

*Bdellocephala borealis* sp. nov., a New Freshwater Planarian  
from Rishiri and Okushiri Islands off 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

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**Introduction**

As was already mentioned in the previous paper (cf. KAWAKATSU, ASAI & YAMADA, 1977), ICHIKAWA (1954) reported the occurrence of a *Bdellocephala* which seems to be a new species in Hime-numa Pond on Rishiri Island off Hokkaido, North Japan. At that time the material was much limited for study. Some years later, KAWAKATSU who visited ICHIKAWA's locality three times (1956, 1957 and 1964) succeeded in collecting a large number of specimens of this species.

Recently, a sufficient number of serial sections of this material was prepared by KAWAKATSU (stained with Delafield's haematoxylin and erythrosin) and ASAI (both stained with Delafield's haematoxylin and eosin and Mallory's triple stain). A preliminary examination of some of the slides was made by ASAI. KAWAKATSU also prepared serial sections of animals from various localities of Japan which seem to be a species belonging to the genus *Dendrocoelopsis* or *Bdellocephala*. Upon a close examination and comparative studies of all those slides, he has come to the conclusion that the material from ICHIKAWA's locality in Rishiri Island is undoubtedly a hitherto undescribed species of the genus *Bdellocephala*. Moreover, his material from Takakusa-numa Pond in Okushiri Island, South Hokkaido (*Bdellocephala* sp. (species of Okushiri Island); cf. KAWAKATSU, 1958 b, and others), proves to be the same new species.

In the present paper, this new triclad turbellarian from North Japan will be described by KAWAKATSU, together with some remarks about the ecology and some

other data observed by himself and YAMADA. The present new species will be named after Dr. ICHIKAWA's preliminary proposal "*Bdellocephala borealis*" found in his 1954 abstract, because it is the same as the present species and the usage of that name for the new species seems appropriate.

### Collecting Data

The followings are the data of collections of the samples examined from the localities of Hime-numa Pond and Takakusa-numa Pond. 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 Nos. 162, 163 and 164 groups. About 200 specimens, both sexually mature and immature, were collected from an outlet of Hime-numa Pond, Rishiri Island (water temp., 12.5°C, pH 7.0). Most of them were fixed in Bouin's fluid. Altitude, 140 m. August 22–24, 1956. Coll. M. KAWAKATSU and Mr. Y. TARUI. Cf. KAWAKATSU, 1958 a; KAWAKATSU & TARUI, 1959.

Specimen Lot Nos. 218 and 219 groups. About 1,500 specimens, both sexually mature and immature, were collected from the same locality (water temp., 12.3–14.6°C, pH 7.0). About 300 specimens were fixed in Bouin's fluid. The remaining live specimens were cultured in KAWAKATSU's former laboratory in Kyoto. September 2–4, 1957. Coll. M. KAWAKATSU. Cf. KAWAKATSU, 1958 a; KAWAKATSU & TARUI, 1959.

Specimen Lot Nos. 418, 419 and 420 groups. About 2,000 specimens, both sexually mature and immature, were collected from the same locality (water temp., 12.7–16.8°C, pH 6.8–7.3). About 300 specimens were fixed in Bouin's fluid (Nos. 418 and 419 groups) and in Nozawa's fluid after killed by SUGINO's method (No. 420 group). The remaining live specimens were cultured both in the laboratories of KAWAKATSU and YAMADA until the end of 1965. A number of cocoons were also obtained from the locality. August 2–5, 1964. Coll. M. KAWAKATSU and T. YAMADA. Cf. KAWAKATSU & YAMADA, 1966. The live specimens were also used for the experiments of regenerative capacity (cf. TESHIROGI & YAMADA, 1966).

Specimen Lot No. 227 group. Twelve specimens, both sexually mature and immature, were collected from the shore of Takakusa-numa Pond, Okushiri Island (water temp., 16.4–20.0°C, pH 6.8). Altitude, 180 m. They were fixed in Bouin's fluid. September 11, 1957. Coll. M. KAWAKATSU. Cf. KAWAKATSU, 1958 b.

### Description of the New Species

#### Order TRICLADIDA

#### Suborder PALUDICOLA or PROBURSALIA

#### Family Dendrocoelidae

Genus *Bdellocephala* DE MAN, 1875

*Bdellocephala borealis* KAWAKATSU, sp. nov.

[Japanese name: Rishiri-ô-uzumushi]

*Principal literature.*

"*Bdellocephala borealis*" nom. nud. and "*Dendrocoelopsis borealis*" nom. nud.: ICHIKAWA, 1954, Zool. Mag., Tokyo, **63**, p. 82. Remarks on taxonomy.

"*Bdellocephala borealis*" nom. nud.: KAWAKATSU, 1958, Bull. Kyoto Gakugei Univ., (B), (12), pp. 49–50, 56–58; KAWAKATSU & TARUI, 1959, Collect. & Breed., Tokyo, **21**, pp. 344, 370.

"*Bdellocephala* sp. (species of Rishiri Island)" and/or "*Bdellocephala* sp. (species of Okushiri Island)": KAWAKATSU, 1958 b, pp. 39–41, 44, 49–51, 1965 a, pp. 62–63, 1965 b, p. 365; YAMADA, 1966, p. 130; KAWAKATSU & YAMADA, 1966, pp. 375–379; TESHIROGI & YAMADA, 1966, pp. 80–81, 86–90; KAWAKATSU, 1967, p. 134, 1969, p. 47, 1977 a, p. 15, 1977 b, p. 66.

For taxonomic remarks, see also KAWAKATSU & ICHIKAWA, 1971, pp. 7–8; KENK, 1974, p. 8.

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

The species has a typical appearance of body shape of the dendrocoelid type. It is very similar to that of the other two Japanese dendrocoelid species, i. e., *Bdellocephala brunnea* IJIMA et KABURAKI from Middle and North Honshu and *Dendrocoelopsis ezensis* ICHIKAWA et OKUGAWA from Hokkaido (cf. KAWAKATSU, 1969, p. 91, pl. 8, figs. 17 and 18). Usually, the sexually mature specimen measures up to 15 to 20 mm in length and 3 to 5 mm in width. The normal movement of the animal is gliding. When the animal is collected by a soft-haired writing brush it usually attaches itself strongly to the substratum. This is apparently due to the action of the adhesive organ and marginal adhesive zones. In the gently gliding animal, the anterior end of the head becomes subtruncated with a convex frontal margin. The slightly rounded auricles are moderately developed (Fig. 1 A–D). Behind the auricles, the body first narrows slightly (i. e., the "neck"), then shortly widens, reaching its widest at the level of pharynx and copulatory apparatus. The posterior end of the body is rounded or bluntly pointed.

Two eyes are situated on the dorsal side of the head; the distance between them is a little wider than one-third the length of the width of head at the level of eyes. Each eye is enclosed in a clear obcordate, pigment-free ocular area (Figs. 1 A–D, 2 A). Some specimens have supernumerary eyes (Fig. 2 B). The auricular sensory organ of an elongated willow-leaf shape is visible on each side of the head (Fig. 1 A–D).

The ground color of the dorsal surface of body is uniformly grayish brown with numerous, small, indistinct, reddish brown pigment spots. The areas above the adhesive organ, the pharynx and the copulatory apparatus are of a darker brownish color. The margin of the body is lighter brown. In the Okushiri population, the ground color is darker than that of the animals in the Rishiri population. The ventral surface is pale grayish brown without conspicuous pigment granules.

