

**Two North American Freshwater Planarian Species Now Naturalized in Japan:
Girardia tigrina (Girard, 1850) and *Girardia dorocephala* (Woodworth, 1897)
---In Connection with the Field Survey of Benthic Invertebrates---**

By

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INTRODUCTION

Kawakatsu, Nishino & Ohtaka (2007) reviewed the occurrence records of exotic planarians in Japan (7 species in total of freshwater and land planarians and a single temnocephalid species). Among them, two North American dugesiid species, *Girardia tigrina* (Girard, 1850) and *Girardia dorocephala* (Woodworth, 1897), were found at first in aquaria and/or culture ponds for tropical fish cultures (cf. Hirao, Kawakatsu & Teshirogi, 1970; Kawakatsu & Hirai, 1986; Kawakatsu, Oki, Tamura & Yamayoshi, 1985; Tamura, Oki, Kawakatsu, Ninagawa, Matsumoto & Suzuki, 1985; [Masuda], 2004).

The naturalized populations of *G. tigrina* in Japan was first recorded in the Urakami-gawa River, Nagasaki City in Kyûshû (cf. Kawakatsu, Tamura, Takai, Yamamoto, Ueno & Oki, 1993). Then, additional naturalized populations of *G. tigrina* were found in the following areas in central Japan, Honshû: Lake Biwa-ko in Shiga prefecture, Kinki Region (cf. Nishino, Ohtaka & Kawakatsu, 2002); streams of the Tone-gawa River system in Chiba Prefecture, Kantô Region (cf. Chinone, Yamamoto & Kawakatsu, 2008).

It must be emphasized that *G. tigrina* from Japan is a result of tentative identification based upon the external morphology of asexual specimens and the result of their karyological data because sexually mature specimens have not been found. For detailed karyological data of Japanese samples and taxonomic discussion of *G. tigrina*, see the following articles: Chinone, Yamamoto & Kawakatsu (2008); Kawakatsu, Nishino, Ohtaka & Yamamoto (2011); Kawakatsu, Oki, Tamura & Yamayoshi (1985); Kawakatsu, Oki, Tamura, Yamayoshi, Hauser & Friedrich (1981); Kawakatsu, Tamura, Takai, Yamamoto, Ueno & Oki (1993); Kawakatsu, Tsuruda, Kimura, Chinone, Murayama & Yamamoto (2008); Nishino & Kawakatsu (2012); Tamura, Oki, Kawakatsu, Ninagawa, Matsusato & Suzuki (1985). (See also Hashimoto, Terao, Yoshii & Yamaguchi, 2007; Tanaka, 2008; Yamamoto, 1994.)

In the late autumn of 2003, many specimens of a brown-colored planarian with two eyes and a pair of slender auricles were found in aquaria for tropical fish cultures of the Hekinan Seaside Aquarium, Hekinan City, Aichi Prefecture, Chûbu Region in Honshû. The collector of those planarians who received the advice of Kawakatsu confirmed the presence of a pigmented pharynx in his samples. Namely, an exotic planarian species from the Hekinan City was supposed as *Girardia dorocephala* (Woodworth, 1897) (cf.

[Masuda], 2004). The results of the chromosomal analysis of the Hekinan samples also supposed that the above-mentioned tentative identification seems to be correct (cf. Kawakatsu, Nishino, Ohtaka & Yamamoto, 2011).

In December 2007, Kawakatsu received live and preserved samples of a long-auricled planarian species collected from the Asa-kawa River, a tributary of the Tamagawa River in Hino City, Tōkyō-To, Kantō Region in Honshū. The collector also supplied fine color photographs of the planarians in life. Kawakatsu also received additional planarian samples collected from the Sagami-gawa River in Sagami-hara City, Kanagawa Prefecture, Kantō Region. The karyological analysis of the Sagami-hara specimens was succeeded. Namely, the above-mentioned planarian species was identified tentatively as *G. dorocephala*. The results of these preliminary studies were published by Kawakatsu, Tsuruda, Kimura, Chinone, Murayama & Yamamoto (2008 in Japanese). (See also its reproduction with English abstract and explanation of figures opened in Kawakatsu's Original Site in 2008.)

The copulatory apparatus of the Sagami-gawa samples was studied by Dr. Sluys and identified as *Girardia dorocephala* (Woodworth, 1897) (cf. Sluys, Kawakatsu & Yamamoto, 2010, fig. 9 on p. 106). Karyological data and general discussion of this North American species were given in that article cited above (see also 11th ISFB 2009 in Kawakatsu's Original Site). Occurrence records in Japan of *G. tigrina* and *G. dorocephala* until the end of the year 2008 and their zoogeographical information were also given in that paper (op. cit., see fig. 1 on p. 104).

During the past several years, occurrence records in Japan of *Girardia tigrina* and *Girardia dorocephala* were found in some governmental and prefectural publications. Moreover, we can find many web articles on this topic. That information can be classified into three main groups as follows: i) Reliable distribution data of aquatic invertebrates including occurrence records of planarians (i.e. official reports of benthos in various river systems investigated by specialists), ii) occurrence records of *Girardia* species published in local journals and magazines by some researchers of aquatic invertebrates, and iii) mainly web information by amateurs such as students and citizens belonging to some local biology clubs as usual. It must be emphasized that some unconfirmed distribution data on Japanese and exotic planarian species can be found in the previous information --- especially in reports of the Group (iii) mentioned above.

The purpose of the present web article is firstly to show the correct distribution records of *Girardia tigrina* and *Girardia dorocephala* on the sketch maps of Japan (with some necessary taxonomic comments given in the text). Secondly, the basic explanations for the study of planarian distribution in Japan will be given. Since this part may have a utility for Japanese persons studying benthic invertebrates in rivers, its synopsis and explanations of figures and photographs used will be given in Japanese at the end of this web article.

Notice for the References Cited.

REFERENCES attached at the end of this web article contain usual articles cited. Web articles opened in the following Home Page and the Data Base are listed here

(Kawakatsu's Original Site =Kawakatsu's Web Library on Planarians=) and Pictorial Database on the Biodiversity of Lake Biwa (Biwa Environ. Res. Inst., Shiga Pref., Ôtsu). Additionally, a necessary note will be given for some of articles cited.

REFERENCES (Web Articles) will be shown separately at the end of REFERENCES mentioned above. Each web article and its publication year will be shown in italics. They will be listed separately according to local areas, or Regions, of the Japanese Islands. A necessary note will be given for some web articles cited.

CONSTRUCTION OF THE CONTENTS

The present web article consists of two parts, i.e., PART I and PART II. Their general statements are given below.

PART I (with Figures 1-6)

I). Tentative identification of two North American *Girardia* species

As shown in Fig. 1 (a-c), the shape of the head of *Girardia tigrina* is considerably different from that of Japanese native and common species, *Dugesia japonica* Ichikawa et Kawakatsu, 1964. An isosceles triangular head with closed two eyes (each encircled by a wide pigment-free ocular area) are conspicuous in *G. tigrina*. This exotic species has a brown coloration with numerous blackish-yellowish pigments and whitish spots on the dorsal surface of the body (see Fig. 1a-c; Fig. 6 A-C). For *D. japonica*, a polymorphic species from six localities, see Fig. 6 (6 and 7, 8: a-d). The head shape of *Girardia dorocephala* with a pair of slender auricles is very conspicuous (Fig. 1e and f; Fig. 6: 11).

The pharynx pigmentation is an important generic character of *Girardia* species (Fig. 1-d). Observation of this character is desirable in fresh planarian samples because pale-grayish spots on the surface of the pharynx will be lost in the preserved specimens kept in 70% ethanol solution (or 3% formalin solution) for a long period.

For the species identification of freshwater planarians, a microscopic examination of the copulatory apparatus and its sagittal reconstruction should be necessary. For *G. tigrina* collected in Japan, sexual specimens are not found (i.e.; a tentative identification of the species at present).

For references, sagittal views of the copulatory apparatus of *G. tigrina* from the U. S. A. is shown in Fig. 2. The sagittal views of the copulatory apparatus of *G. dorocephala* from Hawaii, U. S. A., are also shown in Fig. 3 (a and b). See also the sagittal view of the copulatory apparatus of *G. dorocephala* collected in central Japan (Fig. 4).

For detailed explanations of figures and their sources, see explanation of each figure.

II). Geographical and vertical distributions of native freshwater planarians in Japan

The Japanese Islands --- a large stretch of the arc consists of four main islands (i.e., Kyûshû, Shikoku, Honshû and Hokkaidô) and numerous small islands over 3100 km from the SW to the NE direction. They can be separated into six geographical areas according to both the geographical and vertical distributions of six native freshwater planarian species (for details, see Kawakatsu, 1965, 1967, 1974, 1980). The correct understanding of this unique phenomenon is very important for the field investigators of benthic invertebrates in rivers of Japan (Fig. 5).

The rather widely distributed species in the Japanese Islands are as follows: *Dugesia japonica* Ichikawa et Kawakatsu, 1964; *Dugesia ryukyuensis* Kawakatsu, 1976; *Phagocata vivida* (Ijima et Kaburaki, 1916); *Seidlia auriculata* (Ijima et Kaburaki, 1916); *Polycelis sapporo* (Ijima et Kaburaki, 1916); *Seidlia schmidtii* (Zabusov, 1916). For color sketches and photographs, see Fig. 6 (1-2, 4-9) .

