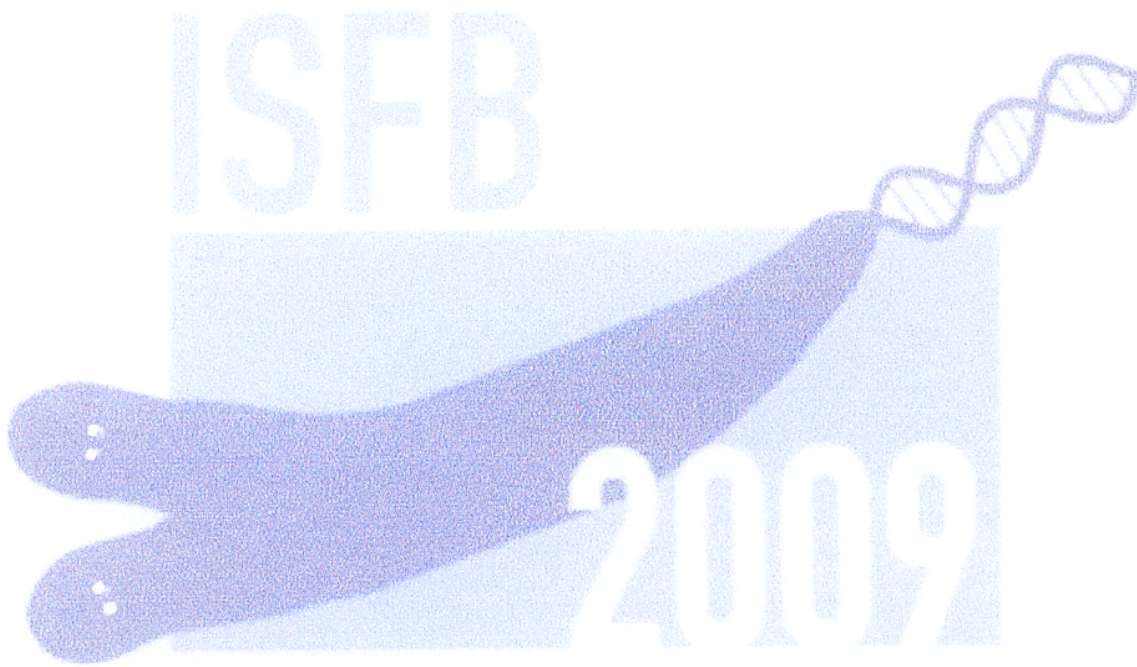


ABSTRACT BOOK



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EXOTIC FRESHWATER PLANARIANS CURRENTLY KNOWN FROM JAPAN

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Exotic freshwater planarians introduced into Japan can be arranged into three species groups: (1) Southeast Asian *Dugesia* sp.; (2) North American *Girardia* spp.; (3) Brazilian *Rhodax?* sp. One, sexually mature, *Dugesia* sp. was described as the new species *Dugesia austroasiatica* Kawakatsu, 1985. Recently, the occurrence of *Girardia dorocephala* (Woodworth, 1897) in Japan was confirmed. The other North American, asexual *Girardia* sp. is tentatively identified as *G. tigrina*. The purpose of the present paper is to review the scattered information available in the literature on non-indigenous freshwater planarians in Japan, and to present new karyological and taxonomic data. With respect to *D. austroasiatica*, five new idiograms of populations from three localities are presented. For *G. tigrina* three new idiograms of specimens from Lake Biwa-ko are given and for *G. dorocephala* three sets of idiograms from three localities in Japan are presented. The present study supports earlier and preliminary identifications of Japanese *G. dorocephala* by providing a reconstruction of the copulatory apparatus. The paper discusses which factors may have facilitated the introduction and subsequent geographical spread of exotic freshwater triclads in Japan: (1) popularization of domestic tropical fish cultures; (2) culture of exotic aquatic animals as food.

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Note. This is a reproduction prepared by Kawakatsu based upon the original Abstract Book (2009).