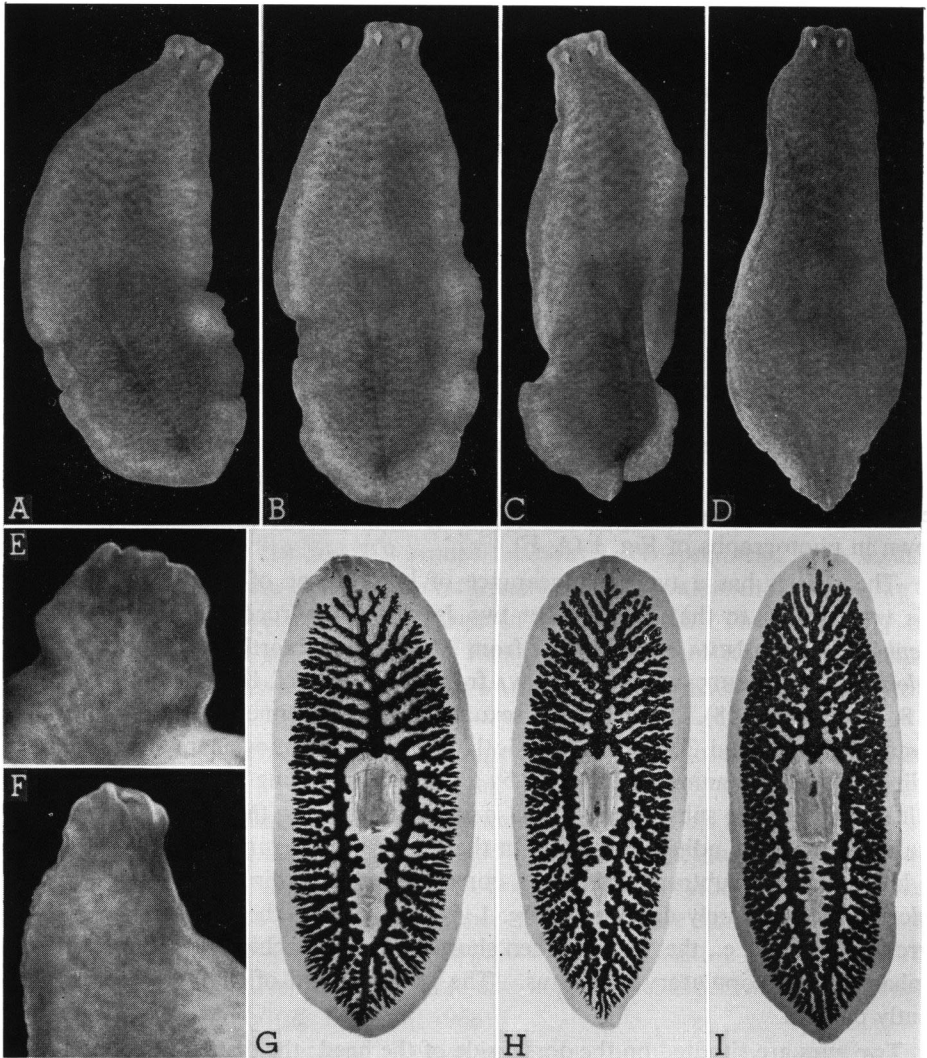


Fig. 1. *Bdellocephala borealis* sp. nov. (Specimen Lot No. 420 group). — E and F, Live specimens; ventral view. — G–I. Whole mounts. G, Specimen No. 420 b. H, Specimen No. 420 c. I, Specimen No. 420 e.

The present new species has a moderately developed subterminal adhesive organ on the frontal end of the ventral side of body. Externally, the organ in live specimens is a rather shallow, concave depression (Fig. 1 E and F). In the preserved specimens, the site of the organ usually forms a thick, grooved rim (Fig. 1 A and B).

The pharynx is inserted behind the middle of the body and is nearly one-fifth the body length. The genital pore is situated in the midline at the level of the middle of the postpharyngeal region (Fig. 1 G–I).

Externally, the present new species is separable from *Bdellocephala brunnea* and *Dendrocoelopsis ezensis*. *Bdellocephala brunnea* is usually larger (20 to 30 mm in length) than the present new species and the "neck" is not so conspicuous. The body is uniformly velvety black without pigment spots. The adhesive organ is well-developed in *Bdellocephala brunnea*. In *Dendrocoelopsis ezensis*, the auricles are slightly pointed. The body is uniformly reddish brown without pigment spots. The adhesive organ is more developed than that of the present new species.

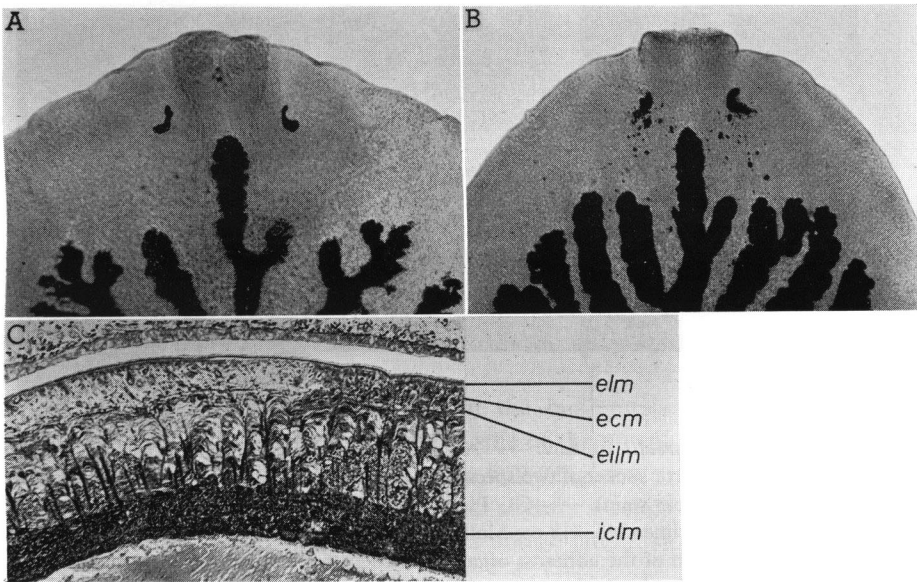


Fig. 2. *Bdellocephala borealis* sp. nov. — A and B. Head of two preserved specimens (photographs taken from the whole mounts). Note the eyes and the adhesive organ. A, Specimen No. 420 b. B, Specimen No. 420 e. — C. Photomicrograph of a sagittal section of a part of pharynx (Specimen No. 218 bb; Mallory's triple stain). ecm, external circular muscle layer; eilm, external irregular longitudinal muscle layer; elm, external longitudinal muscle layer; iclm, internal circular and longitudinal muscle layers.

The anterior intestinal trunk has 9 to 12 short lateral branches on each side; each posterior trunk has 12 to 18 short lateral branches (Fig. 1 G-I). The pharynx is structurally typical of the family Dendrocoelidae: its internal muscle zone consists of intermingled circular and longitudinal fibres (Fig. 2 C).

The marginal adhesive zone is well-developed in the present new species. Anatomically and histologically, the adhesive organ consists of glandular and muscular elements (Figs. 3 A-D, 4). The surface of the organ is covered with numerous, thickly swollen erythrophilic gland ducts filled with a granular secretion. The cell bodies of the glands are scattered through the mesenchyme of the anterior part of body (particularly above the intestine). Numerous cyanophilic gland ducts are also seen in the

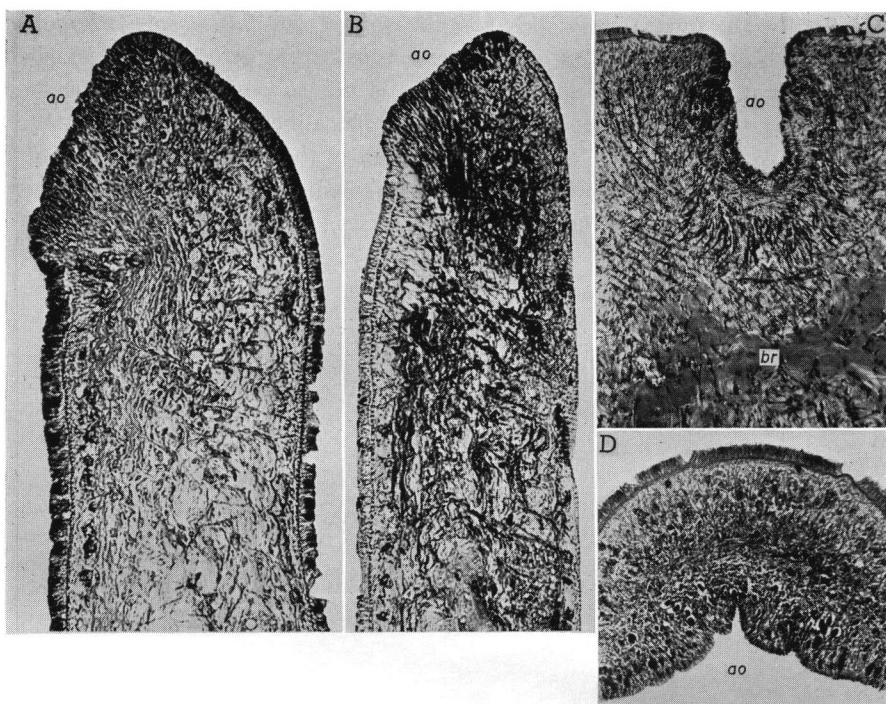


Fig. 3. *Bdellocephala borealis* sp. nov. — A and B. Photomicrographs of sagittal sections of the adhesive organ or sucker of two specimens. A, Specimen No. 218 k. B, Specimen No. 218 v (Mallory's triple stain). — C. Photomicrograph of the horizontal section of the adhesive organ (Specimen No. 218 cc; Mallory's triple stain). — D. Photomicrograph of the transverse section of the adhesive organ (Specimen No. 218 aa; Mallory's triple stain). ao, adhesive organ; br, brain.

greater part of the adhesive organ. The muscular system of this organ is rather weakly developed. Below the outer thin longitudinal layer adjacent to the epithelium of the adhesive organ, slightly thick intermingled layer of circular and longitudinal muscle fibres can be seen. The retractor muscle fibres cannot be analyzed in detail.