For the maps showing the geographical distribution ranges of Japanese six species mentioned above are in the following:

i and ii. *Dugesia japonica* and *Dugesia ryukyuensis*. Cf. Kawakatsu, Oki, & Tamura (1995, fig. 1 on p. 58; the revised one, see Tamura, Yamamoto, Takai, Oki & Kawakatsu, 1998, fig. 3 on p. 324; see also Kawakatsu, Murayama, Kawakatsu, M-y. & Kawakatsu, T., 2009, pl. XV; Kawakatsu, Nishino, Ohtaka & Yamamoto, 2011, pl. VII),

iii. *Phagocata vivida* (cf. Kawakatsu, Timoshkin, Porfirjeva & Takai, 1995, figs 1 and 2 on pp. 64-65).

iv. *Seidlia auriculata* (cf. Kawakatsu, Yamada, Murayama & Naoki, 1991, fig. 1 on p. 356).

v and vi. *Polycelis sapporo* and *Seidlia schmidtii* (cf. Kawakatsu & Timoshkin, 1998, figs 1-2 on p. 309 and figs 2 and 3 on p. 310).

Geographical Distribution

The Japanese Islands can be divided into 6 areas in reference to the geographical distribution of freshwater planarian species listed above (Fig. 5). They are as follows:

1) Ryukyuensis-Japonica area (RJ: the Southwest Islands of Japan and the south-western part of Kyûshû); 2) Japonica area (J: the lowland area in the south-central part of Kyûshû, and the Iki and the Tsushima Islands, the southern parts of Shikoku, and the Kinki, the Chûbu and the Kantô Regions in Honshû); 3) Japonica-Vivida area (JV: the northern part and mountainous areas of Kyûshû, the northern part of Shikoku including the Shikoku Mountains, the Chûgoku Region in Honshû and the Oki Islands on the Sea of Japan, the central and northern parts of the Kinki Region, the Noto Peninsula in the Chûbu Region in Honshû, and Sado Island on the Sea of Japan); 4) Japonica-Vivida-Auriculata area (JVA: the mountainous parts of the Chûbu and the Kantô Regions in Honshû, the Tôhoku Region in Honshû except for the northernmost area); 5) Japonica-Vivida-Sapporo-Auriculata area (JVAS: the Tsugaru and the Shimokita Peninsulas in Aomori Prefecture, i.e., the northernmost area of Honshû, and the South and the South-central parts of Hokkaidô); 6)

Japonica-Sapporo-Schmidt area (JSG: the Central and the Northeastern parts of Hokkaidô. In Central and Eastern Hokkaidô, *Seidlia akkeshi* (Ichikawa et Kawakatsu, 1963) will be found in some localities. Externally, this white species (Fig. 6:3) is very similar to that of *Pol. sapporo*.

Additionally, the Izu Islands and the Ogasawara Islands belong to the Japonica area.

Vertical Distribution

In each of the six geographical areas mentioned above (1-6), there are considerable differences in the vertical extension of the habitats of six freshwater planarian species. In other words, there is a close relationship between the height of their habitats and the latitude of geographical areas. The patterns of the vertical distribution in each of the six geographical areas are different. They can be summarized as follows:

- 1) RJ area. The type of the vertical distribution: RJ.
- 2) J area. The type of the vertical distribution: J.
- 3) JV area. The type of the vertical distribution: J-JV-V.
- 4) JVA area. The types of the vertical distribution: J-JV-JAV-AV-V (Chûbu and Kantô Regions); J-JV-JVA-VA-A (Kantô and Tôhoku Regions).
- 5) JVAS area. The type of the vertical distribution: JSV-SVA-VA-A.
- 6) JSC area. The type of the vertical distribution: JSC-SC-C.

Kawakatsu's Note 1. For example, the type of the vertical distribution is shown as J-JV-V in the JV area, it means that *D. japonica* inhabits the vertical area from the lowland to the mountain side; *Ph. vivida* inhabits the vertical area from the mountain side to the alpine region. Namely, localities of both species can be found in the mountain side.

For a more detailed explanation of the vertical distribution patterns of freshwater planarians in the Japanese Islands, see Kawakatsu (1965, 1967, 1974, 1980). Notice the use of the generic name *Seidlia* Zabusova, 1936 for '*Polycelis auriculata*' and '*Polycelis schmidtii*'. Cf. Kawakatsu & Mitchell (1995, 1998).

III). Common freshwater planarian species distributed both in Japan and the neighboring countries

Among to the six freshwater planarian species inhabiting in the Japanese Islands, the following three species are also distributed in the neighboring countries. They are *Dugesia japonica*, *Phagocata vivida* and *Seidlia schmidtii*. References on their distributional ecology are given below.

TAIWAN. *Dugesia japonica* is common in the entire region. Cf. Ichikawa & Kawakatsu (1967); Kawakatsu & Iwaki (1968); Kawakatsu, Lue, Takai, Hori, Muto & Osawa (1985, 1986a, b; Kawakatsu, Oki, Tamura, Yamayoshi, Lue & Hagiya (1970); Kawakatsu, Takai, Hori, Muto, Osawa & Lue (1989); Tamura, Oki, Kawakatsu, Lue, Takai, Hori, Muto & Osawa (1985, 1987).

CHINA, SOUTH KOREA and NORTH KOREA. *Dugesia japonica* is common in the lowland area. *Phagocata vivida* is common in the high mountain areas in the Korean Peninsula. *Ph. vivida* is also distributed in the North-eastern area of China. Cf. Ichikawa & Kawakatsu (1967); Kawakatsu (1975, 1994, 1996); Kawakatsu, Iwaki & Kim (1967); Kawakatsu & Kim (1966, 1967); Kawakatsu & Lue (1987); Kawakatsu, Oki, Tamura & Sugino (1976); Kawakatsu, Timoshkin, Porfirjeva & Takai (1994); Kawakatsu & Wong (1975).

SAGHALIEN and THE FAR EASTERN SIBERIA in RUSSIA. *Phagocata vivida* is found in the vicinity of Vladivostok in Russia. Cf. Sluys, Kawakatsu & Timoshkin (2001).

THE KAMCHATKAN PENINSULA and the KURIL ISLANDS. *Seidlia schmidtii* is distributed. Cf. Kawakatsu & Kuranishi (2000); Kawakatsu & Timoshkin (1998); Sluys, Smolder, Kawakatsu, Pietsch & Kuranishi (2009).

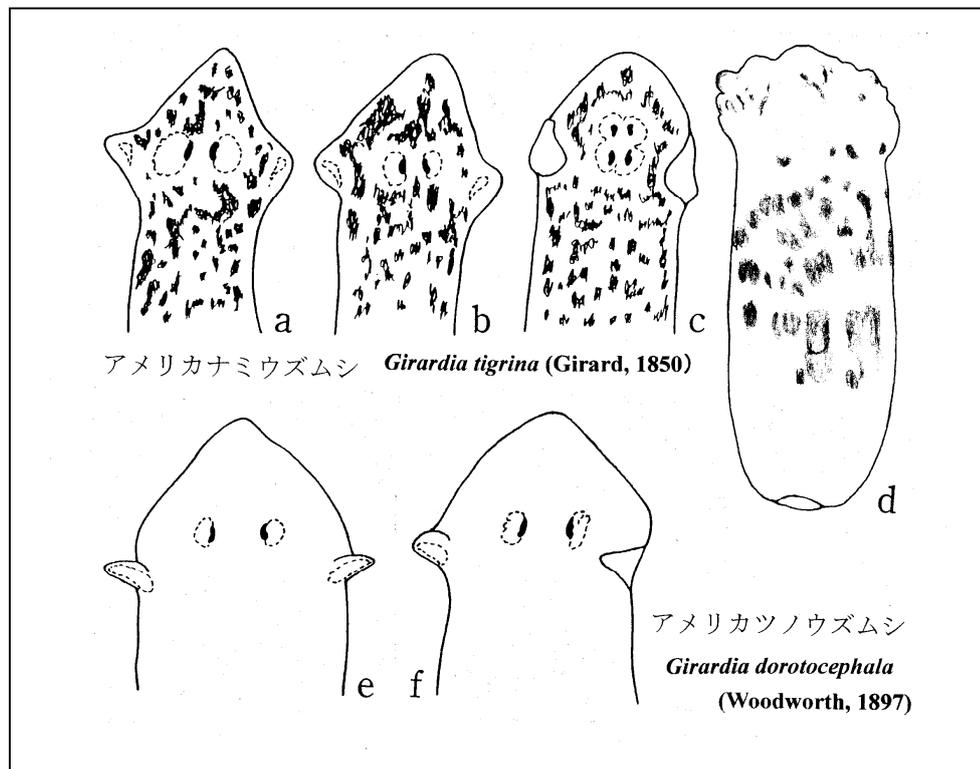


Fig. 1. Pictorial key of the heads and pharynx of two exotic dugesiid species from Japan. a-d: *Girardia tigrina* (Girard, 1850). a and b, sketches of the head of living specimens; c, a specimen with 2 supernumerary eyes; d, an enlarged sketch of the pharynx. e and f: *Girardia dorocephala* (Woodworth, 1897). Sketches of the head of living specimens.