Exotic freshwater planarians currently known from Japan

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Introduction

The purpose of the present paper is to review the scattered information available in the literature on non-indigenous freshwater planarians in Japan, and to present new karyological and taxonomic data.

Species accounts

Genus *Dugesia* Girard, 1850

Dugesia austroasiatica Kawakatsu, 1985

Material examined and distribution: Honshū: Stations 1, 3, 8, 12, 13, and 14 (the only naturalized population). Kyūshū: Station 7 (Fig. 1)

Morphology

A rather small, slender, and pigmented species (ca. 12 mm long and 1.5 mm wide in large, sexually mature specimens) inhabiting warm waters. Head subtriangular with a pair of bluntly pointed auricles; with two eyes, each surrounded by a narrow non-pigmented ocular area; the distance between the pigment cups is slightly smaller than one-third of the width of the head at the level of eyes (Fig. 2).

Karyology

Idiograms of *D. austroasiatica* from the Saga locality (St. 7) and the Chiba (Isumi) locality (St. 8) were reported earlier (Fig. 3). Five new idiograms of populations from 3 localities (Stations 12, 13, and 14) are presented in Fig. 4.



Fig. 1. Map of the Japanese Islands, showing the geographical distribution of 4 species of exotic freshwater planarians from 20 stations:

1. Aquarium in Niigata City;
2. Aquarium in Sapporo City;
3. Aquarium Inokashira Park, Mitaka City;
4. Aquarium in Yokohama City;
5. Aquarium in Nagoya City;
6. Culture ponds of West Australian crayfish in Ibusuki City;
7. Culture ponds of tropical fishes in Saga City;
8. Domestic aquaria in Isumi City;
9. Urakami-gawa River, Nagasaki City;
10. An aquarium in Sapporo City;
11. Lake Biwa-ko in Moriyama City;
12. Domestic aquarium in Aomori City;
13. Domestic aquarium in Tōkyō;
14. Mizoro-ga-ike Pond in Kyōto City;
15. Kamo-gawa River in Kyōto City;
16. Shallow waters in lowland areas in the vicinity of Mitsuikaidō City;
17. Tropical fish culture tank of the Heikinan Sea Side Aquarium in Heikinan City;
18. Muko-gawa River in Amagasaki City;
19. Lower stream of the Asa-kawa River, a tributary of the Tama-gawa River, Hino City (3 localities);
20. Midstream of the Sagami-gawa River and its tributaries, Sagami-hara City (3 localities).



Fig. 2. External features of *Dugesia austroasiatica*.

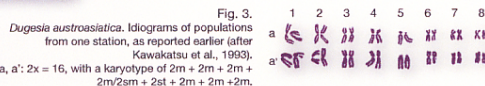


Fig. 3. *Dugesia austroasiatica*. Idiograms of populations from one station, as reported earlier (after Kawakatsu et al., 1985).

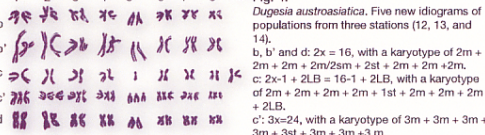


Fig. 4. *Dugesia austroasiatica*. Five new idiograms of populations from three stations (12, 13, and 14).

Genus *Girardia* Ball, 1974

Girardia tigrina (Girard, 1850) (tentative identification)

Material examined and distribution: Hokkaidō: Station 2. Honshū: Stations 4, 5, 11, 15, 16, and 18. Kyūshū: Stations 6 and 9 (Fig. 1). Naturalized populations concern Stations 11, 15, 16, 18, and 9. Recently, a new naturalized population of *G. tigrina* was found in Kagami-hara City (Gifu Pref.), about 50 km N of Station 5.

Morphology

Living, asexual specimens are approximately 10 mm long and 1 mm wide. Head equilateral-triangular, with a pair of broad, short auricles. Two eyes are conspicuous, each surrounded by a large, non-pigmented ocular area. Ground colour of the dorsal surface pale brown with numerous whitish and yellowish pigment spots (Fig. 5). Small masses of irregularly arranged blackish and yellowish brown pigment granules are conspicuous on the surface of the pharynx.

