

Dendrocoelopsis ichikawai sp. nov., a New Freshwater Planarian
from Rishiri Island in Hokkaido

By

Masaharu KAWAKATSU

Biological Laboratory, Fuji Women's College, Sapporo, Japan,

Etsuo ASAI

Biological Institute, Kanazawa Medical University,
Uchinada-machi, Ishikawa, Japan

and

Tatsuya YAMADA

Ogano High School, Ogano-chô, Saitama, Japan

(Communicated by Yoshinori IMAIZUMI)

Introduction

In a lecture on the freshwater planarian fauna of Hokkaido given at the annual meeting of the Zoological Society of Japan held in Kyoto in 1953, Dr. A. ICHIKAWA referred to the occurrence of several undescribed forms of planarians in North Japan (cf. ICHIKAWA, 1954). A new *Bdellocephala* species from Hime-numa Pond in Rishiri Island located on the Sea of Japan, about 40 kilometers southwest of Wakkanai, the northernmost part of Hokkaido, was included in his undescribed forms (cf. KAWAKATSU & ICHIKAWA, 1971).

On August 23 and 24, 1956, the senior author (KAWAKATSU) and Mr. Y. TARUI, who visited ICHIKAWA's locality (a brook or the outlet of Hime-numa Pond, the northeastern part of Rishiri Island), succeeded in collecting about one-hundred specimens of dendrocoelid planarians. On a brief examination of live specimens under a hand-lens at the spot, it was found that a few specimens having an octopus-like sucker at the ventral side of the head were included in the material. Externally, this species is easily separable from ICHIKAWA's *Bdellocephala* species which has a usual sucker of the *Bdellocephala* type (cf. KAWAKATSU & TARUI, 1959). In order to obtain sufficient specimens for taxonomic study, KAWAKATSU revisited this locality in September, 1957; the third survey trip to this locality was also made by KAWAKATSU and YAMADA on August 2 to 5, 1964 (cf. KAWAKATSU & YAMADA, 1966). Thus, a sufficient number of sexual specimens of this species were secured, together with a large number of specimens of *Bdellocephala* sp. which will be described elsewhere.

At first the former species was classified temporarily as "*Monocotylus karafutoensis*" and then as "*Monocotylus?* sp. of Rishiri Island" in the earlier literature (cf. KAWAKATSU, 1958, 1965 a, b, 1966, 1967, 1969, and others; KAWAKATSU & ICHIKAWA, 1971; KAWAKATSU & TARUI, 1959; KAWAKATSU & YAMADA, 1966; YAMADA, 1966). Recently, a sufficient number of serial sections of the species in question were prepared by KAWAKATSU (stained with Delafield's haematoxylin and erythrosin) and ASAI (Mallory's triple stain; the slides were chiefly studied by ASAI). On a close examination of these series of sections, KAWAKATSU has come to the conclusion that the present form is a hitherto undescribed new species of the genus *Dendrocoelopsis*.

In the present paper, this new triclad turbellarian from North Japan is described by KAWAKATSU, together with some remarks about the ecology observed by himself and YAMADA. The authors take pleasure in naming this new species after Dr. Atsuhiko ICHIKAWA, Professor Emeritus of Hokkaido University and a honorary member of the Zoological Society of Japan, in honor of his valuable contribution to the turbellariology.

This paper is dedicated to Dr. Atsuhiko ICHIKAWA on the occasions of his 72nd birthday as well as of his decoration.

Collection Data

The followings are the data of collection of the samples examined from the Hime-numa locality (cf. KAWAKATSU, 1958; KAWAKATSU & TARUI, 1959; KAWAKATSU & YAMADA, 1966). The Specimen Lot Numbers given for each stock are a number registered in KAWAKATSU's fixing notebook according to his permanent recording system.

Specimen Lot No. 165 group. Only one non-fully mature specimen was collected (water temp., 12.5°C, pH 7.0) and fixed in Bouin's fluid. August 23–24, 1956. Coll. M. KAWAKATSU and Mr. Y. TARUI.

Specimen Lot No. 220 group. Five specimens, both sexually mature and immature, were collected (water temp., 12.3–14.6°C, pH 7.0) and fixed in Bouin's fluid. September 1–3, 1957. Coll. M. KAWAKATSU.

Specimen Lot Nos. 421 and 422 groups. About 90 specimens, both sexually mature and immature, were collected (water temp., 16.0–16.8°C, pH 6.9–7.2) and fixed in Bouin's fluid (No. 421 group) and in Nozawa's fluid after being killed by SUGINO's method (No. 422 group). Some remaining live specimens were cultured by YAMADA until the late spring of 1965. August 2–5, 1964. Coll. M. KAWAKATSU and T. YAMADA.

Description of the New Species

Order TRICLADIDA

Suborder PALUDICOLA or PROBURSALIA

Family Dendrocoelidae

Genus *Dendrocoelopsis* KENK, 1930

***Dendrocoelopsis ichikawai* KAWAKATSU, sp. nov.**

[Japanese name: Rishiri-uzumushi]

Principal literature.

- “*Monocotylus karafutoensis*” (also spelled *karafutoensis*) nom. nud.: OKUGAWA, 1953, Bull. Kyoto Gakugei Univ., (B), (3), pp. 21, 40. He mentioned a Sakhalin species under the name of “*Monocotylus karafutoensis*” OKUGAWA, 1945 (original description in Bull. biogeogr. Soc. Japan, 15; Loc. Tomarigishi in South Saghalien). This paper was not published (cf. KAWAKATSU, 1968 c, p. 92; KAWAKATSU & ICHIKAWA, 1971, pp. 9–10).
- “*Monocotylus karafutoensis*” nom. nud.: KAWAKATSU, 1958, Bull. Kyoto Gakugei Univ., (B), (12), pp. 50, 56–58. Remarks on distributional ecology.
- “*Monocotylus karafutoensis*” nom. nud.: KAWAKATSU & TARUI, 1959, Collect. & Breed., Tokyo, 21, p. 344, fig. 11–j, (12), p. 370. Remarks on distributional ecology.
- “*Monocotylus*”: DE BEAUCHAMP, 1961, in *Traité de Zoologie*, 4, p. 108. Taxonomic remarks in reference with OKUGAWA’s 1953 article.
- “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU, 1965, Seikatsu-bunka Kenkyû, (13), p. 63. Remarks on distribution.
- “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU, 1965, Hydrobiologia, 26, pp. 365, 368, 370, table II, 373, fig. 10, 398. Remarks on distribution.
- “*Monocotylus*? sp. of Rishiri Island”: YAMADA, 1966, Jap. J. Ecol., 16, p. 130, fig. 1. Remarks on distribution.
- “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU & YAMADA, 1966, Collect. & Breed., Tokyo, 28, pp. 375–379, fig. 2 B and C. Taxonomic and ecological remarks.
- “*Monocotylus*?”: KAWAKATSU, YAMADA & IWAKI, 1967, Jap. J. Ecol., 17, p. 263. Remarks on distribution.
- “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU, 1967, Bull. Fuji Women’s College, (5), pp. 134, 136, 138–139, table II, 140, fig. 10, 161–165. Remarks on distribution.
- “*Monocotylus* KOROTNEV, 1912”: KAWAKATSU, 1968, Jap. Soc. syst. Zool. Circular, (38–41), pp. 14, 21, fig. IV–1. Taxonomic remarks.
- “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU, 1969, Bull. Fuji Women’s College, (7), II, p. 47, table 1. Taxonomic remarks.
- “*Monocotylus karafutoensis* OKUGAWA” nom. nud. and “*Monocotylus*? sp. of Rishiri Island”: KAWAKATSU & ICHIKAWA, 1971, Proc. Jap. Soc. syst. Zool., (7), pp. 9–10. Taxonomic remarks.
- “*Monocotylus*?”: KAWAKATSU, 1973, Nature & Animals (Dôbutsu-to-Shizen), 3(5), p. 15, table 1. Remarks on distribution.
- “*Monocotylus karafutoensis* OKUGAWA, 1945” nom. nud.: OKUGAWA, 1973, in T. KAWAMURA’s Freshwater Biology of Japan, p. 230. Taxonomic remarks.
- “*Monocotylus*?”: KAWAKATSU, 1974, in Libbie H. HYMAN Mem. Vol.—Biology of the Turbellaria, p. 230. Remarks on distribution.
- “*Monocotylus karafutoensis* OKUGAWA, 1953” nom. nud.: KENK, 1974, Smiths. Contr. Zool., (183), p. 37. Taxonomic remarks (species inquirenda).

