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MORPHOLOGICAL, KARYOLOGICAL AND TAXONOMIC STUDIES OF FRESHWATER PLANARIANS FROM SOUTH BRAZIL VIII. FOUR *DUGESIA* SPECIES (*D. TIGRINA*, *D. SCHUBARTI*, *D. ANDERLANI*, AND *D. ARNDTI*) COLLECTED FROM SEVERAL LOCALITIES IN ESTADO DE RIO GRANDE DO SUL

(Turbellaria, Tricladida, Paludicola)

by

MASAHARU KAWAKATSU, JOSEF HAUSER and SIRLAI MALVINA GEHRKE FRIEDRICH

INTRODUCTION

KAWAKATSU received for identification 14 vials of preserved specimens of freshwater planarians collected from several localities in Estado de Rio Grande do Sul in 1985 by staff members of the HAUSER-FRIEDRICH team at the UNISIONS. From close examination of serial sections of those samples, four *Dugesia* species could be identified: *Dugesia tigrina* (GIRARD, 1850), *Dugesia schubarti* (MARCUS, 1946), *Dugesia anderlani* KAWAKATSU et HAUSER, 1983, and *Dugesia arndti* MARCUS, 1946. *D. anderlani* was described by a single, sexually mature specimen from the Arroio Paixão, the upper stream of the Rio Caí, near Nova Petrópolis. *D. arndti*, a species described originally from the Serra da Mantiqueira in Estado de São Paulo, has not been hitherto recorded from other areas of Brazil.

In the present paper, further observations on the local variation of the genital anatomy of *D. tigrina*, *D. schubarti* and *D. anderlani* are given, together with a redescription of *D. arndti* based upon new material.

MATERIALS AND METHODS

The animals used for morphological, anatomical and histological studies were collected from the following localities. All of the samples were fixed with Susa fluid. The Specimen Lot Numbers given for each stock are those registered in KAWAKATSU's fixing notebook according to his permanent recording system.

1) Specimen Lot No. 1767. *Dugesia schubarti* (2 asexual specimens). Locality is uncertain (Pelotas ?). 12～15 mm long and 2～2.5 mm wide. December 1, 1984; fixed on March 20, 1985.

2) Specimen Lot No. 1768. *Dugesia tigrina*? (4 asexual specimens). Locality is uncertain (Pelotas ?). 8 mm long and 1.5 mm wide. Fixed on March 20, 1985.

3) Specimen Lot No. 1769. *Dugesia anderlani* (1 sexual and 1 asexual specimens). Locality is uncertain (Pelotas ?). 10～12 mm long and 2 mm wide. February 30, 1985; fixed on March 19, 1985.

4) Specimen Lot No. 1817. *Dugesia schubarti* (5 asexual specimens). Collected from a stream

at Saõ Francisco de Paula, approximately 65 km NE of São Leopoldo. Alt. 880 m. 15~17 mm long and 2~2.5 mm wide. August 7, 1985; fixed on August 22, 1985.

5) Specimen Lot No. 1818. *Dugesia schubarti* (5 sexual specimens). Collected from a stream at São Francisco de Paula. Alt. 820 m. 14~17 mm long and 3~3.5 mm wide. August 7, 1985; fixed on August 22, 1985.

6) Specimen Lot No. 1819. *Dugesia schubarti* (4 sexual and 1 asexual specimens). Collected from a stream at São Francisco de Paula. Alt. 820 m. 15~18 mm long and 3~3.5 mm wide. August 7, 1985; fixed on August 22, 1985.

7) Specimen Lot No. 1820. *Dugesia tigrina* (5 sexual specimens). Collected from a stream at São Francisco de Paula. Alt. 810 m. 8~10 mm long and 2~2.5 mm wide. August 7, 1985; fixed on August 22, 1985.

8) Specimen Lot No. 1821. *Dugesia anderlani* (5 sexual specimens). Collected from a stream at Picada Verão, Doïs Irmãos, approximately 25 km NE of São Leopoldo. Alt. 170 m. 12~16 mm long and 2~2.5 mm wide. November 20, 1985; fixed on August 22, 1985.

9) Specimen Lot No. 1822. *Dugesia arndti*? (5 asexual specimens). Collected from a stream at Morro Reuter, Doïs Irmãos, approximately 20 km NE of São Leopoldo. Alt. 540 m. 13~20 mm long and 2~2.5 mm wide. February 17, 1983; fixed on August 22, 1985.

10) Specimen Lot No. 1823. *Dugesia arndti* (5 sexual specimens). Collected from the same locality as Specimen Lot No. 1822 (a stream at Morro Reuter, Doïs Irmaõs; alt. 540 m). Asexual specimens collected from the spot on February 17, 1983, were cut transversally at the level of the prepharyngeal region. They were fed crushed tissues of sexual specimens of *Dugesia tigrina*.[1] Sexually mature specimens of *D. arndti* obtained by this culture method were fixed on August 22, 1985. 13~16 mm long and 2~3 mm wide.

11) Specimen Lot No. 1824. *Dugesia schubarti* (1 asexual specimen). A stream at Morro Reuter, Doïs Irmãos. Alt. 130 m. 13 mm long and 2.5 mm wide. May 17, 1985; fixed on August 22, 1985.

12) Specimen Lot No. 1825. *Dugesia schubarti* (1 asexual specimen). A stream at Morro Reuter, Doïs Irmãos. Alt. 130 m. 10 mm long and 2 mm wide. May 17, 1985; fixed on August 22, 1985.

13) Specimen Lot No. 1826. *Dugesia anderlani* (4 sexual and 1 asexual specimens). A stream at Encruzilhada do Sul, approximately 155 km SW of São Leopoldo. Alt. 130 m. 13~15 mm long and 2 mm wide. May 14, 1983; fixed on August 22, 1985.

14) Specimen Lot No. 1827. *Dugesia tigrina*? (5 asexual specimens). A stream at Constantina, approximately 300 km NW of São Leopoldo. Alt. 170 m. 8~10 mm long and 3~3.5 mm wide. January 10, 1984; fixed on August 22, 1985.

Serial sections (7–8 micrometers) were stained with Delafield's hematoxylin and erythrosin. Some of specimens were mounted on slides without staining.

SPECIES DESCRIPTIONS

order TRICLADIDA

Suborder PALUDICOLA or PROBURSALIA

Family Dugesiidae Ball, 1974

Genus *Dugesia* Girard, 1850

Dugesia tigrina (Girard, 1850)

External and internal features.……Preserved specimens from 3 localities were examined ; 4 sexual specimens from a locality at São Francisco de Paula were sectioned.

Photographs of 3 preserved specimens are shown in Figure 1 (A-D). Sagittal view of the copulatory apparatus of a specimen from São Francisco de Paula is shown in Figure 2 (No. 1820-c) ; photomicrographs showing parts of the copulartory apparatus of 3 specimens from this locality are also shown in Figure 3 (A-C).

Material.……Six sets of serial sections (Specimen Lot Nos. 1768 and 1820) and preserved specimens in alcohol (Nos. 1768, 1820 and 1827) are retained in KAWAKATSU's laboratory, Fuji Women's College, Sapporo, Japan.

Dugesia schubarti (MARCUS, 1946)

External and internal features.……Preserved specimens from 6 localities were examined ; 4 sexual

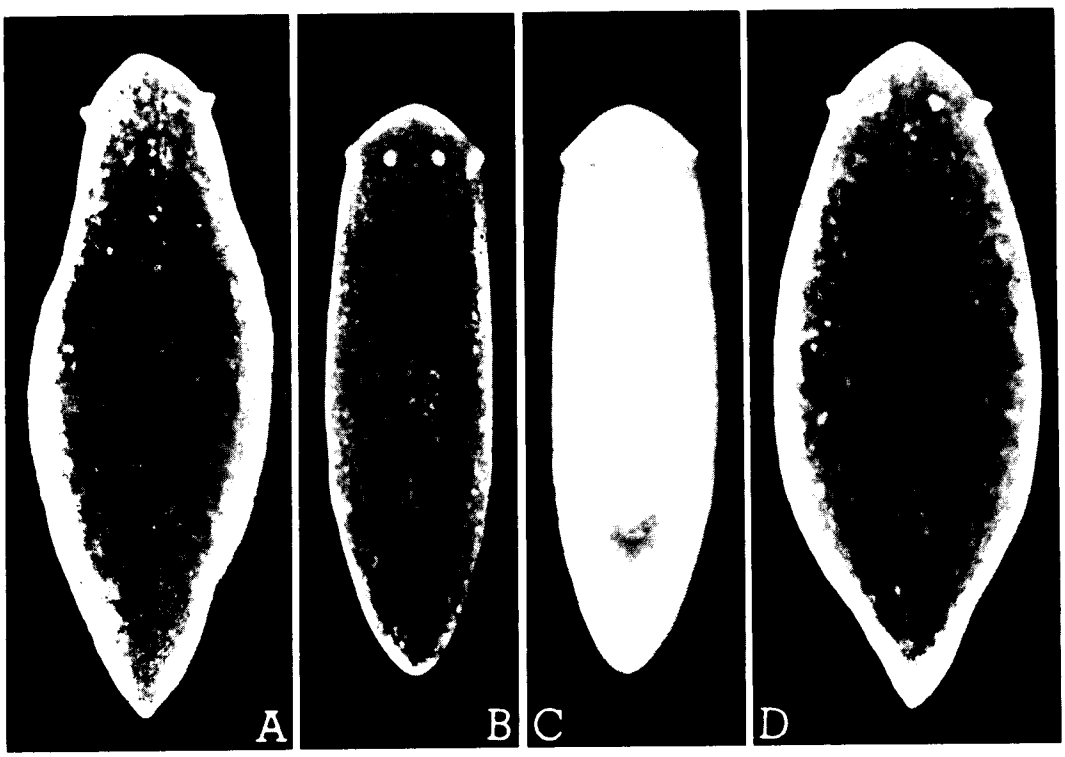

Fig. 1. *Dugesia tigrina* (GIRARD, 1850), photographs of 3 preserved specimens from 3 localities. A : Specimen Lot No. 1768 ; B and C : Specimen Lot No. 1820 (C, ventral view) ; D : Specimen Lot No. 1827.

