

A LIST OF PUBLICATIONS ON TURBELLARIANS RECORDED FROM LAKE BIWA-KO, HONSHÛ, JAPAN

by

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A SHORT HISTORY OF THE STUDY OF TURBELLARIANS IN LAKE BIWA-KO

Lake Biwa-ko, located in the Kinki Region, the central part of Honshû, is the largest lake in Japan. Approximately 63.5 km long and 22.8 km wide, it has a 235.2-km shoreline, a 607.4-km² area, and a maximum depth of 103.6 m (an elevation of the surface of the lake, 85.6 m) (cf. Environ. Div. Shiga Pref. Govern., 1991; Geogr. Survey Inst., 1992; data in HORIE, 1984, are insufficient).

In 1915, the first turbellarian species from Lake Biwa-ko was collected by Dr. T. N. ANNANDALE (Indian Museum of Calcutta), who visited the Ôtsu Hydrobiological Station, and Prof. T. KAWAMURA of Kyôto Imperial University (cf. ANNANDALE, 1922). Their dredged sample of a deep-lake-dwelling planarian was described by IJIMA & KABURAKI (1916) under the name of *Bdellocephala annandalei*; this new species was redescribed by KABURAKI (1922). *Bd. annandalei* is known as a large, endemic triclad inhabiting in Lake Biwa-ko (cf. KAWAKATSU, 1991, p. 390; see also HARADA, 1984).

The distribution of *Bdellocephala annandalei* was reported by KAWAKATSU (1964) and KAWAKATSU, ÔGAWARA & TARUI (1967). From the comparison of the population density of benthonic planarians, *Bd. annandalei* in Lake Biwa-ko, Japan, and *Phagocata tahoena* KAWAKATSU, 1968 (olim *Phagocata nivea tahoena*), and *Dendrocoelopsis hymanae* KAWAKATSU, 1968, in Lake Tahoe in the Sierra Nevada Mountains in North America, KAWAKATSU (1965) considered that the food supply would be one of the main factors that control the density of lake-dwelling planarians (see also KAWAKATSU, 1967, p. 161). GOSE (1966) reported on the food-cycle of this benthonic species; he demonstrated from his microscopic examinations of squashed live specimens of *Bd. annandalei* that the aquatic earthworm (*Tubifex* sp.) inhabiting at the muddy bottom of the Lake seemed to be the main food of planarians.

Lake Yogo-ko (alt. 134 m, 1.6-km² area, maximum depth 14.5 m) is a small lake. It is located close by the northernmost part of Lake Biwa-ko. The Yogo River fed by Lake Yogo-ko runs into Lake Biwa-ko. *Bdellocephala annandalei* was not found in Lake Yogo-ko (cf. MURAYAMA, TAKAHASHI & KAWAKATSU, 1974).

TESHIROGI, YAGIHASHI & ISHIDA (1982) reported on the distribution, the cytological observation and the regeneration ability of *Bdellocephala annandalei*. According to them, the chromosome numbers of this species are $n=14$ and $2n=28$; the karyotype consists of 5 pairs of metacentric chromosomes (of which the first pair is very large), 7 pairs of submetacentric chromosomes, and 2 pairs of subtelocentric chromosomes (cf. TESIROGI, YAGIHASHI & ISHIDA, 1982, pp. 46-47, fig. 10A). In their Japanese paper cited here, they emphasized the occurrence of another benthonic species, *Bdello-*

cephala sp., of a small size in sexually mature condition having a slightly rounded type of a head. Although they considered that it was a new species, the taxonomic position of their animals is not yet determined (KAWAKATSU, Ms.).

NISHINO (1993 a, b) and NISHINO & HARADA (1993) studied an annual change of the population density of some benthonic animals of Lake Biwa-ko during the last 15 years or more (1978-1992). It has become clear from the result of 1991-1992 survey that *Bdellocephala annandalei* is now very rare especially in the northern deep area of the Lake (Pl. III). They (*op. cit.*) emphasized that this endemic triclad species was now on the extinction due to an uncertain change of some environmental factors in the deep layer of the Lake.

Among the animals of triclad turbellarians, KAWAKATSU (1966, p. 57, figs. 11-12) reported a non-described species from the deep bottom off the Tsuzurao-zaki Cape in the northern part of Lake Biwa-ko: *Dendrocoelopsis?* sp. of Lake Biwa-ko (see also KAWAKATSU, 1978; KAWAKATSU, ÔGAWARA & TARUI, 1967). This undescribed, pale brown colored species with 2 eyes is 25 mm in length and 4 mm in width and without an adhesive organ or sucker at the antero-ventral portion of the head (slides of 2 samples collected were lost).

In many lakes in Japan, occurrence of triclads is usually rare at the shore of lakes located in plains and lowland areas. TSUDA (1945) reported a small population of a common dugesiid species from a shallow sand-and-stone beach of the southwestern part of Lake Biwa-ko; the species is undoubtedly *Dugesia japonica* ICHIKAWA et KAWAKATSU, 1964 (cf. KAWAKATSU, ÔGAWARA & TARUI, 1967, p. 114, fig. 2). *D. japonica* is common in many stations of rivers, narrow streams and springs at the vicinity of the Lake. *Phagocata vivida* (IJIMA et KABURAKI, 1916) is also found in some cold-water stations in the Hira Mountains located at the western side of the Lake (cf. KAWAKATSU, ÔGAWARA & TARUI, 1967, p. 113, fig. 1).

Occurrence of the other group of turbellarian animals was first recorded by KAWAMURA (1918) under the name of *Caridinicola indica* (sic). This is an ectoparasitic temnocephalid species, *Scutariella indica* (ANNANDALE, 1912) (olim *Caridinicola indica*; nec *Paracaridinicola indica* (PLATE, 1914)), and is found from a branchial chamber of a freshwater shrimp, *Paratya compressa compressa* (DE HANN) (olim *Xiphocaridina compressa*) from Lake Biwa-ko. This temnocephalid species belongs in the genus *Scutariella* MRÁZEK, 1907, the subfamily Scutariellinae BAER, 1931, the family Scutariellidae ANNANDALE, 1912, the suborder Scutariellidata BAEA, 1953, the order Temnocephalida (cf. KAWAKATSU, NUNOMURA & SUZUKI, 1989). KOBAYASHI (1935) reported on the morphology, reproduction and ecology of *S. indica* from the Lake. HONJÔ (1937) published a detailed biological descriptions (including morphology and regeneration ability) of the same temnocephalid species from the Lake.