Description. This is a middle-sized, rather slender and pigmented epigean species. General appearance of both living and preserved, fully sexually mature specimens is shown in photographs of Fig. 1 (A–I).

Usually, sexually mature specimens measure up to 10 to 12 mm in length and 2 mm in width; a number of large specimens measuring 15 mm long and 3 mm wide were also seen in the material examined. The animals frequently show a noticeable crawling movement using a well-developed, anterior subterminal adhesive organ and marginal adhesive zones. In the gently gliding animal, the anterior end of the head is subtruncated with a semicircular bulge at the central portion (Fig. 1 A–C). The head becomes rather rounded when the animal moves crawlily (Fig. 1 D). The auricles are moderately developed, but short and highly rounded (Fig. 1 A–D). Behind the auricles, the body first narrows slightly (the “neck” is conspicuous in the crawling animal), then gradually widens, reaching its widest at the level of pharynx and copulatory apparatus. The posterior end of the body is moderately pointed.

Two eyes are situated on the dorsal side of the head; the distance between them amounts to about one-third the width of the head at the level of eyes. Each eye is enclosed in a large reniform, pigment-free ocular area (Fig. 1 A–D, G, H). The auricular sensory organ of a broad leaf-shape is visible on each side of the head (Fig. 1 A–D).

The ground color of the dorsal surface of the body is uniformly grayish brown. The margin of the body and the areas above the pharynx and the copulatory organ are of a lighter brownish color. The ventral surface is pale gray.

The rather long pharynx is inserted far behind the middle of the body and is nearly one-fourth to one-fifth the body length. The genital pore is situated on the midline at the level of the middle of the postpharyngeal region (Fig. 1 G, I).

The anterior intestinal trunk has 16 to 18 branches on each side; each posterior trunk has 13 to 15 short lateral branches. In histological sections, the musculature of the pharynx shows the typical arrangement of the family Dendrocoelidae: its internal muscular zone consists of intermingled circular and longitudinal fibres. The external musculature of the pharynx consists of three layers, i.e., an outer thin layer of longitudinal fibres, a middle thick layer of circular ones, and an inner thin layer of longitudinal ones (Fig. 2 A).

The dorsal epithelium is much thicker than the ventral and it is heavily provided with rhabdites. The marginal adhesive zone, pierced by numerous openings of coarsely erythrophilic glands, is found below each lateral submargin of the body.

The present new species has a subterminal adhesive organ or sucker on the frontal end of the ventral side of the body. Externally, the organ in live specimens is a well-developed concave depression like an octopus's sucker (Fig. 1 E). In the fixed specimens it looks like a small pit (Figs. 1 G, I, 2B). The histological construction of the sucker is shown in Figs. 2 (C, D) and 3. The surface of the organ is covered with an epithelium devoid of rhabdites. The epithelium of the marginal area is thicker than that of the interior portion. The muscular system of this organ

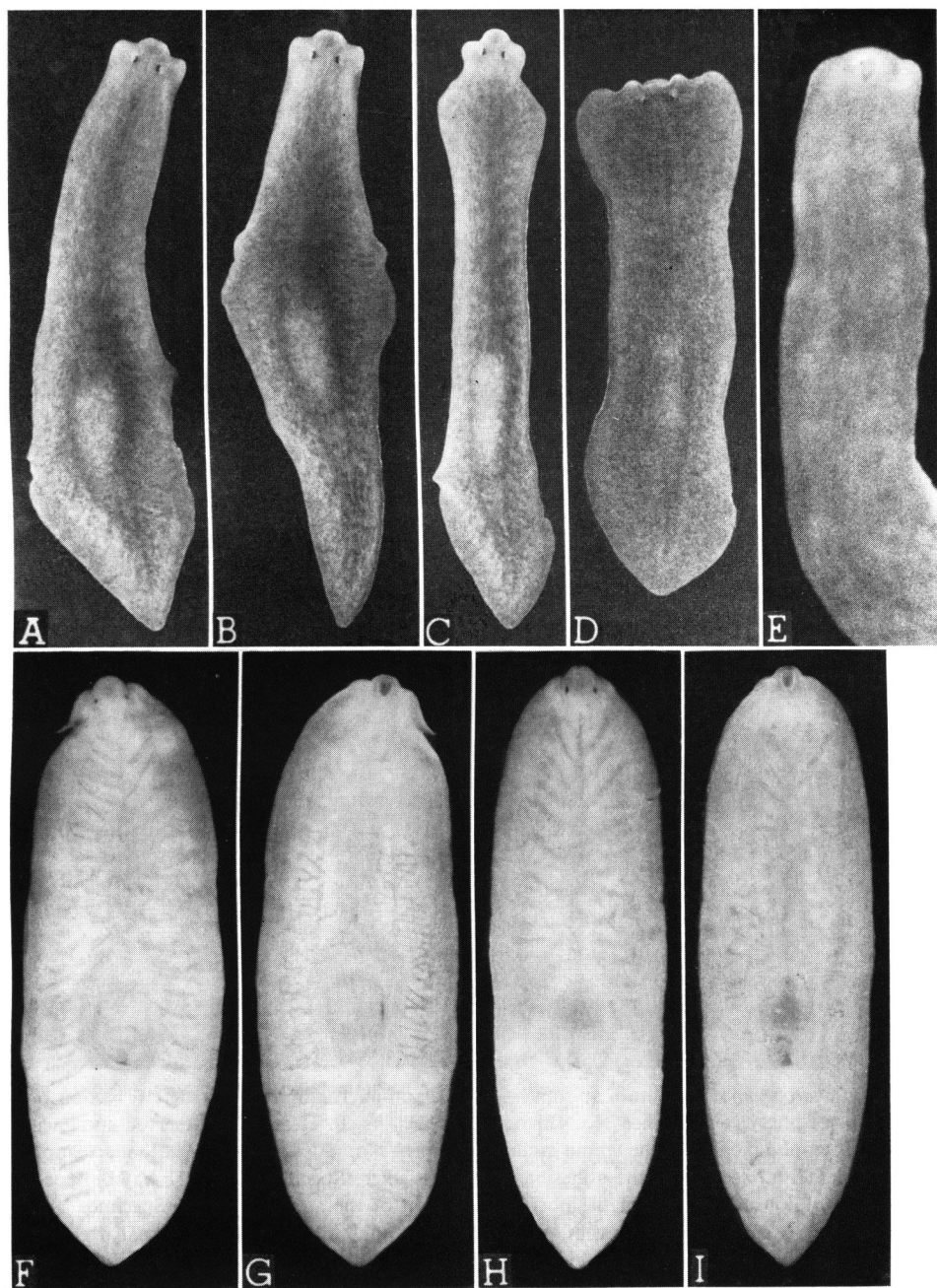


Fig. 1. *Dendrocoelopsis ichikawai* sp. nov. (Specimen Lot Nos. 421 and 422 groups). — A-E. Live specimens. E, Ventral view. — F-I. Preserved specimens. G, Ventral view of the specimen F. I, Ventral view of the specimen H.

