

**A List of Known Bipaliid Land Planarian Species from India,  
with a Record of Three *Diversibipalium* spp.**

**By Masaharu KAWAKATSU & Munirathinam JAYASHANKAR**

**INTRODUCTION**

One group of land (or terrestrial) planarians is known as the “hammer-headed planaria”. Until recently, over 160 species were known in this Asiatic triclad group under a single genus *Bipalium* Stimpson, 1857. However, some 60% of these are known only by their external morphological characters (cf. Ogren & Kawakatsu, 1987, 1988; Ogren, Kawakatsu & Froehlich, 1997, 1998). Anatomical and histological description of the copulatory apparatus based upon fully sexually mature specimens is necessary for the species identification of triclad planarians (cf. Von Graff, 1896a, b). In other words, many bipaliid species described in classical literature could not be precisely identified.

Reclassification of the land planarian species of the genus *Bipalium* Stimpson, 1857 has progressed after the past over ten years or so. All the known bipaliid species have been reclassified into three genera, *Bipalium* Stimpson, 1857, *Novibipalium* Kawakatsu, Ogren & Froehlich, 1998 and *Humbertium* Ogren & Sluys, 2001. The remaining species, those described by non-sexual specimens, and/or uncertain species whose genital anatomy is not clarified, were transferred into a Collective Group *Diversibipalium* Kawakatsu, Ogren, Froehlich & Sasaki, 2002. Uncertain bipaliid species are placed in this genus (collective group) until proper taxonomic confirmation allows the correct genus to be identified (cf. ICZN, 4th Ed., 1999).

The Indian bipaliid land planarian fauna was studied mainly by Von Graff (1894, 1899), Whitehouse (1919) and De Beauchamp (1930). Their described species were already revised in the serial publications of “Land Planarian Indices Series” started in 1987 (some of the publications in this series are cited in the present web article).

The first purpose of the present web article, is to give a list of bipaliid land planarians reported from India. Its higher classification system is based upon the new taxonomic system of triclads proposed by Sluys, Kawakatsu, Riutort & Bagnà (2009). Secondly, three new species of *Diversibipalium* are reported, of which two were collected from the second author's working place in southern India.

Preserved samples of unidentified land planarians are important material for the future study of local biodiversity of India. Undoubtedly, India has many bipaliid species. The authors show a standard method of the registration of land planarian species. The preserved samples of planarians should be kept for future taxonomic study by turbellariologists.

## A LIST OF BIPALIID LAND PLANARIAN SPECIES RECORDED FROM INDIA

Phylum PLATHELMINTHES Schneider, 1873 / PLATYHELMINTHES Claus, 1887

Clade Rhabditophora Ehlers, 1985

Subclade Eulecithophora De Beauchamp, 1961 sense in Soppott-Ehlers, 1997

Superorder Seriata Bresslau, 1933 sense in Soppott-Ehlers, 1997

Order Tricladida Lang, 1884

Suborder Continenticola Carranza, Littlewood, Clough, Ruiz-Trillo,  
Baguña & Riutort, 1998

Superfamily Geoplanoidea Stimpson, 1857

Family Bipaliidae Von Graff, 1896

Genus *Bipalium* Stimpson, 1857

- Bipalium kewense* Moseley, 1878. Cosmopolitan species.  
*Bipalium rigaudi* Von Graff, 1894. Assam, India; Vietnam.  
*Bipalium univittatum* Grube, 1866. Madras, S. India.  
*Bipalium vinosum* Kaburaki, 1925. Andaman Is., India; Sumatra, Indonesia.

Genus *Humbertium* Ogren & Sluys, 2001

- Humbertium core* (De Beauchamp, 1930). Palnis in Madras, S. India.  
*Humbertium dodabettiae* (De Beauchamp, 1930). Nilgiris, S. India.  
*Humbertium palnisium* (De Beauchamp, 1930). Palnis (=Palni), S. India.  
*Humbertium proserpina* (Humbert, 1862). Hooker Estate, Nadu-vattam, Nilgiris, India.

Genus *Novibipalium* Kawakatsu, Ogren & Froehlich, 1998

- Novibipalium alterifuscatum* Kawakatsu, Ogren & Froehlich, 1998. India?; Java,  
Indonesia.