Since early 1970's, the quantitative study of microfossils remained in the core samples of Lake Biwa-ko has been carried out by several limnobiologists of the HORIE's team. KADOTA (1973) reported the fossil egg capsules, or cocoons, of Turbellaria in a 170-meter core taken from the bottom of Lake Biwa-ko (the numbers of cocoons detected from the core sample attained 3975). The further results of Dr. KADOTA's studies were published in 1974, 1975, 1976, 1984, 1987, and 1991. A photomicrograph of his turbellarian egg capsule is printed in his 1974 paper (p. 244, pl. III, top-right); it may be a broken cocoon because it shows a punch cup shape (see also KADOTA, 1991, p. 206, fig. 86). The identification of the species that laid fossil cocoons is impossible (cf. KAWAKATSU, 1973, p. 59).

The present publication is designed to secure the various informations on turbellarians from Lake Biwa-ko, most of which are related to *Bdellocephala annandalei*. Every literature is classified according to the alphabetical order of the authors' names. We have added the English titles to the Japanese papers which have none in any foreign language. Explanatory notes were given for some

literature. For the citation of original figures in each paper, the following abbreviations are employed: DB, dorsal view of the body; DH, dorsal view of the head; DVB, dorsal and ventral views of the body; DVH, dorsal and ventral views of the head; FCA, schematic figure of the copulatory apparatus; FGO, schematic figure of the genital organ; HI, histological figures; PCA, photographs of the copulatory apparatus.

Photographs and sketches of several turbellarian species of Lake Biwa-ko reproduced from previous papers (HONJÔ, 1937; IJIMA & KABURAKI, 1916; KABURAKI, 1922; KADOTA, 1973; KAWAKATSU, 1967; MURAYAMA & KAWAKATSU, 1973; OKUGAWA, 1930) are shown in Plates I and II (Figs. A-P). A distribution map of planarians in the Lake is shown in Plate III. A detailed taxonomic redescription of *Bdellocephala annandalei* will be published in near future (KAWAKATSU, Ms.).

A LIST OF PUBLICATIONS

- Annandale, N., 1922. The macroscopic fauna of Lake Biwa. Annot. Zool. Japon., 10: 127-153.
- Note. *Bdellocephala annandalei* (Turbellaria) and *Caridinicola* sp. (Temnocephaloidea): pp. 131, 150.
- The Asahi (Asahi-Shinbun), 1986. [The scene of the deepest area of Lake Biwa-ko caught by the Asahi TV Camera: The endemic planarian, *Bdellocephala annandalei*, is common at the depth of 104 meters off the mouth of the Adogawa River, the west-side of the lake]. The Asahi, Ôsaka Ed., April 18, 1986 (Tuesday). (Jap.) 朝日新聞. とらえた琵琶湖最深部 ロボット探査104メートル エビも住む. 大阪本社版, 昭和61年4月8日(火曜日)の記事.
- Note. *Bdellocephala annandalei*: The photograph shows several live specimens found on the surface of a round stone located at the deepest point of the Lake.
- Fujitsuna, T., 1915. [Biogeographical notes of organisms in Lake Biwa-ko, No. 22. Leechs, planarians, etc.]. Saiensu, Kyôto, 5 (11): 467-471. Published by Shimazu Co., Kyôto. (Jap.) 藤網藤太郎. 琵琶湖上の生物地理 (22). 第7章 琵琶湖産蠕形動物其他. 1. 琵琶湖に見らるゝ蛭類. サイエンス, 5巻, 11号, 467-471頁. 島津製作所, 京都.
- Note. Freshwater planaria (*Planaria*) collected from the lake shore is listed (p. 471). The species may be *Dugesia japonica*.
- Gose, K., 1966. Food habit of *Bdellocephala annandalei* of Lake Biwa. Jap. Jour. Ecol., 16: 76-79. (Jap.) 御勢久右衛門. 琵琶湖産 *Bdellocephala annandalei* の食性について. 日本生態学会誌, 16巻, 76-79頁.
- Note. No English summary is given in this paper. According to Dr. Gose, *Tubifex* species seems to main food of *Bdellocephala annandalei*. Cf. Kawakatsu (1967, p. 161).
- Harada, E., 1984. Benthos. In: Horie, S. (ed.), Lake Biwa, pp. 323-330. Dr. W. Junk Publishers, Dordrecht.
- Note. *Dugesia japonica* and *Bdellocephala annandalei*: These two species are listed in the group of Platyhelminthes-Turbellaria-Tricladida.
- Honjô, I., 1937. Physiological studies on the neuromuscular systems of lower worms. I. *Caridinicola indica*. Mem. Coll. Sci., Kyôto Imp. Univ., B, XII, (2): 187-210+pl. XIII.
- Note. The material was collected from Lake Biwa-ko. A detailed morphology of this species is given in the present paper (see pl. I, fig. (DB, HI)).
- Horie, S. (ed.), 1972. Paleolimnology of Lake Biwa and the Japanese Pleistocene. First Ed. Contribution on the "Paleolimnology of Lake Biwa and the Japanese Pleistocene", (7): 1-93.
- Note. This publication was a distribution material for the participants of the International Congress of Limnology. It includes short data about the fossil turbellarians (p. 79, table 1; p. 83, fig. 6, 1-3; p. 85, fig. 13).
- Horie, S. (et al.), 1972. [Paleolimnological survey of Lake Biwa-ko]. Abstracts of papers given at the 37th Ann. Meet. of the Jap. Soc. of Limnology held in Sapporo. on Sept. 15-17, 1972, pp. 26-29. (Jap.) 堀江正治 (他). 過去70万年間の琵琶湖の古陸水. 日本陸水学会第37回大会(札幌, 昭和47年9月15-17日) プログラム・講演要旨, シンポジウムIII, 26-29頁.
- Note. Dr. S. Kadota, a member of this team, showed several photographs of the fossil cocoons of turbellarians obtained from the bottom-core samples of Lake Biwa-ko.
- Hyman, L. H., 1953. North American Triclad Turbellaria. 14. A new, probably exotic, dendrocoelid. Amer. Mus. Novitates, (1629): 1-6.
- Note. *Bdellocephala annandalei*: p. 5.
- Ichikawa, A. & Kawakatsu, M., 1961. [Experimental technique for planarian students]. Hokkaidô-Daigaku Rigakubu Kagakukyôiku Kenkyûshitsu Shiryô, I: 1-19+pls. I-IV. Sapporo. (Jap.) 市川純彦・川勝正治. プラナリアの実験・観察. 北海道大学理学部科学教育研究室資料, 1,