Sources. a-f (after Kawakatsu, Nishino & Ohtaka, 2007, fig. 1). See also Kawakatsu, Nishino, Ohtaka & Yamamoto (2011, pl. II, fig. 20); d (after Nishino, Ohtaka & Kawakatsu, 2002, photo 2).

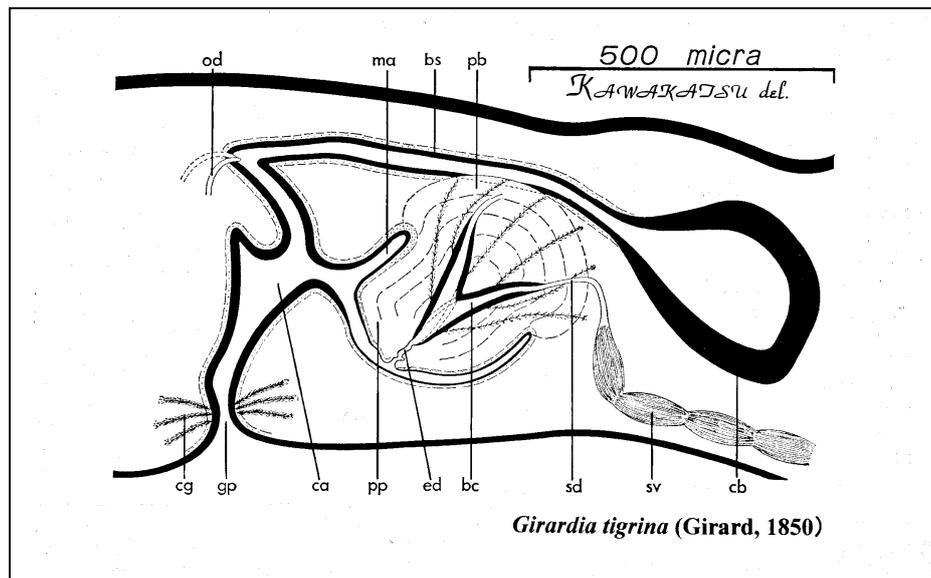


Fig. 2. Sagittal view of the copulatory apparatus of *Girardia tigrina* (Girard, 1850). Louisiana, U. S. A. (after Kawakatsu & Mitchell, 1981, fig. 1).

bc, bulbar cavity; bs, bursa stalk; ca, common antrum; cb, copulatory bursa; cg, cement gland; ed, ejaculatory duct; gp, genital pore; ma, male antrum; od, ovovitelline duct; pb, penis bulb; pp, penis papilla; sd, sperm duct; sv, spermiducal vesicle.

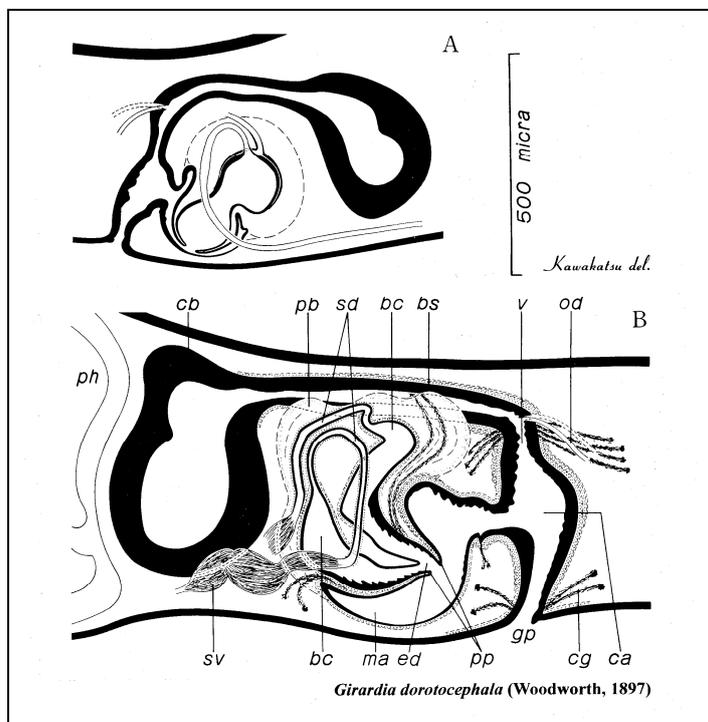


Fig. 3. Sagittal view of the copulatory apparatus of *Girardia dorocephala* (Woodworth, 1897). Manoa River, Honolulu, Oahu Island, Hawaii, U.S.A. (after Kawakatsu, Mitchell, Hirao & Tanaka, 1984, fig. 4). A (non-fully matured specimen); B (fully matured specimen). eg, cement gland; ph, pharynx; v, vagina. For other abbreviations, see Fig. 1.

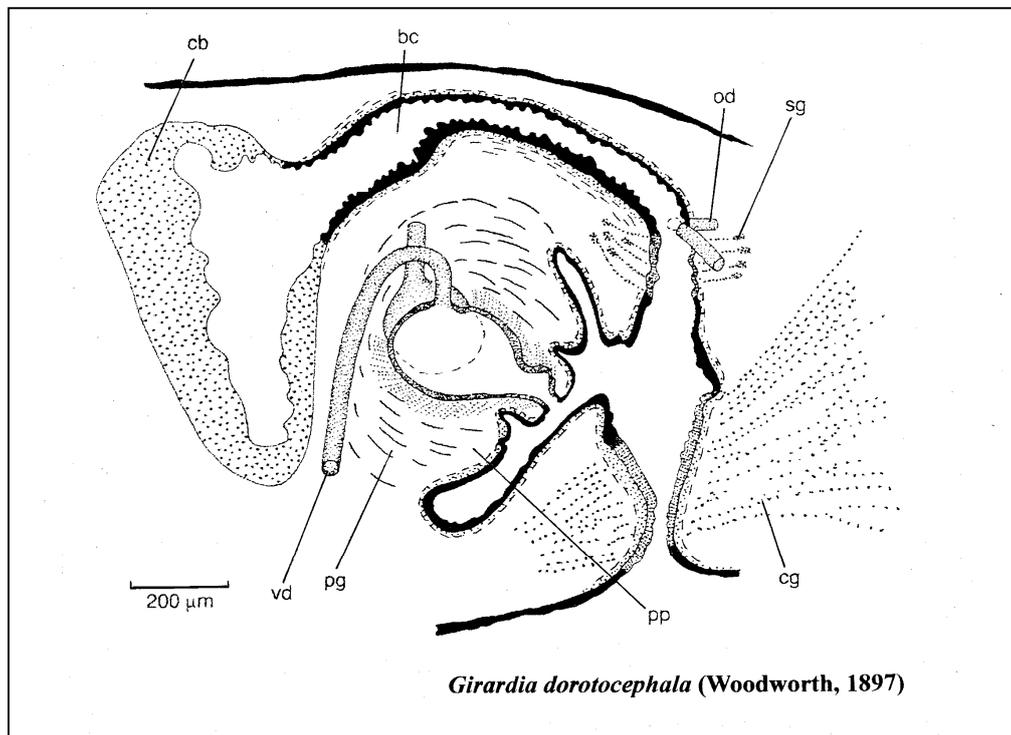
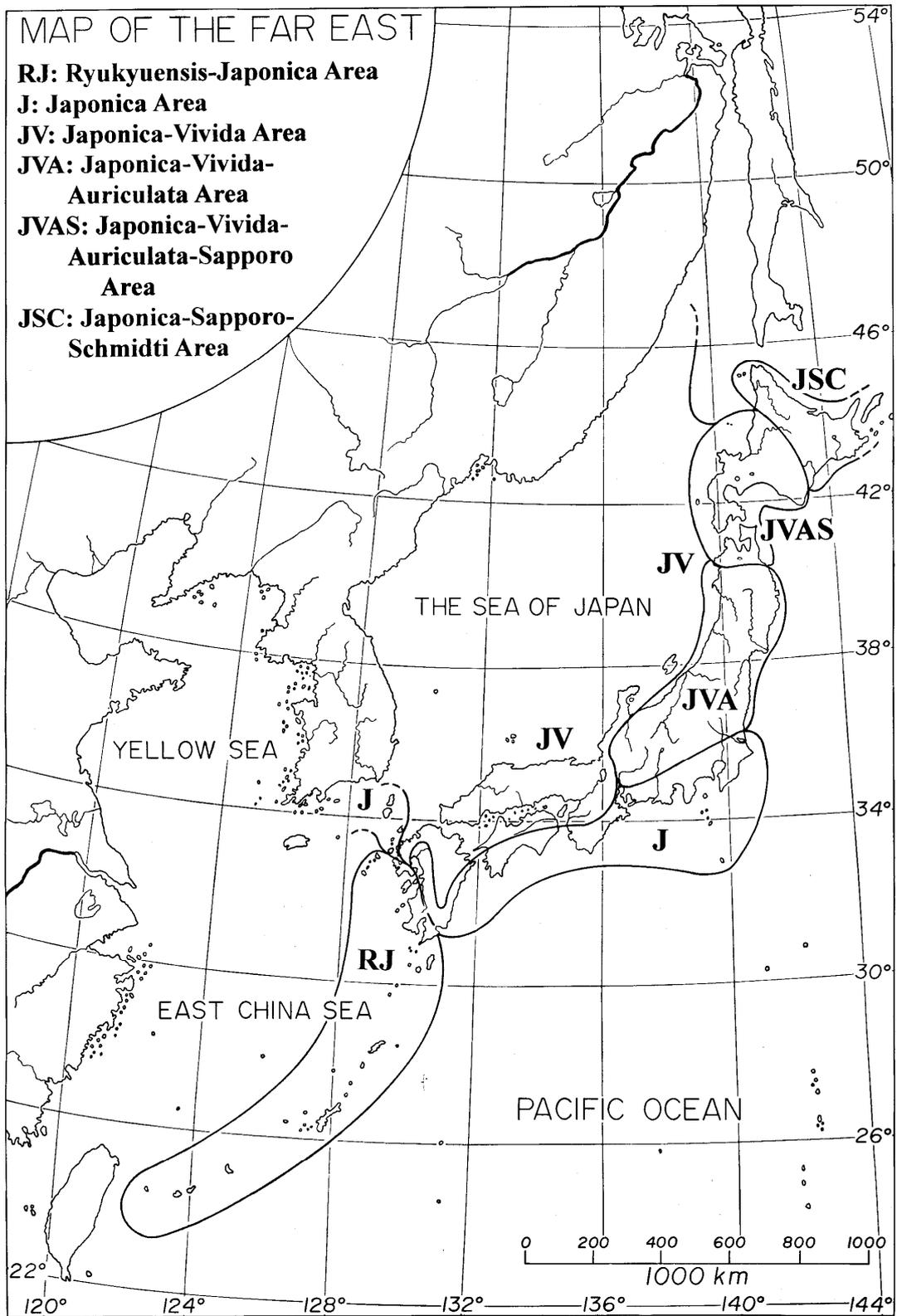