Genus *Diversibipalium* Kawakatsu, Ogren, Froehlich & Sasaki, 2002

- Diversibipalium andrewesi* (Whitehouse, 1919). Nilgiris, S. India.  
*Diversibipalium brunneum* (Whitehouse, 1919). Bagarkote Kumaon in the Western  
Himalaya, and Cochin State, India.  
*Diversibipalium delicatum* (Whitehouse, 1914). Rotung, Assam, India.  
*Diversibipalium dihangense* (Whitehouse, 1914). Valley of the Dihang River, Abor,  
Assam, India.  
*Diversibipalium ferudpoorrense* (Wright, 1860). Bangar and Naga Hills?, India.  
*Diversibipalium floweri* (Von Graff, 1899). Naduvattam, Nilgiris Hills, India.  
*Diversibipalium giganteum* (Whitehouse, 1914). Assam, India.  
*Diversibipalium grayi* (Wright, 1860). Naga-Hills, Assam, India; NE China.  
*Diversibipalium indicum* (Whitehouse, 1919). Calcutta and Goimbatore, India.  
*Diversibipalium kirckpatricki* (Von Graff, 1899). India; Sri Lanka.  
*Diversibipalium lunatum* (Gray, 1835). Bengal, India.  
*Diversibipalium roonwali* (Ramakrishna & Chahan, 1962). Nilgiris Hills, India.

<i>Diversibipalium rotungense</i> (Whitehouse, 1914).	Rotung, Assam, India.
<i>Diversibipalium smithi</i> (Von Graff, 1899).	Darjeeling, India.
<i>Diversibipalium sordidum</i> (Whitehouse, 1914).	The Yemburg River, Assam, India.
<i>Diversibipalium splendens</i> (Whitehouse, 1919).	Kurseong, Eastern Himalaya and Cherrapungi, Assam, India.
<i>Diversibipalium sylvestre</i> (Whitehouse, 1919).	Cochin State, India.
<i>Diversibipalium whitehousei</i> (Ogren & Kawakatsu, 1987).	Rotting, Assam, India.
Olim <i>Placocephalus superbus</i> Whitehouse, 1914 [nec <i>Bipalium superbum</i> Von Graff, 1899]	

## DESCRIPTION OF *Diversibipalium* spp. FROM INDIA

### 1. Redescription of *Bipalium* sp. (species of Madurai)

Cf. Kawakatsu & Basil (1971: 43-45, pl. I, figs D and E). See also Kawakatsu & Basil (1976: 51-52, fig. 1 D and E).

#### *Diversibipalium* sp. (species of Madurai) Kawakatsu & Basil, 1971.

Fig. 1 (A and B).

Redescription. This is a middle-sized, non-sexual specimen. About 30 mm long and 2.5 mm wide in the creeping state (a preserved specimen was about 20 mm long). The general appearance of a living specimen was shown in figures cited above (see Fig. 1 A and B in the present web article).

The head is of a typical semi-lunar shape. Behind the head, the body first narrows, then gradually widens towards the region of the pharynx. The posterior end of the body is bluntly pointed. The ground color of the dorsal surface is a uniform brownish black. The head plate is surrounded by a yellowish white circle. A wide, yellowish white band is found at the posterior of the “neck”. There are three, narrow, inconspicuous longitudinal stripes on the dorsal side of the body. The ventral side has a slightly lighter color except for the midventral creeping sole. Numerous small eyes form a band along the anterior margin of the head (Fig. 1 B). They also occur along the anterior body sides.

Locality and the Collection Data. Alagerkovil Hills situated about 21 km N of Madurai, Tamil Nadu, India. Altitude, about 405 m. July 25, 1969. A single sexually immature specimen. Coll. Mr. J. A. Basil.

Material. One whole mount (Kawakatsu’s Specimen Lot No. 763). This slide is now in the Zoological Museum of the University of Amsterdam, Amsterdam, The Netherlands. Cf. Sluys, Kawakatsu & Bleeker (2006).

## 2. Report of two *Diversibipalium* spp. from Bangalore (Deccan Plateau) in southern India

### i). *Diversibipalium* sp. 1 (species of Bangalore 1). Fig. 1 (C and D).

Description. The large head of a sexually mature specimen examined is semicircular in life. It may attain 3 cm long and 5 mm wide (Fig. 1, C and D). Behind the head, a narrow “neck” is conspicuous; then widens toward the region of the pharynx and copulatory apparatus; the body ended in a bluntly pointed posterior end.