1-19頁+図版1-IV.

Note. *Bdellocephala annandalei*: p. 4.

Iijima, I. & Kaburaki, T., 1916. Preliminary descriptions of some Japanese triclads. Annot. Zool. Japon., 9: 153-171.

Note. *Bdellocephala annandalei* n. sp.: pp. 157-159, figs. 6-8 (DB, HI, FCA). Original description.

Imajima, M., Okutani, T., Shigei, M. & Takeda, M., 1983. [Planarians]. In: Kanai, Y. (ed.), Orbis—Gakushū Kagaku-zukan, Kai・Mizu-no-Dōbutsu, p. 136. Gakushū-kenkyūsha, Tōkyō. (Jap.) 今島 實・奥谷喬司・重井陸夫・武田正倫. プラナリアのなかま 扁形動物. 金井康彦編, オルビス学習図鑑 貝・水の動物, 136頁. 学習研究社, 東京.

Note. *Bdellocephala annandalei*: p. 136, fig. 5 (DB); the head shape of sketches in color is not correct).

Kaburaki, T., 1917. [A key to the Japanese Tricladida Maricola and Tricladida Paludicola]. Zool. Mag., Tōkyō. 29 (344): 164-166. (Jap.) 鍋木外岐雄. 日本海産及淡水産三岐類の検索表. 動物学雑誌, 29巻 (344号), 164-166頁.

Note. *Bdellocephala annandalei*: p. 165.

Kaburaki, T., 1922. On some Japanese freshwater triclads; with a note on the parallelism in their distribution in Europe and Japan. Jour. Coll. Sci., Imp. Univ. Tōkyō, 44, Art. 2: 1-71+pl. I.

Note. *Bdellocephala annandalei*: pp. 2, 3-8, figs. 1-2 (HI, FCA), 71, pl. I, fig. 1 (DB in color).

Kadota, S., 1973. A quantitative study of microfossils in the core sample from Lake Biwa-ko. Jap. Jour. Limnol., 34: 103-109 (+pl. I). (Jap. with Eng. summ.) 門田定美. びわ湖底堆積物の古生物学的研究. II. 微化石分析学的報告. 陸水学雑誌. 34巻, 103-109頁 (+図版1).

Note. The fossil cocoons of turbellarians were reported.

Kadota, S., 1974. A quantitative study of microfossils in a 200-meter core sample from Lake Biwa. In: Horie, S. (ed.), Paleolimnology of Lake Biwa and the Japanese Pleistocene. Second Issue. Contribution on the "Paleolimnology of Lake Biwa and the Japanese Pleistocene", (43): 236-245 (+pls. I-III).

Note. A photomicrograph of his turbellarian egg capsule is shown in pl. III (top-right).

Kadota, S., 1975. A quantitative study of the microfossils in a 200-meter-long core sample from Lake Biwa. In: Horie, S. (ed.), Paleolimnology of Lake Biwa and the Japanese Pleistocene. Vol. 3. Contribution on the "Paleolimnology of Lake Biwa and the Japanese Pleistocene", (85): 354-367.

Kadota, S., 1976. A quantitative study of the mi-

crofossils in a 200-meter-long core sample from Lake Biwa. In: Horie, S. (ed.), Paleolimnology of Lake Biwa and the Japanese Pleistocene. Vol. 4. Contribution on the "Paleolimnology of Lake Biwa and the Japanese Pleistocene", (155): 297-307 (+pl. I).

Kadota, S., 1984. Animal microfossils. In: Horie, S. (ed.), Lake Biwa, pp. 545-555. Dr. W. Junk Publishers, Dordrecht.

Note. Fossil egg caspules of Turbellaria are described in page 547.

Kadota, S., 1987. Microfossil organisms identified from Lake Biwa sediments. In: Horie, S. (ed.), History of Lake Biwa—Its transition as discovered in an extremely long core of 1,400 m obtained in Lake Biwa—, pp. 217-223 (+pl.). Institute of Paleolimnology and Paleoenvironment on Lake Biwa, Kyōto University. Kyōto.

Note. Fossil egg capsules of Turbellaria are described in pages 220-221; see also pl. fig. 11 in page 219.

Kadota, S., 1991. Die Bestimmung von Mikrofossilien aus den Biwa-See-Sedimenten. In: Horie, S. (ed.), Die Geschichte des Biwa-Sees in Japan. 203-210 (+figs. 82-88). Universitätsverlag Wagner, Innsbruck.

Note. Fossil egg capsules of Turbellaria are described in pages 208-209; a photomicrograph of a cocoon and its outline are shown in fig. 86, p. 206 (Turbellaria, Kokonschale).

Kawakatsu, M., 1962. The collecting methods of planarians from lakes and subterranean waters. Seibutsukyōzai no Kaitaku (Shirikishinai Marine Station for Biological Instruction), (2): 12-14. (Jap.) 川勝正治. 湖沼と地下水のプラナリアの採集. 生物教材の開拓, 2号, 12-14頁.

Note. *Bdellocephala annandalei*: p. 14.

Kawakatsu, M., 1964. [Notes on the freshwater planaria of Lake Biwa-ko]. The Heredity (Iden), Tōkyō, 18 (9): 32-35. (Jap.) 川勝正治. 琵琶湖のプラナリアの記. 遺伝, 18巻, 9号, 32-35頁.