A pair of rather large ovaries occur on the ventral side of the anterior region between the third and the fourth intestinal diverticula (Figs. 5 A and B, 6 A). The two ovovitelline ducts run posteriorly and finally unite to form a rather long common ovovitelline duct at the anterior level of the genital pore. It opens to the terminal part of the male genital antrum (Figs. 5 B, 7 A–D). The yolk glands (or vitellaria) are distributed throughout the body in the surrounding parenchyma.

The dorsal testes are small in size and numerous. They are arranged on either side of the midline in six to eight longitudinal zones (in the region of the posterior level of the pharyngeal base they may reduce to four or five zones) extending from the posterior level of the ovaries to nearly the posterior end of the body. The total number of testes can be estimated at about 800 to 900 (Figs. 5 A and B, 6 B and C). In the

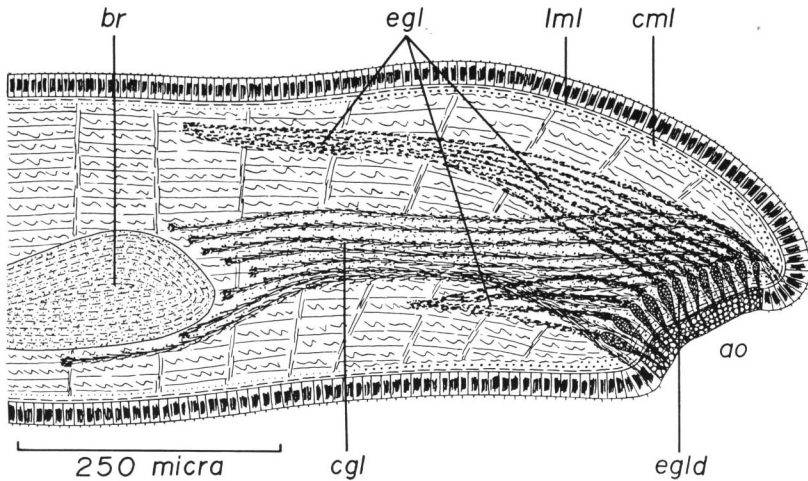


Fig. 4. Sketch of the adhesive organ of *Bdellocephala borealis* sp. nov. drawn from sagittal sections (Specimen No. 218 h). ao, adhesive organ; br, brain; cgl, cyanophilic glands; cml, circular muscle layers; egl, erythrophilic glands; egld, erythrophilic gland ducts; lml, longitudinal muscle layers.

present new species the sperm ducts form the moderately developed spermiducal vesicle and are packed with sperm on either side of the postpharyngeal region between the mouth and the anterior level of the penis bulb (Fig. 5 A and B). On the posterior side of the copulatory bursa, each sperm duct slightly ascends vertically, then becomes a slightly expanded, thick-walled tube at the antero-lateral side of the penis bulb and open into the bulbar cavity separately (Fig. 7 A–D).

The sagittal view of the copulatory apparatus of four specimens is shown in Fig. 7 (A and B: specimens from the Rishiri population; C and D: specimens from the Okushiri population). Photomicrographs of the parts of the copulatory apparatus of several specimens from both Rishiri and Okushiri populations are also shown in Figs. 8 (A–E) and 9 (A–F).

The male parts of the copulatory organ consists of a very large, spherical or ellipsoidal penis bulb embedded in the parenchyme and a wide male genital antrum following the penis lumen (Figs. 7 A–D, 8 A–E, 9 A–C, F). A normal penis papilla is not found in the present new species (a generic character), but a very small one is recognizable. The penis bulb is highly muscular in nature. The penis lumen can be divided into three sections, i. e., an anterior, moderately wide, reniform shaped cavity into which a pair of sperm ducts enter separately, a middle, narrow and long tubular cavity, and a posterior, wide conical cavity of somewhat irregular lobed wall which opens into the male genital antrum. The above-mentioned anterior and middle sections of the penis lumen may represent the bulbar cavity or the seminal vesicle; the posterior section may represent the ejaculatory duct. The middle and the posterior

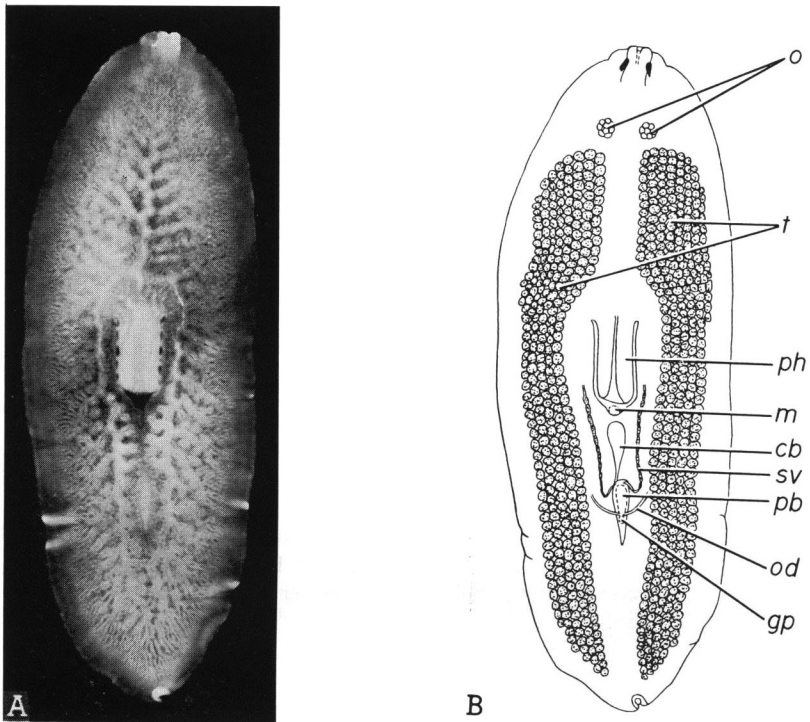


Fig. 5. General view of a mature specimen of *Bdellocephala borealis* sp. nov. (Specimen No. 420 a). — A. Photograph taken from a whole mount. Note the eyes and the digestive system. — B. Sketch of the same specimen. cb, copulatory bursa; gp, genital pore; m, mouth; od, ovovitelline duct; pb, penis bulb; ph, pharynx; sv, spermiducal vesicle; t, testis.

parts of the penis lumen are lined by a very thick, highly glandular epithelium of a nucleate type. The entire region of the penis lumen is surrounded by a well-developed muscular coat consisting of intermingled longitudinal and circular fibres. This muscular coat becomes thicker in the middle and posterior parts of the penis lumen than in the anterior part. Numerous gland ducts filled with granules heavily stained with erythrosin are found around the penis lumen (Figs. 7 A and C, 8 A–E, 9 A–D).

The male antrum is a wide, conical cavity, narrowing toward the narrow common genital antrum, and opens to the genital pore. It is closed with a very thick, glandular, nucleate epithelium below which there are two muscle layers, one circular and the other longitudinal. The male antrum receives a very long common ovovitelline duct at the roof of its posterior region (Figs. 7 A–D, 8 A, B and E).

The copulatory bursa is a middle-sized organ of an ellipsoidal form (its long axis may attain twice the short axis in length) (Figs. 7 A–D, 8 A–E). Its lumen is lined with a tall, glandular epithelium. The bursa stalk is a long, rather slender duct and opens into the common genital antrum near the genital pore (Fig. 7 A–D). The bursal canal is lined with a tall, glandular epithelium of a nucleate type. In the specimens from the



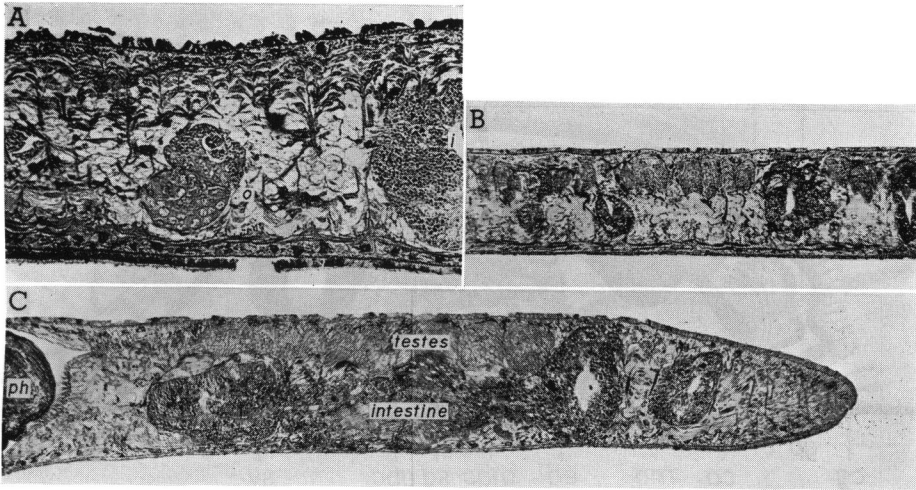


Fig. 6. Photomicrographs showing the parts of the genital organs of *Bdellocephala borealis* sp. nov. — A. Near mid-sagittal section of the anterior part of the prepharyngeal region (Specimen No. 218 k). — B. Near mid-sagittal section of the middle part of the prepharyngeal region (Specimen No. 218 v; Mallory's triple stain). — C. Near mid-sagittal section of the prepharyngeal region (Specimen No. 218 aa; Mallory's triple stain). i, intestine; o, ovary; ph, pharynx.