Since sexual specimens of this *Girardia* species were not available, its tentative identification is based only on external features. However, external morphology of the *Girardia* species from Japan is very similar to that of specimens of *G. tigrina* from the U. S. A., Mexico, Brazil, and Uruguay.

Karyology

Three new idiograms of *G. tigrina* from Lake Biwa-ko (St. 11) are given in Fig. 6. The diploid karyotype is $2x=16$, with 8 pairs of metacentric chromosomes. Triploid karyotypes also occurred. Usually, diploid and triploid karyotypes were found in different specimens. Judging from the idiograms of *G. tigrina* from Japan published earlier, the 6th (or the 7th) pair of chromosomes were submetacentric in some cases, in contrast to the results published in the present paper. A similar situation was encountered in Brazilian *G. tigrina*. Italian *G. tigrina* has a karyotype of 7 pairs of metacentric chromosomes and one pair of submetacentric chromosomes (Fig. 7).

Discussion

For the distribution of *G. tigrina*, Kenk (1974: 28) wrote: "North America, Mexico, Brazil, also introduced to Europe (widely distributed, including the British Isles), Israel, and Japan". Later, *G. tigrina* was reported from several localities in Brazil, Uruguay, and additional localities in Japan.

Fig. 5. External features of *Girardia tigrina*.

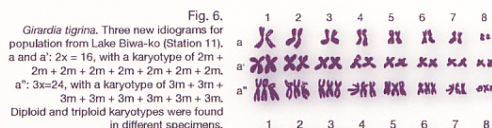


Fig. 6. *Girardia tigrina*. Three new idiograms for population from Lake Biwa-ko (Station 11).
a and a': $2x=16$, with a karyotype of $2m+2m+2m+2m+2m+2m+2m+2m$.
a'': $3x=24$, with a karyotype of $3m+3m+3m+3m+3m+3m+3m+3m$.
Diploid and triploid karyotypes were found in different specimens.

Fig. 7. Metaphasic plates and idiograms of *Girardia tigrina* from Turin, Italy (idiograms reconstructed by Kawakatsu, based on data in Benazzi 1970).

Girardia dorocephala (Woodworth, 1897)

Material examined and distribution: Honshū: Stations 17, 19 (3 localities), and 20 (3 localities) (Fig. 1). Naturalized populations occur at Stations 19 and 20.

Morphology

Living sexually mature specimens from the Hino (Station 19) and Sagami-hara (Station 20) populations measure 12–18 mm × 1.5–2.5 mm. The large head is of a broad, triangular form with a pair of long and pointed tentacles. Two eyes, each surrounded by conspicuous, non-pigmented ocular areas, are located slightly anterior to the level of the base of the auricles. Ground colour of the dorsal surface uniform brown, with the central region of the body being uniformly grey (Fig. 8). The pharynx shows a brownish pigmentation; its outer musculature is provided with a third, extra layer of longitudinal muscle fibres, a feature that is characteristic for this species. Testes ventral, throughout the body. For copulatory apparatus, see Fig. 9.

Karyology

Three sets of idiograms of *G. dorocephala* from three localities in Japan are given in Fig. 10. The karyotype of *G. dorocephala* is $2x=16$, with 8 pairs of metacentric chromosomes. The diploid karyotype of *G. dorocephala* resembles that of *G. tigrina*. *G. dorocephala* specimens from South Virginia, U. S. A. showed a diploid karyotype of 6 pairs of metacentric chromosomes and 2 pairs of submetacentric elements (Fig. 11).

Discussion

The native distribution of *G. dorocephala* concerns North America, northern Canada, and Mexico. The species has been introduced into Hawaii. The occurrence of this North American species in Japan was noted promptly by Kawakatsu et al. (2007a, b, 2008). The present paper supports these earlier and preliminary identifications by providing a reconstruction of the copulatory apparatus of the Japanese representatives of *G. dorocephala*.