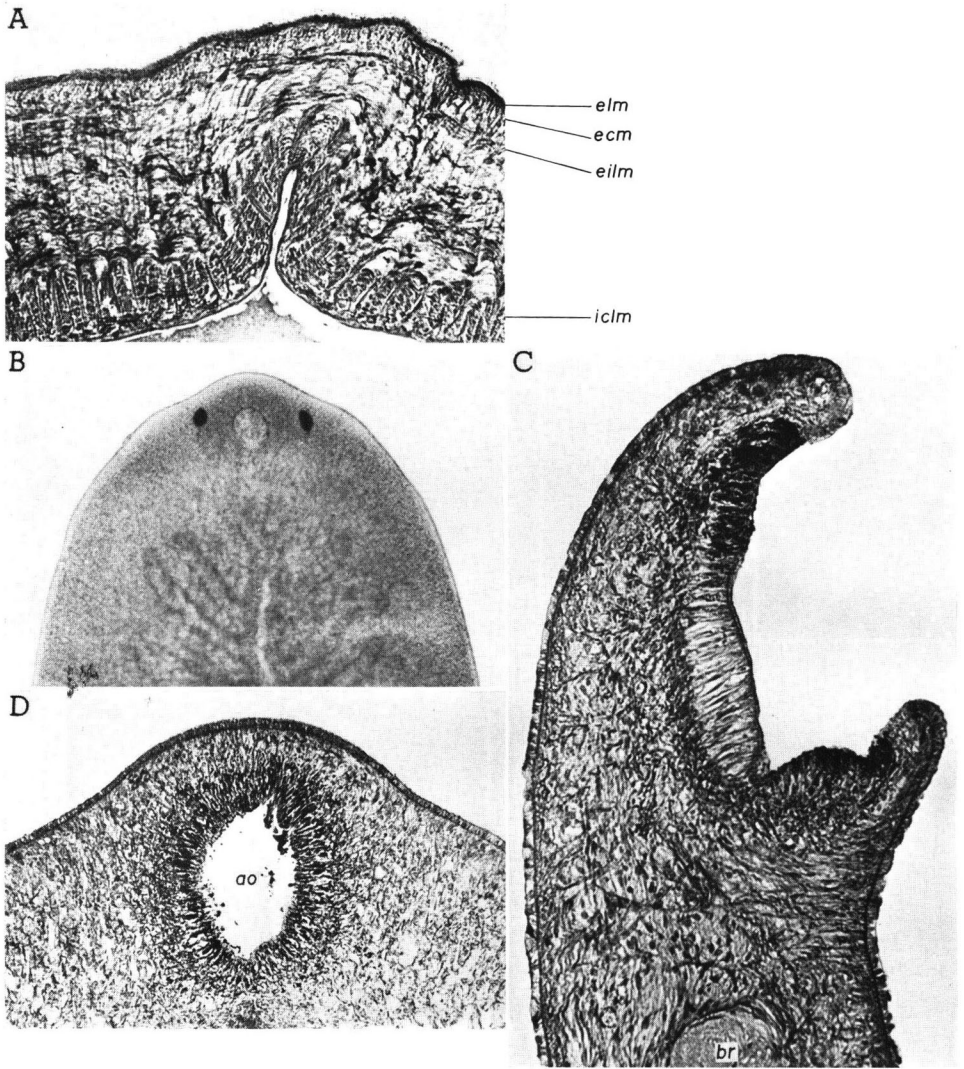


Fig. 2. *Dendrocoelopsis ichikawai* sp. nov. — A. Photomicrograph of the sagittal section of a part of pharynx (Specimen No. 421 h; holotype). — B. Head of a preserved specimen (photograph taken from the whole mount; Specimen No. 421 r). — C. Photomicrograph of the sagittal section of the adhesive organ or sucker (Specimen No. 421 h; holotype). — D. Photomicrograph of the horizontal section of the adhesive organ (Specimen No. 421 m). ao, adhesive organ; ecm, external circular muscle layer; eilm, external irregular longitudinal muscle layer; elm, external longitudinal muscle layer; iclm, internal circular and longitudinal muscle layers.

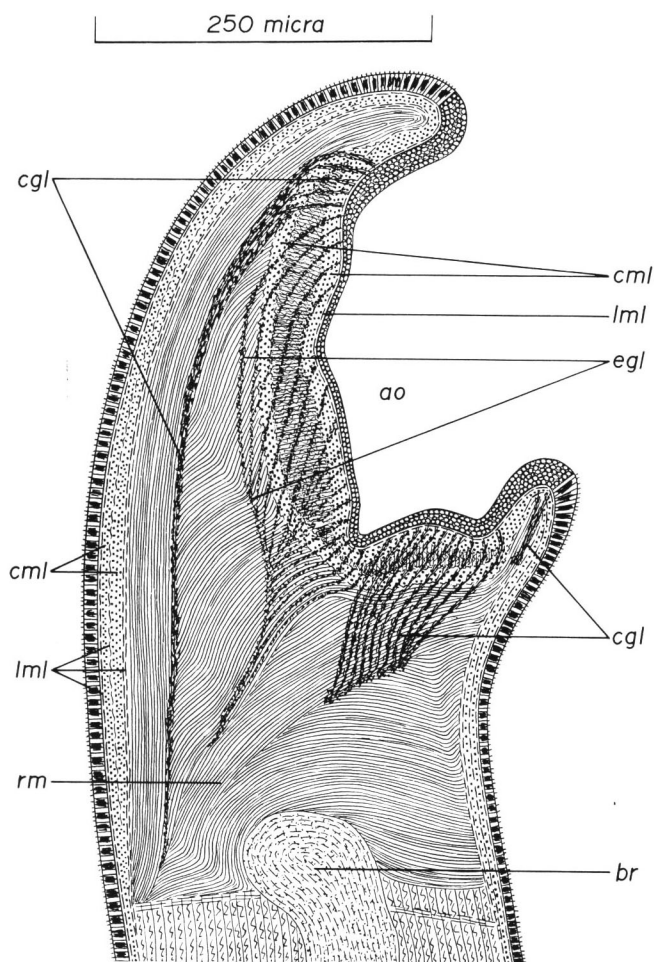


Fig. 3. Sketch of the adhesive organ of *Dendrocoelopsis ichikawai* sp. nov. drawn from the sagittal sections (Specimen No. 421 h; holotype). ao, adhesive organ; br, brain; cgl, cyanophilous glands; cml, circular muscle layers; egl, eosinophilous glands; lml, longitudinal muscle layers; rm, retractor muscle.

consists of three main layers, i.e., the outer thin longitudinal layer adjacent to the epithelium of the sucker, the middle thick circular one, and the inner, rather thick, circular and longitudinal ones intermingled. In the greater part of the sucker, the space between the second and the third muscle layers consists of a reticular parenchyma interspersed with row muscle fibres. Attached to the entire region of the sucker and its postero-ventral portion are many retractor muscle fibres which curve dorsally and join the subepithelial muscle layer of the dorsal side of the head. The sucker is accompanied with numerous glands, whose ducts are filled with a granular,

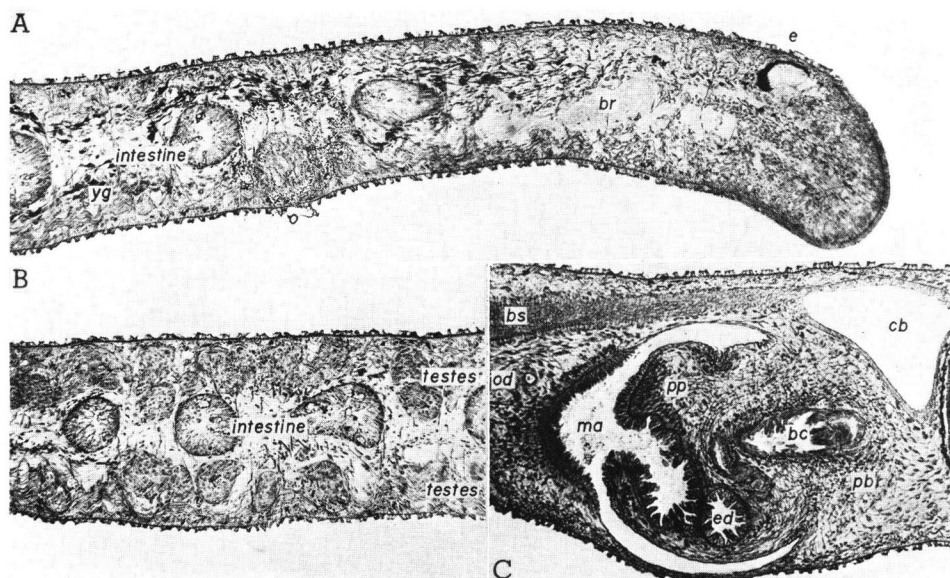


Fig. 4. Photomicrographs showing the parts of the genital organs of *Dendrocoelopsis ichikawai* sp. nov. (Specimen No. 421 h; holotype). — A. Near mid-sagittal section of the anterior part of the prepharyngeal region. — B. Near mid-sagittal section of the part of the prepharyngeal region. — C. Mid-sagittal section of the copulatory apparatus. bc, bulbar cavity; br, brain; bs, bursa stalk; cb, copulatory bursa; e, eye; ed, ejaculatory duct; ma, male antrum; o, ovary; od, ovovitelline duct; pb, penis bulb; pp, penis papilla; yg, yolk gland.

erythrophilic secretion. Numerous cyanophilous granules are also seen in the greater part of the sucker except its central portion.