Fig. 4. Sagittal view of the copulatory apparatus of *Girardia dorocephala* Woodworth, 1897). Midstream of the Sagami-gawa River, Sagamihara City, Kanagawa Pref., Kantô Region, Honshû, Japan (after Sluys, Kawakatsu & Yamamoto, 2010, fig. 9). sg, shell glands; vd, vas deferens (i.e., sperm ducts). For other abbreviations, see Fig. 1. See also Sluys, Kawakatsu & Yamamoto (2009).

Explanation of Fig. 5 on Page 9.

Fig. 5. Map showing the six areas of the geographical and vertical distributions of the six species of common stream-dwelling planarians in the Japanese Islands. For the names of each area, see the top-left corner. The capital alphabets indicate the following species.

R: *Dugesia ryukyuensis* Kawakatsu, 1976; J: *Dugesia japonica* Ichikawa et Kawakatsu, 1964; V: *Phagocata vivida* (Ijima et Kaburaki, 1916); A: *Seidlia auriculata* (Ijima et Kaburaki, 1916); S: *Polycelis sapporo* (Ijima et Kaburaki, 1916); C: *Seidlia schmidtii* (Zabusov, 1916).



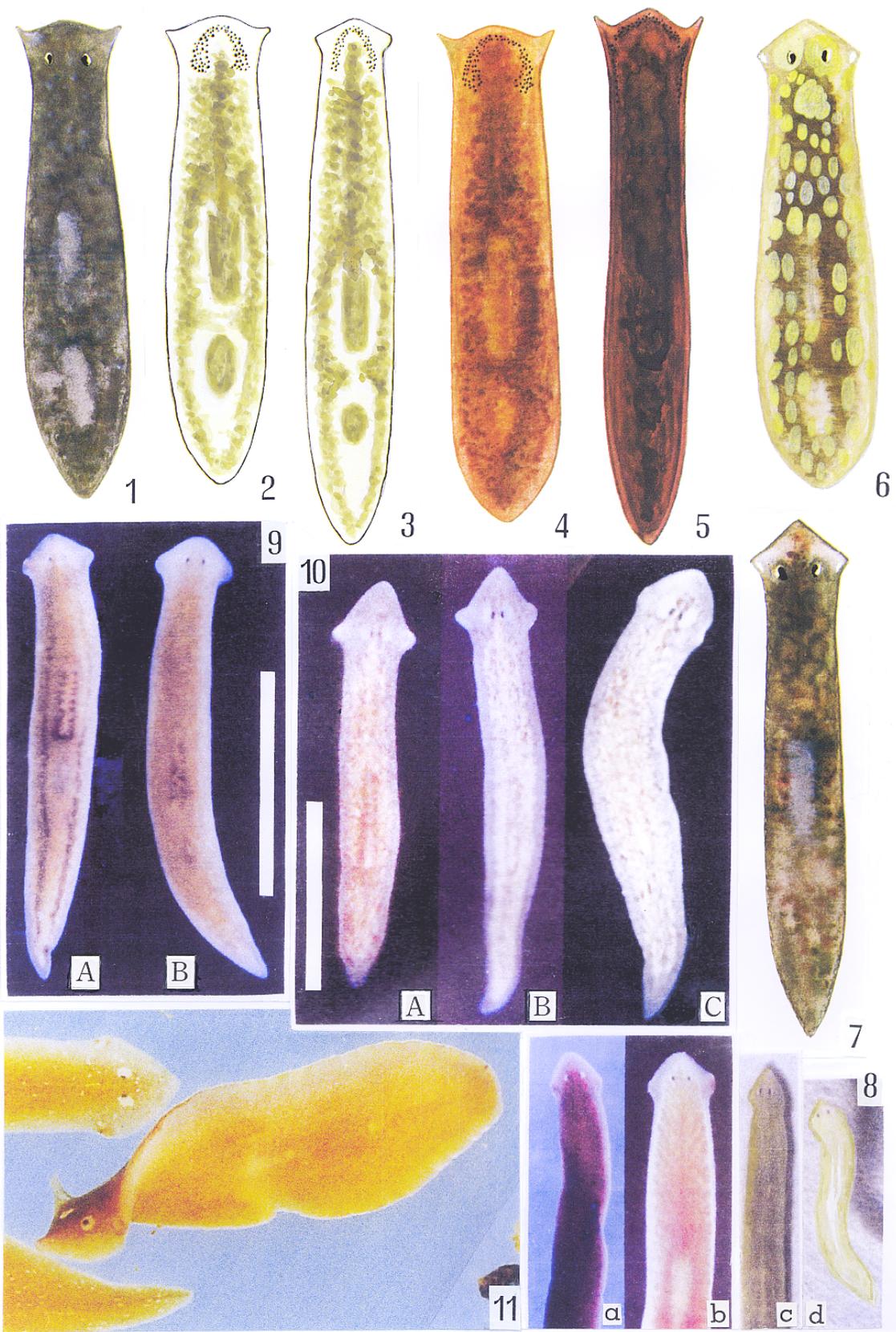


Fig. 6 (on Page 10). Color sketches and photographs (live specimens) of the common Japanese stream-dwelling planarians (6 species and additional one) and 2 exotic *Girardia* species.

1: *Phagocata vivida* (Ijima et Kaburaki, 1916); 2: *Polycelis sapporo* (Ijima et Kaburaki, 1916); 3: *Seidlia akkeshi* (Ichikawa et Kawakatsu, 1963); 4: *Seidlia auriculata* (Ijima et Kaburaki, 1916); 5: *Seidlia schmidtii* (Zabusov, 1916); 6-8: *Dugesia japonica* Ichikawa et Kawakatsu, 1964 (6, Matsumoto specimen, a sexual race; 7, Kyûshû specimen, an asexual race; 8a, Nîgata (Tsunan) specimen; 8b, Okayama specimen; 8c, Tsushima (Izuhara) specimen; 8d, Aichi (Bisai) specimen); 9: *Dugesia ryukyensis* Kawakatsu, 1976 (Nagasaki specimen, scale=5mm), 10: *Girardia tigrina* (Girard, 1850) (A, Yokohama specimen; B, Nagoya specimen; G, Nagasaki specimen, scale=5mm); 11: *Girardia dorotocephala* (Woodworth, 1897) (Asakawa River, Hino specimen, Tôkyô-To). Sources. 1-7 (after Kawakatsu, 1968, pls VII-VIII); 8-10 (after Kawakatsu, Murayama, Kawakatsu, M-y. & Kawakatsu, T., 2009, pl. III); 11 (after Kawakatsu, Murayama, Kawakatsu, M-y. & Kawakatsu, T., 2009, pl. II),

Note. For *Polycelis sapporo* (Photo 2) and *Seidlia akkeshi* (Photo 3), semitranslucent intestine, pharynx and copulatory apparatus those observed from the dorsal surface of the living specimens were painted.

PART II (with Plates I-VII)

These plates show the latest distribution records of two exotic freshwater planarian species, i.e., *Girardia tigrina* and *Girardia dorocephala* now naturalized in the Japanese Islands. The data employed were obtained until the end of August in 2012.

1). Ecological nature of two *Girardia* species and the previous distribution records in Japan

The ecological nature of these two North American species can be summarized as follows:

Girardia tigrina (Girard, 1850). Kenk (1974b, p. 75) wrote: “This is a eurythermic species occurring in stagnant waters and the lower stretches of rivers widely distributed in North America”. This species is now found in various areas of the world as a cosmopolitan species (cf. Kenk, 1972, 1974a, 1989).

The known geographical distribution records of *G. tigrina* in Japan are shown in Plates I-IV. Namely, both the previous data (cf. fig. 1 in Sluys, Kawakatsu & Yamamoto, 2010) and the new data obtained are shown on the maps. For each Plate, see the Explanation of Plates.

