

THE SECOND RECORD OF OCCURRENCE OF *RHODAX*? SP.
IN TANKS OF TROPICAL FISHES IN JAPAN
(TURBELLARIA, SERIATA, TRICLADIDA, CAVERNICOLA)

MASAHARU KAWAKATSU, SACHIKO TAMURA,
IWASHIRO OKI, MASAYUKI TAKAI,
and EUDOXIA MARIA FROEHLICH

INTRODUCTION: Historical Background to the Taxonomy

In 1946, MARCUS (pp. 133-142, 171-173, 236-241, pls. XXIV-XXVI, figs. 144-153, p. 250, pl. XXXI, fig. 5) reported a small and slender species of freshwater planarian under the name of *Rhodax evelinae*. This new species, collected from the vicinity of São Paulo, Brazil, was placed in a new paludicolen genus of the family Planariidae STIMPSON, 1857. MARCUS' original description cited above includes morphology, anatomy and histology of sexual specimens with sufficient figures. For many years, the species was known only from the type locality.

In July of 1982, a number of small, non-sexual specimens of planarian were collected from tanks for tropical fish culture (water temp., 22-26 °C) in the Biological Laboratory, Faculty of Science, Nagoya University, Nagoya, Honshū, Japan. This animal was reported as *Rhodax*? sp.; its chromosome numbers and karyotypes were studied by KAWAKATSU's team (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985, pp. 2, 13-17, table 1, figs. 7 A-J, 8 C-D', 9 C-E). Two different karyotypes were found in animals examined: 1) $3x = 24$; 2) $3x = 24$ & $3x + 1LB + 1SB = 25 + 1SB$. These authors considered that *Rhodax*? sp. might have been imported with an Amazon sword plant, one of the most common aquatic plants occurring in tropical fish tanks in Japan.

SLUYS (1990), who studied the type material of *Rhodax evelinae*, gave a detailed taxonomic redescription of the species (pp. 14-16, figs. 1 and 2). And, he placed the genus *Rhodax* MARCUS, 1946, and the 3 other genera — *Opisthobursa* BENAZZI, 1972, *Balliania* GOURBAULT, 1978, and *Mitchellia* KAWAKATSU et CHAPMAN, 1983 — in the family Dimarcusidae MITCHELL et KAWAKATSU, 1972 (see also KAWAKATSU & MITCHELL, 1983, 1984 a, b). In his paper, SLUYS (*op. cit.*, p. 28) wrote as follows:

"...there is a fourth major lineage within the Tricladida which should be given the same categorical rank as the three lineages previously recognized. I propose to use the name Cavernicola, which has ecological roots but no such connotation, for the lineage from which at present we only know the genera *Rhodax*, *Opisthobursa*, *Balliania* and *Mitchellia* of the family Dimarcusidae".

In early September, 1993, KAWAKATSU was informed by FROEHLICH (*in litt.*, São Paulo, Aug. 30) of the occurrence of *Rhodax evelinae* at a site other than the type locality. According to her information, several live specimens of this species, collected from an artificial lake located in Município Americana, Estado de São Paulo (approximately 135 km NW of São Paulo City), were brought to her

laboratory by Miss Regina Sawaya SÁFADI, a Master Course student of the Instituto de Biociências. These planarian specimens were obtained by cleaning roots of waterhyacinths (*Eichhornia crassipes*) collected from the lake. Unfortunately, all of the live specimens died within a few days.

Although FROEHLICH knows live specimens of *Rhodax evelinae* from the type locality (i.e., São Paulo population), the discovery of the Americana population mentioned above provided her a second chance to see live specimens of this species. Tentative identification of the species was made, based upon external morphology alone. No photographs of live specimens were prepared. Their karyotypes were not studied. Additionally, the type locality of this species was lost in 1960–1970 due to the great expansion and urbanization of the city of São Paulo.

On October 3, 1993, Miss Miyuki and Mrs. Kazuko KAWAKATSU (KAWAKATSU's daughter and wife) found many planarian specimens creeping on the inside surface of the glass wall of a tropical fish tank at a local tropical fish store, "The Fish Gallery — Sakana-no-Yakata", in the northeastern part of Sapporo. They brought several live specimens of this planarian to KAWAKATSU. Within a week, KAWAKATSU succeeded in collecting over 30 live specimens at "Sakana-no-Yakata" for taxonomic study.