1) GRASSO & BENAZZI (1973) succeeded the sexual induction in specimens of several fissiparous strains of *Dugesia gonocephala s. l.* which have been subjected for many months to continuous feeding on crushed tissues of sexually mature specimens of *Polycelis nigra*, or (in a few cases), *Dugesia lugubris*. SAKURAI (1977) also succeeded the sexual induction in some specimens of an asexual race of *Dugesia japonica japonica* by a continuous feeding on crushed tissues of sexual specimens of *Bdellocephala brunnea*. The induced copulatory apparatus was typical of *D. j. japonica*.

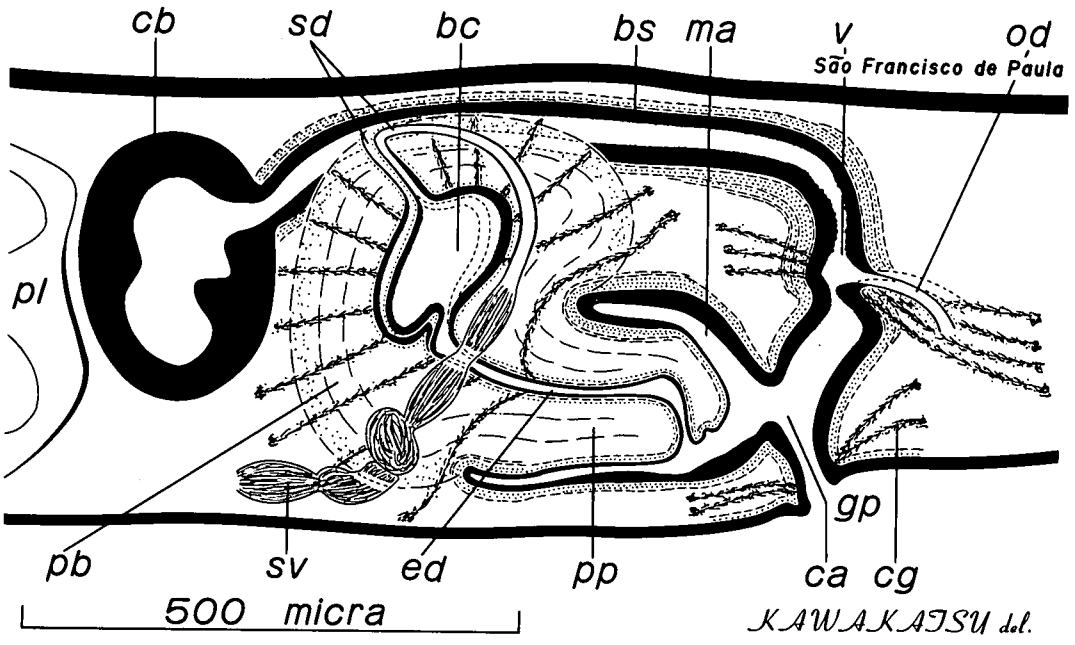

Fig. 2. *Dugesia tigrina*, semidiagrammatic sagittal view of the copulatory apparatus of the specimen from the São Francisco de Paula locality (No. 1820-c). **bc**, bulbar cavity ; **bs**, bursal stalk ; **ca**, common genital antrum ; **cb**, copulatory bursa ; **cg**, cement gland ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **pl**, pharynx lumen ; **pp**, penis papilla ; **sd**, sperm duct ; **sv**, spermiducal vesicle ; **v**, vagina.

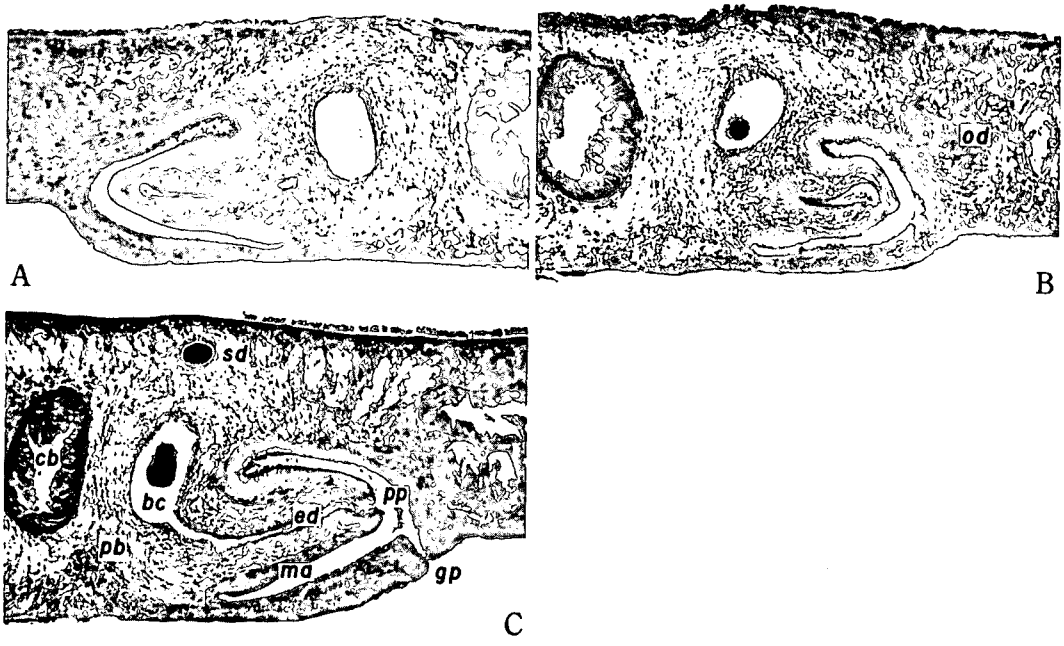

Fig. 3. *Dugesia tigrina*, photomicrographs of near midsagittal sections of the copulatory apparatus of 3 specimens from the São Francisco de Paula locality. A, No. 1820-a ; B, No. 1820-c ; C, No. 1820-d. **bc**, bulbar cavity ; **cb**, copulatory bursa ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **pp**, penis papilla ; **sd**, sperm duct.

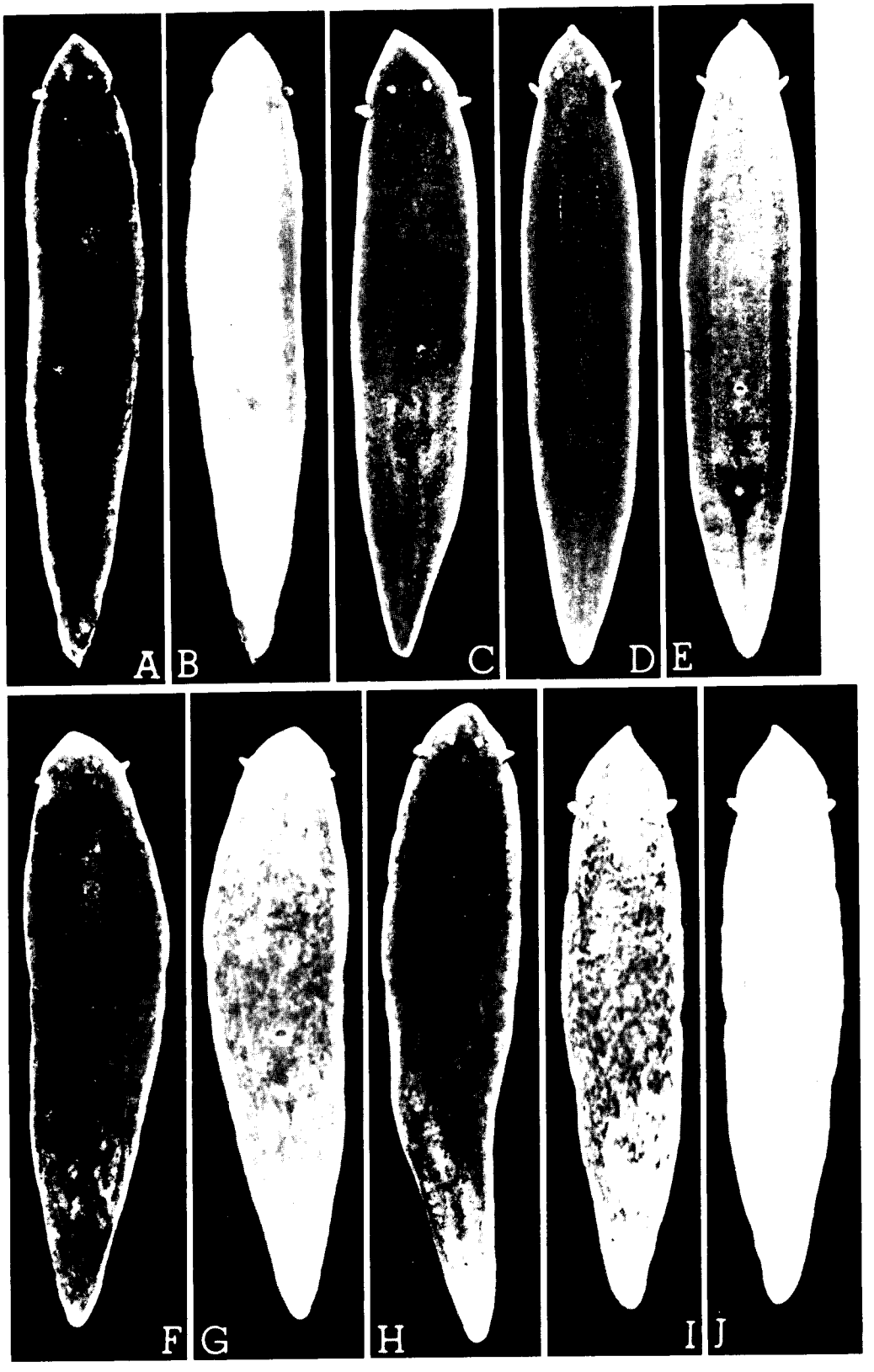

Fig. 4. For explanation see page 46.

