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Original Article

The Indian species of *Testudinella* (Rotifera: Flosculariacea: Testudinellidae) and their distribution

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Abstract: Our plankton and semi-plankton collections from India revealed 14 species of *Testudinella* including two undetermined species yet awaiting descriptions. The Oriental endemic *T. insinuata* is a new record from India while the Australasian *T. walkeri* and the palaeotropical *T. brevicaudata* and *T. greeni* are other globally interesting species. *Testudinella amphora*, *T. brevicaudata*, *T. dendradena*, *T. greeni*, *T. parva semiparva*, *T. tridentata* and *T. walkeri* are characterized by distribution restricted till date to northeast India (NEI); *T. insinuata* is restricted to the floodplains of the Kashmir valley of Jammu and Kashmir state of western Himalayas; and *T. incisa* and *T. mucronata* are known for valid reports from Tamil Nadu and Jammu and Kashmir, respectively. *T. emarginula*, *T. patina* and *T. tridentata* are believed to be cryptic species-complexes and thus desired ecological and genetic analysis of local populations. This study merits interest vis-à-vis biodiversity and distribution of the Indian Rotifera.

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Introduction

Rotifera had been documented and described from different states of India since pioneering taxonomic survey of Anderson (1889) yet *Testudinella* species (Family: Testudinellidae) were characterized by their little known nature in the Indian waters (Sharma and Michael, 1980). This generalization holds valid even till date although Sharma (1990) firstly gave an account of species from NEI while Sharma and Sharma (2014a) maintained *status-quo* on the diversity of the taxon from this region. Our more extensive plankton and semi-plankton collections from NEI as well as elsewhere from India resulted in some interesting additions. We present an account of *Testudinella* spp, including two undetermined species yet pending descriptions, known till date from this country. Various taxa are illustrated and briefly commented with remarks on their distribution. The report is of interest for biodiversity and distribution of Rotifera of the Indian sub-region.

Materials and Methods

This present study is based on analysis of plankton and

semi-plankton collections examined from wide range of habitats from various states of India including our extensive collections from seven states of Northeast India (NEI). The samples were collected by towing a nylobolt plankton net (50 µm) and were preserved in 5% formalin. Individual specimens were screened with Wild-stereoscopic binocular and mounted in Polyvinyl alcohol-lactophenol mixture. Illustrations are made with a Leica DM 1000 phase contrast microscope using an image analyzer. *Testudinella* spp. was identified following Koste (1978), Sharma (1990) and Sharma and Sharma (2008, 2013, 2015).

Results

Presented below is the systematic list of *Testudinella* spp. observed from India (# new record from India; * examined in our collections from northeast India):