Externally, the Sapporo specimens agree very well with previous descriptions and photographs of *Rhodax?* sp. from the Nagoya population (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985). There were no sexual specimens in this Sapporo population. Photographs of live specimens were prepared in KAWAKATSU's laboratory. About 10 specimens were sent to TAMURA (Ôsaka in Honshû) for chromosomal study. An additional 10 specimens were sent for culturing to TAKAI (Saga in Kyûshû) following his method of breeding of planarians (cf. TAKAI, 1989). The remaining specimens were placed in a tropical fish aquarium in Miss KAWAKATSU's room at home (Sapporo in Hokkaidô). Unfortunately, animals of both TAKAI's and KAWAKATSU's cultures disappeared within a month.

The karyological data obtained by TAMURA showed that the karyotypes of animals from the Sapporo population agree with those of animals from the Nagoya population of *Rhodax?* sp. (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985). TAMURA's draft of idiograms was examined carefully and confirmed by OKI.

FROEHLICH, who received a complete set of the data on *Rhodax?* sp. of the Nagoya and the Sapporo populations from KAWAKATSU, has studied the comparative morphology of animals found in Japan (based upon KAWAKATSU's photographs, sketches and observation notes *in litt.*) and MARCUS' (1946) original description and figures of *Rhodax evelinae* (including her memory of external morphology of animals). She concluded that specimens of *Rhodax?* sp. from Japan are very similar to those of *Rhodax evelinae*.

The second record of occurrence of *Rhodax?* sp. in Japan has been listed in the 1993 Åbo Symposium preprint, abstract and the 1995 publication: The Biology of Turbellaria and Some Related Flatworms (cf. KAWAKATSU, OKI, TAMURA, TAKAI, TIMOSHKIN & PORFIRJEVA, 1993, p. 2, fig. 1; OKI, TAMURA, TAKAI & KAWAKATSU, 1993, p. 91, 1995, pp. 71–74).

The purpose of the present paper is to provide photographs of live specimens of *Rhodax?* sp. from the Sapporo population and their idiograms, together with an additional discussion on the possible accidental distribution route of Brazilian freshwater planarian species into Japan.

MATERIALS AND METHODS

KAWAKATSU's Specimen Lot No. 2013 was given to the Sapporo specimens of *Rhodax?*

sp. used in the present study (see the above section). Chromosomes were observed according to the technique described in the previous papers (cf. OKI, TAMURA & KAWAKATSU, 1976; OKI, TAMURA,

