. No. 1, pp. i-ix + 1-81. U. S. Environm. Protect. Agency, Washington, D. C. **1974.** Index of the genera and species of the freshwater Triclads (Turbellaria) of the World. Smithsonian Contrib. Zool., (183): i-ii + 1-90.

MARCUS, E., 1955 Turbellaria. South African Animal Life, Res. Lund. Univ. Exped. in 1950-1951, 1: 101-151 (+ pls. 1-12). Uppsala.

PENNYPACKER, M. I., 1938. The chromosomes in the maturation of the germ cells of two species of triclad Turbellarians. Jour. Morphol., 63: 421-439 (+ pls. 1-2).

STEVENS, N. M., 1904. On the germ cells and the embryology of *Planaria simplissima*. Proc. Acad. Nat. Sci. Philad., 56: 208-220 + pls. 13-16.

STRAND, E., 1942. Miscellanea nomenclatoria zoologica et palaeontologica. Folia Zool. Hydrobiol., 11: 386-402.

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