A pair of large ovaries occur on the ventral side of the anterior region between the third and the fourth intestinal diverticula (Fig. 4 A). The two ovovitelline ducts converge in the region of the copulatory apparatus and finally unite to form a short, but rather thick-walled common ovovitelline duct at the anterior level of the genital pore. It opens to the male genital antrum (Figs. 5 A–B, 6 C–D). The yolk glands (or vitellaria) are distributed throughout the body in the surrounding parenchyma.

The testes are moderate in size, numerous, and both dorsal and ventral in position (Fig. 4 B). They are arranged on either side of the midline in two to three longitudinal zones extending from the posterior level of the ovaries to the nearly posterior end of the body, where the two zones meet. The total number of testes can be estimated at about 500 to 700. No conspicuous sinus tubes packed with sperm (spermiducal vesicle) are found in the present new species. On the anterior side of the copulatory bursa, each sperm duct ascends vertically, then becomes a slightly expanded, thick-walled tube at the antero-lateral side of the penis bulb, and again narrows to a slender duct and opens into the bulbar cavity separately (Fig. 5 A, B).

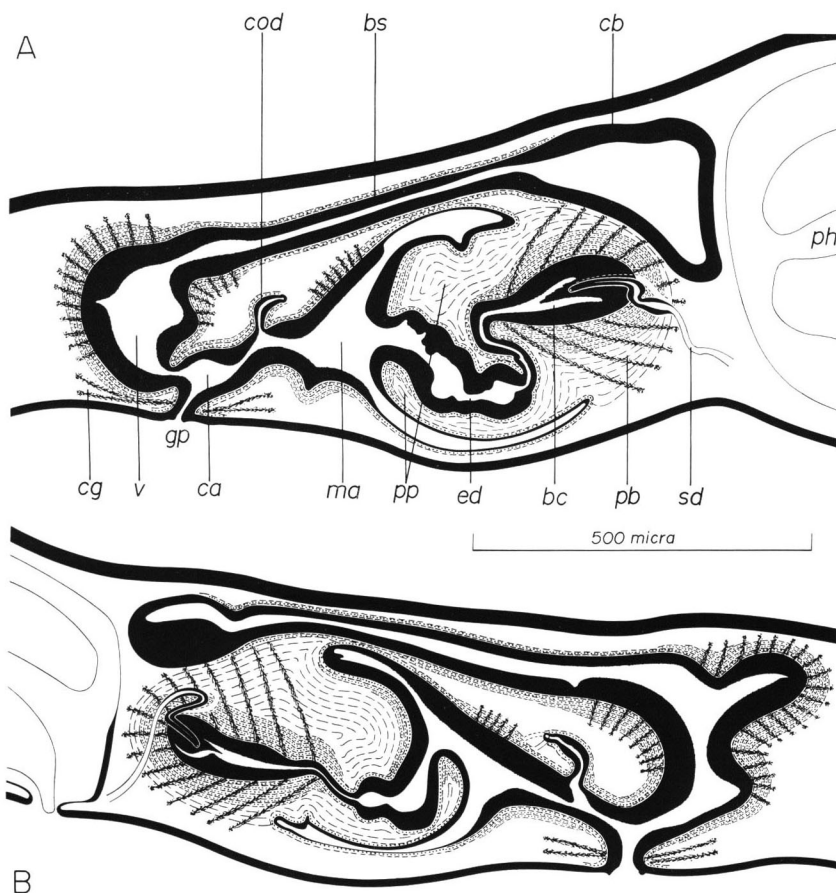


Fig. 5. Diagrams showing the sagittal view of the copulatory apparatus of *Dendrocoelopsis ichikawai* sp. nov. Same magnifications. — A. Specimen No. 421 h; holotype. — B. Specimen No. 422 a. bc, bulbar cavity; bs, bursa stalk; ca, common antrum; cb, copulatory bursa; cg, cement gland; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; ma, male antrum; pb, penis bulb; ph, pharynx; pp, penis papilla; sd, sperm duct; v, vagina.

The sagittal view of the copulatory apparatus of two specimens is shown in Fig. 5 (A and B). The penis of Fig. 5 (A) illustrated from the animal fixed in Bouin's fluid shows a slightly contracted state; the penis of Fig. 5 (B) illustrated from the animal killed by 2% solution of hydrochloric acid and fixed in Nozawa's fluid shows a rather elongated state. Photomicrographs of the parts of the copulatory apparatus of several specimens are also shown in Figs. 4 (C) and 6 (A-F).

The penis has a considerably large, hemispherical bulb embedded in the parenchyme and a very large papilla of an ovoid shape, projecting into the male genital antrum (Figs. 4 C, 5 A-B, 6 C-F). Both the bulb and the papilla are

highly muscular in nature. The bulb contains a moderately wide, elongated obovoid cavity (bulbar cavity or seminal vesicle), into which a pair of sperm ducts enter closely together from the antero-lateral sides. The bulbar cavity, of which the posterior half is long and narrow, continues to the papilla as an ejaculatory duct. It is lined by a very thick, highly glandular epithelium. This epithelium forms a club-shaped projection at the basal part of the bulbar cavity, so that the space of the cavity is rather narrow. The anterior two-thirds of the bulbar cavity is surrounded by a well-developed muscular coat consisting of intermingled longitudinal and circular fibres (Fig. 5 A, B). The penis bulb is pierced by numerous ducts of the penis glands.

The penis papilla is slightly asymmetrical in shape (the dorsal lip is larger than the ventral one). It contains a rather wide ejaculatory duct which opens at its tip (Fig. 5 A, B). The ejaculatory duct is lined by a very thick, glandular epithelium. Below this epithelium there are three layers of muscle fibres, i.e., a thin layer of longitudinal, a slightly wide layer of circular, and a thin layer of longitudinal. The outer wall of the papilla is covered with a nucleate, cubical epithelium, which becomes thicker toward the tip. In the basal part of the papilla, the subepithelial musculature consists of two layers of fibres, one rather thick circular and the other thin longitudinal. In the middle and terminal parts of the papilla, the subepithelial musculature becomes thicker than that of the basal part and consists of two layers of fibres, one thin longitudinal and the other intermingled longitudinal and circular (Fig. 5 A, B).

The male genital antrum is a wide cavity, narrowing toward the common genital antrum, and opens to the genital pore postero-ventrally. The anterior half of the wall of the male antrum is closed with a thin, nucleate epithelium below which are two muscle layers, one circular and the other longitudinal. Both the posterior half of the male antrum and the common antrum are closed with a very tall, glandular, nucleate epithelium. In these parts the subepithelial musculature consists of two layers of fibres, one thin longitudinal and the other thick, intermingled, longitudinal and circular. The male antrum receives the common ovovitelline duct at the roof of its posterior region (Figs. 5 a, B, 6 C-D).

The copulatory bursa is a middle-sized organ and is somewhat irregularly lobed (Figs. 4 C, 5 A-B, 6 C-D). Its lumen is lined with a tall glandular epithelium. The bursa stalk is a long duct and opens into the common genital antrum near the genital pore. It is divided into two parts: a narrow anterior section which connected with the bursa and a posterior thick-walled wider section including a well-developed vagina (Figs. 5 A-B, 6 A-D). The bursal canal is lined with a tall glandular epithelium of a nucleate type. The muscular coat surrounding the anterior section of the stalk consists of three layers of fibres, i.e., a thin layer of longitudinal, a thin layer of circular and a thin layer of longitudinal. In the posterior section of the stalk (especially in the posterior one-third section which is differentiated as the vagina), the surrounding muscular coat becomes much thicker than that of the anterior section. It consists of thin longitudinal muscle fibres and intermingled longitudinal and circular ones. Numerous ducts of erythrophilous glands open into the vagina. Weakly erythrophilous