Girardia dorocephala (Woodworth, 1897). Kenk (1974b, pp. 75-76) wrote: “Eurythermic species, found usually in running water, more recently (in the western states) in lakes. Distributed all across the North American continent” (cf. Kenk, 1972, 1974a, 1989).

The known geographical distribution records of *G. dorocephala* in Japan are shown in Plates V-VII (cf. fig. 1 in Sluys, Kawakatsu & Yamamoto, 2010). For each Plate, see the Explanation of Plates,

2). Regional information on the distribution of two *Girardia* species

a. Okinawa in the Southwest Islands of Japan.

High school students of the Sinpô Science Club reported the occurrence in Okinawa Island that two native species (i.e., *Dugesia japonica* and *Dugesia ryukyuensis*) and two exotic dugesiid species (i.e., *Girardia tigrina* and *Girardia dorocephala*) (cf. Tanaka, Miyazato, Miyagi & Shiga, 2011; Shiga, Miyagi, Tanaka & Miyazaki, 2011). Kawakatsu examined carefully the contents of those two web articles including color photos of live specimens of above-mentioned four species. Kawakatsu also obtained a more detailed printing of their unpublished Club Report on their planarian surveys (34 pages in total). It is regrettable that their blurry photos of planarians did not permit the distinction of each species. Their planarian samples were also lost. In conclusion, the occurrence of *G. tigrina* and *G. dorocephala* in Okinawa Island is not proved at present.

b. Kyûshû.

Girardia tigrina is already recorded from Nagasaki City and Ibusuki City (cf. Sluys, Kawakatsu & Yamamoto, 2010: 104, fig. 1). See Pl. I.

Girardia dorocephala is recorded from the lower and middle streams in Fukuoka Prefecture (cf. Ogata, Tokunaga & Nakamura, 2008: 49, a color photo in the fig.). See Pl. V. *G. dorocephala* is not recorded in the previous survey report of the same area in Fukuoka Prefecture (cf. Ogata, Sugi & Yamazaki, 2002).

Additionally, *Dugesia japonica* is found commonly in the streams of Fukuoka Prefecture. *Phagocata vivida* is found only in the upper streams (cf. Ogata, Tokunaga & Nakamura, 2008).

c. Shikoku.

Both *Girardia tigrina* and *Girardia dorocephala* are not recorded at present. See Pls I and V.

d. Chûgoke Region in Honshû.

A naturalized population of *Girardia tigrina* was recorded from the Kurose River, Higashi-Hiroshima City, Hiroshima Prefecture (cf. Tomikawa & Torikoshi, 2011). Although these authors wrote the possibility of an occurrence of *Girardia dorocephala* in Onomichi City, Hiroshima Prefecture, it is not a positive data at present. See Pls I and V.

e. Kinki Region in Honshû.

Girardia tigrina was already recorded from the Muko-gawa River in Amagasaki City located in the SW of Hyôgo Prefecture (cf. Hashimoto, Terao, Yoshii & Yamaguchi, 2007; Tanaka, 2008). *G. tigrina* was also recorded from the Kamo-gawa River in Kyôto City and Lake Biwa-ko (they belong to the upper part of the Yodo-gawa River System) (cf. Kawakatsu, Nishino & Ohtaka, 2007; Kawakatsu, Nishino, Ohtaka & Yamamoto, 2011; Sluys, Kawakatsu & Yamamoto, 2010: 104, fig. 1). See Pls I and II.

During the past five years or more duration, the freshwater planarian fauna of the Yodo-gawa River system (including Lake Biwa-ko) was studied well by the three groups. Namely, its lower area (so-called the Yodo-gawa River and its tributaries) was studied mainly by the groups of 'Project P' and 'Project Y' under the guidance of the Ôsaka Museum of Natural History (cf. [Okade] 2007, 2008; Okade, Ishida, Chûjô, Nakaguchi & 'Project-Y', 2010). The contents of those web articles cited above were reported as usual publications by Ishida (2010) and Ishida & Okade (2009).

According to their serial studies, *Girardia tigrina* is now very common in many stations of the lower and middle streams of the Yodo-gawa River (i.e., the vicinities of Ôsaka City, Toyonaka City, Takatsuki City, and Ibaraki City in Ôsaka Prefecture, the vicinities of Nishinomiya City, Takarazuka City and Mita City in Hyôgo Prefecture). The

occurrence of *G. tigrina* in Ôsaka Prefecture is also recorded by the *Aquatic Life Conservation Center, etc. (2011)* and *Moire Institute Inclusion (2011)*.

The freshwater planarian fauna of the Kamo-gawa River in Kyôto City (the upper part of the Yodo-gawa River system) was studied by the *Biology Club of the High School attached to the Kyôto Sangyô University under the guidance of Mr. N. Yonezawa (2007)* (see also *Yonezawa, 2009*). According to their reports, *G. tigrina* is now common in lower and middle streams of the Kamo-gawa River. Cf. Takemon & Iwasaki (2007); The Yomiuri (2012). See Pl. II.

The Lake Biwa-ko joins on to the Seta-gawa River, the upper stream of the Uji-gawa River, i.e., the middle tributary of the Yodo-gawa River. The repeated surveys for the occurrence of *G. tigrina* in the lake shores and their vicinities were studied repeatedly during the past 10 years by the members of the Shiga Prefectural Institute of Public and Environmental Science Center. Conclusively, *G. tigrina* is now very common in Lake Biwa-ko (cf. Kaneko, Azuma, Sasaki, Tatsumi, Hashimoto, Sukawa, Ishikawa, Haga, Inoue & Nishino, 2012; see also Nishino & Kawakatsu, 2012). See Pls II and III.

The occurrence of *Girardia dorocephala* in the Yodo-gawa River system seems to be correct. About 5 years ago, Kawakatsu received a color photograph of a living specimen of the long-auricled planarian from Mr. N. Yonezawa who collected the sample specimen from the Kamo-gawa River in Kyôto City. At that time Kawakatsu sent him a reply message that his unidentified sample planarian species may be a North American species *Girardia dorocephala*. A copy of the web article by [Masuda] (2004) was also sent. Kawakatsu also received a color photograph of the long-auricled planarian collected from the Yodo-gawa River by members of the 'Project Y' Group.

Although the preserved planarian samples from the Yodo-gawa and Kamo-gawa Rivers mentioned above for taxonomic identification were not obtained at that time, they seem to be *G. dorocephala*. Namely, the occurrence of this exotic species in Japan was already proved by Dr. Sluys based upon the samples from the Sagami-gawa River, Sagami-hara City, Kanagawa Prefecture in the Kantô Region (cf. Sluys, Kawakatsu & Yamamoto, 2010: 106, fig. 9).

In the lower and middle streams of the Yodo-gawa River and their tributaries, *G. dorocephala* is found commonly (cf. Ishida, 2010; Ishida & Okade, 2009). The main localities are: Ôsaka City, Toyonaka City, Hirakata City, and Takatsuki City in Ôsaka Prefecture.

In the Kamo-gawa River in Kyôto City; populations of *G. dorocephala* are found in the lower and middle streams. This exotic species is also recorded from the Uji-gawa River (cf. *Biology Club of the High School attached to the Kyôto Sangyô University, 2007; Yonezawa, 2009*). See Pls V and VI.

Kawakatsu's Note 2. Kawakatsu & Takahashi (1973) reported the freshwater planarians distributed in the vicinities of Ôsaka City. *Dugesia japonica* Ichikawa et Kawakatsu, 1964 is common in both lowland and mountainous areas. *Phagocata*

vivida (Ijima et Kaburaki, 1916) is found in the mountainous area. Exotic *Girardia* species were not found at that time.

Kawakatsu's Note 3. Kawakatsu, Ôgawara & Tarui (1987) reported the freshwater planarians distributed in Kyôto City and its adjacent district. *Dugesia japonica* and *Phagocata vivida* are common. *Phagocata kawakatsui* Okugawa, 1956 and *Bdellocephala brunnea* Ijima et Kaburaki also occur sporadically in the lowland area. Exotic *Girardia* species are not found at that time.

Kawakatsu's Note 4. Yonezawa (2009), a web article, includes copies of nearly 30 project-slides used in his lecture. He recorded 5 planarians found in the Kamo-gawa River, i.e., two native species *D. japonica* and *Bd. brunnea*, and two exotic species *G. tigrina* and *G. dorotocephala*. Mr. Yonezawa also reported the occurrence of the third exotic species, *Dugesia austroasiatica* Kawakatsu, 1985, from the Kamo-gawa River. This is, however, doubtful because *D. austroasiatica* (probably South East Asiatic origin) is very similar in its external appearance to small and pale-colored specimens of *D. japonica* (cf. Yonezawa, 2009).

Kawakatsu's Note 5. In September of 2011, Kawakatsu had a chance to examine the sample of planarians from the Akanoi area of Lake Biwa-ko in Moriyama City (collected by Mr. Y. Yoshinari and Ms. M. Tsushima of the Idea Co. of the Kankyô-Sôgô Kenkyû-Sho; the sample belongs to the Water Agency, Lake Biwa Development Integrated Operation and Management Office). The preserved three specimens examined (ca. 3mm long) have the head with a pair of short auricles; two eyes with clear and large pigment-free ocular areas are located in a near position. Although the Akanoi sample of planarians is labeled tentatively as '*Girardia dorotocephala*?' by the collectors, it may be *Girardia tigrina*.