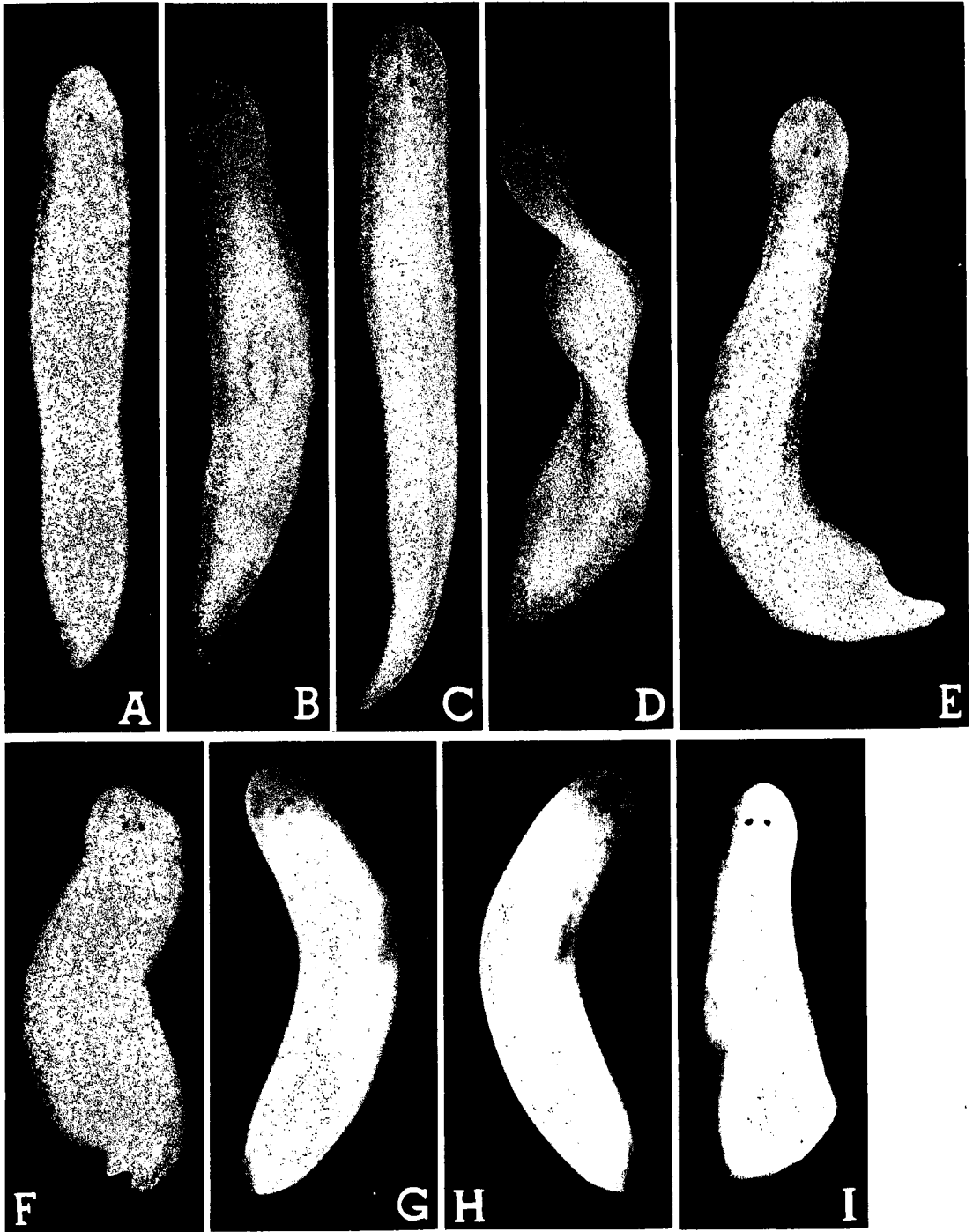


Fig. 1. Photographs of *Rhodax?* sp. from the Sapporo population (Specimen Lot No. 2013). A-F: Two live specimens. G-I: Two preserved specimens. G, dorsal view; H, ventral view.

YAMAYOSHI & KAWAKATSU, 1980, p. 4, fig. 4; KAWAKATSU, OKI, TAMURA, OGREN, YAMADA & MURAYAMA, 1990, p. 10, fig. 20; OKI, TAMURA, OGREN & KAWAKATSU, 1991, pp. 164-165, fig. 1).

DESCRIPTION

Order SERIATA BRESSLAU, 1933

Suborder TRICLADIDA LANG, 1884

Infraorder CAVERNICOLA SLUYS, 1990

Family D i m a r c u s i d a e MITCHELL et KAWAKATSU, 1972

Genus *Rhodax* MARCUS, 1946

Rhodax? sp.

External features. Photographs of live specimens of *Rhodax*? sp. from the Sapporo population are shown in Fig. 1 (A-E). Non-sexual specimens in life measure 3-5 mm in length and 0.4-0.5 mm in width. The head is of a rounded shape with a gentle swelling on either side (a pair of non-conspicuous auricular sense organ). It was observed in creeping animals that the anterior end formed a slight obtuse protrusion. Behind the head, the body reaches its greatest width at the level of the short pharynx, which is inserted anterior to the middle of the body. The posterior end of the body is bluntly pointed (Fig. 1 A-E).

A slightly thick adhesive region was observed at the antero-ventral end of the body of the Sapporo specimens. In live specimens, this organ is recognizable as a small swelling. Its histological description, based upon the animal from the Nagoya population, was given in a previous paper (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985, p. 14; see also MARCUS, 1946, pp. 236-237, fig. 144, z, i.e., "área adhesiva").

The two eyes are situated on the dorsal side of the head at a somewhat posterior level. The distance between them is about one-sixth of the head width at the level of the eyes (Fig. 1 A-E).