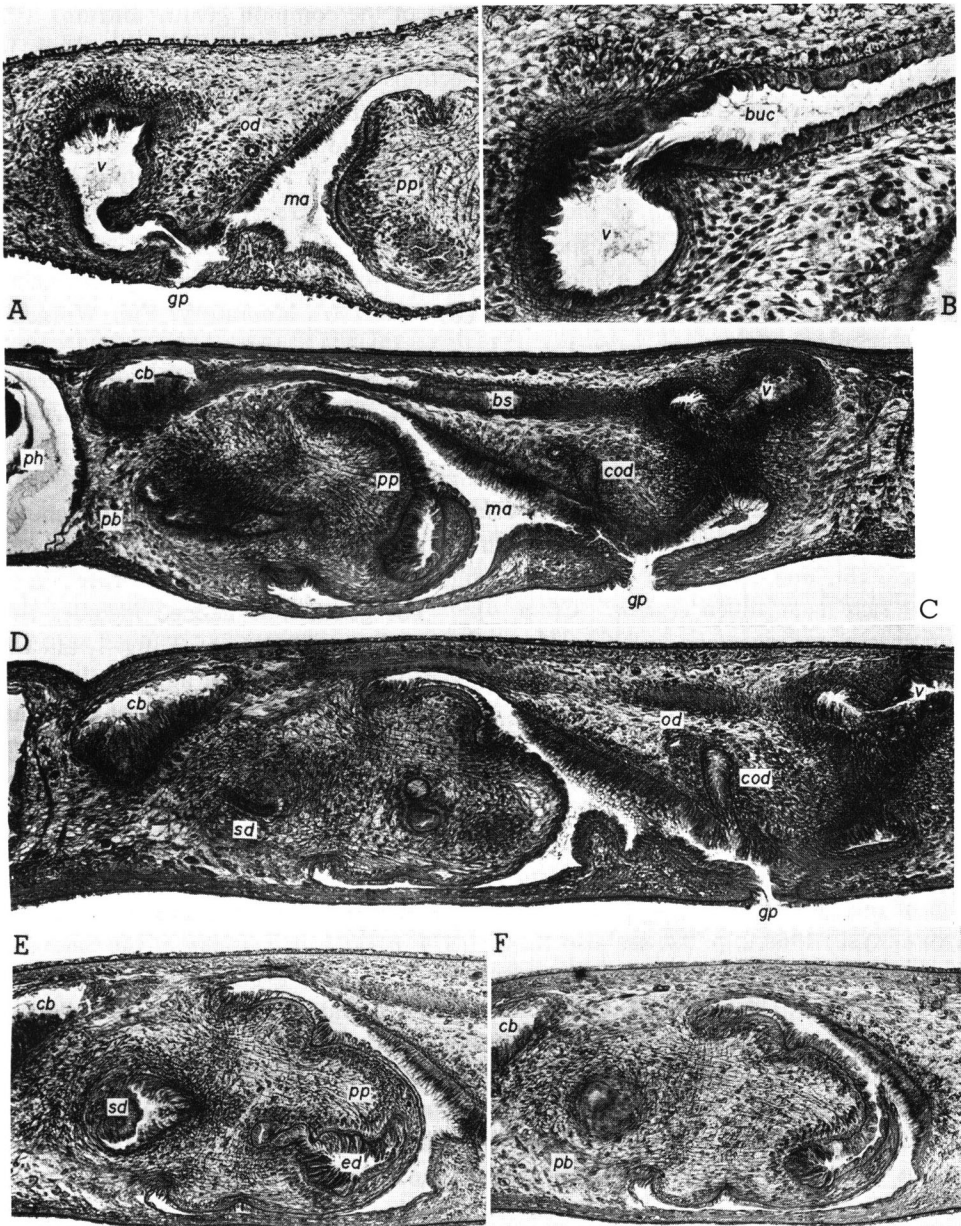


Fig. 6. Photomicrographs showing the parts of the copulatory apparatus of *Dendrocoelopsis ichikawai* sp. nov. — A. Near mid-sagittal section of the posterior part of the copulatory apparatus (Specimen No. 421 h; holotype). — B. Near mid-sagittal section through the vagina and the bursal canal (enlarged) (Specimen No. 421 h; holotype). — C. Mid-sagittal section of the copulatory apparatus (Specimen No. 422 a). — D. Mid-sagittal section of the copulatory apparatus (Specimen No. 422 b). — E and F. Near mid-sagittal sections of the copulatory apparatus (Specimen No. 422 b). A, C, D, E and F are of the same magnifications.

cement glands also open into the terminal part of the common genital antrum.

The cocoon of the present new species is spherical in shape, having no stalk.

Holotype. One set of sagittal serial sections (Specimen No. 421 h; 5 slides) will be deposited in the Department of Zoology, National Science Museum, Tokyo. Three paratypes (No. 422 m, horizontal sections; No. 422 n, transverse sections; No. 422 p, sagittal sections) and one whole mount (No. 421 r, sexually immature specimen) will be deposited in the same museum. The remaining slides including several paratypes of fully mature specimens (No. 421 a–g, i–l, o, q; No. 422 a and b), two whole mounts (No. 421 s and t) and several immature specimens preserved in alcohol are retained by the senior author (KAWAKATSU's laboratory, Fuji Women's College, Sapporo).

Locality. A stream or an outlet of Hime-numa Pond, the northeastern part of Rishiri Island, North Hokkaido. Altitude, about 140 m. Collected by M. KAWAKATSU and T. YAMADA on August 2–5, 1964.

Taxonomic remarks and differential diagnosis. In 1912, KOROTNEV (=KOROTNEFF) established a new genus *Monocotylus* for Lake Baikal planarians (Diagnose: Das vordere Ende des Tieres besitzt einen Saugnapf, der etwas unter dem vorderen Rande steht, und etwas nach hinten zu befindet sich eine komplizierte Drüse, deren Sekret sich nach außen ergießt. Cf. p. 9).¹⁾ The genus thus defined includes two new species, *Monocotylus subniger* KOROTNEV, 1912 (pp. 9–10, taf. I, fig. 1, taf. IV, figs. 1–3) and *Monocotylus cingulatus* KOROTNEV, 1912 (p. 10, taf. I, fig. 2, taf. IV, fig. 4). The former was designated by KENK (1974, p. 37) as the type-species of the genus *Monocotylus*.

OKUGAWA (1953, pp. 21, 40) mentioned a Sakhalin species under the name of "*Monocotylus karafutoensis*" (also spelled "*karafutoensis*"). According to his list on page 40 of that article, it appeared that this species had already been described by himself in 1945 (type-loc., Tomarigishi in South Saghalien). The original description of this species was not published (cf. KAWAKATSU & ICHIKAWA, 1971, pp. 9–10; KAWAKATSU, 1968 c, p. 92; see also KENK, 1974, p. 37). His slides of the Sakhalin specimens have been lost now (cf. KAWAKATSU & ICHIKAWA, 1971, p. 10). Some years later, Dr. OKUGAWA, who examined KAWAKATSU's slides of the animals collected from Hime-numa Pond in Rishiri Island (i.e., the type-locality of *Dendrocoelopsis ichikawai* described in the present paper; Specimen Nos. 165 and 220 groups), stated that the new material from Rishiri Island is the same species as his "*Monocotylus karafutoensis*". This *nomen nudum* was used in some of KAWAKATSU's earlier articles on the distributional ecology of planarians (cf. KAWAKATSU, 1958, pp. 56, 58, and others).

In 1973, the type-species of KOROTNEV's genus *Monocotylus*, *Monocotylus subniger*, has been united by PORFIRJEVA (1973, p. 101) with *Bdellocephala baicalensis* (ZABUSOV, 1903), the species originally described as *Procotyla baicalensis* ZABUSOV, 1903 (pp. 23–25, fig. 11; see also HYMAN, 1953, p. 5; KENK, 1930, p. 297, 1974, p. 8;

1) BALL (1974, p. 351) placed the genus *Monocotylus* in his subfamily Dendrocoelinae.

LIVANOW, 1962, pp. 165–177; PORFIRJEVA, 1970, pp. 1458–1459, 1971, pp. 83–87, 1973, pp. 101–106; UMYLINA, 1976, pp. 96–98). The only other species in the genus, *Monocotylus cingulatus* KOROTNEV, 1912, is a species inquirenda (cf. KENK, 1974, p. 37).