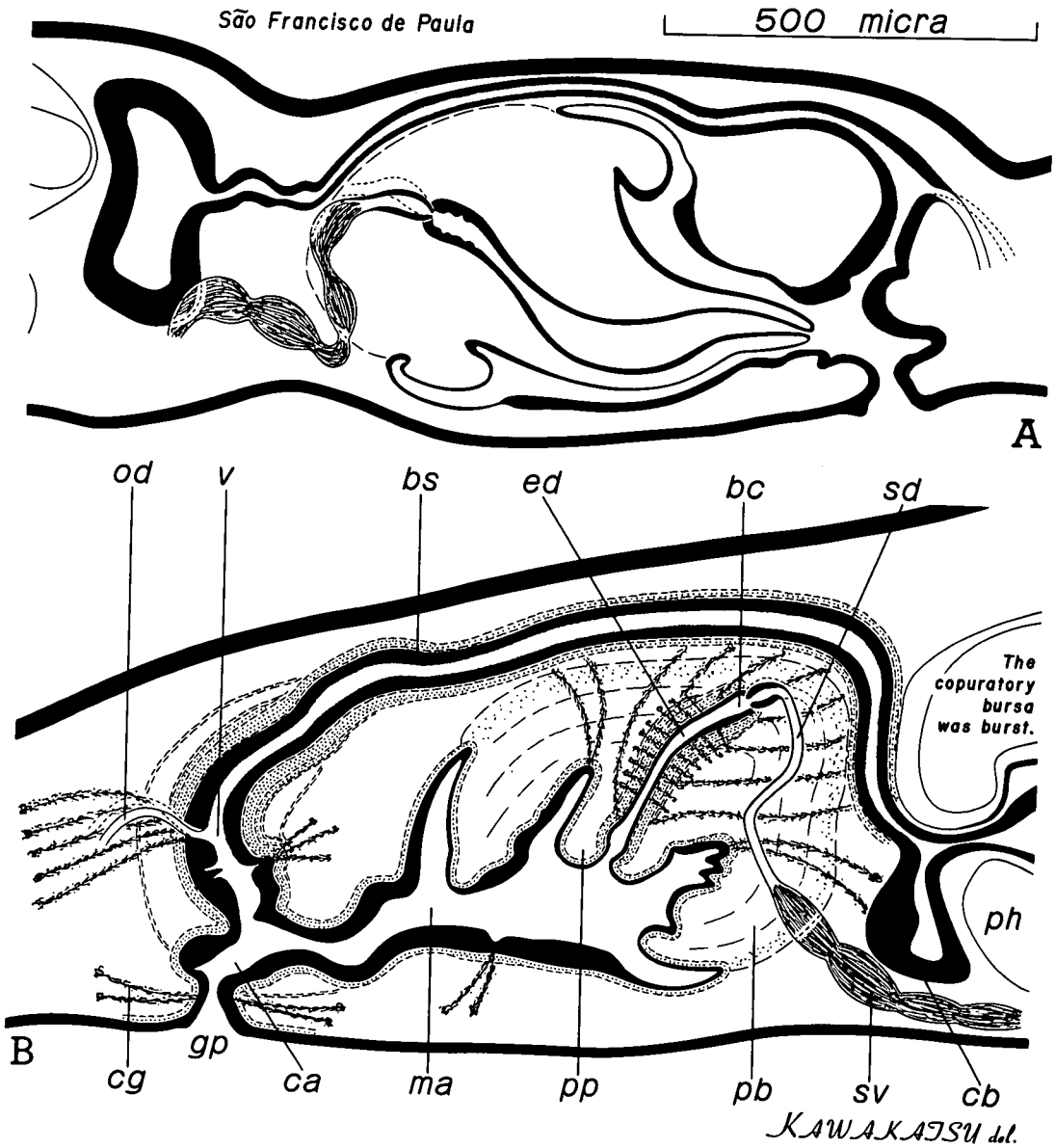

Fig. 5. *Dugesia schubarti*, semidiagrammatic sagittal views of the copulatory apparatus of 2 specimens from the São Francisco de Paula locality. A, No. 1818-b ; B, No. 1819-a. **bc**, bulbar cavity ; **bs**, bursal stalk ; **ca**, common genital antrum ; **cb**, copulatory bursa ; **cg**, cement gland ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **ph**, pharynx ; **pp**, penis papilla ; **sd**, sperm duct ; **sv**, spermiducal vesicle ; **v**, vagina.

Fig. 4. *Dugesia schubarti* (MARCUS, 1946), photographs of 6 preserved specimens from 6 localities. A and B : Specimen Lot No. 1767 (B, ventral view) ; C : Specimen Lot No. 1817 ; D and E : Specimen Lot No. 1818 (E, ventral view) ; F and G : Specimen Lot No. 1819 (G, ventral view) ; H : Specimen Lot No. 1824 ; I and J : Specimen Lot No. 1825 (J, ventral view).

Fig. 6. *Dugesia schubarti*, photomicrographs of near midsagittal sections of the copulatory apparatus of 3 specimens from the São Francisco de Paula locality. A, No. 1818-b ; No. 1819-a ; C, No. 1819-b. **bc**, bulbar cavity ; **ca**, common genital antrum ; **cb**, copulatory bursa ; **ed**, ejaculatory duct ; **gp**, genital pore; **ma**, male genital antrum; **od**, ovovitelline duct; **pb**, penis bulb; **ph**, pharynx; **pp**, penis papilla; **v**, vagina.

specimens from 2 localities at São Francisco de Paula were sectioned.

Externally, they classified into 3 groups, *i. e.*, the Tupandí type, the Cascata type and the Black type (cf. KAWAKATSU, OKI, TAMURA, YAMAYOSHI, HAUSER & FRIEDRICH, 1984, p. 47, fig. 1 A-C). Photographs of 6 preserved specimens are shown in Figure 4 (A-J). Sagittal views of the copulatory apparatus of 2 specimens from 2 localities at São Francisco de Paula are shown in Figure 5 (A and B; Nos. 1818-b and 1819-a); photomicrographs showing parts of the copulatory apparatus of 3 specimens from the São Francisco de Paula localities are also shown in Figure 6 (A-C).

Material.……Six sets of serial sections (Specimen Lot Nos. 1767, 1818 and 1819) and preserved specimens in alcohol (Nos. 1817, 1818, 1819, 1824, and 1825) are retained in KAWAKATSU's laboratory, Fuji Women's College, Sapporo, Japan.

Dugesia anderlani KAWAKATSU et HAUSER, 1983

External and internal features.……Preserved specimens from 3 localities were examined; 9 sexual specimens from 3 localities (Pelotas ?, Picada Verão in Doïs Irmãos and Encruzilhada do Sul) were sectioned.

Photographs of 3 preserved specimens are shown in Figure 7 (A-F). The largest sexually mature specimen from the Picada Verão locality measures, in preserved condition, 16 mm in length and 2.5 mm in width. It is larger than the holotype specimen in life from the Arroio Paixão locality (cf. KAWAKATSU, HAUSER, FRIEDRICH, OKI, TAMURA & YAMAYOSHI, 1983, p. 198). From the new data mentioned above, *Dugesia anderlani* seems to be a middle-sized species among the known freshwater planarians in Brazil.

The shape of the body (especially the head with a pair of moderate-sized, pointed and prominent auricles) is coincident with that of the holotype specimen. A pair of non-pigmented auricular sense organs is conspicuous in the preserved specimens examined. Coloration of the dorsal surface of the body is also coincident with that of the holotype specimen. In the preserved specimens from the localities of Pelotas ?, Picada Verão and Morro Reuter, numerous, dark brownish spots are conspicuous; this character is indistinct in the preserved specimens from the Encruzilhada do Sul locality. A specimen with supernumerary eyes was found in the samples from the last mentioned locality.

The surface of the pharynx is pigmented. The outer pharyngeal musculature consists of two layers, a thin outer layer of longitudinal fibers and a thin inner layer of circular ones. The testes are arranged dorsally; they occupy almost all the dorsoventral space behind the level of the copulatory apparatus. The hyperplastic ovaries are conspicuous. These internal characters observed in the new samples examined are coincident with those of the holotype specimen.

Sagittal views of the copulatory apparatus of 3 specimens from 3 localities, Pelotas ? (No. 1769-a), Picada Verão (No. 1821-c) and Encruzilhada do Sul (No. 1826-b), are shown in Figure 8 (A-C). Photomicrographs showing parts of the copulatory apparatus of 5 specimens from these localities are also shown in Figure 9 (A-I).