The ground color of the dorsal surface is pale yellowish brown. There are four blackish longitudinal stripes. Namely, a pair of the wide mid-dorsal stripes forms a reverse-hastate mark at the postero-central portion of the head plate. A pair of the wide lateral stripes is conspicuous (Fig. 1, C and D). The ventral side of the body has a slightly lighter coloration except for the mid-ventral creeping sole.

Locality and the Collection Data. Grounds of the Dhanavantheri Vana Medical Plant Nursery, Bangalore, Urban District, India. Altitude, about 950 m. April 17, 2010. A single sexually mature specimen of *Diversibipalium* sp. (species of Bangalore 1) was obtained. Coll. M. Jayashankar.

Material. One preserved specimen kept in the former Laboratory of the collector at the Department of Zoology, Bangalore University. The sample is, however, not available for the future taxonomic study due to poor preservation.

### ii). *Diversibipalium* sp. 2 (species of Bangalore 2). Fig. 1 (E).

Description. The moderate large head of a sexually mature specimen is of a crescent-shape in life. It may attain 5 cm long and 7 mm wide (Fig. 1 E). Behind the head, a narrow “neck” is conspicuous. The body ended in a bluntly pointed posterior end.

The ground color of the dorsal surface is a uniform blackish brown (without any stripes, or color patterns). The ventral side of the body has a slightly lighter color except for the mid-ventral creeping sole.

Locality and the Collection Data. Grounds of the Dhanavantheri Vana Medical Plant Nursery, Bangalore, Urban District, India. Altitude, about 950 m. October 15, 2010. A single sexually mature specimen of *Diversibipalium* sp. (species of Bangalore 2) was obtained. Coll. M. Jayashankar.

Material. One preserved specimen kept in the former Laboratory of the collector at the Department of Zoology, Bangalore University. The sample is, however, not available for the future taxonomic study due to poor preservation.