The bodies of small specimens are translucent or milky white. Somewhat larger specimens show a pale brown coloration on the dorsal surface of the body; small brownish pigments occur at the pharyngeal region. The shape of both anterior and posterior intestinal trunks can be seen through the body surface (Fig. 1 A-E).

Karyological observation. Idiograms of the animal examined from the Sapporo population are shown in Fig. 2 (A and B). The specimen has two different types of cells intermingled in one body: triploid cells and triploidic aneuploidy cells ($3x = 24$ & $3x + 1LB + 1SB = 25 + 1SB$) (Fig. 2 A and B). The triploidic karyotype consists of 4 sets of metacentric chromosomes (labeled Nos. 1, 2, 3, and 6 in the idiograms) and 4 sets of submetacentric chromosomes (labeled Nos. 4, 5, 7, and 8) (Fig. 2 A and B). The large B-chromosomes (LB) is a submetacentric (Fig. 2 B).

The karyotypes of the Sapporo specimen reported in the present paper agree with those of the Nagoya population (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985, p. 15, fig. 8 C-D).

Remarks on accidental distribution. This is a continuation of the "Taxonomic remarks" for *Rhodax*? sp. of the Nagoya population (cf. KAWAKATSU, OKI, TAMURA & YAMAYOSHI, 1985, pp. 15-17).

The discovery of the Nagoya population was some 13 years ago (see the "Introduction"). According to tropical fish catalogs issued in Japan, importations of various kinds of tropical fishes and water-plants from abroad — especially, Hong Kong, Singapore, Australia, Europe (Germany and The Netherlands), South and East Africa, North America, and South America (Peru, Brazil) — have greatly increased now in Japan. Fig. 3 (left) shows a copy of the Varig Air Cargo invoice for a direct




Fig. 2. Idiograms of *Rhodax?* sp. from the Sapporo population. A: $3x=24$. B: $3x+1LB+1SB = 25 + 1SB$. A and B were found in the body of a single specimen.

import of tropical fishes from Peru (Lima) to Japan (Tôkyô). This cargo arrives in less than 15 hours. Fig. 3 (right) shows a copy of a domestic air cargo from the consignee in Tôkyô (Japan Pet Fish Trading Co., Ltd.) to the Fish Gallery in Sapporo (*Rhodax?* sp. was found in this shop).

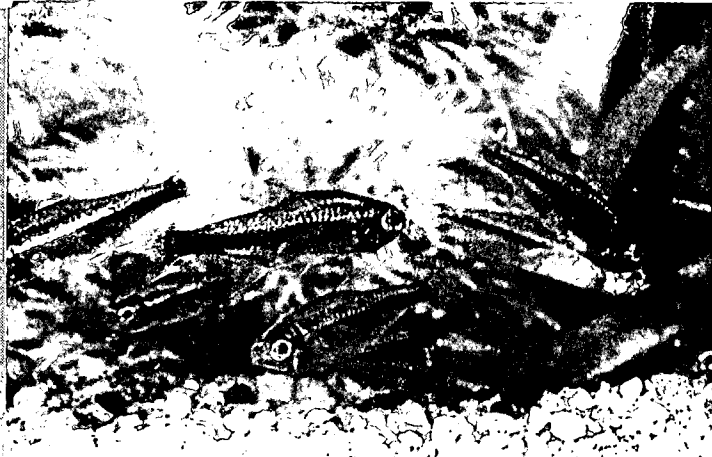
According to the recent article printed in The Asahi Newspaper (Asahi-Shinbun) (Fig. 4), the reporter who stayed at Manaus in Brazil stated that the number of specimens of tropical fishes collected annually in the Estado de Amazonas for commercial dealings may reach over 42 million (approximately 60 species). The lost specimens in the transportation from their localities (Barcelos on the Rio Negro for Cardinal Tetra, etc.) to Manaus also reach huge numbers (over 80 per cent of the whole!). Survivors will be exported to the United States, Japan, etc. Air cargo from Manaus to Tôkyô via São Paulo requires over 30 hours.

The artificial migration of small, aquatic, invertebrate animals is probably an everyday event.