The male part of the copulatory apparatus (*i. e.*, penis bulb, penis papilla, etc.) of the new samples examined is more strongly contracted than that of the holotype specimen (cf. KAWAKATSU, HAUSER, FRIEDRICH, OKI, TAMURA, YAMAYOSHI, 1983, p. 201, fig. 4). This may be due to the effect of Susa fluid (cf. KAWAKATSU, HAUSER & FRIEDRICH, 1976, p. 208, footnote 2). *Dugesia anderlani* is characterized in having a large, hemispherical shaped penis bulb of moderately musculature; a wide bulbar cavity, having the form of a gourd, which is separated into two chambers; a large, highly asymmetrical penis papilla of a conical form; and an external ejaculatory duct opening on the underside of the penis (cf. KAWAKATSU, HAUSER, FRIEDRICH, OKI, TAMURA & YAMAYOSHI, 1983). These anatomical and histological characters can be seen

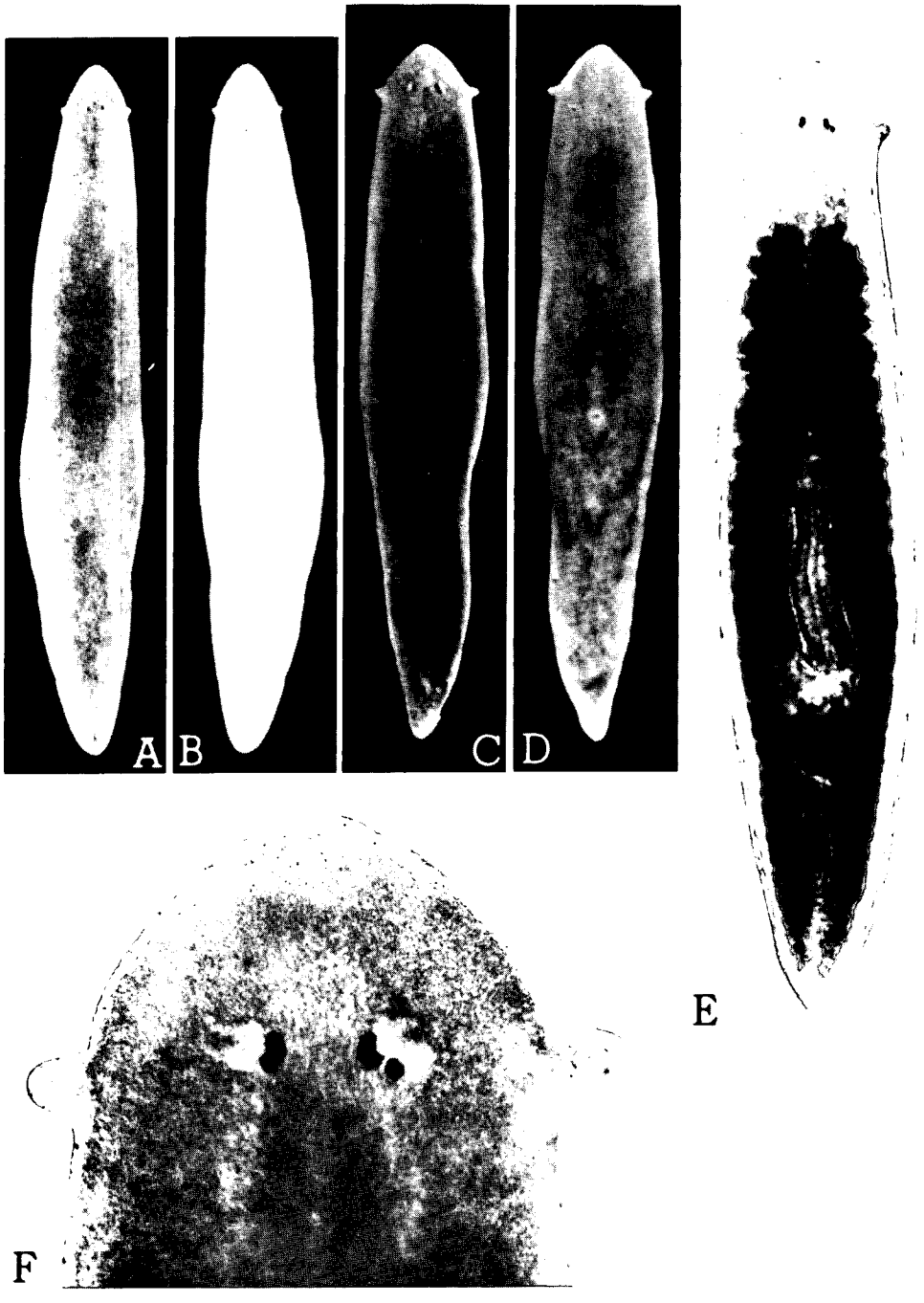

Fig. 7. *Dugesia anderlani* KAWAKATSU et HAUSER, 1983, photographs of 3 preserved specimens from 2 localities. A and B : Specimen Lot No. 1821 (B, ventral view) ; C and D : Specimen Lot No. 1826 (D, ventral view). E and F : Specimen No. 1826-e (whole mount). F, enlarged photograph showing the head.

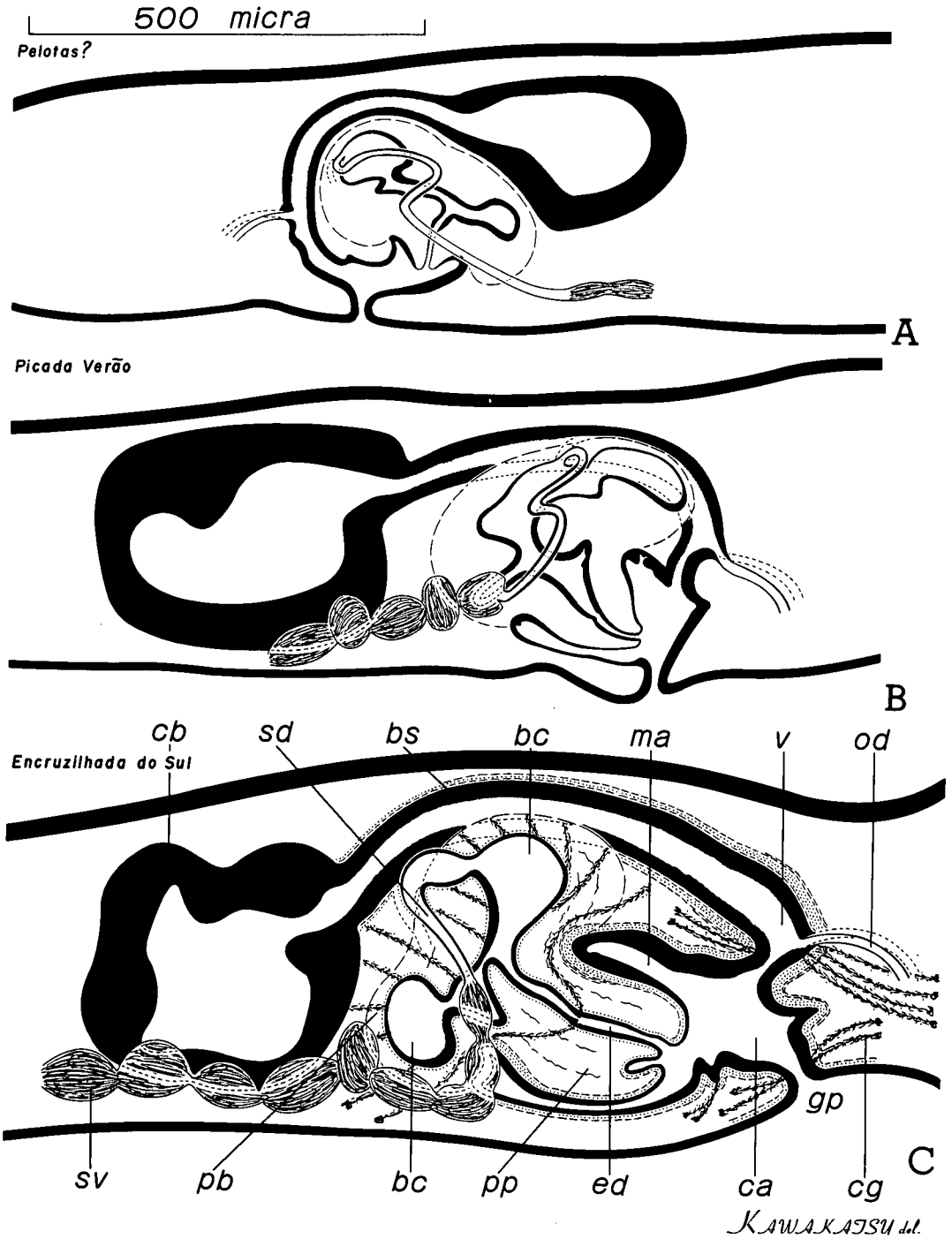

Fig. 8. *Dugesia anderlani*, semidiagrammatic sagittal views of the copulatory apparatus of 3 specimens from 3 localities. A, No. 1769-a from the Pelotas ? locality ; B, No. 1821-c from the Picada Verão locality ; C, No. 1826-b from the Encruzilhada do Sul locality. **bs**, bursal salk ; **ca**, common genital antrum ; **cb**, copulatory bursa ; **cg**, cement gland ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **pp**, penis papilla ; **sd**, sperm duct ; **sv**, spermiducal vesicle ; **v**, vagina.