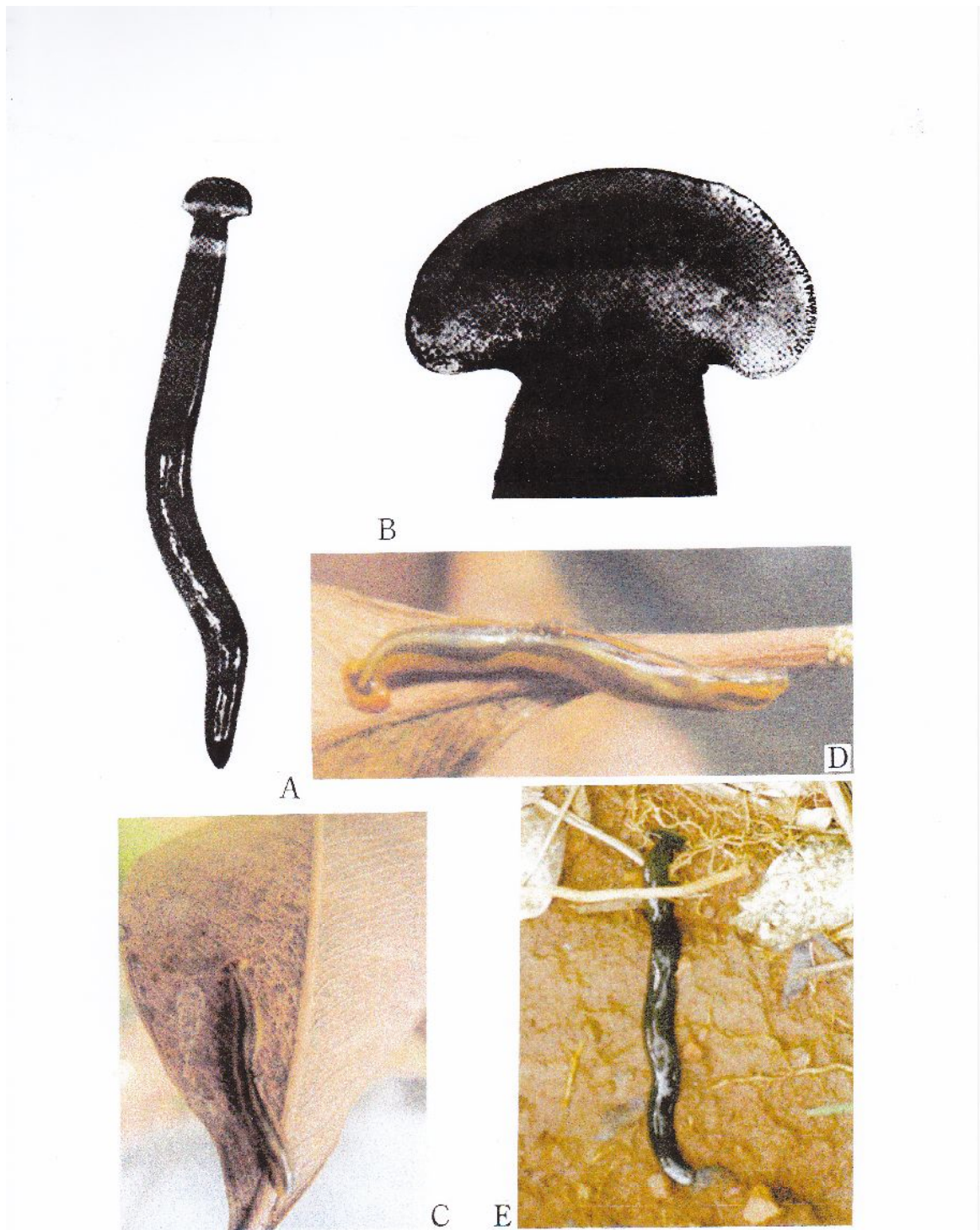


Fig. 1. Three unidentified species of bipaliid land planarians from India. A and B. *Diversibipalium* sp. (species of Madurai) Kawakatsu & Basil, 1971. Black-and-white photos. A: Entire specimen; B: Enlarged head. C and D: *Diversibipalium* sp. (species of Bangalore 1). Color photos. The same specimens (D is enlarged photo). E: *Diversibipalium* sp. 2 (species of Bangalore 2). Color photo.

## APPENDIX

### Recording and Preservation Methods of Land Planarians for Taxonomic Study

For the taxonomic study of land planarians, the microscopic examination of serial sections of the copulatory apparatus is necessary. Thus, well-preserved, fully sexually mature specimens are essential for the study of land planarian fauna.

The external appearance of planarians, especially, the shape of the head, body form, general coloration, pigmentation patterns, colour bands and stripes on both the dorsal and ventral sides of the body, is very important. Color photographs and brief sketches of living specimens (especially the shape of the head with small eyes) are indispensable for the future taxonomic study of the preserved specimens.

Fixative solutions used for the preservation of planarians have a material effect upon the morphological, anatomical and histological conditions of land (and freshwater) planarian samples (cf. Kawakatsu & Miyazaki, 1972). In general, Bouin's fluid (sat. sol. of picric acid 75 ml + formalin 25 ml + acetic acid glacial 5 ml) is good for preservation. Ethanol (70% or 80%) is also rather good as a general fixative; absolute ethanol has the bonus of allowing future DNA analysis. Formalin (3% solution) should be avoided for the preservation of planarians.

#### Suggested protocol:

- 1). Transfer the live specimen(s) with a fine brush into a Petri dish containing clean water. Remove soil (and other extraneous matter) from the body surface of living specimens.
- 2). Remove the water (and refuse) by tilting the dish to an angle of 90°.
- 3). Pour Bouin's fluid (or 70% ethanol, etc.) over the living planarian(s). Shake the dish until the worm(s) do not move. Note that it is not desirable to leave the fixed land planarian specimens in Bouin's fluid under direct sunlight.
- 4). After 2 to 10 hours, the preserved planarian specimen(s) should be transferred to a glass tube containing 70-80% ethanol solution (except for the samples of future DNA analysis kept in absolute ethanol). A slip of paper described the collection data Must be added.

The following publications are useful for the method of taxonomic study of land planarians: Winsor (1997) (1-4); Winsor (1998).

## ACKNOWLEDGEMENT

The authors are indebted to Dr Hugh D. Jones, Scientific Associate of the Natural History Museum, London, for his kind reading and corrections of the draft of this web article (Kawakatsu's typewritten manuscript) as well as a preparation of its digital draft.