 VARIG AIR CARGO		
Nº DO CONHECIMENTO: 042 57204125 AIR WAYBILL NUMBER:		
PARA TO TYO		
AEROPORTO DE TRANSFERÊNCIA: TRANSFER STATION:		
AEROPORTO DE TRANSFERÊNCIA: TRANSFER STATION:		
PESO DESTA VOLUME: WGT. OF THIS PIECE:	Nº TOTAL DE VOLUMES: TOTAL Nº OF PIECES:	PESO TOTAL DE EMBARQUE: TOTAL WGT. OF SHIPMENT:
KGS	90	540 KGS
AEROPORTO DE ORIGEM: AIRPORT OF DEPARTURE:		
CARGA 16 (315.792.450.795) 1.700 Bhs. LIM		

 JAPAN PET FISH TRADING CO., LTD.	
住所 受 名 人 前	065 札幌市豊区北23条 東合字番区北 フィッシュギャラリー 011-712-2500 TEL
荷 送 人	日本観賞魚貿易株式会社 〒166 東京都杉並区成田東4の1の26 TEL03 (3318) 5281代
	個 数 18
生きた熱帯魚に付取扱いに注意して下さい。	

Fig. 3. Invoices of the Varig Air Cargo (left) and a domestic air cargo (right) for importation and transportation of tropical fishes. For other explanations, see text.



熱帯魚の宝庫であるアマゾン奥地の川で生態系に異常が起きている。特定の魚の数が激減したり、二斤を超すほどの大魚は小魚りのものばかり目立つようになったり……。原因は、日本など先進国での熱帯魚ブームを受けた乱獲にあるからだ。ブラジル政府はこの秋から、絶滅の恐れがある魚の全面禁漁に踏み切るとしている。

(マナウス(アマゾン)川 磯村健太郎)

アマゾン 熱帯魚 受難

アマゾン川やその支流には、淡水魚では世界最大級のピラルクーという魚が生息する。成魚は体長二・二―二・五斤を越えてきたが、最近これほどの大ものは減ってしまった。

アマゾン川流域に各州に支部を置き、河川の大規模な調査をして、アマゾン州を調べてきたジョゼ・レラン管理課長(音仮)は、一筋縄ではいかない。アマゾン川流域の環境・資源部は、アマゾン川流域の各州に支部を置き、河川の大規模な調査をして、アマゾン州を調べてきたジョゼ・レラン管理課長(音仮)は、一筋縄ではいかない。

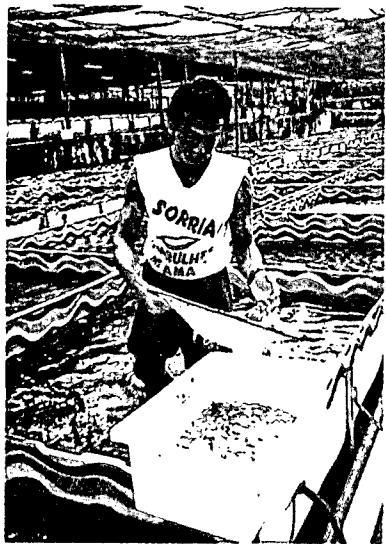


乱獲 ▼ 輸出拠点まで二割昇天 ▼ 空輸途中にも昇天 ▼ また乱獲

地元民はピラルクーを食べるので、一・五斤以上なら取るのは認められてきた。しかし、この魚は世界の愛好者も水族館に人気があり、輸出もされる。コロロンビアとの国境近くでは、ピラルクーの稚魚を狙う密漁が横行している。川で密漁できる駆逐艇を使い、国外へ運び出す大掛かりな手口だ。

調査の結果、漁獲量は十五年前の十分の一以下に減っていた。このためIBAMAは今年中にも、食用を

ブームのニッポン お得意さま



アマゾン州には輸出業者が十数あり、半数はマナウスに拠っている。同州からは約八割、合法分だけ年間約四千二百萬匹の熱帯魚が輸出される。アマゾン州には輸出業者が十数あり、半数はマナウスに拠っている。同州からは約八割、合法分だけ年間約四千二百萬匹の熱帯魚が輸出される。