Note. *Bdellocephala annandalei*: pp. 32-35, figs. 1 (distribution), 2 A-D (photographs of preserved specimens), 3 (DB), 4-5 (collecting method).

Kawakatsu, M., 1965. 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. Jour. Limnol., 26: 106-112. (Jap. with Eng. summ.) 川勝正治. Tahoe湖 (シエラ・ネバダ山脈) と琵琶湖のプラナリア類の生態に関する若干の知見. 陸水学雑誌, 26巻, 106-112頁.

Note. *Bdellocephala annandalei* and *Dendrocoelopsis*? sp. of Lake Biwa-ko: pp. 109, 112.

Kawakatsu, M., 1965. On the ecology and distribution of freshwater planarians in the Japanese Islands, with special reference to their vertical distribution. *Hydrobiologia*, 26: 349-408.

Note. *Bdellocephala annandalei*: pp. 350, 396.

Kawakatsu, M., 1966. [Japanese freshwater planarians]. The Heredity (Iken), Tōkyō, 20 (4): 54-57. (Jap.) 川勝正治. 日本のプラナリア. 遺伝, 20巻, 4号, 54-57頁.

Note. *Bdellocephala annandalei* and *Dendrocoelopsis*? sp. of Lake Biwa-ko: pp. 55-57, tables 1-3 (taxonomic key), figs. 11 (DB) and 12 (DH, photograph of a live specimen).

Kawakatsu, M., 1966. Synopsis of the known species of freshwater planarians of Japan. *Bull. Biogeogr. Soc. Japan*, 24: 9-28. (Jap.) 川勝正治. 日本産淡水棲三岐腸類既知種の総覧. 日本生物地理学会会報, 24巻, 9-28頁.

Note. *Bdellocephala annandalei*: p. 21.

Kawakatsu, M., 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 College*, (5): 117-177.

Note. *Bdellocephala annandalei*: pp. 119, 159, 161, Note 7. For *Dendrocoelopsis*? sp. of Lake Biwa-ko: p. 159.

Kawakatsu, M., 1968. North American Triclad Turbellaria, 17: Freshwater Planarians from Lake Tahoe. *Proc. U. S. Nat. Mus.*, 124 (3638): 1-21+pls. I-II.

Note. *Bdellocephala annandalei*: p. 16.

Kawakatsu, M., 1968. [Photographs of the preserved specimens of *Bdellocephala annandalei* (Ijima et Kaburaki)]. *Collect. & Breed.*, Tōkyō, 30: 33 (cover photograph of the February issue), 37 (explanation of the cover photograph). (Jap.) 川勝正治. ピワオオウズムシ(固定標本) 世界最大の淡水プラナリアとして知られている. 採集と飼育, 30巻, 33頁, (表紙), 37頁 (説明).

Note. *Bdellocephala annandalei*: Cover photograph (DVB, a monochrome photograph of many preserved specimens).

Kawakatsu, M., 1968. Illustrated list of Japanese freshwater planarians. *Collect. & Breed.*, Tōkyō, 30: 40-45. (Jap.) 川勝正治. 日本の淡水産プラナリア図説. 採集と飼育, 30巻, 40-45頁.

Note. *Bdellocephala annandalei*: pp. 41-43, plate, fig. 16 (DB).

Kawakatsu, M., 1969. An illustrated list of Japanese freshwater planarians in color. *Bull. Fuji Women's College*, (6), II: 45-91 (+pls. VII-VIII in color).

Note. *Bdellocephala annandalei*: pp. 80-81, fig. 17-a and b (maps showing the geographical distribution); p. 91, pl. VIII, fig. 16 (DB in color).

Kawakatsu, M., 1971. Ōzumushi (*Bdellocephala*). In: *Grand Gendai Encyclopedia*, 3: 509. Gakushū-Kenkyūsha Co., Tōkyō. (Jap.) 川勝正治. おおうずむし. グランド現代百科事典, 3巻, 509頁. 学習研究社, 東京. 改訂版 (1983) で, この項目は部分訂正した.

Note. *Bdellocephala annandalei*: p. 509. In the Revised Edition (1983), this item was rewritten (vol. 5, p. 121).

Kawakatsu, M., 1971. A list of publications on Japanese turbellarians (1970)---Including titles of publications on foreign turbellarians written by the Japanese authors ---. *Bull. Fuji Women's College*, (9), II: 29-40+1 folder (table 2). (Both in Eng. & Jap.) 川勝正治. 日本産渦虫類文献目録 (1970) —外国産渦虫類に関する邦人著作を含む—. 藤女子大学・藤女子短期大学紀要, 9号, II部, 29-40頁+折込み1葉.

Note. *Bdellocephala annandalei*: Table 2 (List of triclads (Turbellaria) described and listed in the four books of the *Encyclopedia of the Fauna of Japan*).

Kawakatsu, M., 1972. Tricladida. In: Uchida, T. (ed.), *Yatsu & Uchida, Dōbutsu-bunruimei Jiten (Classification Tables of Animals)*, pp. 161-166. Nakayama-shoten, Tōkyō. (Jap.) 川勝正治. 三岐腸類. 内田 亨 編, 谷津・内田 動物分類名辞典, 161-166頁. 中山書店, 東京. 本書第2版は1988年出版.

Note. *Bdellocephala annandalei*: p. 164. The Second Edition of this book was published in 1988.

Kawakatsu, M., 1973. [Taxonomy and ecology of planarians, 1-4]. *The Nature & Animals*, Tōkyō, 3 (5): Plate figure in the prefatorial page+9-16; (6): 11-16; (7): 8-11; (8): 7-13. (Jap.) 川勝正治. プラナリアの分類と生態 (1)-(4). 動物と自然, 3巻, 5頁, 巻頭頁+9-16頁, 同6号, 11-16頁, 同7号, 8-11頁, 同8号, 7-13頁.

Note. *Bdellocephala annandalei*: Prefatorial page, fig. 16 (DB), 1, pp. 14-16; 2, pp. 11-13, table 3 (taxonomic key).