## REFERENCES

- For the literatures cited in the "LIST OF BIPALIID LAND PLANARIAN SPECIES RECORDED FROM INDIA", the following articles on the higher classification of Tricladida, see Kawakatsu, Murayama, Kawakatsu, M-y. & Kawakatsu, T. (2009). They are: Carranza, Littlewood, Clough, Ruiz-Trillo, Bagueña & Riutort (1997); Claus (1887); De Beauchamp (1961); Ehlers (1985); Lang (1884); Soppott-Ehlers (1997).
- De Beauchamp, P., 1930. Turbellariés Triclades de l'Inde méridionale. Rev. Suisse Zool., 37 (23): 673-746 + Pl. 8.
- Gray, J. E., 1835. Description of two new species of Indian articulated animals (Annelida) discovered by Gen. Hardwicke, in India. Zool. Miscel., (1), 8: 5. London.
- Grube, E., 1866. Beschreibungen neuer von der Novara-Expedition Verhandl. d. k. k. Zool.-bot. Ges. Wien, 16: 173-184.
- Humbert, 1, A. & Glaparede, M. E., 1862. Description de quelques espèces nouvelles de planaires terrestres de Ceylon. Mém. Soc. Phys. Genève, 16: 293-311 + Pl.
- International Commission on Zoological Nomenclature, 1999. International Code of Zoological Nomenclature Fourth Edition Adopted by the International Union of Zoological Sciences, i-xxxix + 1-306 pp. London.
- Kaburaki, T., 1925. Planarians from the Andamans. Rec. Ind. Mus., 27: 29-32.
- Kawakatsu, M. & Basil, J. A., 1971. Records of freshwater and land planarians from India. Bull. Fuji Women's College, (9), II: 41-50 (+ Pls 1-2).
- Kawakatsu, M. & Basil, J. A., 1976. An account of triclad turbellarians: Especially the freshwater genus *Dugesia*. Jour. Madurai Univ., 5: 50-54.
- Kawakatsu, M. & Miyazaki, T., 1972. Effect of different fixatives on a common Japanese freshwater planarian, *Dugesia japonica* Ichikawa et Kawakatsu. Bull. Fuji Women's College, (10), II: 81-117 (+ Pls VII-XXXII).

- Kawakatsu, M., Murayama, H., Kawakatsu, M-y. & Kawakatsu, T., 2009. A new list of Japanese freshwater planarians based upon a new higher classification of planarian flatworms proposed by Sluys, Kawakatsu, Riutort & Baguña (2009). Kawakatsu's Web Library on Planarians. Dec. 25, 2009. <http://www.riverwin.jp/pl/> . Left Button: NewList FPs JAPAN.
- Kawakatsu, M., Ogren, H. E. & Froehlich, E. M., 1998. The taxonomic revision of several homonyms in the genus *Bipalium*, family Bipaliidae (Turbellaria, Seriata, Tricladida, Terri-cola). Bull. Fuji Women's College, (36), II: 83-93.
- Kawakatsu, M., Ogren, R. E., Froehlich, E. M. & Sasaki, G.-Y., 2002. Miscellaneous Papers on Turbellarians, Article II. Additions and corrections of the previous land planarian indices of the world (Turbellaria, Seriata, Tricladida, Terricola). Additions and corrections of the previous land planarian indices of the world - 10. Bull. Fuji Women's Univ., (40), II: 162-177. Kawakatsu's Home Page. <http://www.riverwin.jp/pl/> . Left Button: Planarian net mirror. Land planarian indices series: 2002.
- Moseley, H. N., 1878. Description of a new species of land planarian from the hothouses at Kew Gardens. Ann. Mag. Nat. Hist., (5), 1: 237-239.
- Ogren, R. E. & Kawakatsu, M., 1987. Index to the species of the genus *Bipalium* (Turbellaria, Tricladida, Terricola). Bull. Fuji Women's College, (25), II: 79-119.
- Ogren, R. E. & Kawakatsu, M., 1988. Index to the species of the genus *Bipalium* (Turbellaria, Tricladida, Terricola): Additions and corrections. Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (19): 1-16.
- Ogren, R. E., Kawakatsu, M. & Froehlich, E. M., 1997. Additions and corrections of the previous land planarian indices of the world (Turbellaria, Seriata, Tricladida, Terricola). Addendum IV. Geographic locus index: Bipaliidae; Rhynchodemidae (Rhynchodeminae; Microplaninae); Geoplanidae (Geoplaninae; Gaenoplaninae; Pelmatoplaninae). Bull. Fuji Women's College, (35), II: 63-103 (+ Appedix I-V).
- Ogren, R. E., Kawakatsu, M. & Froehlich, E. M., 1998. Additions and corrections of the previous land planarian indices of the world (Turbellaria, Seriata, Tricladida, Terricola). Addendum IV. Geographic locus index: Bipaliidae; Rhynchodemidae (Rhynchodeminae; Microplaninae); Geoplanidae (Geoplaninae; Gaenoplaninae; Pelmatoplaninae). Errata. Occ. Publ., Biol. Lab. Fuji Women's College, Sapporo (Hokkaidô), Japan, (31): 1-4.
- Ogren, R. E. & Sluys, R., 2001. The genus *Humbertium* gen. nov., a new taxa of the land planarian family Bipaliidae (Tricladida, Terricola). Belg. Jour. Zool., 131 (Supplement 1): 201-204.