Judging from the external appearance of *Bdellocephala baicalensis* (cf. PORFIRJEVA, 1970, p. 1458, fig. 1–3, 1971, p. 84, fig. I–v, 1973, p. 102, fig. 30–a and b), it is very similar to the Japanese new form described in the present paper. The Lake Baikal species has a pair of three clustered eyes in the usual positions of the head. The anatomical structure of the copulatory apparatus of *Bdellocephala baicalensis* (cf. LIVANOW, 1962, p. 171, fig. 7–b, p. 173, fig. 8; PORFIRJEVA, 1973, p. 103, fig. 31) is also somewhat similar to that of the Japanese new form (cf. Fig. 5 A and B in the present paper). It is, however, clear that the latter form has a well-developed penis papilla and should be excluded from the genus *Bdellocephala* (penis papilla absent). On the other hand, the Japanese form would conform better to the diagnosis of the genus *Dendrocoelopsis* KENK, 1930 (partly modified by KENK, 1953, p. 178; see also DAHM, 1960, pp. 28–30; KENK, 1973, p. 1). KAWAKATSU sent Dr. Roman KENK copies of the preliminary sketches of the adhesive organ and the copulatory apparatus of the Japanese form (Fig. 3 and Fig. 5 A and B printed in the present paper) and asked for his opinion upon the taxonomic position of the species in question. He considered that the Japanese species with a penis papilla (Specimen Nos. 421 h and 422 a) would make it a *Dendrocoelopsis* (pers. comm.).

The genus *Dendrocoelopsis* (including *Amyadenium* DE BEAUCHAMP, 1931) has representatives in Europe, Asia and North America. The world-wide distribution map of the genus except some new data described in the papers by KENK (1973) and GOURBAULT, BENAZZI and HELLOUET (1976) is found in KAWAKATSU's previous paper (1968 b, p. 18, fig. III–9). The taxonomy and/or karyology of *Dendrocoelopsis* are chiefly discussed by BENAZZI and GOURBAULT (1974), DE BEAUCHAMP (1931), DAHM (1960, 1963), GOURBAULT (1969, 1972, 1975, 1976), GOURBAULT and BENAZZI (1974), GOURBAULT, BENAZZI and HELLOUET (1976), HOLMQUIST (1967), HYMAN (1935, 1951), ICHIKAWA and OKUGAWA (1958), KAWAKATSU (1968 a), KENK (1930, 1953, 1973), and PORFIRJEVA (1958, 1973). The karyological studies on *Dendrocoelopsis* species are recently reviewed by BENAZZI and BENAZZI-LENTATI (1976).

Among these studies, GOURBAULT (1972, pp. 78–83) showed the distribution map of *Dendrocoelopsis* species in Europe (fig. 20 on page 80). She also reduced the genus *Amyadenium* as a subgenus and placed five of the six European *Dendrocoelopsis* species in it (i.e., *vandeli*, *beauchampi*, *chattoni*, *brementi* and *garmieri*). This classification system has not been accepted by KENK (1973).²⁾ Recently, KENK (1973) who restudied every known North American *Dendrocoelopsis* species demonstrated that

2) As was already pointed out by KENK (1953, pp. 176–177, 1973, p. 1), there is a gradual differentiation of the adhesive organ in *Dendrocoelopsis*. The first group, *D. lactea* and *D. alaskensis*, lacks the adhesive organ. The second group, *D. brementi*, *D. vandeli*, *D. chattoni*, *D. garmieri*, *D. beauchampi*, *D. bessoni*, *D. oculata*, *D. ezensis*, *D. piriformis*, *D. vaginata*, *D. hymanae* and *D. americana*, has a

Sorocelis americana HYMAN, 1939, from Arkansas and Oklahoma should be transferred into the genus *Dendrocoelopsis*. Recently, one additional European species of the genus is described by GOURBAULT, BENAZZI and HELLOUET (1976).

Up to the present, some 15 species of *Dendrocoelopsis* are known in the world and are listed in KENK's 1974 paper (except one European species). They are: *D. spinosipenis* (KENK, 1925) from Yugoslavia and Sweden, *D. brementi* (DE BEAUCHAMP, 1919) from Spain and France, *D. vandeli* (DE BEAUCHAMP, 1931), *D. chattoni* (DE BEAUCHAMP, 1949), *D. garmieri* (DE BEAUCHAMP, 1950), *D. beauchampi* (GOURBAULT, 1969), and *D. bessoni* GOURBAULT, BENAZZI et HELLOUET, 1976, from France, *D. oculata* (PORFIRJEVA, 1958) (syn. *Amyadenium brementi oculatum* PORFIRJEVA, 1958; cf. KENK, 1974, p. 14) from Caucasus, *D. ezensis* ICHIKAWA et OKUGAWA, 1958, and *D. lactea* ICHIKAWA et OKUGAWA, 1958 (cf. KAWAKATSU & ICHIKAWA, 1971) from North Japan, *D. vaginata* HYMAN, 1935 (cf. KENK, 1953, p. 177), *D. piriformis* KENK, 1953, *D. alaskensis* KENK, 1953, *D. hymanae* KAWAKATSU, 1968, and *D. americana* (HYMAN, 1939) (cf. KENK, 1973, pp. 10–14) from the United States.

KAWAKATSU (1969, p. 47, table 1) listed two undescribed Japanese forms which seem to be the members of *Dendrocoelopsis*. On close examination of the additional sexually mature specimens from the Otoineppu locality in North Hokkaido, it was proved that *Dendrocoelopsis* sp. of Otoineppu (= *Bdellocephala* sp. of Otoineppu; cf. KAWAKATSU, 1965 b, p. 365, 1967, p. 134; YAMADA, 1966, pp. 129–133) is *D. ezensis*. *Dendrocoelopsis*? sp. of Lake Biwa-ko (cf. KAWAKATSU, 1965 c, p. 112, 1966, p. 57, figs. 11–12) is a true lake-dwelling species (loc., bottom off Tsuzurao-zaki Cape in the northern part of the lake, about 40 m in depth; about 25 mm in length and 4 mm in width; pale brown in color; with two eyes located closely; without adhesive organ). Sexually mature specimens of this form have not been obtained yet.

The present new species, *Dendrocoelopsis ichikawai*, is the fourth pigmented and two-eyed species with an adhesive organ in the genus. The other three pigmented species, i.e., *D. ezensis* from Hokkaido in North Japan, *D. piriformis* from Alaska and *D. vaginata* from Montana, Oregon and Washington in the northwestern part of the United States, resemble rather closely in the external appearance (cf. KENK, 1973, p. 6).

weakly or moderately developed one. The third group, *D. spinosipenis* and *D. ichikawai* (the present new species), has a highly developed and muscular one. According to GOURBAULT's (1972, p. 81) classification system, the species of the second group may be included in her subgenus *Amyadenium* (type-species, *Amyadenium vandeli* DE BEAUCHAMP, 1931). Then, the species of the third group may be included in the nominate subgenus *Dendrocoelopsis* (type-species, *Dendrocoelum spinosipenis* KENK, 1925). And the remaining species in the first group can be separated from the second and third groups as the members included in a new subgenus. Although KAWAKATSU agrees with KENK's (1953, pp. 177–178) opinion that the taxonomic value of adhesive organs in triclad appears to be subordinate to that of the other anatomical characters, the presence or absence of the adhesive organ may have a taxonomic utility for the separation of the natural groups of animals in the subgeneric rank. But he has an opinion that the subgeneric division of the above-mentioned second and third groups (i.e., subgenera *Amyadenium* and *Dendrocoelopsis* respectively) may not have much use as compared with the subgeneric division of the first and the second-third groups.

Dendrocoelopsis ichikawai is easily distinguishable from them by a highly developed, octopus' sucker-like adhesive organ (so that the anterior margin of the head shows a peculiar, semicuspidate shape). Anatomically, only *D. ichikawai* and *D. ezensis* have the testes which are located in the dorsal and ventral positions, extending to the nearly posterior end of the body. In the anatomy of the copulatory apparatus, *D. ichikawai* has an ovoid shaped penis papilla, a wide ejaculatory duct, and a thick muscular layer surrounding the penis lumen and a well-developed vagina. *Dendrocoelopsis ezensis* has a plug-shaped penis papilla, a narrow and long ejaculatory duct, and a thick muscular layer surrounding the penis lumen and a well-developed vagina. The glandular epithelium in the bulbar cavity is taller and more developed in the former species than in the latter.