Kawakatsu, M., 1973. Biwa-ōzumushi (*Bdellocephala annandalei*). In: *Grand Gendai Encyclopedia*, 17: 101-102 (+figure). Gakushū-Kenkyūsha, Tōkyō. (Jap.) 川勝正治. びわおおうずむし. グランド現代百科事典, 17巻, 101-102頁 (+原色図). 学習研究社, 東京.

Note. *Bdellocephala annandalei*: pp. 101-102, fig. (DB in color).

Kawakatsu, M., 1973. [Planarians]. In: *Grand Gendai Encyclopedia*, 17: 404 (+figures). Gakushū-Kenkyūsha Co., Tōkyō. (Jap.) 川勝正治. プラナリア. グランド現代百科事典, 17巻, 404頁 (+原色図, 4種類). 学習研究社, 東京. 改訂版 (1983) で, この項目は部分訂正した.

Note. *Bdellocephala annandalei*: p. 404, fig. (top-left; color photograph of a live specimen). In the Revised Edition (1983), this item was partly rewritten (vol. 25, pp.

416-417).

Kawakatsu, M., 1973. A list of publications on Japanese turbellarians (1972)---Including titles of publications on foreign turbellarians written by the Japanese authors ---. Bull. Fuji Women's College, (11), II: 57-65. (Both in Eng. & Jap.) 川勝正治. 日本産渦虫類文献目録(1972)---外国産渦虫類に関する邦人著作を含む---. 藤女子大学・藤女子短期大学紀要, 11号, 第II部, 57-65頁.

Note. Kawakatsu's opinion about the fossil cocoons of Turbellaria from Lake Biwa-ko (observed by Dr. Kadota) is described on page 59.

Kawakatsu, M., 1974. Further studies on the vertical distribution of freshwater planarians in the Japanese Islands. In: Riser, N. W. & M. P. Morse (eds.), Libbie H. Hyman Memorial Volume---Biology of the Turbellaria, pp. 291-338. McGraw-Hill Book Co., Nw York, etc.

Note. *Bdellocephala annandalei*: pp. 293-295, 311, table 3. For *Dendrocoelopsis?* sp. of Lake Biwa-ko: p. 295.

Kawakatsu, M., 1974. [Planarians]. Alpha Weekly Encyclopedia, (213): 5090. Nippon Mail Order Co., Tōkyō. (Jap.) 川勝正治. プラナリア. 週刊アルファ大辞書, 213号, 5090頁. 日本メールオーダー社, 東京.

Note. *Bdellocephala annandalei*: p. 5090, figs. 5 and 6 (DB, a sketch and photograph of a live specimen in color).

Kawakatsu, M., 1977. [Ecology and distribution of freshwater planarians]. The Heredity (Iden), Tōkyō, 31 (10): 13-24. (Jap.) 川勝正治. プラナリアーその生態と分布. 遺伝, 31巻, 10号, 13-24頁.

Note. *Bdellocephala annandalei*: pp. 15-16, table 2, fig. 1 (DB, photograph of a live specimen).

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Note. *Bdellocephala annandalei*: pp. 64-67, table 1.

Kawakatsu, M., 1978. [Planarians from lakes, I and 2]. The Nature & Animals, Tōkyō, 8 (2): 6-10; (3): 6-9. (Jap.) 川勝正治. 湖沼のプラナリア I・II. 動物と自然, 8巻, 2号, 6-10頁, 同3号, 6-9頁.

Note. *Bdellocephala annandalei* and *Dendrocoelopsis?* sp. of Lake Biwa-ko: The distribution map, II, p. 6, figs. 1 (distribution), 2 A-B (photographs of live specimens), p. 7, fig. 11 (food-cycle of *Bd. annandalei* modified from Gose, 1966).

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Note. *Dendrocoelopsis?* sp. of Lake Biwa-ko: p. 212.

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Note. *Bdellocephala annandalei*: p. 93.

Kawakatsu, M., Ōgawara, G. & Tarui, Y., 1967. Report on the ecological survey of freshwater planarians in Kyōto City and its adjacent district, Honshū. Jap. Jour. Ecol., 17: 112-118. (Jap. with Eng. summ.) 川勝正治・大河原玄沖・垂井由継. 京都市及びその近接地域の淡水産プラナリアの生態調査報告. 日本生態学会誌, 17巻, 112-118頁.

Note. *Dugesia japonica*, *Bdellocephala annandalei* and *Dendrocoelopsis?* sp. of Lake Biwa-ko: pp. 112-114, figs. 1 and 2 (distribution), p. 117, table 2 (the data of 8 stations in Lake Biwa-ko), p. 118. Geographical distribution of freshwater planarians in the adjacent district of Lake Biwa-ko is shown in fig. 1 (on p. 113).

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Note. *Bdellocephala annandalei*: p. 4.

Kawakatsu, M., Teshirogi, W., Sugino, H., Oki, I., Kishida, Y., Yamada, T., Asai, E., Tamura, S., Ōgawara, G., Murayama, H., Tanaka, I., Miyazaki, T., Horikoshi, I., Takahashi, N., Nimura, F., Katayama, M., Okafuji, G., Aoki, K. & Shimamura, M., 1978. [Collecting, breeding, observation and experiment of freshwater planarians]. Collect. & Breed., Tōkyō, 40: 39-54, 95-110 (= Live Teaching Materials Information Service, nos. 30: 427-442; 31: 443-458). (Jap.) 川勝正治・手代木 渉・杉野久雄・沖 岩四郎・岸田嘉一・山田達也・朝井悦夫・田村幸子・大河原玄沖・村山 均・田中一郎・宮崎武史・堀越 功・高橋信夫・新村文男・片山満秋・岡藤五郎・青木 舜・島村峯雄. プラナリアの採集・飼育・観察・実験. 採集と飼育, 40巻, 39-54頁, 95-110頁. (=教材生物ニュース, 30号, 427-442頁; 31号, 443-458頁).

Note. *Bdellocephala annandalei*: pp. 430-431 (taxonomic key).