Rishiri population, the muscular coat surrounding the anterior and middle sections of the stalk consists of a thin layer of longitudinal fibres and a thin layer of circular ones (Figs. 7 A, 9 C). In the specimens from the Okushiri population, the third outer layer of longitudinal fibres can be seen (mostly intermingled) (Fig. 7 C). In the posterior one-fourth or one-fifth section of the bursa stalk, the glandular epithelium of the bursal canal becomes slightly thicker than that of the other parts and forms a weakly developed vagina (Figs. 7 A–D, 8 D, 9 C). The muscular coat surrounding the vagina consists of intermingled longitudinal and circular fibres. Numerous ducts of erythrophilic glands open into the vagina (Fig. 7 A and C). It was observed in the specimens from the Okushiri population that these gland ducts are found around the entire region of both the bursa stalk and copulatory bursa (Fig. 7 C). Weakly erythrophilous cement glands open into the terminal part of the tubular region of the common genital antrum.

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

*Type-series.* Holotype. One set of sagittal serial sections (Specimen No. 218 a; 7 slides) will be deposited in the Department of Zoology, National Science Museum (Nat. Hist.), Tokyo. Six paratypes (No. 218 h, sagittal sections; No. 218 i, sagittal sections; No. 218 p, horizontal sections; No. 218 v, sagittal sections; No. 218 aa, transverse sections; No. 218 cc, horizontal sections) and two whole mounts (No. 420 a and b, sexually mature specimens) will be deposited in the same Museum. The other slides including several paratypes of the fully mature specimens (No. 218 b–g, j–o, q–u, w–z, bb; No. 227 a–g), five whole mounts (No. 420 c–g) and many sexually mature and

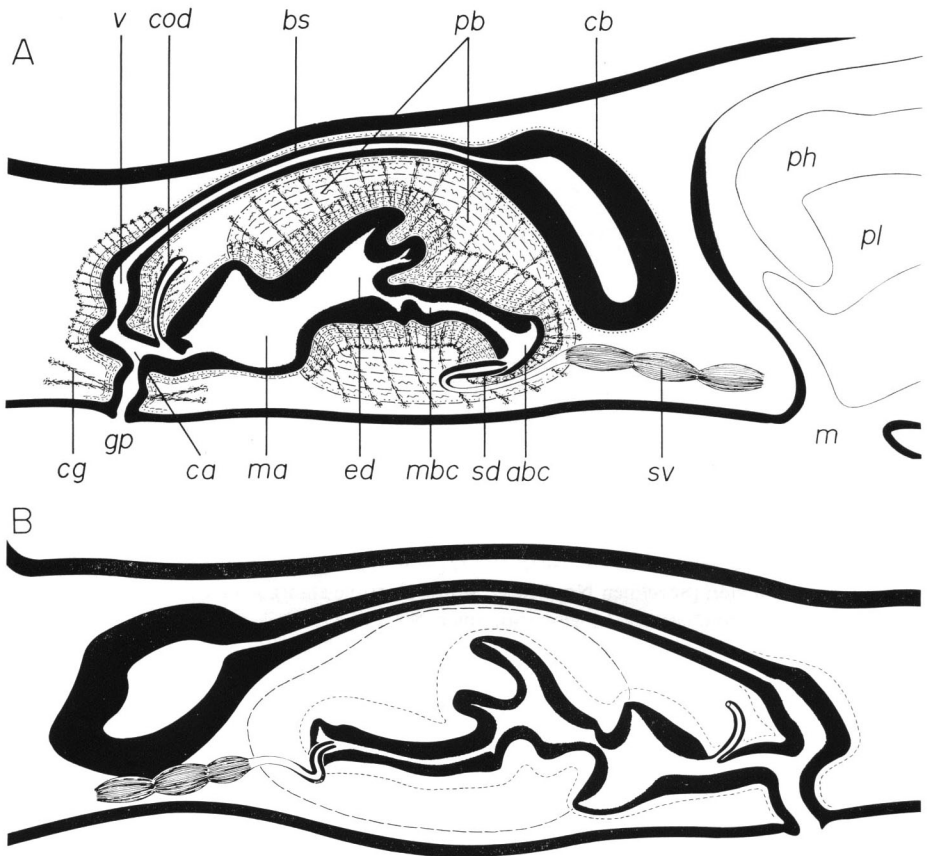


Fig. 7 (on pp. 88–89). Diagrams showing the sagittal view of the copulatory apparatus of *Bdellocephala borealis* sp. nov. Same magnifications. — A. Specimen No. 218 a (holotype). — B. Specimen No. 218 k. Both from Rishiri Island. abc, anterior section of the bulbar cavity; bs, bursa stalk; ca, common antrum; cb, copulatory bursa; cg, cement gland; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; m, mouth; ma, male antrum; mbc, middle section of the bulbar cavity; pb, penis bulb; ph, pharynx; pl, pharynx lumen; sd, sperm duct; sv, spermiducal vesicle; v, vagina.

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 on September 2–4, 1957 (holotype). For other collection data at this locality, see the section "Collecting Data". Takakusa-numa Pond, Okushiri Island, South Hokkaido. Altitude, about 180 m. Collected by M. KAWAKATSU on September 11, 1957.

*Taxonomic remarks and differential diagnosis.* The genus *Bdellocephala* DE MAN, 1875 (type-species: *Fasciola punctata* PALLAS, 1774) has a representative in Europe and

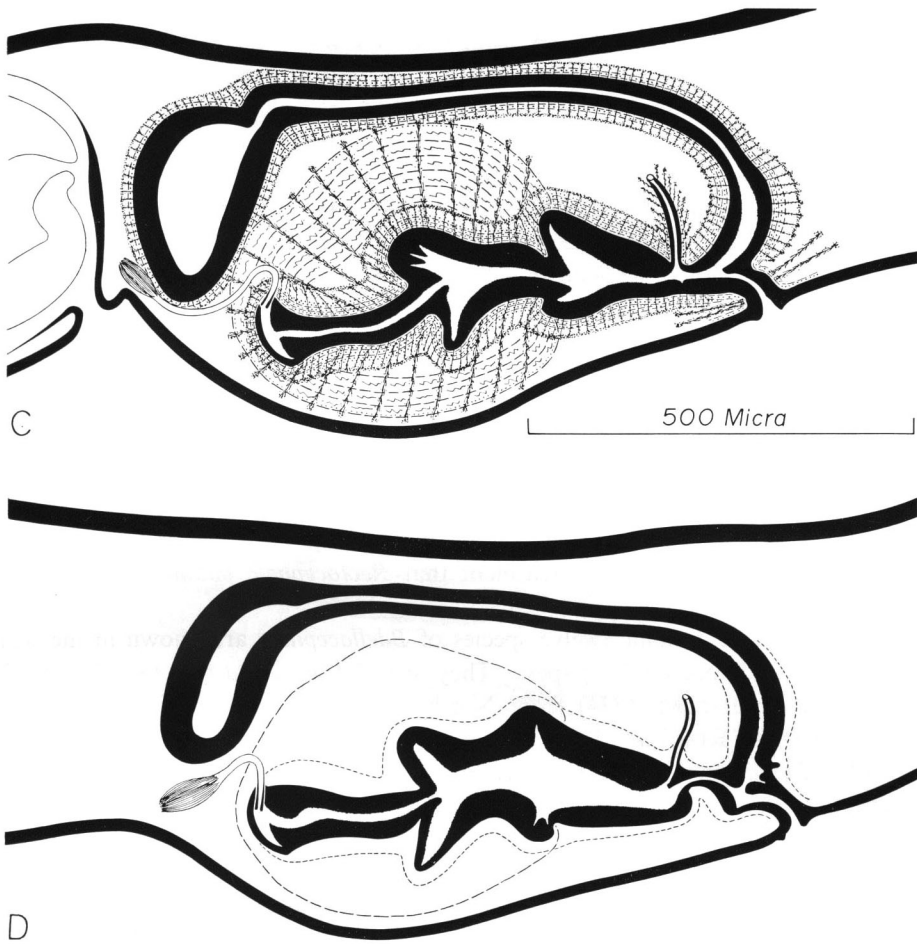


Fig. 7 (continued from p. 88). — C. Specimen No. 227 c. — D. Specimen No. 227 f. Both from Okushiri Island.