Kawakatsu's Note 6. Kawakatsu found items on YouTube. Brief shots of *G. tigrina* and *G. dorotocephala* can be seen. The original English explanation of the latter is as follows: "*Girardia dorotocephala* is one of non-native freshwater planarians (Turbellaria) in Japan. This zooid was collected in an artificial stream around the Lake Biwa."

This record is doubtful because the correct locality of planarian is not shown. To avoid confusion, this *YouTube* is not listed in *REFERENCES (Web Articles)*. It is emphasized that the occurrence of *G. dorotocephala* from the vicinity of Lake Biwa-ko is not known at present. See PI. III.

f. Chûbu Region in Honshû.

Girardia tigrina is already recorded from the Aquaria in Nîgata City (Nîgata Prefecture) and Nagoya City (Aichi Prefecture) (cf. Hirao, Kawakatsu & Teshirogi, 1970; Kawakatsu, Nishino & Ohtaka, 2007; Kawakatsu, Nishino, Ohtaka & Yamamoto, 2011; Kawakatsu, Oki, Tamura & Yamayoshi, 1985; Sluys, Kawakatsu & Yamamoto, 2010). *G. tigrina* is also recorded from Kagamihara City in Gifu Prefecture (cf. Sluys, Kawakatsu & Yamamoto, 2010: 104, top of the right column). See PI. I.

The occurrence of *Girardia dorocephala* in Chita City in Aichi Prefecture is reported (cf. *Anonym, 2009*). *G. dorocephala* is also reported from Anjô City in Aichi Prefecture (cf. *Nishi-Mikawa Yasei Seibutsu Kenkyû- Kai, 2010*) and in rivers of the Kôfû Basin in Yamanashi Prefecture (cf. *Horiuchi, 2010*). See Pl. V.

g. Kantô Region in Honshû.

Girardia tigrina is already recorded from the aquaria of the Inokashira Park in Mitaka City (Tôkyô-To), Isumino City (Chiba Prefecture) and Yokohama City (Kanagawa Prefecture). Its naturalized populations are common in lowland areas in the vicinity of Mitsukaidô City (the Tone-gawa River system) in Ibaraki Prefecture (cf. *Chinone, Yamamoto & Kawakatsu, 2008*; *Hirao, Kawakatsu & Teshirogi, 1970*; *Kawakatsu, Nishino & Ohtaka, 2007*; *Kawakatsu, Nishino, Ohtaka & Yamamoto, 2011*; *Kawakatsu, Oki, Tamura & Yamayoshi, 1985*; *Sluys, Kawakatsu & Yamamoto, 2010: 104, fig. 1*). See Pls I and IV.

During the past few years, new naturalized populations of *G. tigrina* are reported from the Kantô Region as follows:

Yokohama City and Ebina City in Kanagawa Prefecture (cf. *Akutsu, Nigorikawa & Muraoka, 2010*; *Ishio, 2012*; *Ministry of Land, Infrastructure, Transport and Tourism, Japan, Annual Versions*; *Sankei Shinbun, 2012*; *Yokohama Environmental Science Research Institute, 2009, 2012a, b, c*).

‘Rakukô’, the Kan’na-gawa River in Gunma Prefecture (cf. *Anonym, 2011, 2012*; *Kakegawa, 2012*).

Kuranishi (2009) mentioned the occurrence of *G. tigrina* in the Bôsô Peninsula (Chiba Prefecture).

Mr. Kuranishi, one of the coauthors of the present web article, has unpublished additional distribution data of *G. tigrina* in Totte City (Ibaraki Prefecture). The collection data: typical specimens of this exotic species are common (April 4, 2007 and March 2, 2009; collected by Kuranishi, R. B., Kaneta, S., Satake, K. and Tôjô, K.). See Pls I and IV.

It was already reported about the occurrence of *Girardia dorocephala* in the lower tributaries of the Tama-gawa River, Hino City (Tôkyô-To) and the mid-stream of the Sagami-gawa River in Sagamihara City (Kanagawa Prefecture). Cf. *Kawakatsu, Tsuruda, Kimura, Chinone & Murayama (2008)*; *Kawakatsu, Nishino, Ohtaka & Yamamoto (2011)*; *Sluys, Kawakatsu & Yamamoto (2010: 104, fig. 1)*. See Pls V and VII.

During the past few years, new naturalized populations of *G. dorocephala* are reported from the Kantô Region as follows:

The Sagami-gawa River system and Atsugi City in Kanagawa Prefecture (cf. *Torii, Saitou & Himura, 2011*; *Ministry of Land, Infrastructure, Transport and Tourism, Japan, Annual Versions*).

Yokohama City (cf. Sankei Shinbun, 2012; Yokohama Environmental Science Research Institute, 2009, 2012a, b, c). The three Japanese publications cited here are issued from Yokohama City. The 2009 publication includes a column about the taxonomy of dugesiid planarian species found in streams in Yokohama City (on p. 48 with 2 sets of color photos showing the head and pharynx of two planarians samples). The point of the subject written by the field investigator ([Mr. N. Kobayashi], one of the coauthors of the present web article) is as follows (translated into English by Kawakatsu).

“It became clear that *Girardia dorocephala* (Woodworth, 1897), a North American common species, is now naturalized in some rivers in Yokohama City. There is some possibility that the previous occurrence record of *Dugesia japonica* Ichikawa et Kawakatsu, 1964, in Yokohama City may include some erroneous occurrence record of *G. dorocephala*.”

Concerning the problem mentioned above, the following two articles contain important informations on the occurrence of *D. japonica* in Yokohama City during from the years 1984 to 2002 (cf. Kaneda, 2005; Kobayashi, 1989).

Hino City and Higashi-Murayama City (Tôkyô-To) in the Tama-gawa River system (cf. *Anonym (D. T.), 2010; Higashi-Murayama City (Tôkyô-To), 2012; Ministry of Land, Infrastructure, Transport and Tourism, Japan, Annual Versions*).

Tôkyô-To in the Arakawa River system (cf. *Katsushika-Ku, Tôkyô, 2009*).

‘Rakukô’ (or Rakkô), the Kan’na-gawa River in Gunma Prefecture (cf. *Anonym, 2010, 2011, 2012; Kakegawa, 2012*).

Mr. Kuranishi has unpublished additional distribution data of *G. dorocephala* in the following spots those belong to the Tama-gawa River system. The collection data: i) The Yudono-gawa River, Katakura-machi in Hachiôji City (Tôkyô-To: May 15, 2005); ii) The Okuri-gawa River, Hori-no-Uchi, in Hachiôji City (Tôkyô-To: May 15, 2005); iii) The Kotta-gawa River, Tsurumaki in Tama City (Tôkyô-To: May 15, 2005); iv) The Misawa-gawa River, Yamanouchi in Inagi City (Tôkyô-To: May 15, 2005); v) The Sen-gawa River, Kamata in Setagaya-Ku (Tôkyô-To: May 15, 2005). See Pls V and VII.

h. Tôhoku Region in Honshû.

Only *Girardia tigrina* is recorded from a domestic aquarium in Aomori City (cf. Kawakatsu, Tsuruda, Kimura, Chinone & Murayama, 2008; Sluys, Kawakatsu & Yamamoto, 2010: 10a, fig. 1). See Pl. I.

According to Mr. N. Kobayashi (a private message), one of the coauthors of the present web article, he has unpublished data of the occurrence of exotic *Girardia* species in the Tôhoku Region.

i. Hokkaidô.

Only *Girardia tigrina* was recorded from a domestic aquarium (cf, Kawakatsu & Hirai, 1968; Hirao, Kawakatsu & Teshirogi, 1970; Kawakatsu, Nishino, Ohtaka & Yamamoto (2011); Kawakatsu, Oki, Tamura & Yamayoshi (1985); Sluys, Kawakatsu & Yamamoto (2010 104, fig. 1). See PI. I.

Up to the present, there is no new record of the occurrence of exotic *Girardia* species in Hokkaidô.

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Note. The correct scientific name of an exotic species is *Girardia dorocephala* (Woodworth, 1897). Color photos of those 2 native species (*D. japonica* and *Ph. vivida*) and an exotic species (*G. dorocephala*) are shown on pp. 37 and 49. See also p. 67 (a list only).

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<http://www.riverwin.jp/pl/> . Left button: 11th ISFB 2009.

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Note. Cf. Sluys, Kawakatsu & Yamamoto (2009). An abstract of the paper and a reduced copy of the Poster used at the occasion of the ISFB 2009 (Hasselt, Belgium) are shown.

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249. Kankyô-Sôzô-Kyoku, Yokohama City. (In Japanese.)
<http://www.city.yokohama.lg.jp/kankyo/mamoru/kenkyu/shiryo/pub/d0016/> .

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The Yomiuri (Yomiuri Shinbun), 2012. [Distribution and population size of three freshwater planarian species found in the Kamo-gawa River in Kyôto City observed by high school students: *Dugesia japonica* Ichikawa et Kawakatsu, 1964 (a common native species), *Girardia tigrina* (Girard, 1850) and *Girardia dorocephala* (Woodworth, 1897) (two North American exotic species)]. *Bdellocephala brunnea* Ijima et Kaburaki, 1916 is also recorded.