IBAMAの報告では、カリフォルニア州の熱帯魚輸出業者は約二千人いる。捕まえた魚の輸送には地元民が利用する客船を使う。マナウスまで約四百キロ、約十六時間かかる。ほとんどの場合、魚を入れる容器には酸素の入れ替えも、水温調整の五月から七月は禁漁だが、効果は上がっていない。

大手輸出業者は地方から届けられた熱帯魚を飼っておき、急な注文にも応じる。出荷準備も洋文に記されたマナウスで、磯村の手

輸出業者によると、マナウスに寄るまで約八割の魚が死ぬ。業者は漁師に生き残った分しか代金を払わない。だから漁師は、魚が死ぬのを計りに入れて大損を取る。マナウスでは輸出に向け

が、実態は捕獲されるのはその何倍にも上る。カリフォルニア州の熱帯魚輸出業者は約二千人いる。捕まえた魚の輸送には地元民が利用する客船を使う。マナウスまで約四百キロ、約十六時間かかる。ほとんどの場合、魚を入れる容器には酸素の入れ替えも、水温調整の五月から七月は禁漁だが、効果は上がっていない。

ACKNOWLEDGEMENT

The authors wish to thank to Dr. Robert W. MITCHELL (Professor Emeritus of Texas Tech University), Bandera, Texas, U. S. A., for his kind reading of a draft of the present paper.

REFERENCES

- BENAZZI, M., 1972. Notizie preliminari sulle planarie raccolte nella Seconda Spedizione Lincea in Messico. Att. Acad. Naz. Lincei, Rend. Cl. Sci. Fis., Mat. Nat., (8), 52 : 403-405.
- BRESSLAU, E., 1933. Turbellaria. In: KÜKENTHAL, W. & T. KRUMBACH (eds.), Handbuch der Zoologie, Bd. 2 (1 Hälfte). Vermes Amera : 52-293. Walter de Gruyter & Co., Berlin und Leipzig.
- GOURBAULT, N., 1978. Une nouvelle planaire primitive d'origine marine, Turbellarié Triclade de Polynésie. Cahiers Biol. Mar., 19 : 23-36 + pl. 1.
- KAWAKATSU, M. & CHAPMAN, P., 1983. *Mitchellia sarawakana* gen. et sp. nov. (Turbellaria, Tricladida, Maricola), a new freshwater planaria from Water Polo Cave, Sarawak, East Malaysia. Jour. Speleol. Soc. Japan, 8 : 21-34.
- KAWAKATSU, M. & MITCHELL, R. W., 1983. Record of a cave-adapted planarian (Turbellaria, Tricladida, Maricola) from Guatemala. Annot. Zool. Japon., 56 : 291-298. 1984a. *Oahu-hawaiiiana kazukolinda* gen. et sp. nov. (Turbellaria, Tricladida, Maricola), a new freshwater planarian from Honolulu, Oahu Island, Hawaii, U.S.A. Zool. Sci., Tôkyô, 1 : 487-500. 1984 b. A list of retrobursal triclads inhabiting freshwaters and aquatic probursal triclads regarded as marine relicts, with corrective remarks on our 1984 paper published in Zoological Science, Tôkyô. Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (11) : 1-8.
- KAWAKATSU, M., OKI, I., TAMURA, S., OGREN, R. E., YAMADA, T. & MURAYAMA, H., 1990. Preprint of papers given at the Sixth International Symposium on the Turbellaria, Hirosaki, Japan (August 7-12, 1990). Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (22) : 1-16.
- KAWAKATSU, M., OKI, I., TAMURA, S., TAKAI, M., TIMOSHKIN, O. A. & PORFIRJEVA, N. A., 1993. Preprint of papers given at the Seventh International Symposium on the Turbellaria, Åbo, Finland (June 17-22, 1993). Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (25) : 1-20.
- KAWAKATSU, M., OKI, I., TAMURA, S. & YAMAYOSHI, T., 1985. Reexamination of freshwater planarians found in tanks of tropical fishes in Japan, with a description of a new species, *Dugesia austroasiatica* sp. nov. (Turbellaria ; Tricladida ; Paludicola). Bull. Biogeogr. Soc. Japan, 40 : 1-19.
- LANG, A., 1884. Die Polycladen (Seeplanarien) des Golfes von Neapel und der Angrenzenden Meeresabschnitte. In : Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte herausgegeben von der Zoologischen Station zu Neapel. XI. Monographie. I-IX + 1-688 pp. + pls. 1-39. Verlag von Wilhelm Engelmann, Leipzig.