Asia (the world-wide distribution map of the genus, see KAWAKATSU, 1968, p. 18, fig. III-10). The taxonomy of *Bdellocephala* based upon the modern taxonomic viewpoint is chiefly discussed by BALL (1974), HYMAN (1953), KAWAKATSU (1968), KENK (1930, 1974), LIVANOW (1962), PORFIRJEVA (1970 a, b, 1971, 1973), ZABUSOVA (1936), and ZABUSOVA-ZUDANOVA (1955). Some taxonomic and chorological remarks on *Bdellocephala* species are also found in the following papers: DE BEAUCHAMP (1932, 1961), DAHM (1963), GOURBAULT (1972), DEN HARTOG (1962), KAWAKATSU (1964, 1965 b, 1966 a, 1967, 1969), KAWAKATSU and ICHIKAWA (1971), KOMÁREK (1930), LUTHER (1961), OKUGAWA (1953), PORFIRJEVA (1974), REYNOLDSON (1967), ZABUSOVA (1929), and ZABUSOVA-ZUDANOVA (1960). The phylogenetical consideration about the genus and the speciation are discussed by KAWAKATSU (1968) and PORFIRJEVA (1970 b,

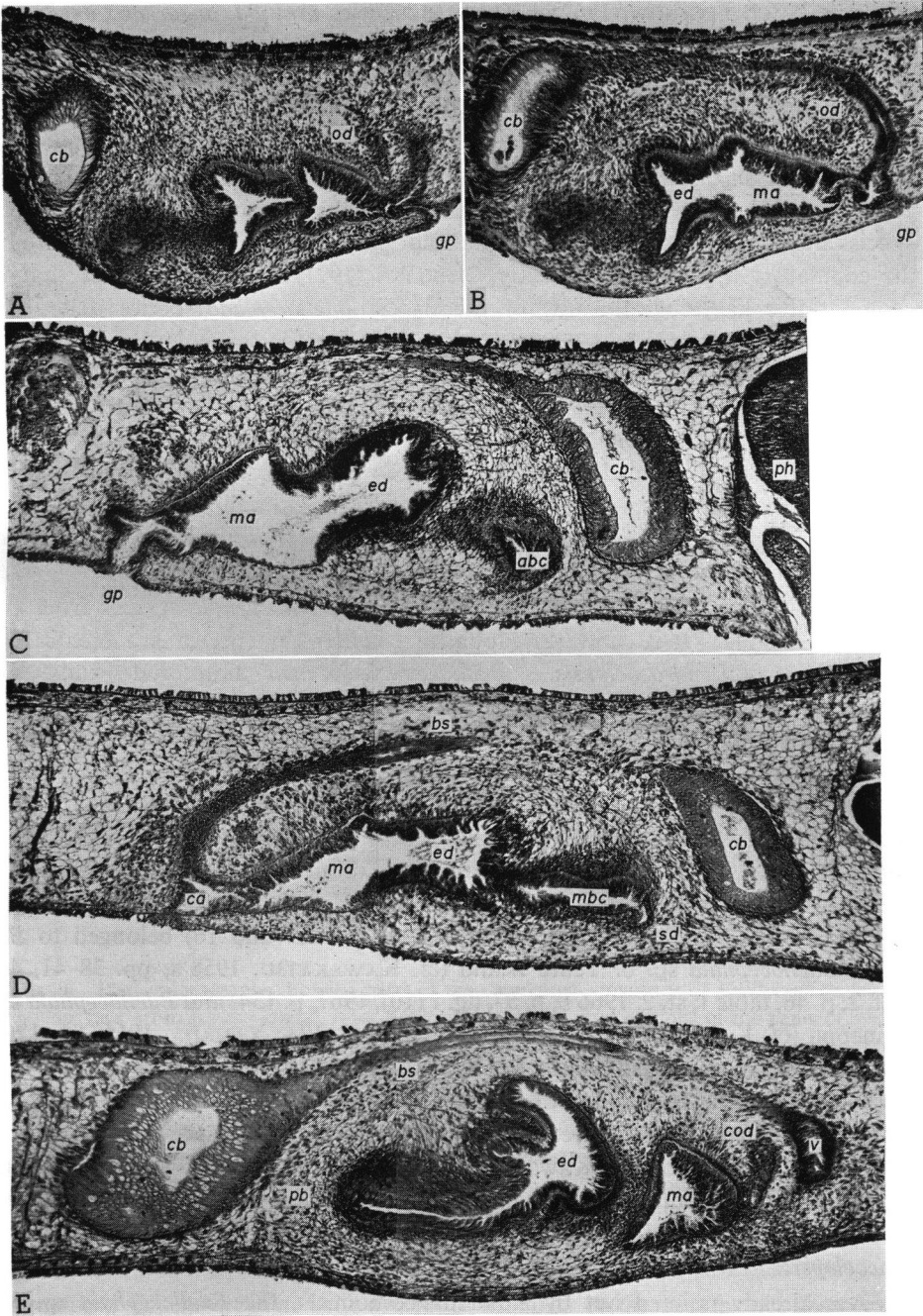
1973). The karyological studies on some *Bdellocephala* species are made by DAHM (1963) and UMYLINA (1971, 1976) (see also BENAZZI & BANAZZI-LENTATI, 1976).

HYMAN (1953), who studied an exotic dendrocoelid species from a pond in Washington, D. C., erected a new genus *Rectocephala* (type-species: *Bdellocephala mediobuccalis* ZABUSOVA, 1929) for her new species *Rectocephala exotica* and some other dendrocoelids that had been placed into *Bdellocephala* (*schneideri*, *baicalensis*, *mediobuccalis* and *kamtschatica*). Although the genus *Rectocephala* HYMAN, 1953, was accepted by several turbellariologists (cf. BALL, 1969, 1974; GOURBAULT, 1972; KAWAKATSU, 1965 b, 1967, 1968; KENK, 1972), the genus has been united by KENK (1974, p. 7) with *Bdellocephala*. According to HYMAN's (1953, pp. 1-2) original definition of *Rectocephala*, the principal generic character which separates *Rectocephala* from *Bdellocephala* is as follows: "ejaculatory duct enters large, expanded, weakly muscular but highly glandular chamber (presumably the penis bulb) continuous posteriorly with the reduced male antrum". The chamber that she interpreted as "penis bulb" in her figures of the copulatory apparatus of *Rectocephala exotica* (1953, p. 4, figs. 3 and 4) may represent very wide male genital antrum (this was already pointed out by DE BEAUCHAMP, 1961, p. 106; see also GOURBAULT, 1972, p. 84; KENK, 1972, p. 65). For this point KAWAKATSU fully agrees with KENK's (1974) treatment that *Rectocephala* should be included in *Bdellocephala*.

Up to the present, some twelve species of *Bdellocephala* are known in the world and are listed in KENK's 1974 paper. They are: *Bd. punctata* (PALLAS, 1774) (olim *Fasciola punctata* PALLAS, 1774) from North and Central Europe including British Isles; *Bd. schneideri* KOMÁREK, 1930, from Central Europe; *Bd. angarensis* (GERSTFELDT, 1858) (olim *Planaria angarensis* GERSTFELDT, 1858) from Lake Baikal and its vicinities in Siberia; *Bd. baicalensis* (ZABUSOV, 1903) (olim *Procotyla baicalensis* ZABUSOV, 1903) and *Bd. hypervesiculina* LIVANOW, 1962, from Lake Baikal in Siberia; *Bd. grubiiiformis* (ZABUSOVA, 1929) (olim *Planaria grubiiiformis* ZABUSOVA, 1929), *Bd. mediobuccalis* ZABUSOVA, 1929, *Bd. parva* ZABUSOVA, 1936, and *Bd. kamtschatica* ZABUSOVA, 1929, from East Asia; *Bd. brunnea* IJIMA et KABURAKI, 1916, from Central Japan (Middle and North Honshu) and *Bd. annandalei* IJIMA et KABURAKI, 1916, from Lake Biwa-ko in Central Japan; *Bd. exotica* (HYMAN, 1953) (olim *Rectocephala exotica* HYMAN, 1953) from Washington, D. C., the United States. The last one is apparently an introduced species with water plants (cf. HYMAN, 1953, p. 1; KENK, 1972, p. 65, 1974, p. 8).