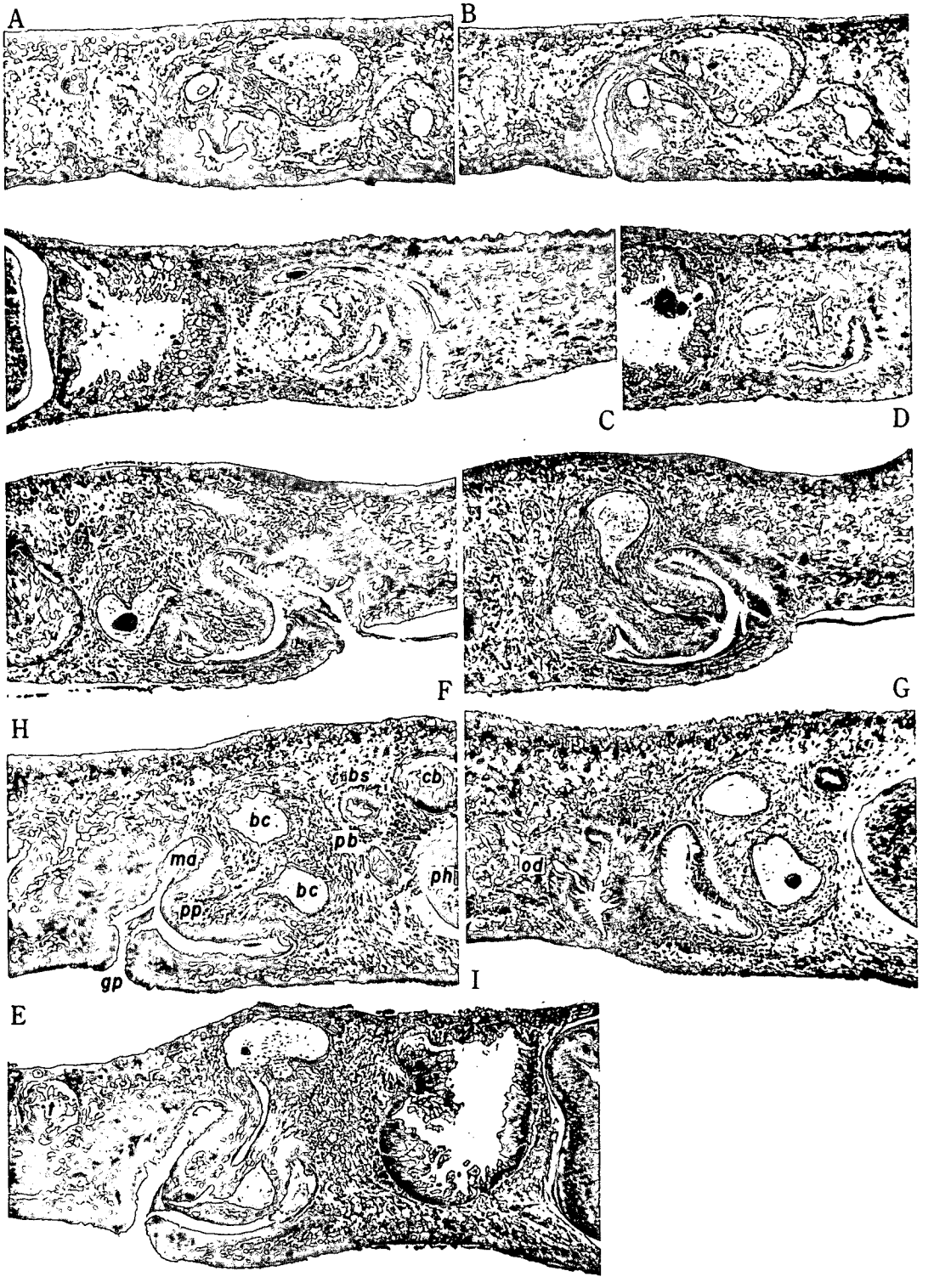

Fig. 9. For explanation see page 52.

in the new samples (Figs. 8 A-C, 9 A-I). It is, however, observed in some specimens that the ventral lip of the penis papilla is larger than the dorsal one (Figs. 8 C, 9 G). This asymmetry does not appear to be a pronounced departure from the original description. In the specimens from the Pelotas ? locality, spermiducal vesicles are less developed.

No special characters in addtion to those in the original description were found in the anatomy and histology of the female part of the copulatory apparatus of new samples examined.

Material.……Nine sets of serial sections (Specimen Lot Nos. 1769, 1821 and 1826), one whole mount (No. 1826-e) and preserved specimens in alcohol (Nos. 1769 and 1821) are retained in KAWAKATSU's laboratory, Fuji Women's College, Sapporo, Japan.

Dugesia arndti MARCUS, 1946

The following redescription of *Dugesia arndti* was given based upon the 5 sexual specimens collected from the Morro Reuter locality in Doïs Irmãos (Specimen Lot No. 1823) ; asexual specimens of the Specimen Lot No. 1822 seem to be the same species. A set of serial sagittal sections of this species borrowed from Dr. Eveline du Bois-Reymond MARCUS was also used. Her slides of the specimen from the Serra da Mantiqueira may be one of the paratypes used in the original description of this species by the late Dr. Ernst MARCUS.

External features.……The largest sexual specimen in the preserved condition measures 16 mm in length and 3 mm in width ; the smallest one, 13 mm long and 2 mm wide. The head is of a mucronate, triangular form and has a swelling on both sides just anterior to rather short, moderately pointed auricles. The non-pigmented auricular sense organs, of hemielliptical form, are conspicuous on each side of the head (Fig. 10 A-F). Behind the auricles, the body gradually widens, reaching its greatest width at the level of the pharynx and copulatory apparatus. The posterior end of the body is bluntly pointed (Fig. 10 A-E).

The dorsal surface is a uniform brown in coloration. The body margin and the areas above the pharynx and copulatory apparatus are of a lighter hue. The ventral side is pale brown.

The two rather small eyes, each surrounded by a narrow pigment-free ocular area, are situated on the dorsal side of the head ; the distance between them is about one-fourth the width of the head at the level of eyes (Fig. 10 A, C, E and F). The genital pore is situated on the ventral side at about the middle of the postpharyngeal region (Fig. 10 B ; see also Fig. 10 E).

The external characters described above of the material from the Morro Reuter locality are essentially the same as those of MARCUS' (1946) original description and color painting of *Dugesia arndti* (see pl. XXXI, fig. 14). In condition, the auricles of *D. arndti* (Fig. 10 A-F) are shorter than those of *D. anderlani* (Fig. 7 A-F).

Internal characters.……Due to the limited number of animals examined from the Morro Reuter

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Fig. 9. *Dugesia anderlani*, photomicrographs of near midsagittal sections of the copulatory apparatus of 5 specimens from 3 localities. A and B, No. 1769-a from the Pelotas ? locality ; C and D, No. 1821-a from the Picada Verão locality ; E, No. 1826-a from the Encruzilhada do Sul locality ; F and G, No. 1826-b ; H and I, No. 1826-c. **bc**, bulbar cavity ; **bs**, bursal stalk ; **cb**, copulatory bursa ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **ph**, pharynx ; **pp**, penis papilla ; **t**, testis.

locality, the pigmentation of the surface of the pharynx was not examined. According to MARCUS (1946, p. 155), this species has a uniformly pigmented pharynx. The inner pharyngeal musculature consists of two distinct layers, a thick circular layer adjacent to the epithelium of the pharynx lumen and a thinner layer of

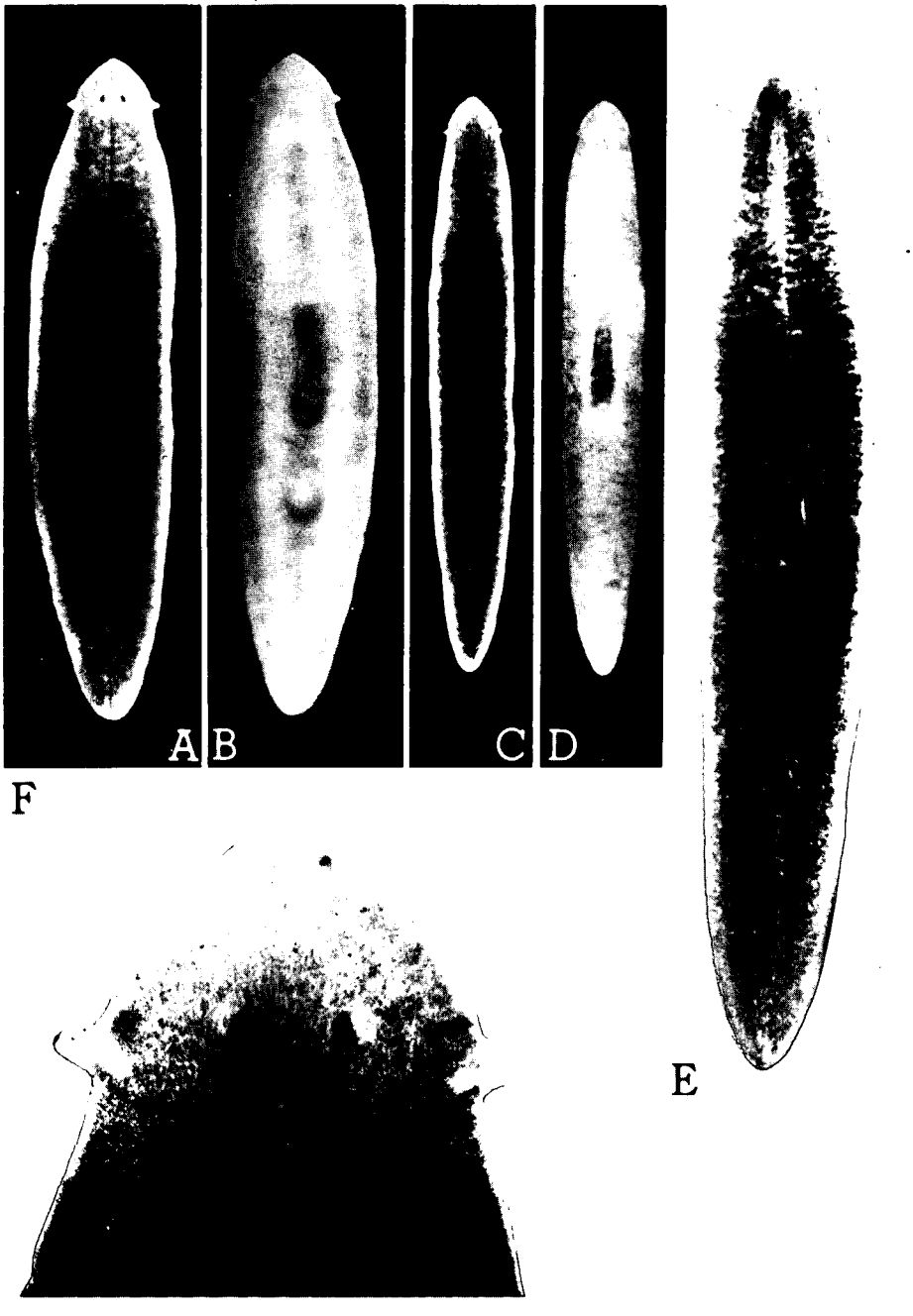

Fig. 10. *Dugesia arndti* MARCUS, 1946, photographs of 3 preserved specimens from the Morro Reuter locality. A and B : Specimen Lot No. 1823 (B, ventral view). C and D : Specimen No. 1822 (D, ventral view). E and F : Specimen No. 1823-e (whole mount). F, enlarged photograph of the head.