Fig. 8. External features of *Girardia dorocephala*.

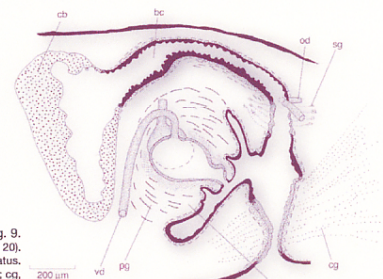


Fig. 9. Sagittal reconstruction of the copulatory apparatus.

Girardia dorocephala. ZMA V.P.I. 6813.1 (Station 20).
Abbreviations: bc, bursal canal; cb, copulatory bursa; eg, cement glands; od, oviduct; pg, penis glands; pp, penis papilla; sg, shell glands; vd, vas deferens.

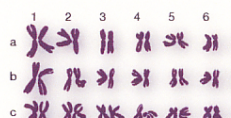


Fig. 10. *Girardia dorocephala*. Three idiograms for populations from three locations (Stations 17, 19, and 20; a, b and c, respectively).
a: $2x=16$, with a karyotype of $2m+2m+2m+2m+2m+2m+2m+2m$.
b and c: $2x=16$, with a karyotype of $2m+2m+2m+2m+2m+2m+2m+2m$.

Fig. 11. Metaphasic plate of *Girardia dorocephala* from South Virginia, U.S.A. (idiograms reconstructed by Kawakatsu, based on data in Benazzi 1970).

Genus *Rhodax* Marcus, 1946

Rhodax evelinae? Marcus, 1946

Material examined and distribution: *R. evelinae*? has been reported from two stations (Fig. 1). Honshū: Nagoya City (Station 5). Hokkaidō: Sapporo City (Station 10).

Morphology

Living, asexual specimens of the Nagoya (Station 5) and Sapporo (Station 10) populations measure 3–5 mm × 0.4–0.5 mm. Head rounded, with a gentle swelling on either side. Eyes situated close together, each surrounded by a non-pigmented ocular area. Ground colour of the dorsal surface pale brown. Numerous, small, darkish pigments present at the pharyngeal region. Ventral surface pale. A slightly thickened adhesive region present at the antero-ventral end of the body (Fig. 12).

Karyology

Two idiograms of *Rhodax evelinae*? from the Sapporo locality are shown in Fig. 13. The karyotype of asexual specimens of *Rhodax evelinae*? is $3x=24$, with four pairs of metacentric chromosomes and four pairs of submetacentric chromosomes (4th, 5th, 7th, 8th pairs). A few B-chromosomes are also present. Idiograms a and a' concern somatic cells of a single specimen.

Discussion

Rhodax evelinae? was found only in aquaria for tropical fish culture (water temperature $\geq 20^\circ\text{C}$). In Brazil *Rhodax evelinae* Marcus, 1946 inhabits dirty ponds, rivers and clear-water brooks near the city of São Paulo.



Fig. 12. External features of *Rhodax evelinae*?

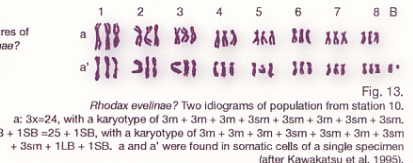


Fig. 13. *Rhodax evelinae*? Two idiograms of population from station 10.
a: $3x=24$, with a karyotype of $3m+3m+3m+3m+3m+3m+3m+3m$.
a': $3x+1LB+1SB=25+1SB$, with a karyotype of $3m+3m+3m+3m+3m+3m+3m+3m+3m+1LB+1SB$. a and a' were found in somatic cells of a single specimen (after Kawakatsu et al. 1995).

General discussion

The following factors may have facilitated the introduction and subsequent geographical spread of exotic freshwater triclads in Japan:

1. Popularization of domestic tropical fish cultures;
2. Culture of exotic aquatic animals as food;
3. Importation of live specimens of Chinese freshwater shrimps

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