Note. This is a signature article by Imazu, H. who introduced the recent activity of the Biology Club high school students in Kyôto City. See the two web informations in the *REFERENCES (Web Articles): Biology Club of the High School attached to the Kyôto Sangyô University, 2007 (Guide: Yonezawa, N.)* and *Yonezawa, N., 2009*. See also the Section 'Kinki Region in Honshû' in Part II of the present web article.

Zabusov, I. P. (= Sabussow, H.; Zabusoff, H.), 1916. *Rjabuschinskya schmidti* n. g. n. sp., novyi vid i rod Tricladida Paludicola iz' Kamchatki. *Rus. Zool. Zhur.*, Saratov, 1: 273-286. (In Russian, with French summary.)

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Selected web articles are listed according to the local order of Japan from the South-to-North direction (1-9). Authors' names and publication years for each article are shown in italics..

1. Okinawa Island in the Southwest Islands of Japan (Okinawa Prefecture).

Tanaka, N. , Miyazato, Y., Miyagi, Y. & Shiga, K., 2011. [Distribution of freshwater planarians in Okinawa Island]. The Ryûkyû Shinpô Science Club, Blog Archive, Abstract with it photos (a single page); Text (4 pages without pagination). (In Japanese.)

http://science.ryukyushimpo.jp/?page_id=28

<http://science.ryukyushimpo.jp/?p=866>

Note. For the detailed explanation and evaluation of this report, see Part II (2-a) in the present web article. See also *Shiga, Miyagi, Tanaka & Miyazato (2011)* listed below.

Shiga, K., Miyagi, Y., Tanaka, N. & Miyazato, Y., 2011. [A distribution survey of native and exotic freshwater planarians in Okinawa Island, Japan]. Shinpô Science Club, Ryûkyû Shinpô. A single page with 4 photos. (In Japanese.)
mhtml://F:\新報サイエンスクラブ .

Note. Printed copy of the unpublished Club Report (by Tanaka, Miyazato, Miyagi & Shiga (2011)) is there. See PART II (2-a).

These four high school students who studied freshwater planarians in Okinawa Island reported the occurrence of two native *Dugesia* species and two exotic *Girardia* species. However, their occurrence records of *Girardia* species in Okinawa Island are very doubtful.

2. Kyûshû. No web articles at present.

3. Shikoku. No web articles at present.

4. Chûgoku Region in Honshû. No web articles at present.

5. Kinki Region in Honshû.

Aquatic Life Conservation Research Center, Research Institute of Environment, Agriculture, and Fisheries, Ôsaka Prefectural Government, 2011. [America-nami-uzumushi (*Girardia tigrina* (Girard, 1850)) and America-tsuno-uzumushi (*Girardia dorotocephala* (Woodworth, 1897)) found in the Yodo-gawa River System, Ôsaka Prefecture], (In Japanese.)

<http://www.epcc.pref.osaka.jp/afr/fish/tenji/gairai/americauzumushi.html>

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Biology Club of the High School attached to the Kyôto Sangyô University, 2007 (Guide: Yonezawa, N.). [A survey of aquatic organisms living in the Kamo-gawa River system in Kyôto City, 2007-2008 (with 4 color photos of the head of living specimens: *Dugesia japonica* Ichikawa et Kawakatsu, 1964; *Bdellocephala brunnea* Iima et Kaburaki, 1916; *Girardia tigrina* (Girard, 1850); *Girardia dorotocephala* Woodworth, 1897)].

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Moire Institute Inclusion, 2011. [Photographic gleaning of aquatic insects and other invertebrates. Revised Edition 2011]. (In Japanese.)

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Note. Color photos of *Girardia tigrina* (Girard, 1850) and *Girardia dorotocephala* (Woodworth, 1897) collected in the vicinity of Ôsaka (the Yodo River system), Kinki Region, Honshû, are included.

[Okade, T.], 2007. Project P - project of planaria. [*Girardia tigrina* (Girard, 1850) and *Girardia dorotocephala* (Woodworth, 1897) found in the lower part of the Yodo River System, Ôsaka Prefecture, Kinki Region, Honshû (with color photos of the head of living specimens)]. (In Japanese.)

[Okade, T.], 2008. [Planarians from the Yodo River system, Ôsaka Prefecture, Kinki Region, Honshû (with color photos of *Dugesia japonica* Ichikawa et Kawakatsu, 1964; *Phagocata vivida* (Ijima et Kaburaki, 1916); *Girardia tigrina* (Girard, 1850) and *Girardia dorotocephala* (Woodworth, 1897)]. (In Japanese.)
http://www.mus-nh.city.osaka.3p/project_yodogawa/09planaria.pdf

Tanaka, T., 2008. [Histological observation of a freshwater planarian (*Girardia tigrina* (Girard, 1850) collected in Amagasaki City, Hyôgo Prefecture, Kinki Region, Honshû, Japan)]. Tôsho E-net, Kôtô-Gakkô Rika Kyôzai-Kenkyû-Jôhô, Jissen-Jirei. Seibutsu (Aug. 4, 2008), pp. 1-6. Tôkyô. (In Japanese.)
<http://www.hyogo-c.ed.jp/~amaoda-hs/ssh/pdf/planaria.pdf>

Yonezawa, N., 2009. [A high school teacher's practical record about the environmental education — A lecture with 70 lantern slides given at the 7th Annual Meeting of the Chikyû-Kankyô University Lecture for 2009 held in Ôsaka, on Sept. 12, 2009]. (In Japanese.) <http://www.uee.or.jp/09tikannaiyou1/09naiyou1.html>
Note. For a detailed explanation of this report, see PART II (2-e) in the present web article.

6. Chûbu Region in Honshû.

Anonym, 2009. [Observation of aquatic animals living in the Shinano-gawa River, Chita City, Aichi Prefecture]. file://F: index.htm

[Masuda, M.], 2004. [A freshwater planarian species found in aquaria of our Hekinan Seaside Aquarium was identified tentatively as *Girardia dorotocephala* (Woodworth, 1897) by Dr. M. Kawakatsu]. Homepage of Hekina Seaside Aquarium / Hekinan City Museum Maritime for Youth: February 5, 2004. (In Japanese.)
<http://www.city.hekinan.aichi.jp/aquarium/index.html>

Note. For comparison, Kawakatsu's photo of *Dugesia japonica* Ichikawa et Kawakatsu, 1964 is also shown. See also the URL. mhtml:file://F: TOPICS. Mht .

Nishi-Mikawa Yasei-Seibutsu Kenkyû-Kai, 2010. [America-tsuno-uzumushi = *Girardia dorococephala* (Woodworth, 1897)].
mhtml:file://F: F:川虫紹介・アメリカツノウズムシ mht

7. Kantô Region in Honshû.

Anonym, 2010. [Occurrence of *Girardia dorotocephala*, an exotic freshwater planaria, in the Kan'na-gawa River, Gunma Prefecture, Kantô Region (with 6 color photos of living planarians)]. Kawagera Tsûshin (October, 2010). (In Japanese.)

<http://www.justmystage.com/home/kawagera/index.html>
<http://www.justmystage.com/home/kawagera/tunou2u.html>

Anonym, 2011. [Occurrence of two exotic planarians, *Girardia dorocephala* and *Girardia tigrina*, in the Kan'na-gawa River, Gunma Prefecture, Kantô Region (with 10 color photos of living planarians)]. Kawamushi-Shôkai (November, 2011). (In Japanese.)
F:\川虫紹介・アメリカツノウズムシ mht

Anonym, 2012. [Occurrence of two exotic planarians, *Girardia dorocephala* and *Girardia tigrina*, in the Kan'na-gawa River, Gunma Prefecture, Kantô Region (with a color photo of living planarian)]. Kan'na-gawa Mizube no Rakkô (May, 2012). (In Japanese.)
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Higashi-Murayama City (Tôkyô-To), 2012. Kitagawa-Kappa no Kai [Monthly Informations of the Higashi-Murayama City 3. February, 2012.
mhtml:file://F:\北川かつぱの会.mht .

Kakegawa, Y., 2012. [Two exotic freshwater planarian species and diatoms found in mesoaprobic water in the vicinity of Rakkô, the Kasa'na-gawa River system, Gunma Prefecture, Kantô Region, Honshû, Japan]. Chi'ki ni Seisoku suru Seibutsu ni tsuite no Kenshû-kai, Kôen-Yôshi (February 25, 2012). One page with color photos of living specimens of *Girardia tigrina* (Girard, 1850) and *Girardia dorocephala* (Woodworth, 1897). (In Japanese.)
<http://www.justmystage.com/home/kawagera/rakukou/kensyu201202.html>

Note. This author (speaker) wrote the occurrence of “Tônán-Azia-uzumushi” (*Dugesia austroasiatica* Kawakatsu, 1985) in the same studied area. This uncertain record seems to be a misunderstanding for *Dugesia japonica* Ichikawa et Kawakatsu, 1964.

Katsushika-Ku, Tôkyô-To, 2009. [Reports on the Environmental Research of ponds and water-courses in the Katsushika-Ku, Tôkyô-To (2009)]. Five pages (in part). (In Japanese.) <http://www.city.katsushika.lg.jp/55/6200/001501.html>

Note. *Girardia dorocephala* (Woodworth, 1897) is recorded from streams in the Hikifune-gawa Shinsui Park (the Ara-kawa River system).