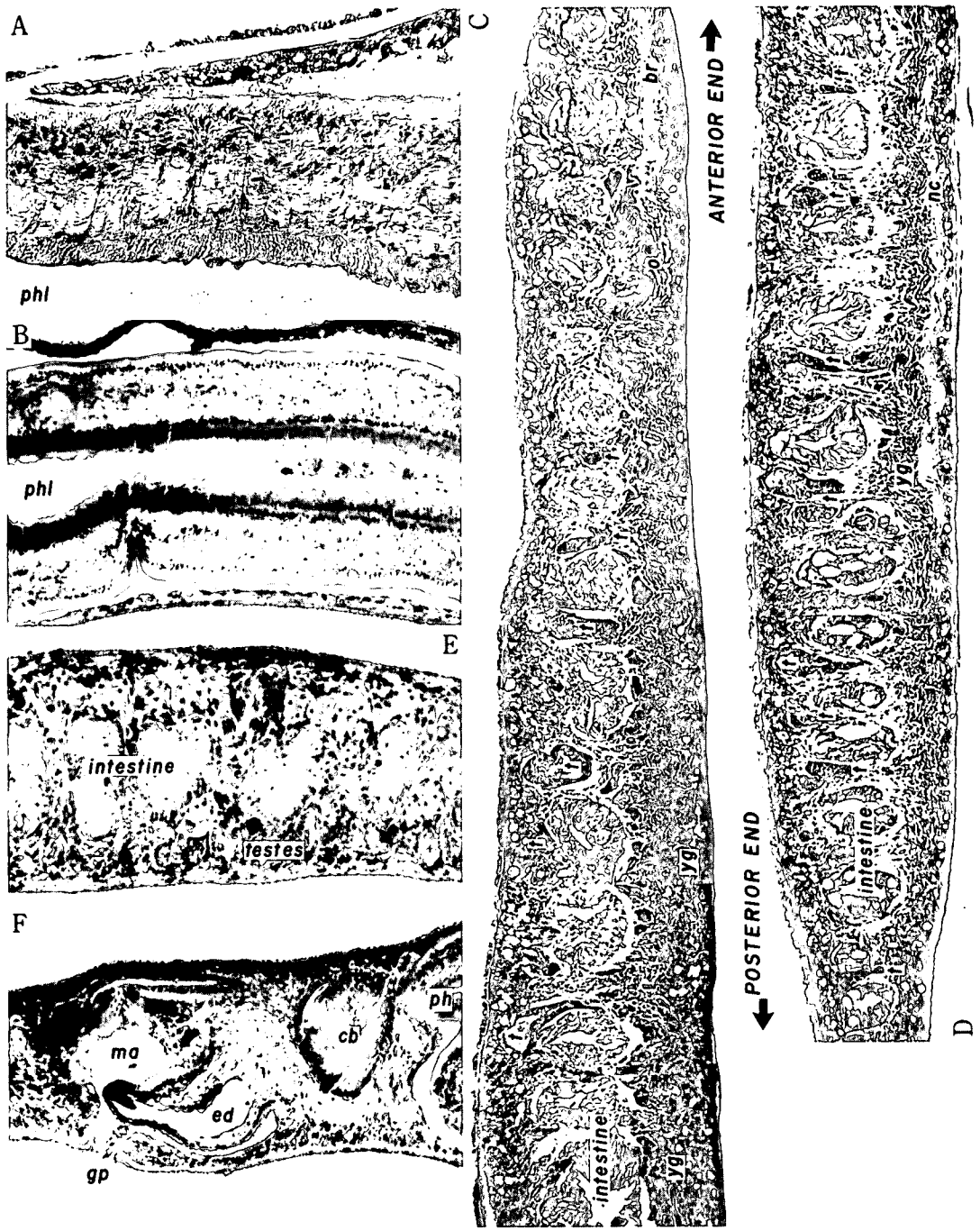

Fig. 11. *Dugesia arndti*, photomicrographs of near midsagittal sections of the pharynx (A and B), parts of the body (C-E) and the copulatory apparatus (F). A, C and D : No. 1823-b from the Morro Reuter locality. A, pharynx ; C, a part of the prepharyngeal region ; D, a part of the postpharyngeal region. B, E and F : one of the paratypes from the Serra da Mantiqueira locality. B, pharynx ; E, a part of the prepharyngeal region ; F, copulatory apparatus. **br**, brain ; **cb**, copulatory bursa ; **ed**, ejac-

longitudinal fibers. The outer pharyngeal musculature consists of two layers, a thin outer layer of longitudinal fibers and a thin inner layer of circular ones (Fig. 11 A and B). In one series of sections (No. 1823-b), an endoparasitic nematode species was observed in the pharyngeal tissue (Fig. 13 E). The anterior trunk of the intestine bears about 16 lateral branches ; each posterior trunk has 20 to 22 lateral branches.

The rather small-sized testes are long and slender ; they essentially occupy all the dorsal space (Fig. 11 C and D) and are arranged on either side of the midline in two or three longitudanal rows extending from the level of ovaries almost to the posterior end of the body. Spermiducal vesicles are not very well developed in the specimens examined.

Concerning the arrangement of testes in *Dugesia arndti*, MARCUS (1946, p. 156) wrote as follows : "Os testículos começam, em vários dos exemplares examinados, anterríormente aos ovários ; em outros, ao nível dêstes ou posteriormente. Estendem-se, para trás, até a região caudal. Situam-se sempre ventralmente aos vitelários, cuja estensão para os lados não acompanham. Folículos testiculares ocorrem também entre os divertículos intestinais, nas regiões média e posterior do corpo." It was observed in the slides borrowed from Dr. Ev. du Bois-Reymond MARCUS that the testes were located ventrally (Fig. 11 F).

A pair of ovaries is found in the usual ventral position (Fig. 11 C). Numerous, well-developed yolk glands are distributed throughout the body in the surrounding mesenchyme (Fig. 11 C and D).

Figure 12 (A and B) shows sagittal views of the copulatory apparatus of the Morroo Reuter specimen (A ; No. 1823-b) and of the specimen from the Serra da Mantiqueira locality which was drawn by KAWAKATSU from one of the paratypes (B ; Dr. MARCUS' sketch of the figure 172 on page 249 in the original description seems to drawn from the same slides). Photomicrographs of parts of the copulatory apparatus of several specimens from both localities are also shown in Figures 11 (F) and 13 (A-E).

The penis has a moderately large, semiglobose bulb and a rather large, bluntly pointed papilla of an elongated conical shape projecting into the male genital autrum (Figs. 12 A, 13 A-E). The bulb is moderately muscular and contains a narrow and long, tubular bulbar cavity which continues to a tubular ejaculatory duct located in the ventral part of the asymmetrical papilla ; it opens on the ventral side of the papilla near its tip (Figs. 12 A, 13 A-E). The two sperm ducts open into the beginning of the bulbar cavity separately (Fig. 12 A). The shape of the penis lumen (*i. e.*, the bulbar cavity and the ejaculatory duct) mentioned above is almost the same in all 4 sets of sections of the specimens from the Morro Reuter locality (Figs. 12 A, 13 A-E). The penis lumen is lined with a flat but glandular epithelium of a nucleate type. Below this epithelium there is a single layer of circular muscle fibers. The penis bulb is pierced by ducts of the erythrophilous penis glands.

The dorsal lip of the penis papilla is larger than the ventral one. The dorsal lip is covered with a thick, glandular, nucleate epithelium ; only the middle part of the epithelium has insunk nuclei. The ventral lip is covered with a rather flat, glandular, nucleate epithelium. Below the covering epithelium of the penis papilla, there are two layers of muscle fibers, one circular and the other longitudinal. The subepithelial musculature of the papilla is more developed at the dorsal lip than at the ventral lip (Fig. 12 A).

The male genital antrum is a wide, drinking horn-shaped cavity, which widens anteriorly. It opens into the common genital antrum (or directly into the genital pore) posteriorly. The roof of the male antrum is lined with a very tall, glandular, nucleate epithelium ; the floor is lined with a rather flat, glandu-

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ulatory duct ; **ma**, male genital antrum ; **nc**, nerve cord ; **o**, ovary ; **ph**, pharynx ; **phl**, pharynx lumen ; **yg**, yolk gland.