The two *Bdellocephala* species from Lake Baikal show a wide degree of variation in their morphology and anatomy. *Bdellocephala angarensis* can be divided into

Fig. 8. Photomicrographs showing parts of the copulatory apparatus of *Bdellocephala borealis* sp. nov. — A-E. Near mid-sagittal sections of the copulatory apparatus of 5 specimens from Okushiri Island (A and B) and Rishiri Island (C-E). Same magnifications. A, Specimen No. 227 c. B, Specimen No. 227 f. C, Specimen No. 218 a (holotype). D, Specimen No. 218 i. E, Specimen No. 218 k. abc, anterior section of the bulbar cavity; bs, bursa stalk; ca, common antrum; cb, copulatory bursa; cod, common ovovitelline duct; ed, ejaculatory duct; gp, genital pore; ma, male antrum; mbc, middle section of the bulbar cavity; od, ovovitelline duct; pb, penis bulb; ph, pharynx; sd, sperm duct; v, vagina.



five subspecies (cf. LIVANOW, 1962). These subspecies are: *Bd. angarensis angarensis* (GERSTFELDT, 1858), *Bd. angarensis cotyloides* RUBTSOV, *Bd. angarensis olivacea* (KOROTNEV, 1912), *Bd. angarensis melanocinerea* (KOROTNEV, 1912), and *Bd. angarensis subrufa* (KOROTNEV, 1912). PORFIRJEVA (1970 a, b, 1973, pp. 93–100, 167, fig. 58) classified the species into three subspecies, i. e., *Bd. angarensis angarensis*, *Bd. angarensis olivacea* and *Bd. angarensis melanocinerea*. According to the morphological studies on *Bdellocephala angarensis* made by the members of the Kazan school (op. cit.), each subspecies shows wide variations both in the color pattern of the body and the anatomy of the copulatory apparatus. Recently, UMYLINA (1971, 1976) pointed out that in her comparative karyological study of the Baikal *Bdellocephala* species that *Bdellocephala angarensis melanocinerea* seems to be only a form in this polymorphic species (see also PORFIRJEVA, 1973, pp. 93–100). *Bdellocephala baikalensis* had been divided into two subspecies by LIVANOW (1962, p. 175): *Bd. baikalensis baikalensis* (ZABUSOV, 1903) and *Bd. baikalensis compacta* LIVANOW, 1962. Later, PORFIRJEVA (1970 b, pp. 1458–1459; see also 1973, pp. 101–106, 167, fig. 58) proposed another system of classification; she divided the species into two subspecies, i. e., nominate subspecies and *Bd. baikalensis subniger* (KOROTNEV, 1912) (olim *Monocotylus subniger* KOROTNEV, 1912). Her classification system was not accepted by KENK (1974, pp. 7–8).

MİYADI (1937, p. 450) recorded an undescribed *Bdellocephala* species from the North Kuril Islands. It is, however, doubtful whether the species is a member of *Bdellocephala* or of *Dendrocoelopsis*. “*Bdellocephala jezensis*” nom. nud. (ICHIKAWA, 1954, p. 82) is *Dendrocoelopsis ezensis* (cf. KAWAKATSU & ICHIKAWA, 1971, p. 9; KENK, 1974, pp. 8, 14). KAWAKATSU (1969, p. 47, table 1) listed four undescribed Japanese forms which were then considered to be the members of *Bdellocephala*. Among these forms, *Bdellocephala* sp. of Rishiri Island and *Bdellocephala* sp. of Okushiri Island are *Bd. borealis*, the new species described in the present paper. On close examination of the additional sexually mature specimens from the Towada National Park in northern Honshu, it was proved that *Bdellocephala* sp. of Towada (cf. KAWAKATSU, TESHIROGI, ISHIOKA & KASAHARA, 1968, pp. 250–253, table 1, sts. 12' and 16) belonged to *Bd. brunnea*. *Bdellocephala* sp. of Teure Island (cf. KAWAKATSU, 1958 a, pp. 38–41, 43, fig. 1, st. 2, p. 46, table 1, st. 2, 1966 b, p. 57, fig. 1 (10), 1967, p. 134) and *Bdellocephala* sp. of Otoineppu (cf. KAWAKATSU, 1965 b, p. 365, 1967, p. 134; YAMADA, 1966, pp. 129–133) are *Dendrocoelopsis ezensis* (see also KAWAKATSU, ASAI & YAMADA, 1977). Recently, NAKANO, YAMAZAKI and MUKAIBARA (1976, pp. 347–350, fig. 5 (3 and 4)) recorded a single sexually immature specimen of a dendrocoelid species from a well in Toyo'oka in Middle Honshu (Kawakatsu's Specimen Lot No. 1290 a; about 15 mm in length and 3 mm in width; pale brown in color with numerous reddish pigment granules; with two eyes; with adhesive organ). This form may belong to *Bdellocephala* or *Dendrocoelopsis*.

As was already pointed out by Russian taxonomists, the *Bdellocephala* species from Lake Baikal (*Bd. angarensis*, *Bd. baikalensis* and *Bd. hypervesiculina*), Kamchatka (*Bd. grubiformis*, *Bd. mediobuccalis*, *Bd. kamtschatica*, and *Bd. parva*) and Japan (*Bd.*

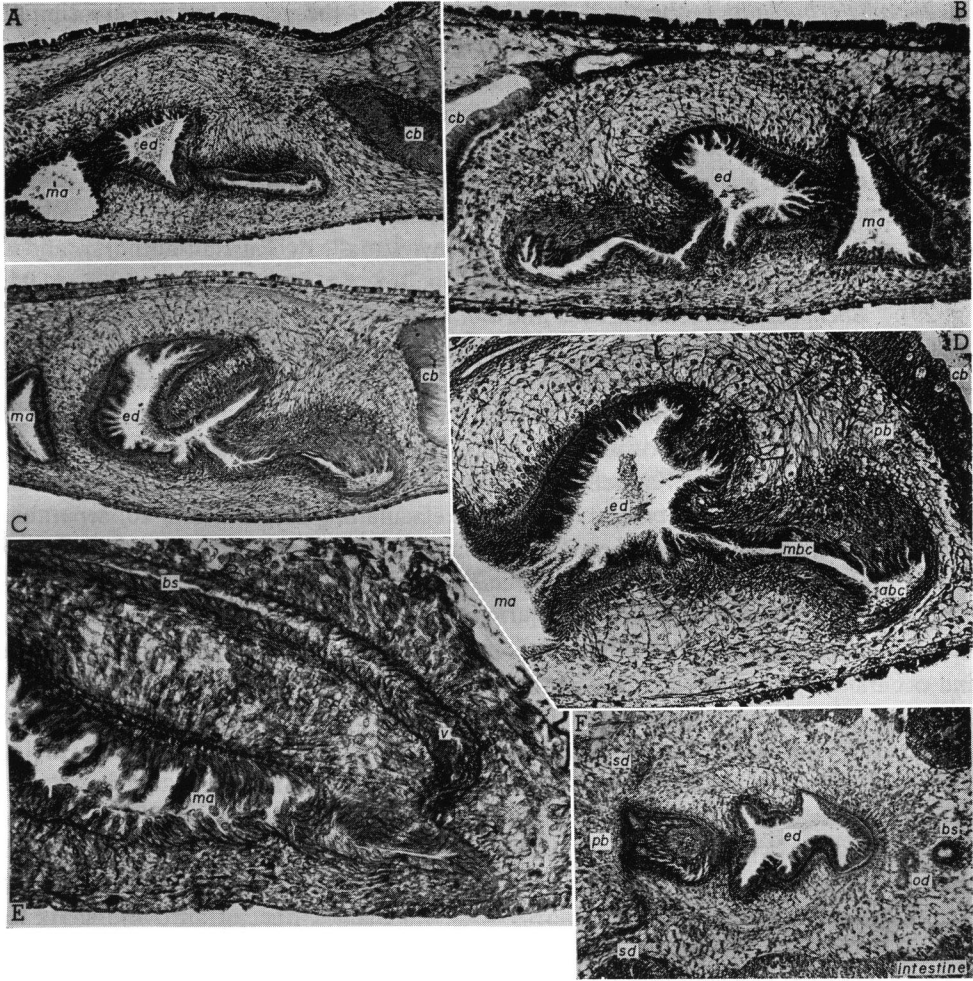


Fig. 9. Photomicrographs showing parts of the copulatory apparatus of *Bdellocephala borealis* sp. nov. from Rishiri Island. — A–C. Near mid-sagittal sections of the penis of 3 specimens. A, Specimen No. 218 h. B, Specimen No. 218 c (enlarged). C, Specimen No. 218 m. A and B are of the same magnifications. — D. Near mid-sagittal section of the anterior part of the penis (enlarged) (Specimen No. 218 a; holotype). — E. Near mid-sagittal section through the male antrum and the vagina (enlarged) (Specimen No. 218 v; Mallory's triple stain). — F. Horizontal section of the copulatory apparatus (Specimen No. 218 p). abc, anterior section of the bulbar cavity; bs, bursa stalk; cb, copulatory bursa; ed, ejaculatory duct; ma, male antrum; mbc, middle section of the bulbar cavity; od, ovovitelline duct; pb, penis bulb; sd, sperm duct; v, vagina.