- Ramakrishna, G. & Chauhan, B. S., 1962. Description of *Bipalium roonwali* sp. nov., with notes on two other species of the family Bipaliidae from the Nilgiris, India. Rec. Indian Mus., 58: 53-56.
- Sluys, R., Kawakatsu, M. & Bleeker, J., 2006. The Kawakatsu Collection incorporated within the collections of the Zoological Museum Amsterdam. Kawakatsu's Web Library on Planarians. Oct. 31, 2006. Pp. 1-5 (+ Poster); Abstract in Ber. nat.-med. Vereins in Innsbruck, Suppl. 16 (p. 89). <http://www.riverwin.jp/> . Left Button: 10th ISFB.
- Sluys, R., Kawakatsu, M., Riutort, M. & Bagnà, J., 2009. A new higher classification of planarian flatworms (Platyhelminthes, Tricladida). Jour. Nat. Hist., 43 (29-30): 1763-1777.
- Stimpson, W., 1857. Prodromus descriptiones animalium evertibratorum quae in Expeditione ad Oceanum, Pacificum Septentrionalem a Republica Federata missa, Johanne Rodgers Duce, observavit et descripsit. Proc. Acad. Nat. Sci. Philadelphia, 9: 19-31.
- Von Graff, L., 1894. Description d'une planaire terrestre du Tonkin. Bull. Soc. Zool. France, 19: 100-101.
- Von Graff, 1896a. Über das System und die geographische Verbreitung der Landplanarien. Verhandl. Deutsch. Zool. Gesellschaft, 6: 61-75.
- Von Graff, L., 1896b. Über die Morphologie des Geschlechtsapparates der Landplanarien. Verhandl. Deutsch. Zool. Gesellschaft, 6: 75-93.
- Von Graff, L., 1899. Monographie der Turbellarien. II. Tricladida Terricola (Landplanarien). Pp. i-ixv + 1-574; Atlas von Achtundfunzig Tafeln zur Monographie der Turbellarien. II. Tricladida Terricolen (Landplanarien). Pls I-LVIII. Verlag von Wilhelm Engelmann. Leipzig.
- Whitehouse, R. H., 1914. Indian land planarians. Record of the Indian Museum, 8 (Abor Expedition): 455-464 + Pls XXIX-XXX.
- Winsor, L., 1997. Terrestrial flatworms Infosheet Nos 1-4. 10 pages in total. Central Services Office, James Cook University, Townsville, QLD 4811. Australia.
- Winsor, L., 1998. Collection, handling, fixation, histological and storage procedures for taxonomic studies of terrestrial flatworms (Tricladida: Terricola). Pedobiologia, 42, 405-411.
- Wright, E. P., 1860. Notes on *Dunlopea*. Ann. Mag. Nat. Hist., 6, 3 Ser.: 54-56.

*Addresses of the Authors:*

Dr. Masaharu KAWAKATSU: 9jô 9chôme 1-8, Shinkotoni, Kita-Ku, Sapporo (Hokkaidô)  
001-0909, Japan.  
Tel. & Fax (International: 81-11-762-4450); (Domestic: 011-762-4450).  
E-mail (Miss Miyuki Kawakatsu): [DQA01524@nifty.ne.jp](mailto:DQA01524@nifty.ne.jp)

Dr. Munirathinam JAYASHANKAR: Research Associate, Division of Entomology and  
Nematology, Indian Institute of Horticultural Research (IIHR), Hessaraghatta,  
Bangalore-89, Karnataka, India.  
E-mail: [jay-zoology@rediffmail.com](mailto:jay-zoology@rediffmail.com)

\*\*\*\*\*

December 30, 2013.

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

Notice. Kawakatsu's old HP (<http://victoriver.com>) was closed in April, 2012. The new HP (<http://www.riverwin.jp/pl/>) was opened in August, 2012. All of the web articles opened in his old HP were transferred into the new HP by the end of 2012.