Dendrocoelopsis ichikawai differs from the other members of the genus in the following characters: living animal moderate in size and uniformly grayish brown in color; head subtruncated with a semicircular bulge at the central portion of the frontal end and with short and rounded auricles; two eyes; subterminal adhesive organ in a shape of an octopus' sucker accompanied with well-developed musculatures; numerous dorsal and ventral testes lie in two to three longitudinal rows on either side and extend almost to the posterior end; hemispherical penis bulb considerably large and highly muscular with an elongated obovoid bulbar cavity lined with a tall, glandular epithelium into which sperm ducts enter separately (conspicuous spermiducal vesicle non-existent); slightly asymmetrical penis papilla large and of an ovoid form, containing a rather wide ejaculatory duct; with a thick muscular layer surrounding the penis lumen; short common ovovitelline duct entering the roof of the posterior part of the male genital antrum; the posterior one-third of the bursa stalk forms a well-developed vagina surrounded by a thick muscular coat; cocoon spherical in shape.

Ecology and Laboratory Observations

The type-locality of *Dendrocoelopsis ichikawai*, the present new species, is an outlet of Hime-numa Pond in Rishiri Island, about 40 kilometers to the southwest off the Cape of Sôya, the northernmost part of Hokkaido Island. The pond is located near the Port of Oshidomari, the northeastern part of Rishiri Island (Lat. 45°14'N and Long. 141°15'E). Formerly, it was a small natural pond; it became rather large after a dam was built in 1924. The pond has about a 700-meter shoreline (alt. 140 m). It is fed by cold-water from two large springs located on the south immediate shore; the water flows out from two outlets in the north shore and joins the Omomabetsu-zawa River. There are five floating islands in the pond (cf. KAWAKATSU, 1958, pp. 48-49, figs. 2-3; KAWAKATSU & YAMADA, 1966, p. 379, figs. 3-4).

Four species of freshwater planarians occur in the vicinities of Hime-numa Pond. They are: *Polycelis sapporo* (IJIMA et KABURAKI, 1916), *Polycelis schmidt* (ZABUSOV, 1916), *Bdellocephala* sp. (species of Rishiri Island), and *Dendrocoelopsis ichikawai* (cf. KAWAKATSU, 1958, p. 48, fig. 2, p. 61, table 2, sts. 60-64, 1964, p. 183; KAWA-

KATSU & TARUI, 1959; KAWAKATSU & YAMADA, 1966, p. 378, table 1; YAMADA, 1966, p. 130, fig. 1). *Dendrocoelopsis ichikawai* only occurs near the outlet of the pond (collection data, on page 200; water temp. in summer, 12.3–16.8°C, pH 6.0–7.2). The animals are usually found under stones and dead leaves in the shallow and slow stream and on the surface of a colonial Kamptozoa, *Plumatella emarginata*. No planarians were obtained in the pond by the baited trap method (cf. KAWAKATSU & TARUI, 1959; KAWAKATSU & YAMADA, 1966).

In the laboratory cultures, the animals preferred nymphs of caddis-flies and stone-flies to chicken spleen as foods. The animals collected in the summer of 1964 laid several spherical shaped cocoons (1–2 mm in diameter) in the spring of 1965.

Acknowledgement

The senior author wishes to express his sincere gratitude to Dr. Roman KENK, Division of Worms of the National Museum of Natural History, Smithsonian Institution, Washington, D. C., for his invaluable advice about the taxonomy of *Dendrocoelopsis* and *Bdellocephala* groups which greatly aided the author in the present work. Also he would like to thank Mr. Yoshitsugu TARUI for his assistance in the field work during the first trip to Rishiri Island. He is also grateful to Dr. Iwashiro OKI, Osaka Prefectural Institute of Public Health, for his translation of some of the Russian texts. One of the junior authors (ASAI) is indebted to Professor Tetsuji KIDO, Biological Institute of Kanazawa Medical University, for his interest and encouragement.

Summary

A new species of the genus *Dendrocoelopsis* (Turbellaria, Tricladida, Paludicola), *Dendrocoelopsis ichikawai* KAWAKATSU, sp. nov., from Rishiri Island off Hokkaido, North Japan, is described in the present paper. This pigmented and two-eyed species is conspicuous among the species of the genus in having an adhesive organ like an octopus' sucker accompanied with well-developed musculatures, numerous dorsal and ventral testes, a large, muscular, hemispherical penis bulb and a slightly asymmetrical, ovoid penis papilla, a thick muscular layer surrounding the penis lumen, and a well-developed vagina.

References

- BALL, I. R., 1974. A contribution to the phylogeny and biogeography of the freshwater triclad (Platyhelminthes: Turbellaria). In RISER, N. W., & M. P. MORSE, "Libbie H. HYMAN Memorial Volume — Biology of the Turbellaria", pp. 339–401. McGraw-Hill Book Co., New York, etc.
- BEAUCHAMP, P. DE, 1919. Diagnoses préliminaires de Triclades obscuricoles. *Bull. Soc. zool. France*, **44**: 243–251.
- 1931. Nouvelles diagnoses de Triclades obscuricoles. 4. Essai d'une classification des

- Dendrocoelidae. *Bull. Soc. zool. France*, **55**: 155–163.
- BEAUCHAMP, P. DE, 1949. Turbellariés (3 sér.). *Biospeologica*, LXIV; *Arch. Zool. exptl. gén.*, **86**: 50–65.
- 1950. Nouvelles diagnoses de Triclades obscuricoles. 7. *Bull. Soc. zool. France*, **75**: 65–70.
- 1961. Classe de Turbellariés. In GRASSÉ, P. P., *Traité de Zoologie*, **4**: 35–212, 887–890. Masson et C^{ie}, Paris.
- BENAZZI, M., & G. BENAZZI-LENTATI, 1976. Platyhelminthes. In JOHN, B., *Animal Cytogenetics*, **1**: i–v+1–182. Gebrüder Borntraeger, Berlin.
- & N. GOURBAULT, 1974. Recherches caryologiques sur quelques Dendrocoelidae hypogés. *C. R. hebd. Séanc. Acad. Sci., Paris*, **278** (D): 1051–1054.
- DAHM, A. G., 1960. *Dendrocoelopsis spinosipenis* (KENK) from Yugoslavia and Sweden, and *Digonoporus macroposthia* AN DER LAN (Turbellaria, Tricladida, Paludicola). *Lunds Univ. Årsskr.*, (N. F.–Avd. 2), **56**: 1–38.
- 1963. The karyotypes of some freshwater triclads from Europe and Japan (Turbellaria, Tricladida, Paludicola). *Ark. Zool.*, (2), **16**: 41–67.
- GOURBAULT, N., 1969. Triclades obscuricoles des Pyrénées. II. Une nouvelle espèce française du genre *Amyadenium* BEAUCHAMP. *Ann. Spéleol.*, **24**: 105–110.
- 1972. Recherches sur les Triclades paludicoles hypogés. *Mém. Mus. Hist. nat. Paris*, (A–Zool.), **73**: 1–249, pls. I–III.
- 1975. Karyology of the troglophile planarian *Dendrocoelopsis americana* (HYMAN). *Ann. Spéleol.*, **30**: 125–127.
- 1976. Recent karyological research on cave planarians from Europe. *Int. J. Speleol.*, **8**: 69–74.
- & M. BENAZZI, 1974. Étude caryologique du Triclade hypogé *Dendrocoelopsis chattoni* (DE BEAUCHAMP). *Ann. Spéleol.*, **29**: 621–626.
- , ——— & M. N. HELLOUET, 1976. Triclades obscuricoles de Pyrénées. V. Études morphologique et cytotaxonomique de *Dendrocoelopsis bessoni* n. sp. *Bull. Mus. Hist. nat. Paris*, (3), (406), Zool. (283): 1095–1106.
- HOLMQUIST, C., 1967. *Dendrocoelopsis piriformis* (Turbellaria, Tricladida) and its parasites from Northern Alaska. *Arch. Hydrobiol.*, **62**: 453–466+1 folder.
- HYMAN, L. H., 1935. Studies on the morphology, taxonomy, and distribution of North American triclad Turbellaria. VI. A new dendrocoelid from Montana, *Dendrocoelopsis vaginatus* n. sp. *Trans. Amer. micros. Soc.*, **54**: 338–345.
- 1939. North American triclad Turbellaria. X. Additional species of cave planarians. *Ibid.*, **58**: 276–284.
- 1951. North American triclad Turbellaria. XII. Synopsis of the known species of freshwater planarians of North America. *Ibid.*, **70**: 154–167.
- 1953. North American Triclad Turbellaria. XIV. A new, probably exotic, dendrocoelid. *Amer. Mus. Novit.*, (1629): 1–6.
- ICHIKAWA, A., 1954. Notes on the probursalian fauna of Hokkaidô and Saghalien. *Zool. Mag., Tokyo*, **63**: 82. (In Japanese.)
- & K. I. OKUGAWA, 1958. Studies on the probursalian (fresh-water triclads) of Hokkaido. I. On two new species of the genus *Dendrocoelopsis* KENK, *D. lacteus* and *D. ezensis*. *Bull. Kyoto Gakugei Univ.*, (B), (12): 9–18, pls. 1–5.
- KAWAKATSU, M., 1958. Studies on the vertical distribution of Japanese freshwater planarian. V. Rishiri and Rebun Islands. *Bull. Kyoto Gakugei Univ.*, (B), (12): 45–64. (In Japanese, with English summary.)
- 1965 a. The outline of the investigations of ecology, taxonomy and chorology made on freshwater planarians in Japan. *Seikatsubunka-Kenkyû, Osaka*, (13): 53–68. (In Japanese.)
- 1965 b. On the ecology and distribution of freshwater planarians in the Japanese Islands,