*brunnea* and *Bd. annandalei*) bear a certain similarity to one another in their external appearance and the anatomy of the copulatory apparatus (cf. LIVANOW, 1962; PORFIRJVA, 1973 and others; ZABUSOVA, 1929, 1936). The present new species,

*Bdellocephala borealis*, is the third Japanese species in the genus and is very similar to the following four species. They are: *Bd. angarensis*, *Bd. mediobuccalis*, *Bd. kamtschatica*, and *Bd. brunnea*.

*Bdellocephala angarensis*, a species endemic to Lake Baikal, is a giant form (it may attain 40 mm in length). Externally, the species shows a high degree of variation of color patterns. In the genital anatomy the species has a weakly muscular penis bulb, a rather wide bulbar cavity (called "semennai puzyrek" by Russian authors), a very wide ejaculatory duct (called "semiaizvergatel'nyi kanal" by Russian authors), and a weakly developed vagina (see LIVANOW, 1962, p. 168, fig. 6; PORFIRJEVA, 1973, p. 95, fig. 29). *Bdellocephala mediobuccalis* and *Bd. kamtschatica*, both distributed in lakes of Kamchatka, are rather small forms with pigment spots. The former has a well developed adhesive organ, a muscular penis bulb of a spherical shape, a rather narrow bulbar cavity, a wide ejaculatory duct, a wide male genital antrum, and a long common ovovitelline duct (see ZABUSOVA, 1929, p. 522, text-fig. 10, p. 524, text-fig. 12, taf. 4, figs. 9-11). The latter has a well-developed adhesive organ, a spherical penis bulb, a rather narrow bulbar cavity, and a very wide ejaculatory duct which is not separable from the male genital antrum (see ZABUSOVA, 1929, p. 528, text-fig. 10, taf. 4, figs. 5 and 6). The present new species, *Bd. borealis*, is easily distinguishable from the above-mentioned species by the external appearance and the details of the genital anatomy.

*Bdellocephala brunnea* is a rather common species in Middle and North Honshu and occurs in springs, spring-fed streams and shallow lakes (cf. KAWAKATSU, 1966 a, 1969). Although illustrations of the copulatory apparatus of this species are found in the papers by IJIMA and KABURAKI (1916, p. 159, fig. 11) and KABURAKI (1922, p. 11, text-fig. 4), they are much simplified as diagrammatic ones. KAWAKATSU prepared a sufficient number of sketches of the copulatory apparatus of *Bd. brunnea* from various localities (KAWAKATSU's unpublished data). The species has a very large, ellipsoidal muscular penis bulb, a wide bulbar cavity of an elongated ovoid shape surrounded by a thick muscular coat, an extraordinarily wide ejaculatory duct of an ovoid shape, a wide male genital antrum, a rather short common ovovitelline duct, a very large copulatory bursa, and a weakly developed vagina. Externally, the present new species, *Bd. borealis*, differs from *Bd. brunnea* in the size and coloration (especially the pigment spots on the dorsal surface conspicuous only in the former). The adhesive organ is more developed in *Bd. brunnea* than in the former. Anatomically, *Bd. borealis* is distinguishable from *Bd. brunnea* by the shape and structure of the penis lumen (especially the conically shaped ejaculatory duct found in the former). A very long common ovovitelline duct in *Bd. borealis* is also one of the distinguishing characters of the present new species.

*Bdellocephala borealis* differs from the other members of the genus in the following characters: living animal moderate in size and uniformly grayish brown in color with numerous, indistinct reddish brown pigment spots; head subtruncated with a convex frontal margin, and with moderately developed and rounded auricles; two eyes; sub-terminal adhesive organ with weakly developed musculature; numerous dorsal testes



lie in four to eight longitudinal rows on either side and extend almost to the posterior end; without normal penis papilla; spherical or ellipsoidal penis bulb large and highly muscular with a very long bulbar cavity and a wide conical ejaculatory duct, both lined with a tall, glandular epithelium and surrounded by a moderately developed muscle layers (the sperm ducts open into the anterior reniform part of the bulbar cavity separately); very long common ovovitelline duct entering the roof of the posterior part of the male genital antrum; copulatory bursa middle-sized, ellipsoidal in form with a long bursa stalk, of which posterior one-fourth or one-fifth section forms a weakly developed vagina; cocoon spherical in shape.

### Ecology and Laboratory Observations

The type-locality of *Bdellocephala borealis*, the present new species, is an outlet of Hime-numa Pond in Rishiri Island. The ecological data of this locality will be found in the papers by KAWAKATSU, ASAI and YAMADA (1977, pp. 213–214) and KAWAKATSU and YAMADA (1966, pp. 375–379). Numerous specimens of this species occur in the shallow stream of the outlet (*Polycelis sapporo* (IJIMA et KABURAKI, 1916), *Polycelis schmidti* (ZABUSOV, 1916) and *Dendrocoelopsis ichikawai* KAWAKATSU, 1977, also occurred there) and one of the cold-water springs located in the south shore close to the pond. The animals are very common near the outlet (cf. KAWAKATSU, 1958 a, p. 48, fig. 2, p. 61, table 2; KAWAKATSU & YAMADA, 1966, p. 378, table 1, p. 379, figs. 3 and 4) (water temp. in summer, 10.4–16.8°C, pH 6.5–7.3).

Takakusa-numa Pond (another locality of *Bdellocephala borealis*) is located at the southwestern part of Okushiri Island (lat. 42°07'N and long. 139°26'E). The Island is about 40 kilometers to the west off Kutô, the Oshima Peninsula in southern Hokkaido. The pond located in a forest has about a 100-meters shoreline (alt. 180 m). There are no streams around it. Animals were collected from the surface of dead leaves lying on the muddy bottom of the pond (about 20 cm in depth, water temp., 16.4–20.0°C in summer, pH 6.8; cf. KAWAKATSU 1958 b, p. 44, fig. 4, p. 50, table 3).

Several cocoons of *Bdellocephala borealis* were collected in the Rishiri locality in September. They are spherical in shape and about 2.5 mm in diameter. In the laboratory culture, the animals collected in the summer of 1964 laid cocoons from autumn to the next spring.

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### Summary

A new species of the genus *Bdellocephala* (Turbellaria, Tricladida, Paludicola), *Bdellocephala borealis* KAWAKATSU, sp. nov., from Rishiri Island and Okushiri Island off Hokkaido, North Japan, is described in the present paper. This pigmented and two-eyed species seems to be nearly related to *Bdellocephala angarensis* (Lake Baikal form), *Bdellocephala mediobuccalis* and *Bdellocephala kamtschatica* (Kamchatkan forms), and *Bdellocephala brunnea* (Japanese form). The present new species is distinguishable from them in having a moderate size, grayish brown coloration with indistinct reddish brown pigment spots, a moderately developed adhesive organ, very numerous dorsal testes, and details of the penial anatomy.

### References

- BALL, I. R., 1969. An annotated checklist of the freshwater Tricladida of the Nearctic and Neotropical Regions. *Can. J. Zool.*, **47**: 59–64.
- 1974. A contribution to the phylogeny and biogeography of the freshwater triclads (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, 1932. Turbellariés, Hirudinées, Branchiobdellidés. Deuxième sér. *Biospeologica*, LVI; *Arch. Zool. exptl. gén.*, **73**: 113–380, pls. 6–8.
- 1961. Classe de Turbellariés. In GRASSÉ, P. P., *Traité de Zoologie*, **4**: 35–212, 887–890. Masson et C<sup>ie</sup>, Paris.
- BENAZZI, M., & G. BENAZZI-LENTATI, 1976. Platyhelminthes. In JOHN, B., *Animal Cytogenetics*, 1: i–v + 1–182. Gebrüder Borntraeger, Berlin.
- DAHM, A. G., 1963. The karyotypes of some freshwater triclads from Europe and Japan (Turbellaria, Tricladida, Paludicola). *Ark. Zool.*, (2), **16**: 41–67.
- GERSTFELDT, G., 1858. Ueber einige zum Theil neue Arten Platoden, Anneliden, Myriapoden und Crustaceen Sibiriens, namentlich seines östlichen Theiles und des Amur-Gebietes. *Mém. prés. Acad. imp. Sci. St.-Petersbourg*, **8**: 259–296. For Turbellaria, pp. 259, 261–263, 294.
- GOURBAULT, N., 1972. Recherches sur les Triclades paludicoles hypogés. *Mém. Mus. Hist. nat., Paris*, (A–Zool.), **73**: 1–249, pls. 1–3.
- HARTOG, C. DEN, 1962. De Nederlandse Platwormen (Tricladida). *Wetenschap. Med. koninklijke Nederl. Naturhist. Verenig.*, (42): 1–40.
- HYMAN, L. H., 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.)
- IJIMA, I., & T. KABURAKI, 1916. Preliminary descriptions of some Japanese triclads. *Annot. zool. Japon.*, **9**: 153–171.
- KABURAKI, T., 1922. On some freshwater triclads; with a note on the parallelism in their distribution in Europe and Japan. *J. Coll. Sci., Imp. Univ. Tokyo*, **44** (2): 1–71, pl. 1.
- KAWAKATSU, M., 1958 a. 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.)