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salier (Tricladida Paludicola). Zool. Anz., 89: 289-302.

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Kenk, R., 1974. Index of the genera and species of the freshwater triclad (Turbellaria) of the world. Smithsonian Contrib. Zool., (183): i-ii+1-90.

Note. *Bdellocephala annandalei*: p. 7.

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Livanov, N. A., 1962. Maloshetinkovye chervi i planarii Ozera Baikal. Ocherki planarii Baikala. Bdellocephalina i Rimacephalina. Akad. Nauk SSSR, Sibirskoe Otdelenie, Trudy Limnologicheskogo Instituta, I (XXI), (I): 152-188. Izdatel'stvo Akad. Nauk SSSR, Moskva, etc.

Note. *Bdellocephala annandalei*: p. 169.

Machida, M. & Kawakatsu, M., 1974. Platyhelminthes. The Asahi-Larousse, Weekly Encyclopedia of Animals in the World. Supplementary Volumes, The Japanese Animals, IV (Crustacea, Mollusca, Protozoa, etc.), p. 30. The Asahi-Shinbunsha, Tôkyô. (Jap.) 町田昌昭・川勝正治. 扁形動物門 (ピワオオウズムシ). 朝日=ラルース週刊世界動物百科, 増刊, 日本の動物 IV, 甲殻類・軟体・原生動物他, 30頁. 朝日新聞社, 東京.

Note. *Bdellocephala annandalei*: p. 30, fig. (top-right) (DB, a color photograph of a live specimen).

The Mainichi (Minichi-Shinbun), 1993. [*Bdellocephala annandalei*, a deep bottom inhabitant of Lake Biwa-ko, is now considered as an endangered species]. The Mainichi, Morning Ed., May 14, 1993 (Friday). (Jap.) 毎日新聞. 虫すめ琵琶湖 絶滅の危機「ピワオオウズムシ」 50万年生息の扁形動物 開発で湖底の酸素減少. 平成5年5月14日朝刊(金曜日).

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Miura, T., 1985. [Natural history of Lake Biwa-ko: Aquatic organisms]. Kokoku to Bunka, Ôtsu, (31): 39-42. (Jap.) 三浦泰蔵. びわ湖の博物誌 水生生物の消長. 第4回低温天国の湖族. 湖国と文化, 31号, 39-42頁.

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Murayama, H. & Kawakatsu, M., 1973. [Photographs

of living specimens of a Japanese giant planarian, *Bdellocephala annandalei* Ijima et Kaburaki]. Collect. & Breed., Tôkyô, 35: 163-165. (Jap.) 村山 均・川勝正治. ピワオオウズムシの生体写真. 採集と飼育, 35巻, 163-165頁.

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Murayama, H., Takahashi, N. & Kawakatsu, M., 1974. *Bdellocephala annandalei*, an endemic inhabitant of freshwater planarian of Lake Biwa-ko, did not occur in Lake Yogo-ko, Shiga Prefecture, Japan. Collect. & Breed., Tôkyô, 36: 164. (Jap.) 村山 均・高橋信夫・川勝正治. 余呉湖のプラナリア調査. 採集と飼育, 36巻, 164頁.

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Note. *Bdellocephala annandalei*: pp. 21, 23, fig. 17 (DB and cocoons in color).

Nishino, M., 1993. [Evolution of organisms in Lake Biwa: A consideration from the viewpoint of the benthic animals, I and II]. Ômia (Lake Biwa Research Institute News), (42): 3-5; (43): 3-5. (Jap.) 西野麻知子. 底生動物からみた琵琶湖の生物進化 I, II. オウミア (滋賀県琵琶湖研究所ニュース), 42号, 3-5頁; 43号, 3-5頁.

Note. *Bdellocephala annandalei*: p. 4, table 2 (42); pp. 3-4 (43).

Nishino, M., 1993. Platyhelminthes, Turbellaria, Dendrocoelidae: *Bdellocephala annandalei*. In: Nishino, M. (ed.), Handbooks of Zoobenthos in Lake Biwa, III. Poriifera, Platyhelminthes, Annelida, Tentaculata, and Crustacea. Pp. 1-3, 17, 58. Published by the Lake Biwa Research Institute, Ôtsu. (Jap.) 西野麻知子. 扁形動物門・ウズムシ (渦虫) 綱・デンドロシーラ科. ピワオオウズムシ (固有種). 西野麻知子 編, びわ湖の底生動物—水辺の生きものたち—. II. カイメン動物, 扁形動物, 環形動物, 触手動物, 甲殻類編, 1-3頁, 17頁, 58頁. 滋賀県琵琶湖研究所, 大津.

Note. *Bdellocephala annandalei*: pp. 1-3, fig. 1 (left, DB), 17, figs. (DB and a cocoon in color; a distribution map showing the data of 1978-1981 and 1991-1992 surveys).

Nishino, M. & Harada, H., 1993. [Changes of the macro-benthic fauna of Lake Biwa during the past 10 years]. Abstracts of lectures given at the 40th Ann. Meet. of the Ecol. Soc. of Japan held in Matsue, on April 1-4, 1993, p. 245. (Jap.) 西野麻知子・原田英司. 琵琶湖におけるマクロベントスの10年間の変化. 第40回日本生態学会大会 (松江, 平成5年4月1~4日) 講演要旨集, 245頁.

Note. *Bdellocephala annandalei*: The species becomes very rare especially in the northern deep area of

the Lake.

Okugawa, K., 1930. A list of fresh-water Rhabdocoelids found in Middle Japan, with preliminary descriptions of new species. Mem. Coll. Sci., Kyôto Imp. Univ., B, V: 75-88+pls. III-IV.