Ministry of Land, Infrastructure, Transport and Tourism, Japan, Every Year. A national census of rivers and water systems in Japan. Kasen-suihen no Kokusei-chôsa (Seibutsu-Chôsa Hen). [A national census of rivers and water systems in Japan. Species list of aquatic plants and animals]. (In Japanese.)

<http://www?.river.go.jp/> .
mhtml:file://F:\河川水辺の国勢調査 生物リスト.mht .

8. Tûhoku Region in Honshû. No web articles at present.

9. Hokkaidô. No web articles at present.

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Explanation of Plates I-VII

Plate I. *Girardia tigrina* (Girard, 1850).

Map of the Japanese Islands, showing the geographical distribution of *G. tigrina*. For the detailed distribution maps of the areas A (the northern half of the Kinki Region) and B (the southern half of the Kantô Region). For the explanation of two kinds of pentagon symbols, see the top-left corner of Plate I. See Plates II, III and IV.

Plate II. *Girardia tigrina* (Girard, 1850)

Map of the northern half of the Kinki Region, showing the geographical distribution of *G. tigrina*.

①, Kako-gawa River; ②, Yodo-gawa River; ③, Kizu-gawa River; ④, Uji-gawa River; ⑤, Yasu-gawa River; ⑥, Echi-gawa River; ⑦, Ado-gawa River; ⑧, Kamo-gawa River; ⑨, Katsura-gawa River; ⑩, Yura-gawa River.

For the pentagon symbols used, see the top-left corner of Plate I.

Plate III. *Girardia tigrina* (Girard, 1850)

Map of Lake Biwa-ko and its surrounding area, showing the detailed geographical distribution of *G. tigrina*. Names of 19 stations where *G. tigrina* occurred are as follows:

1, Ôtsu City; 2, Kita-Ogoto; 3, Wani, south; 4, Wani; 5, Ukawa; 6, Harie-hama; 7, Kaizu; 8, Kaizu-Ôsaki; 9, Ôura; 10, Sugaura; 11, Tsuzurao-zaki Cape; 12, Chikubu-jima Is.; 13, Tsukide; 14, Fuji-ga-saki Cape; 15, Han-no-Ura; 16, Asozu; 17, Hayasaki; 18, Miya-ga-Hama; 19, Mizu-ga-Hama.

For the pentagon symbols used, see the top-left corner of Plate I.

Plate IV. *Girardia tigrina* (Girard, 1850)

Map of the southern half of the Kantô Region, showing the geographical distribution of *G. tigrina*.

①, Sagami-gawa (Banyû-gawa) River; ②, Nakatsu-gawa River; ③, Tama-gawa River; ④, Ara-kawa River; ⑤, Iruma-gawa River; ⑥, Edo-gawa River; ⑦,

Tone-gawa River; ⑧, Kinu-gawa River; ⑨, Omoi-kawa River; ⑩, Watarase-gawa River; ⑪, Katashina-gawa River; ⑫, Naka-gawa River.

For two kinds of pentagon symbols used, see the top-left corner of Plate I.

Plate V. *Girardia dorocephala* (Woodworth, 1897)

Map of the Japanese Islands, showing the geographical distribution of *G. dorocephala*. For the detailed distribution maps of the areas A (the northern half of the Kinki Region) and B (the southern half of the Kantô Region).

For the explanation of two hexagon symbols used, see the top-left corner of Plate V. See Plates VI and VII.

Plate VI. *Girardia dorocephala* (Woodworth, 1897)

Map of the northern half of the Kinki Region, showing the geographical distribution of *G. dorocephala*.

For the names of rivers ① - ⑩, see the explanation of Plate II. For the hexagon symbols used, see the top-left corner of Plate V.

Plate VII. *Girardia dorocephala* (Woodworth, 1897)

Map of the southern half of the Kantô Region, showing the geographical distribution of *G. dorocephala*.

For the names of rivers ① - ⑫, see the explanation of Plate II. For the hexagon symbols used, see the top-left corner of Plate V.

日本各地に出現する北米原産の淡水生プラナリア 2 種:

アメリカナミウズムシ (*Girardia tigrina*) とアメリカツノウズムシ (*Girardia dorocephala*)

(三岐腸目・結合三岐腸亜目・地上性ウズムシ上科・サンカクアタマウズムシ科)

川勝正治・西野麻知子・故緒方 健・倉西良一・小林紀雄・大高明史

1). 平成 5 年(1993)頃から、九州の長崎市で *Girardia tigrina* (Girard, 1850)の野外生息個体群が確認された。また、平成 17 年(2005)頃から、*Girardia dorotocephala* (Woodworth, 1897)の野外生息個体群が東京都日野市(多摩川)や、神奈川県相模原市(相模川)から見付かった。これらの 2 種は北アメリカ大陸原産の普通種で、生活力も強い。日本では、最初は熱帯魚の水槽や飼育池で発見されたが、その数年後には自然水域でも見られるようになった……というのが分布の経緯である。

2). *Girardia* 属は新大陸原産のもので、種類数も多い。頭部が正三角形で 2 眼、頭部左右の耳葉(感覚器官)が発達している。この属の特徴として、咽頭の表面に淡い墨色の斑紋が見られる(図 1)。

G. tigrina は、19 世紀以降ヨーロッパの水域にも拡がり、現在では汎世界的に分布している。地球上の人間の生活圏の拡大と交流に伴い、水生植物などに付着して分布域が広がったと推定される。日本では生殖器官を持った個体が採集されていないので、無性個体の外部形態と核型による仮同定である(図 2 参照)。*G. dorotocephala* は相模川の生殖個体で種が同定されている(図 3 と 4)。

3). 日本列島は南西諸島から北海道まで、南北 3100 km ほどに渡って拡がっている。また、山地が多く、河川も急流域が多い。更に、太平洋側と日本海側とでは、海流の関係もあって気候も大幅に異なっている。従って、淡水生プラナリア相も複雑であり、分布域の広い普通種も 6 種類ほど生息している。また、それらの種の垂直分布範囲も、地域ごとに大幅に異なっている(図 5)。

各調査者は、この図から調査予定地に生息しているプラナリア類の種類と分布域を予測することができる。この図に示した略号(RJ, J, JV, JVA, JVAS, JSC)は 6 種のプラナリアの学名の種小名の頭文字を大文字で示した‘垂直分布型’で、日本列島全体を 6 地域に区分することができる。また、各垂直分布型については、標高の低い地域から高い地域にかけて出現する種類を左⇒右の順に示している。

なお、それぞれの種の学名と和名は図 6 の説明を参照のこと。また、日本列島の淡水生プラナリア類の垂直分布のあらましについては、下記の記事を参照して欲しい。

川勝正治, 1980. プラナリア 多目的教材として. 山田卓三・山際 隆(編), 新しい教材生物の研究, 74—96 頁. 講談社.

4). 日本産の分布域の広い淡水生プラナリア類 6 種と近似の 1 種、及び *Girardia* 属の外来種 2 種の生体のスケッチと写真を図 6 に示した。それらの和名と学名は下記の通りである。

1: ミヤマウズムシ *Phagocata vivida* (Ijima et Kaburaki, 1916). 2: キタシロカズメウズムシ *Polycelis sapporo* (Ijima et Kaburaki, 1916). 3: アッケシカズメウズムシ *Seidlia akkeshi* (Ichikawa et Kawakatsu, 1963). この種は北海道の東南部に分布しているが、外見的には *Pol. sapporo* に酷似している(肉眼的な区別は難しい)。4: カズメウズムシ *Seidlia auriculata* (Ijima et Kaburaki, 1916). 5: キタカズメウズムシ *Seidlia schmidtii* (Zabusov, 1916). 6—8(a—d): ナミウズムシ *Dugesia japonica* Ichikawa et Kawakatsu, 1964. 多型種で、体の大きさや、体色、それに背面の模様などの変異に富む。9(A と B): リュウキュウナミウズムシ *Dugesia ryukyuensis* Kawakatsu, 1976. 前種よりもほっそりした感じであるが、外見だけで区別するのは困難。なお、基本的な染色体数は *D. japonica* が $2x=16$, *D. ryukyuensis* が $2x=14$ である。両種ともに、三倍体や、過剰染

色体を持つ個体も多い。10 (A—C): アメリカナミウズムシ *Girardia tigrina* (Girard, 1850). 外来の多型種。11: アメリカツノウズムシ *Girardia dorocephala* (Woodworth, 1897). 外来種。

5). 図版類 (Plates 1—VII). 日本列島における *G. tigrina* と *G. dorocephala* の最新の分布状況 (2012 年 8 月末現在) を 6 枚の地図で示した。既出版の文献類・インターネットで検索した記録類を取捨選択した結果、及び著者らの未発表のデータによる。

後 記

本稿は、基本的には日本列島における北米産の外来種 *Girardia* 2 種の最新の分布記録をまとめたものである (英文版)。他方、この目的で作成した図と図版類は、“財団法人 河川環境管理財団” と “全国水生生物調査” の指導員に方達、それに調査者で “プラナリア類” を担当される方々の参考にもなると考え、この日本語解説を付した。

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Link: <http://www.riverwin.jp/pl/>

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