Fig. 4 (on page 68). Reproduction in reduced size of Mr. K ISOMURA's Japanese article on the "Suffering of Tropical Fishes in the Amazon." After The Asahi Newspaper (Evening edition, October 7, 1995). For explanation, see the "Remarks on the accidental distribution" in the present paper.

MARCUS, E., 1946. Sobre Turbellaria Brasileiros. Zoologia, Fac. Filos., Ciênc. Let. Univ. São Paulo, (11): 5-250 (+ pls. I-XXX) + pl. XXXI.

MITCHELL, R. W. & KAWAKATSU, M., 1972. A new family, genus, and species of cave-adapted planarian from Mexico (Turbellaria, Tricladida, Maricola). Occ. Pap., Mus. Texas Tech Univ., (8): 1-16.

OKI, I., TAMURA, S. & KAWAKATSU, M., 1976. A technique for the study of planarian chromosomes. The Heredity (Iden), Tôkyô, 30 (12): 32-40. (In Japanese.)

OKI, I., TAMURA, S., OGREN, R. E. & KAWAKATSU, M., 1991. Karyology of four land-planarian species of the genus *Bipalium* from Japan. Hydrobiologia, 227: 163-167.

OKI, I., TAMURA, S., TAKAI, M. & KAWAKATSU, M., 1993. Chromosomes of *Temnocephala minor*, an ectosymbiotic turbellarian on Australian crayfish found in Kagoshima Prefecture, with karyological notes on exotic turbellarians found in Japan. VII ISBT Åbo/Turku Abstracts, p. 91. Åbo Akademi Univ., Åbo, Finland. 1995. Chromosomes of *Temnocephala minor*, an ectosymbiotic turbellarian on Australian crayfish found in Kagoshima Prefecture, with karyological notes on exotic turbellarians found in Japan. Hydrobiologia, 305: 71-77.

OKI, I., TAMURA, S., YAMAYOSHI, T. & KAWAKATSU, M., 1980. Preprint of a paper given at the Third International Symposium — The Biology of the Turbellaria in Honour of Prof. Tor G. KARLING, Hasselt (Diepenbeek), Belgium (August 10-15, 1980). Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (2): 1-23.

SLUYS, R., 1990. A monograph of the Dimarcusidae (Platyhelminthes, Seriata, Tricladida). Zool. Scripta, 19: 13-29.

STIMPSON, W., 1857. Prodromus descriptiones animalium evertibratorum quae in Expeditione and Oceanum, Pacificum Septentrionalem a Republica Federata missa, Johanne RODGERS Duce, observavit et descripsit. Proc. Acad. Nat. Sci. Philad., 9: 19-31.

TAKAI, M., 1989. A new collecting method of freshwater planarians and a system of breeding in large number. Acta Eruditorum (General Educ., Saga Med. School), (8): 15-26. (In Japanese, with English summary.)

Addresses of the Authors :

Dr. Masaharu KAWAKATSU, Professor of Biology, Biological Laboratory, Fuji Women's College, Kita-16, Nishi-2, Kita-ku, Sapporo (Hokkaidô) 001, Japan.

Dr. Sachiko TAMURA, Ôsaka Prefectural Institute of Public Health, Nakamichi-1-chôme 3-69, Higashinari-ku, Ôsaka 537, Japan.

Dr. Iwashirô OKI, Environmental Creative Engineering Laboratory Inc., Tokiwachô-1-chôme 4-12, Chûô-ku, Ôsaka 540, Japan.

Dr. Masayuki TAKAI, Professor of Biology, Biological Laboratory, Saga Medical School, Nabeshima 5-1-1, Saga 849, Japan.

Dr. Eudoxia Maria FROEHLICH, Professor of Biology, Emeritus, Instituto de Biociências, Departamento de Zoologia, Universidade de São Paulo, Rua do Matão, Travessa 14, Cidade Universitária, Caixa Postal 11461, Cep 05422-970, São Paulo, SP, Brasil.

December 25, 1995.