Note. The following microturbellarian species are recorded from Lake Biwa-ko. *Catenula lemnae* Dugès, 1832; *Stenostomum leucops* (Dugès, 1828); *Stenostomum unicolor* Schmidt, 1848; *Microstomum lineare* (Müller, 1774); *Macrostomum tuba* var. *gigas* Okugawa, 1930; *Macrostomum kawamurai* Okugawa, 1930; *Macrostomum japonicum* Okugawa, 1930; *Dalyellia biwae* Okugawa, 1930; *Strongylostoma radiatum* (Müller, 1774); *Rhynchomesostoma rostratum* (Müller, 1774); *Bothromesostoma personatum* (Schmidt, 1858); *Prorhynchus stagnalis* Schulze, 1851; *Plagiostomum lemni* (Plassis, 1874). See figures of pls. III and IV (DB, HI, FCA, etc.). *M. tuba* var. *gigas* is now classified as *Macrostomum gigas* Okugawa, 1930 (cf. Hyman, 1936, 1943; Marcus, 1946).

Okugawa, K. I., 1947. [Triclad and microturbellarians]. In: Uchida, S. (ed.), Illustrated Encyclopedia of the Fauna of Japan (Exclusive of Insects). Revised Edition, pp. 1486-1491, 1493-1495 (figs. 4187-4203, 4208-4213). Hokuryû-kan, Tôkyô. (Jap.) 奥川一之助. 扁形動物一渦虫綱 (三岐腸目, 他). 内田清之助 編, 改訂増補 日本動物図鑑, 1486-1491 頁, 1493-1495 頁. 北隆館, 東京.

Note. *Bdellocephala annandalei*: p. 1486, fig. 4187 (DB, DH). *Caridinicola indica* (sic) and several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also illustrated.

Okugawa, K. I., 1953. A monograph of Turbellaria (Acoela, Rhabdocoela, Alloecoela and Tricladida) of Japan and its adjacent regions. Bull. Kyôto Gakugei Univ., B, (3): 20-43.

Note. *Bdellocephala annandalei*: pp. 21, 40. Several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also listed in this paper.

Okugawa, K. I., 1960. [Triclad and microturbellarians]. In: Okada, Y.-K. & T. Uchida (eds.), Encyclopedia Zoologica Illustrated in Colours, IV: pl. 87. Hokuryû-kan, Tôkyô. (Jap.) 奥川一之助. 扁形動物一渦虫綱 (三岐腸目, 他). 岡田 要・内田 享 編, 原色動物大図鑑, IV 巻, 図版 87. 北隆館, 東京.

Note. *Bdellocephala annandalei*: pl. 87, fig. 10 (DB, DH in color). *Caridinicola indica* (sic) and several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also illustrated.

Okugawa, K. I., 1965. [Microturbellarians and triclad]. In: Uchida, T. (ed.), New Illustrated Encyclopedia of the Fauna of Japan, Part. I: 312-317, 319-322

(figs. 7-17, 20-21, 25, 32-46). Hokuryû-kan, Tôkyô. (Jap.) 奥川一之助. 扁形動物一渦虫綱 (三岐腸目, 他). 内田 享 編, 新日本動物図鑑, (上), 312-317 頁, 319-322 頁. 図鑑の北隆館, 東京.

Note. *Bdellocephala annandalei*: p. 321, fig. 41 (DB). *Caridinicola indica* (sic) and several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also illustrated.

Okugawa, K. I., 1970. [Platyhelminthes-Turbellaria]. In: Uchida, T. & S. Mawatari (eds.), Gendai-Seibutsugaku-Taikei, 1, Invertebrates A, pp. 91-124. Nakayama-shoten, Tôkyô. (Jap.) 奥川一之助. 扁形動物. 内田 享・馬渡静夫 編, 現代生物学大系 1, 無脊椎動物 A, 91-124 頁. 中山書店, 東京.

Note. *Bdellocephala annandalei*: pp. 102, fig. 73 i and j (DB, photographs of live specimen), 108, fig. 78 D (DB). Several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also described.

Okugawa, K. I., 1973. Platyhelminthes-Turbellaria. In: Uéno, M. (ed.), The late Tamiji Kawamura's Fresh-water Biology of Japan / Enlarged and Revised Edition, pp. 207-249. Hokuryû-kan Publ. Co., Ltd., Tôkyô. (Jap.) 奥川一之助. 扁形動物一渦虫類. 上野益三 編. 川村多賀二 原著, 日本淡水生物学, 207-249 頁. 図鑑の北隆館, 東京.

Note. *Bdellocephala annandalei*: pp. 229-230, fig. B (DB). Several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also described. For corrections of the section written by Okugawa of the book, see Kawakatsu (1973, pp. 63-65).

Sabussowa, Z. (= Zabusova, Z.), 1929. Die Turbellarien der Kamtschka-Halbinsel nach den Sammlungen der Rjabuschinsky-Expedition 1908-1909. Zool. Jahrb. Syst., 57: 497-536+pl. IV.

Note. *Bdellocephala annandalei*: p. 526.

Teshirogi, W. & Ishida, S., 1987. Biology of Planarians—Foundation, Application & Experiment—. Pp. i-viii+1-190. Kyôritsu-Shuppan Co., Tôkyô. (Jap.) 手代木 涉・石田幸子. プラナリアの生物学—基礎と応用と実験—, i-viii+1-190 頁. 共立出版株式会社, 東京.

Note. *Bdellocephala annandalei*: p. 11, fig. 2·1 (distribution), p. 16, table 2·2, pp. 21-22, fig. 2·10, ①-② (photographs of live specimens, DVB); ③ and ④, another *Bdellocephala* sp.? from Lake Biwa-ko, p. 27, table 2·4 (chromosome nos., n=14 and 2n=28, p. 173, appendix-fig. 31, I (idiogram).

Teshirogi, W., Yagihashi, M. & Ishida, S., 1982. Notes on the two freshwater planarians, *Bdellocephala annandalei* and *Bdellocephala* sp. from Lake Biwa-ko. Collect. & Breed., Tôkyô, 44: 43-47. (Jap.) 手代木 涉・八木橋元一・石田幸子. 琵琶湖のプラナリア—ピワオウズムシとオ

オウズムシ属の1新種。採集と飼育, 44巻, 43-47頁。

Note. *Bdellocephala annandalei* (and *Bdellocephala* sp.): pp. 43-47, figs. 1-10 (DVB, photographs of live specimens, distribution map, DH, photographs of cocoons, HI of the adhesive organ, head-and-tail frequency curves, regenerated worms, idiograms, etc.).