- with special reference to their vertical distribution. *Hydrobiologia*, **26**: 349–408.
- KAWAKATSU, M., 1965 c. Some ecological notes on the freshwater planarians of Lake Tahoe in the Sierra Nevada Mountains in North America and Lake Biwa-ko in Middle Japan. *Jap. J. Limnol.*, **26**: 106–112. (In Japanese, with English summary.)
- 1966. Japanese freshwater planarians. *The Heredity (Iden)*, Tokyo, **20** (4): 54–57. (In Japanese.)
- 1967. On the ecology and distribution of freshwater planarians in the Japanese Islands, with special reference to their vertical distribution (revised edition). *Bull. Fuji Women's Coll.*, (5): 117–177.
- 1968 a. North American triclad Turbellaria. 17. Freshwater planarians from Lake Tahoe. *Proc. U. S. Natn. Mus.*, **124** (3638): 1–21 + pls. 1–2.
- 1968 b. On the origin and phylogeny of turbellarians: Suborder Paludicola. *Jap. Soc. syst. Zool. Circular*, (38–41): 11–22. (In Japanese, with English explanation of figures.)
- 1968 c. A list of publications on Japanese turbellarians (1855–1967) — Including titles of publications written by the Japanese authors —. *Bull. Fuji Women's Coll.*, (6): 71–127. (Both in English and Japanese.)
- 1969. An illustrated list of Japanese freshwater planarians in color. *Bull. Fuji Women's Coll.*, (7), Ser. II: 45–91 (+pls. VII and VIII).
- 1973. Taxonomy and ecology of planarians, 1–4. *The Nature and Animals (Dôbutsu-to Shizen)*, Tokyo, **3** (5): 9–16 + plate figure; (6): 11–16; (7): 8–11; (8): 7–13. (In Japanese.)
- 1974. Further studies on the vertical distribution of freshwater planarians in the Japanese Islands. In RISER, N. W., & M. P. MORSE, "Libbie H. HYMAN Memorial Volume — Biology of the Turbellaria", pp. 291–338. McGraw-Hill Book Co., New York, etc.
- & A. ICHIKAWA, 1971. *Dendrocoelopsis lactea*, an emendation of the specific name of a freshwater planarian referred to in the literature as *Dendrocoelopsis lacteus* ICHIKAWA et OKUGAWA, with remarks on some nomina nuda of Japanese freshwater planarians. *Proc. Jap. Soc. syst. Zool.*, (7): 5–12.
- & Y. TARUI, 1959. Planarians, insects and snails collected from the Islands of Rebun and Rishiri. *Collect. & Breed.*, Tokyo, **21**: 342–347, 367–371. (In Japanese.)
- T. YAMADA, 1966. Planarians collected from Hime-numa in Rishiri Island, Hokkaidô. *Ibid.*, **28**: 375–379. (In Japanese.)
- , ——— & S. IWAKI, 1967. Environment and reproduction in Japanese freshwater planarians. *Jap. J. Ecol.*, **17**: 263–266.
- KENK, R., 1925. Zur Anatomie von *Dendrocoelum spinosipenis* KENK (Turbellaria, Tricladida). *Zool. Anz.*, **63**: 131–146.
- 1930. Beiträge zum System der Probursalier (Tricladida, Paludicola). *Ibid.*, **89**: 145–162, 289–302.
- 1953. The fresh-water triclads (Turbellaria) of Alaska. *Proc. U. S. Natn. Mus.*, **103** (3322): 163–186, pls. 6–8.
- 1972. Freshwater planarians (Turbellaria) of North America. *Biota of Freshwater Ecosystems, Identification Manual*, (1): i–ix + 1–81. U. S. Environment. Protect. Agency.
- 1973. Freshwater triclads (Turbellaria) of North America. VI: The genus *Dendrocoelopsis*. *Smiths. Contr. Zool.*, (138): 1–16.
- 1974. Index of the genera and species of the freshwater triclads (Turbellaria) of the world. *Ibid.*, (183): 1–90.
- KOROTNEV, A. A., 1912. Die Planarien des Baikalsees (Tricladen). In: *Wissenschaftliche Ergebnisse einer zoologischen Expedition nach den Baikalsee unter Leitung des Professors Alexis KOROTNEFF in den Jahren 1900–1902*. Lief. 5: 1–28, taf. I–VII. Kiew u. Berlin.
- LIVANOW, N. A., 1962. Ocherki planarii Baikala. Bdellocephalina i Rimacephalina. *Akad. Nauk SSSR, Sibirskoe Otdelenie, Trud. Limnol. Inst.*, **1** (1): 152–188.

- OKUGAWA, K. I., 1953. A monograph of Turbellaria (Acoela, Rhabdocoela, Alleocoela and Tricladida) of Japan and its adjacent regions. *Bull. Kyoto Gakugei Univ.*, (B), (3): 20–43.
- 1973. Platyhelminthes: Turbellaria. In UENO, M., *The Late Tamiji KAWAMURA, Freshwater Biology of Japan, Enlarged and Revised Edition*, pp. 207–249. Zukan-no-Hokuryukan, Tokyo. (In Japanese.)
- PORFIRJEVA, N. A., 1959. Planarii Kavkaza. *Trud. Obshch. Estestvoisp. Kazan. Gosud. Univ.*, **62**: 39–89. (In Russian, with German summary.)
- 1970. Ob endemichnom vidoobrazovanii u baikal'skikh Dendrocoelid (Tricladida, Paludicola). *Zool. Zhur.*, **49**: 1456–1464. (In Russian, with English summary.)
- 1971. O nekotorykh putiakh evoliutsii baikal'skikh planarii. *Voprosy Morphol. Ekol. Bespozvonochnykh*, pp. 81–93. Kazanskii Univ., Kazan'. (In Russian.)
- 1973. *Fauna Planarii Oзера Baikal*. 1–192 pp. Kazanskii Univ., Kazan'. (In Russian.)
- UMYLINA, T. M., 1976. Khromosomy v spermatogeneze u Bdellocefal Oзера Baikal (Tricladida, Paludicola). *Ekologo-Morfologicheskie Issledovaniia Bespozvonochnykh*, pp. 90–101. Kazanskii Univ., Kazan'. (In Russian.)
- YAMADA, T., 1966. Report on the ecological survey of freshwater planarians in the Teshio Mountains and its adjacent seaboard district on the Sea of Japan, Hokkaido. *Jap. J. Ecol.*, **16**: 129–133. (In Japanese, with English summary.)
- ZABUSOV, I. P., 1903. Zamietki po morfologii i sistematike Triclada. IV. Pervyi predvaritel'nyi otchet o planariakh oz. Baikala, sobrannykh V. P. GARIAEVYM. *Trud. Obshch. Estestvoisp. Imper. Kazanskom Univ.*, **36** (6): 1–58, 1 plate. (In Russian, with German summary.)