Phylum: Rotifera

Class: Eurotatoria

Subclass: Monogononta

Order: Flosculariacea

Family: Testudinellidae

1. *Testudinella amphora* Hauer, 1938*

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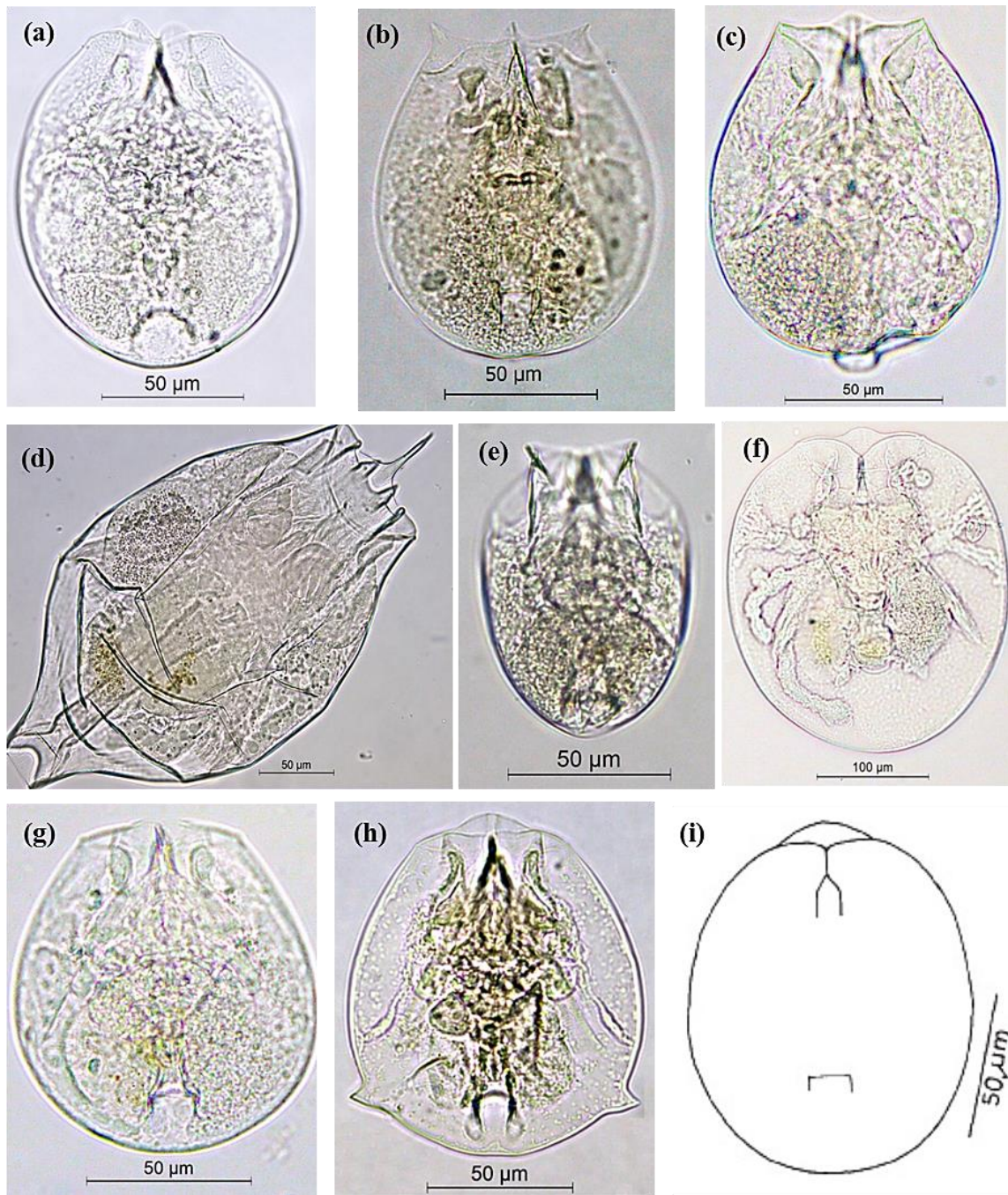


Figure 1. *Testudinella* spp. from India: (a) *T. insinuata* Hauer (ventral view), (b) *T. walkeri* Koste & Shiel (ventral view), (c) *T. brevicaudata* Yamamoto (ventral view), (d) *T. greeni* Koste (ventral view), (e) *T. amphora* Hauer (ventral view), (f) *T. dendradena* de Beauchamp (ventral view), (g) *T. parva parva* (Ternetz) (ventral view), (h) *T. parva bidentata* (Ternetz) (ventral view) and (i) *T. parva semiparva* Hauer (ventral view) (after Sharma, 1990).

2. *T. brevicaudata* Yamamoto, 1951*
3. *T. dendradena* de Beauchamp, 1955*
4. *T. emarginula* (Stenroos, 1898) s. lato*
5. *T. greeni* Koste, 1981*
6. *T. incisa* (Ternetz, 1892)
7. *T. insinuata* Hauer, 1938 #*
8. *T. mucronata* (Gosse, 1886)

9. *T. parva parva* (Ternetz, 1892)*
T. parva bidentata (Ternetz, 1892)*
T. parva semiparva Hauer, 1938*
10. *T. patina* (Hermann, 1783) s. lato*
11. *T. tridentata* Smirnov, 1931 s lato*
12. *T. walkeri* Koste & Shiel, 1980*
13. *T. sp.*