Tomoda, Y., 1984. Fauna and flora of the Lake Biwa—An approach to the recent geohistory of the Lake Biwa—. Bull. Japan Sea Res. Inst., Kanazawa Univ., (16): 59-91 (+pls. I-VI). (Jap. with Eng. summ.) 友田淑郎, 琵琶湖の生物相—湖の最近の地史へのアプローチ—. 金沢大学日本海域研究所報告, 16号, 59-91頁(+図版 I-VI).

Note. *Bdellocephala annandalei*: pp. 66, 88, pl. III, fig. 7 (DB).

Tomoda, T., 1989. [*Bdellocephala annandalei* of Lake Biwa-ko]. In: Tomoda, T., "Biwa-ko no Ima to Mukashi", p. 63, fig. 2·15 (3). Aoki Shoten, Tōkyō. (Jap.) 友田淑郎, ビワオウズムシ. 友田淑郎 (著), 琵琶湖のいまとむかし (地球の歴史をさぐる⑦), 2章, 5節, 深みにすむ生きもの, 63頁, 図2-15の3. 青木書店, 東京.

Note. *Bdellocephala annandalei*: p. 63, fig. 2·15 (3) (DB).

Tu, T.-J., 1940. Geschichtlicher Überblick über das Studium der Turbellarien in Ostasien und Stand unserer Kenntnisse von Diesen. Zool. Jahrb. Syst., 73: 201-260.

Note. *Bdellocephala annandalei*: p. 217. Several microturbellarian species reported from Lake Biwa-ko (cf. Okugawa, 1930) are also listed.

Tsuda, M., 1945. [Studies on the benthic animal communities of the lake shore of the Chōmeiji-Matsugasaki district in Lake Biwa-ko, with special reference to the aquatic production]. Kyōto Teikoku-Daigaku Rigakubu Dōbutsugaku-kyōshiitsu, Ōtsu Rinko-jikkensho Seiriseitaigaku Kenkyūgyōseki, (24): 1-9+1 folder. (Jap.) 津田松苗, 琵琶湖長命寺松ヶ崎湖岸の底棲動物群衆並にその水産上の意義 (琵琶湖沿岸帯生物群衆の研究5). 京都帝国大学動物学教室・大津臨湖実験所 生理生態学業績, 24号: 1-9頁+折込み1葉.

Note. *Dugesia japonica* (olim *Dugesia gonocephala*): p. 5, folder.

Uéno, M., 1984. Biogeography of Lake Biwa. In: Horie, S. (ed.), Lake Biwa, pp. 625-633. Dr. W. Junk Publishers, Dordrecht.

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EXPLANATION OF PLATES I-III

Plates I and II

- A-F: *Bdellocephala annandalei* IJIMA et KABURAKI, 1916. A, live specimen (photo by Mr. H. MURAYAMA); B, preserved specimen; C, woodcut figure (after IJIMA & KABURAKI, 1916); D, color painting (after KABURAKI, 1922); E, sucker (after IJIMA & KABURAKI, 1916; a part of the original figure is damaged); F, sucker (after KABURAKI, 1922).
- G and H: *Dendrocoelopsis?* sp. of Lake Biwa-ko (after KAWAKATSU, 1967). G, sketch of a live specimen; H, enlarged photograph of the head of a live specimen.
- I and J: Schematic figures of the copulatory apparatus of *Bd. annandaled.* I, after IJIMA & KABURAKI (1916); J, after KABURAKI (1922). Abbreviations of new terms were used. bc, bulbar cavity; bs, bursal stalk; cb, copulatory bursa; cod, common ovovitelline duct; gp, genital pore; ma, male genital antrum; od, ovovitelline duct; p, penis; sd, sperm duct.
- K-O: Several microturbellarians from Lake Biwa-ko (after OKUGAWA, 1930). K and L, *Macrostomum gigas* OKUGAWA, 1930; M, *Macrostomum kawamurai* OKUGAWA, 1930; N, *Macrostomum japonicum* OKUGAWA, 1930; O, *Plagiostomum lemani* (PLASSIS, 1874). Abbreviations were changed. br, brain; ch, chitinous penis; e, eye; o, ovary; ph, pharynx; t, testis.
- P: *Scutariella indica* (ANNANDALE, 1912) (after HONJÔ, 1937). Terms in the original figure are shown by abbreviations. an, anterior nerve; br, brain; e, eye; ec, excretory canal; ep, excretory pore; go, genital opening; i, intestine; ln, lateral nerve; m, mouth; o, ovary; ov, oviduct; pe, penis; ph, pharynx; su, sucker; t, testis; te, tentacle; to, terminal organ; vd, vas deferens; vg, vitelline gland; vn, ventral nerve; vs, vesicula seminalis.
- Q: The fossil egg capsule of Turbellaria (the pencil sketch reproduced from the photomicrograph of KADOTA's 1973 paper, pl. II).

Plate III

A map of Lake Biwa-ko, showing the distribution record of planarians (modified from KAWAKATSU, 1964; KAWAKATSU, ÔGAWARA & TARUI, 1967; TESHIROGI, YAGIHASHI & ISHIDA, 1982—exclusive of the records of *Bdellocephala* sp.—; NISHINO, 1993 a). Arrow indicates the stations where *Bdellocephala annandalei* were collected in the 1991-1992 survey (based upon the map by NISHINO, 1993 a, p. 17, fig. 16). 1, Chikubu-jima Island; 2, Takei-jima Island; 3, Shiraiishi-jima Island; 4, Oki-no-shima Island.

Plate IV

The Landsat image of Lake Biwa-ko and the vicinities (photos by the Landsat, NASA).

Plate V

- Top: The northwestern part of Lake Biwa-ko and the snow-covered Hira Mountains (photo by Dr. H. FUSHIMI). An artificial structure of the left-bottom corner is an "Eri" (fixed-net traps; a special fishing method commonly used around the Lake).
- Bottom: The northwestern part of Lake Biwa-ko (a town of the Kosei area) and the Hira Mountains (photo by Dr. H. FUSHIMI).

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