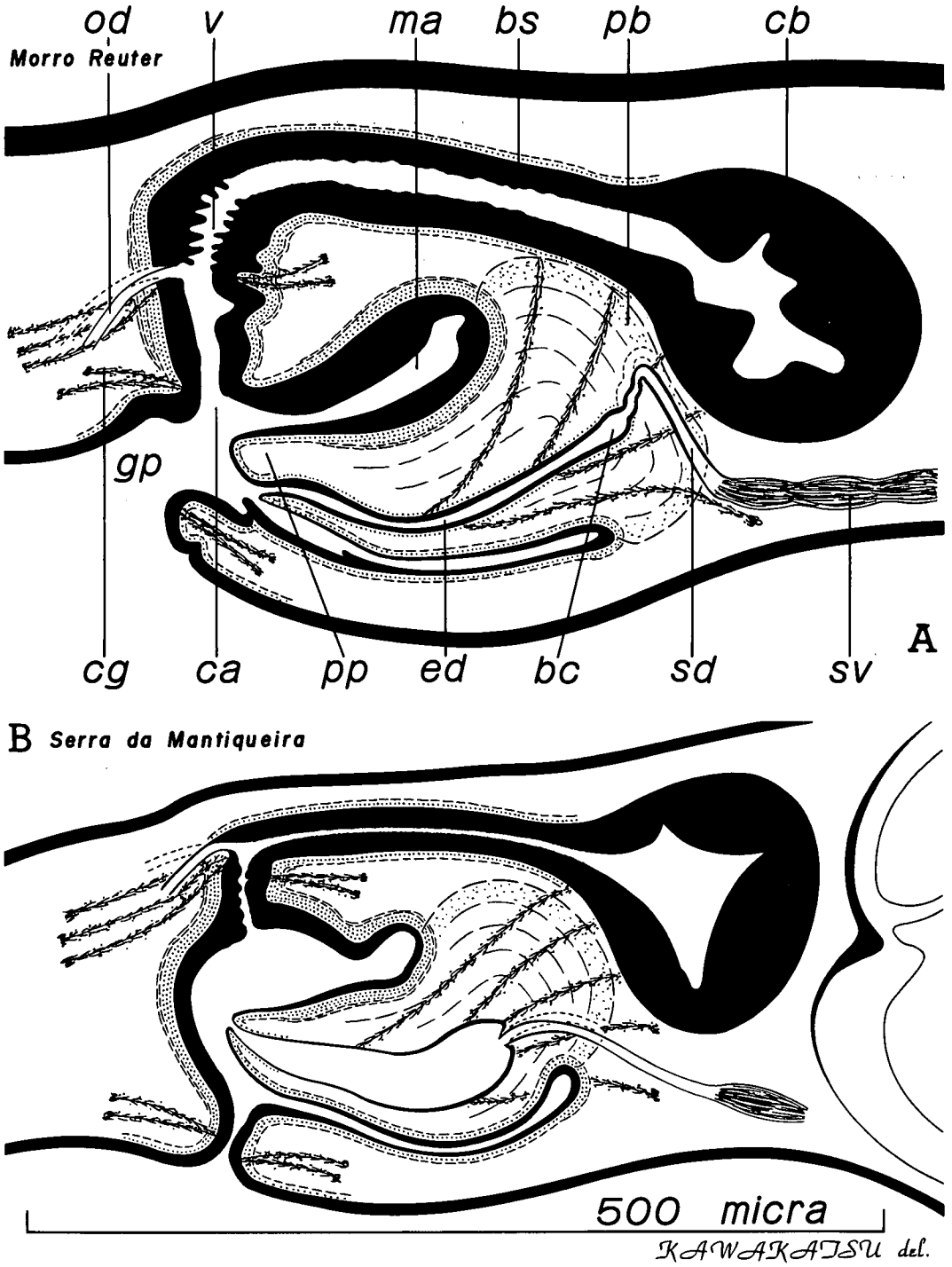

Fig. 12. *Dugesia arndti*, semidiagrammatic views of the copulatory apparatus of 2 specimens from 2 localities. A, No. 1823-b from the Morro Reuter locality ; B, one of the paratypes from the Serra da Mantiqueira locality (Dr. Ev. du Bois-Reymond MARCUS' collection). **bs**, bursal stalk ; **ca**, common genital antrum ; **cb**, copulatory bursa ; **cg**, cement gland ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **od**, ovovitelline duct ; **pb**, penis bulb ; **pp**, penis papilla ; **sd**, sperm duct ; **sv**, spermiducal vesicle ; **v**, vagina.

lar, nucleate epithelium. The subepithelial musculature of the male antrum consists of inner circular and outer longitudinal muscle fibers ; it is much thicker in the roof of the antrum than in the floor (Fig. 12 A).

The copulatory bursa is a middle-sized, spherical shaped organ. The bursal stalk, a long and rather broad duct almost uniform in diameter, runs posteriorly and then widens at its postero-terminal portion as a moderately developed vagina, and opens into the common genital antrum (or directly into the genetal pore) (Figs. 12 A, 13 B-D). The bursal stalk is lined with a tall, glandular, nucleate epithelium. Its anterior two-thirds has a muscular coat consisting of an inner, thin layer of circular fibers and an outer, thin layer of longitudinal ones. The posterior one-thirds of the stalk, or the vagina, has a thick muscle coat consisting of an inner, thick layer of circular fibers and an outer, rather thick layer of longitudinal fibers, which are partly intermingled with circular ones. Two ovovitelline ducts open separately, but near to each other, into the posterior portion of the vagina ; they are accompanied by erythrophilic glands. The epithelium of the ovovitelline duct has nuclei.

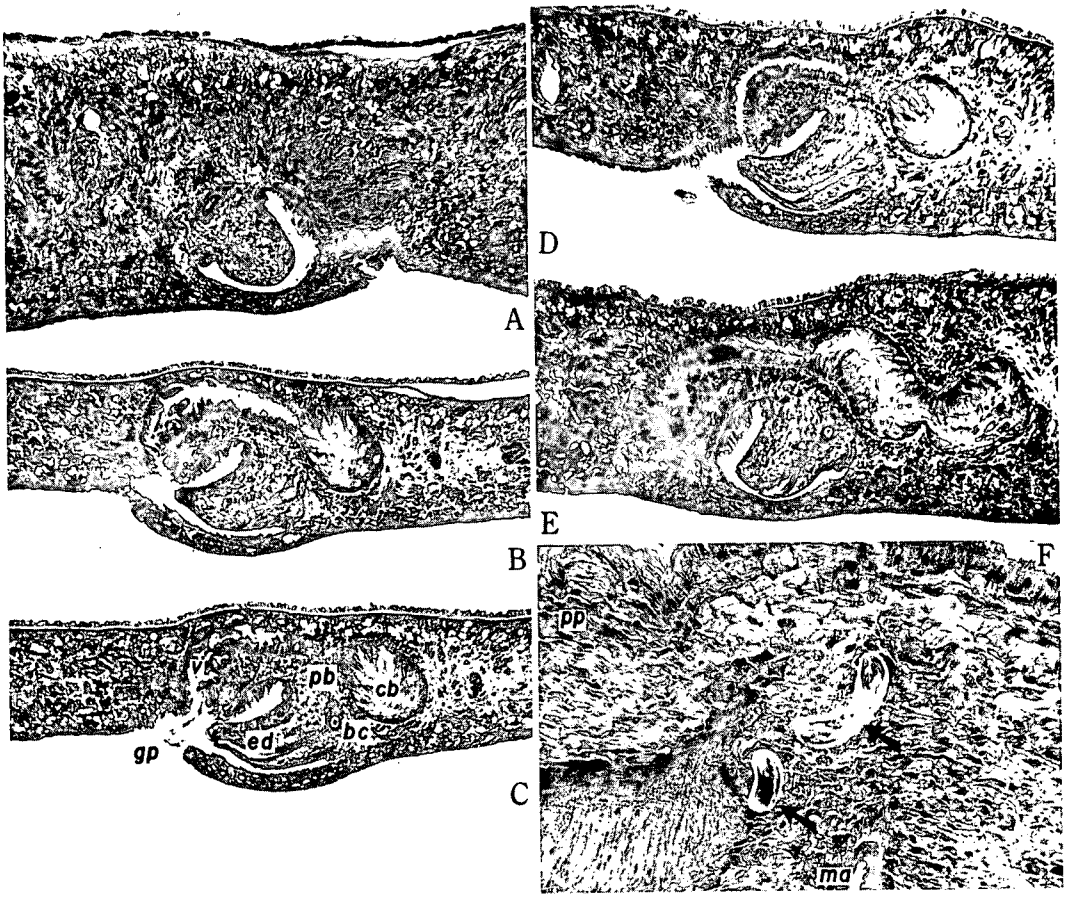

Fig. 13. *Dugesia arndti*, photomicrographs of near midsagittal section of the copulatory apparatus of 3 specimens from the Morro Reuter locality. A, No. 1823-a ; B and C, No. 1823-b ; D and E, No. 1823-c. F : enlarged photomicrograph of a part of the penis papilla showing endoparasitic nematode species (No. 1823-b ; see arrows). **bc**, bulbar cavity ; **cb**, copulatory bursa ; **ed**, ejaculatory duct ; **gp**, genital pore ; **ma**, male genital antrum ; **pb**, penis bulb ; **pp**, penis papilla ; **v**, vagina.

Faintly erythrophilous cement glands are found around the genital pore.

Concerning the foregoing description of the copulatory apparatus of *Dugesia arndti* based upon the Morro Reuter specimens, there are some differences between the authors' material and that of MARCUS (1946) used for his original description of the species (pp. 155–158, 174, 246–249, pls. XXIX–XXX, figs. 170–176). His material from the vicinity of the Serra da Mantiqueira is different from the Morro Reuter material in the following anatomical characters of the copulatory apparatus.

The penis lumen in MARCUS' (1946) specimens consists of a moderately wide, rounded bulbar cavity and a wide, elongated ejaculatory duct (p. 247, pl. XXIX, figs. 170 and 171, p. 249, pl. XXX, figs. 172 and 173; see also Figs. 11 F and 12 B in the present paper).

In MARCUS' (1946) specimens, the vagina opens into the roof of the female genital antrum, which is sharpely separated from the male genital antrum (see p. 247, pl. XXIX, fig. 171) or connected with the male antrum (see p. 247, pl. XXIX, fig. 170, p. 249, pl. XXX, fig. 172; see also Figs. 11 F and 12 B in the present paper). A narrow and short common genital antrum is also found in figures cited above.