- KAWAKATSU, M., 1958 b. Studies, etc. VI. Teure, Yangeshiri and Okushiri Islands. *Bull. Kyoto Gakugei Univ.*, (B), (13): 36–51. (In Japanese, with English summary.)
- 1964. Notes on the freshwater planaria of Lake Biwa-ko. *The Heredity (Iden)*, Tokyo, **18** (9): 32–35. (In Japanese.)
- 1965 a. The outline of the investigation of ecology, taxonomy and chorology made on freshwater planarians in Japan. *Seikatsubunka-Kenkyū*, 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.
- 1966 a. Synopsis of the known species of freshwater planarians in Japan. *Bull. biogeogr. Soc. Japan*, **24** (2): 9–28. (In Japanese.)
- 1966 b. Japanese freshwater planarians. *The Heredity (Iden)*, Tokyo, **20** (4): 54–67. (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. 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.)
- 1969. An illustrated list of Japanese freshwater planarians in color. *Bull. Fuji Women's Coll.*, (7), Ser. II: 45–91 (pls. 7–8).
- 1977 a. Ecology and distribution of freshwater planarians. *The Heredity (Iden)*, Tokyo, **31** (10): 13–24. (In Japanese.)
- 1977 b. A list of publications on Japanese turbellarians (1976)—Including titles of publications written by the Japanese authors—. *Bull. Fuji Women's Coll.*, (15), Ser. II: 57–68. (Both in English and Japanese.)
- , E. ASAI & T. YAMADA, 1977. *Dendrocoelopsis ichikawai* sp. nov., a new freshwater planarian from Rishiri Island in Hokkaido. *Bull. Natn. Sci. Mus., Tokyo*, (A), **3**: 199–217.
- & 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.)
- , W. TESHIROGI, T. ISHIOKA & H. KASAHARA, 1968. Report on the ecological survey of freshwater planarians in the central part of Aomori Prefecture (Kuroishi City, the Mt. Kushi-gamine and the Ōwani districts). *Jap. J. Ecol.*, **18**: 250–258. (In Japanese, with English summary.)
- & T. YAMADA, 1966. Planarians collected from Hime-numa in Rishiri Island, Hokkaidō. *Collect. & Breed.*, Tokyo, **28**: 375–379. (In Japanese, with English summary.)
- KENK, R., 1930. Beiträge zum System der Probursalier (Tricladida, Paludicola). *Zool. Anz.*, **89**: 145–162, 289–302.
- 1972. Freshwater planarians (Turbellaria) of North America. *Biota of Freshwater Ecosystems, Identification Manual*, (1): i–ix+1–81. U. S. Environment. Protect. Agency.
- 1974. Index of the genera and species of the freshwater triclad (Turbellaria) of the world. *Smiths. Contr. Zool.*, (183): 1–90.
- KOMÁREK, J., 1930. Eine blinde *Bdellocephala* (Tricladida) aus dem Harz. *Zool. Anz.*, **87**: 327–332.
- KOROTNEV, A. A., 1912. Die Planarien des Baikalsees (Tricladen). In: *Wissenschaftliche Ergebnisse einer zoologischen Expedition nach den Baikalsee unter Leitung Professor 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. (In Russian.)

- LUTHER, A., 1961. Die Turbellarien Ostfennoskandiens, II: Tricladida. *Fauna fennica*, (11): 1–42.
- MAN, J. G. DE, 1875. Eerste bijdrage tot de Kennis der nederlandsche Zoetwater-Turbellarien, benevens eene beschrijving van nieuwe soorten. *Tijdschr. Nederl. Dierkund. Vereen.*, 1: 108–122, pls. III–V.
- MIYADI, D., 1937. Limnological survey of the North Kuril Islands. *Arch. Hydrobiol.*, 31: 433–483.
- NAKANO, M., Y. YAMAZAKI & Y. MUKAIBARA, 1976. Notes on freshwater planarians found in the vicinity of Toyo'oka City, Hyôgo Prefecture, Honshû (with an appendix written by M. KAWAKATSU). *Collect. & Breed., Tokyo*, 38: 347–350. (In Japanese.)
- OKUGAWA, K. I., 1953. A monograph of Turbellaria (Acoela, Rhabdocoela, Alloecoela and Tricladida) of Japan and its adjacent regions. *Bull. Kyoto Gakuji Univ.*, (B), (3): 20–43.
- PALLAS, P. S., 1774. *Spicilegium zoologicum quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur*. Fasc. 10: 1–42, pls. I–IV. Berolini. For Turbellaria, pp. 20–23, pl. I.
- PORFIRJEVA, N. A., 1970 a. K kharakteristike fauny Planarii (Tricladida Paludicola) Baikala. In: *Voprosy Evolutsionnoi Morfologii i Biogeografii*, pp. 77–91. Kazanskii Univ., Kazan'. (In Russian.)
- 1970 b. Ob endemichnom vidoobrazovanii u baikal'skikh Dendrotselid (Tricladida, Paludicola). *Zool. Zhur.*, 49: 1456–1464. (In Russian, with English summary.)
- 1971. O nekotrykh putiakh evoliutsii baikal'skikh planarii. In: *Voprosy Morfologii i Ekologii Bespozvonochnykh*, pp. 81–93. Kazanskii Univ., Kazan'. (In Russian.)
- 1973. *Fauna Planarii Ozera Baikal*. 1–192 pp. Kazanskii Univ., Kazan'. (In Russian.)
- 1974. Bikal'skii ochg vidoobrazovaniia planarii i ego zoogeograficheskie otnosheniia. In *Produktivnost' Baikala i Antropogennye Izmeneniia ego Prirody*, pp. 287–294. Irkutsk. (In Russian.)
- REYNOLDS, T. B., 1967. A key to the British species of freshwater triclads (Turbellaria, Paludicola). *Biological Association, Scientific Publication*, (23): 1–28, pl. I.
- RUVTSOV, I. G., 1928. K poznaniu fauny planarii reki Angary. *Russ. Gidrobiolog. Zhur.*, 7: 190–197. (In Russian, with German summary.)
- TESHIROGI, W., & T. YAMADA, 1966. Regenerative capacities of transverse pieces in the four species of freshwater planarian, *Phagocata teshirogii*, *Ph. albata*, *Polycelis schmidti* and *Bdellocephala* sp. *Sci. Rept. Hirosaki Univ.*, 13 (1–2): 80–91.
- UMYLINA, T. M., 1971. Kariotipy baikal'ckikh planarii roda *Bdellocephala* DE MANN (Turbellaria, Tricladida, Paludicola). *Zool. Zhur.*, 50: 130–133. (In Russian, with English summary.)
- 1976. Khromosomy v spermatogeneze u Bdelotsefal Ozera Baikal (Tricladida, Paludicola). In: *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, Hokkaidô. *Jap. J. Ecol.*, 16: 129–133. (In Japanese, with English summary.)
- ZABUSOV, I. P., 1903. Zamietki po morfologii i sistematikie Tricladida. IV. Pervyi predvaritel'nyi otchet o planariikh oz. Baikala, sobrannykh V. P. GARIAEVYM. *Trudy Obshch. Estestvoisp. Imp. Kazanskom Univ.*, 36 (6): 1–58, 1 pl. (In Russian, with German summary.)
- ZABUSOVA, Z. I., 1929. Die Turbellarien der Kamtschatka-Halbinsel nach den Sammlungen der Rjabuschinsky-Expedition 1908–1909. *Zool. Jahrb., Abt. Syst. ökol. Geogr. Tiere*, 57: 497–536, pl. 4.
- 1936. Planarii Kamchatki. *Kazanskii gosud. Univ., Uchenye Zapiski, Zoologiya*, 96 (7): 141–174. (In Russian, with French summary.)
- ZABUSOVA-ZUDANOVA, Z. I., 1955. Novye dannye o rasprostraneni Planarii v Sibiri. *Zametki po Faune i Flore Sibiri*, 18: 50–54. (In Russian.)
- 1960. Planarii Dal'nego Vostoka. *Trudy Obshch. Estestvoisp. Kazanskom gosud. Univ.*, 63: 112–121. (In Russian.)