According to MARCUS (1946, pp. 156–157, 174, 249, pl. XXX, figs. 174 and 175), a short common ovovitelline duct was found in some of his specimens. In one of his paratypes examined by KAWAKATSU (Fig. 12 B), the specimen may have a common ovovitelline duct (the anatomy of this part could not be clarified in detail). Moreover, the ovovitelline duct(s) opens into the beginning of the vagina in the specimens from the Sierra da Mantiqueira locality. MARCUS (1946) also pointed out that the terminal portion of the ovovitelline duct has a normal nucleate epithelium with cilia; further inwards it has depressed nuclei (see p. 249, pl. XXX, figs. 174 and 175).

The above-described differences in the genital anatomy of the Sierra da Mantiqueira specimens are very different from those of the Morro Reuter specimens. It is known, however, that the shape of the penis lumen and the genital antra are sometimes changeable by the effect of different fixatives. KAWAKATSU considered that these anatomical and histological characters found in the animals from the Sierra da Mantiqueira (Estado de São Paulo) and Morro Reuter (Estado de Rio Grade do Sul) may be due to local variation in *Dugesia arndti*. The distance between both localities is about 1200 kilometers.

Meterial……Four sets of serial sections (Specimen Lot No. 1823) and one whole mount (No. 1823-e) and preserved specimens in alcohol (No. 1822) are retained in KAWAKATSU's laboratory, Fuji Women's College, Sapporo, Japan. Two sets of sections separated from this collection will be sent to the Department of Zoology (Nat. Hist.), National Science Museum, Tôkyô, Japan, and to the U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C., U. S. A., respectively. The slides of one of the paratypes used for this study are retained in Dr. Eveline du Bois-Reymond MARCUS' collection, São Paulo, Brazil.

Differential diagnosis……*Dugesia arndti* differs from the other members of the genus in the following characters: the living animal moderate in size (13–18 mm) and uniformely brown above; head mucronated triangular with a swelling on both sides; with rather short and pointed auricles; two small eyes; pharynx pigmented and its external muscle layer consisting of outer longitudinal and inner circular fibers; dorsal (and ventral) testes long and slender, extending to the posterior end; penis bulb moderately large, semiglobose in shape and moderately muscular with a narrow (sometimes moderately wide), tubular bulbar cavity into which sperm ducts enter separately at its beginning; asymmetrical penis papilla rather large, elongated conical in shape, and containing tubular ejaculatory duct (some local variations may occur in the shape of the penis lumen); copulatory bursa middle-sized, with rather broad bursal stalk, of which posterior one-thirds forms a moderately developed vagina, opening into the roof of the female genital antrum at its posterior portion (male and common genital antra continuous and sometimes the latter could not be separable); ovovitelline ducts (sometimes short common ovovitelline duct may occur) opening into the vagina;

epithelia of the copulatory apparatus nucleate except for the middle part of the dorsal lip of the penis papilla.

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The authors are grateful to Dr. Eveline du Bois-Reymond MARCUS of São Paulo for the loan of the slides of *Dugesia arndti*. They also wish to express their thanks to Professor Dr. Robert W. MITCHELL of the Department of Biological Sciences, Texas Tech University, Lobbock, Texas, U. S. A., for his careful reading of this manuscript.

SUMMARY

In the series of publications on the freshwater planarian fauna of South Brazil, of which this is the eighth, the authors have described the morphology, anatomy and histology of 4 species collected from several localities in Estado de Rio Grande do Sol.

Dugesia tigrina (GIRARD, 1850) was recorded from 3 localities : Pelotas ?, São Francisco de Paula and Constantina. Additional description of the genital anatomy is given in the present paper.

Dugesia schubarti (MRACUS, 1946) was recorded from 6 localities : Pelotas ?, São Francisco de Paula (3 localities) and Morro Reuter at the Doïs Irmãos (2 localities). Additional description of the genital anatomy is given in the present paper.

Dugesia anderlani KAWAKATSU et HAUSER, 1983, was recorded from 3 localities : Pelotas ?, Picada Verão and Morro Reuter at the Doïs Irmãos, and Encruzilhada do Sul. Since this species was described by the single specimen from the Arroio Paixão locality, additional description of the genital anatomy based upon the new material is given in detail in the present paper.

Dugesia arndti MARCUS, 1946, was recorded from the locality at Morro Reuter, Doïs Irmãos. This is the first record of this species other than the type locality at the Serra da Mantiqueira, Estado de São Paulo. A detailed redescription of this species based upon the new material is given in the present paper, together with the result of examination of one of the paratypes. Some local variation was found in the genital anatomy of this species.

RESUMO

Na série de publicações da fauna de planárias de água doce do sul do Brasil, da qual esta é a oitava, os autores descreveram a morfologia, anatomia e histologia de 4 espcie coletadas de várias localidades, no estado do Rio Grande do Sul.

Dugesia tigrina (GIRARD, 1850) foi registrada em 3 localidades : Pelotas(?), São Francisco de Paula e Constantina. Descrição adicional da anatomia genital foi dado no presente trabalho.

Dugesia schubarti (MARCUS, 1946) foi registrada em 6 localidades. Pelotas(?), São Francisco de Paula (3 localidades) e Morro Reuter em Doïs Irmãos (2 localidades). Descrição adicional da anatomia genital foi dada no presente trabalho.

Dugesia anderlani KAWAKATSU et HAUSER, 1983, foi registrada em 3 localidades : Pelotas(?), Picada Verão e Morro Reuter em Doïs Irmãos, e Encruzilhada do Sul. Uma vez que esta espécie foi descrita por um exemplar único da licalidade do Arroio Paixão, descrição adicional da anatomia genital baseada sobre o novo material foi dada em detalhes no referente trabalho.

Dugesia arndti MARCUS, 1946, foi registrada na localidade do Morro Reuter em Doïs

Irmãos. Este é o primeiro registro desta espécie, diferente do tipo de localizado na Serra da Mantiqueira, estado de São Paulo. Uma redescrição detalhada desta espécie, baseado sobre o novo material foi dada no presente trabalho, juntamente com o resultado do exame de um dos parátipos. Algumas variações locais foram encontradas na anatomia genital destas espécies.

RÉSUMÉ

Cette étude constitue la huitième de la série de publications de la faune de planaires d'eau douce du sud du Brésil, dans lesquelles les auteurs ont décrit la morphologie, l'anatomie et l'histologie de 4 espèces recueillies de plusieurs localités dans l'état de Rio Grande do Sul.

Dugesia tigrina (GIRARD, 1850) a été enregistrée enregistrée dans 3 localités : Pelotas(?), São Francisco de Paula et Constantina. Ce travail présente une description additionnelle de l'anatomie génitale.

Dugesia schubarti (MARCUS, 1946) a été enregistrée dans 6 localités : Pelotas(?), São Francisco de Paula (3 localités) et Morro Reuter à Doïs Irmãos (2 localités). Ce travail présente une description additionnelle de l'anatomie génitale.

Dugesia anderlani KAWAKATSU et HAUSER, 1983, a été enregistrée dans 3 localités : Pelotas(?), Picada Verão et Morro Reuter à Doïs Irmãos, et Encruzilhada do Sul. Cette espèce ayant été décrite dans un seul exemplaire, dans la localité de Arroio Paixão, en se basant sur le nouveau matériel, cette étude présente une description additionnellle détaillée de l'anatomie génitale.

Dugesia arndti (MARCUS, 1946) a été enregistrée dans la localité de Morro Reuter à Doïs Irmãos. C'est le premier enregistrement de cette espèce, qui est différente du type localisé dans la Serra da Mantiqueira, dans l'état de São Paulo. Ce travail, en se basant sur le nouveau matériel, présente une redescription détaillée de cette espèce, en même temps que le résultat de l'examen d'un des Paratypes. Quelques variations locales ont été trouvées dans l'anatomie génitale de ces espèces.

ZUSAMMENFASSUNG

Dieses ist die achte Veröffentlichung in der Serie über Süsswasserplanarien von Südbrasilien. Die Verfasser beschreiben die Morphologie, Anatomie und Histologie von vier Arten, die an verschiedenen Orten des Staates Rio Grande do Sul gesammelt wurden.

Dugesia tigrina (GIRARD, 1850) wurde an drei Orten registriert : Pelotas(?), São Francisco de Paula und Constantina. Es wird in dieser Arbeit eine zusätzliche Beschreibung des Genitalapparates dargestellt.

Dugesia schubarti (MARCUS, 1946) registrierte man an sechs Orten : in Pelotas(?), in São Francisco de Paula an drei Stellen und in Morro Reuter im Stadkreis Doïs Irmãos an zwei Stellen. Hier wird ebenfalls eine zusätzliche Beschreibung des Genitalapparates zugefügt.

Dugesia anderlani KAWAKATSU et HAUSER, 1983, wurde an drei Stellen registriert. In Pelotas(?), Picada Verão, Morro Reuter im Stadtkreis Doïs Irmãos und Encruzilhada do Sul. Da diese Art bisher nur an Hand eines einzigen Exemplares beschrieben wurde, wird num eine neue Beschreibung des neuen Materials eingehender dargestellt.

Dugesia arndti (MARCUS, 1946) wurde in Morro Reuter im Stadtkreis Doïs Irmãos gefunden. Das ist der erste Fund von dieser Art. Sie weicht etwas von dem Typ ab, der in Serra da Mantiqueira im Staat São Paulo gefunden wurde. In dieser Arbeit wird eine eingehende Beschreibung an Hand des neuen Materials, begleitet von Beobachtungen der Schnitte von einem Paratypus gegeben. Man hat einige

Abweichungen in der Anatomie des Genitalapparates der beiden Arten voneinander vorgefunden.

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