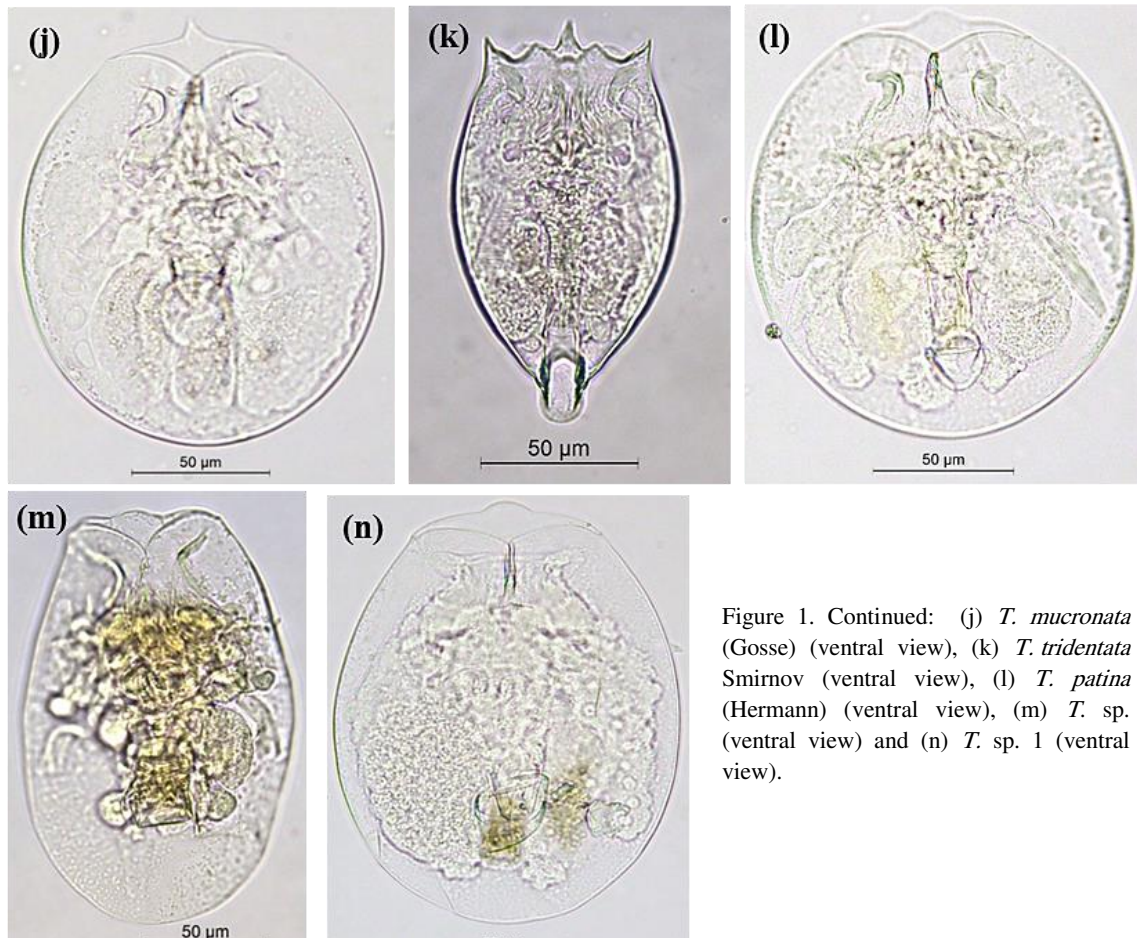


Figure 1. Continued: (j) *T. mucronata* (Gosse) (ventral view), (k) *T. tridentata* Smirnov (ventral view), (l) *T. patina* (Hermann) (ventral view), (m) *T. sp.* (ventral view) and (n) *T. sp. 1* (ventral view).

14. *T. sp. 1*

Testudinella insinuata Hauer (Fig. 1a) is a new record from India. *Testudinella walkeri* (Fig. 1b) and the palaeotropical *T. brevicaudata* (Fig. 1c) and *T. greeni* (Fig. 1d) are species of global distribution interst. *Testudinella amphora* (Fig. 1e), *T. dendradena* (Fig. 1f), *T. incisa*, *T. parva parva* (Fig. 1g), *T. parva bidentata* (Fig. 1h), *T. parva semiparva* (Fig. 1i), *T. mucronata* (Fig. 1j) and *T. tridentata* (Fig. 1k) are examples of the regional distribution interest in the Indian subcontinent while *T. patina* (Fig. 1l) is widely known from this country. In addition, *Testudinella sp.* (Fig. 1m) and *T. sp. 1* (Fig. 1n) are un-determined species awaiting descriptions pending examination of more specimens. The former is characterized by its elongated oblong lorica morphologically distinct from other known species of *Testudinella* while *T. sp. 1* is notable for its pear-shaped lorica with closer affinity with *T. patina* species-complex.

Discussion

A total of 14 species of *Testudinella* (including two un-determined species awaiting descriptions) documented from India assert the most speciose nature of the genus known till date from South and Southeast Asia and from the Indian sub-region in particular. This report assumes additional interest in view of the occurrence of 15 species of the taxon from the Oriental region (Segers, 2008) amongst nearly four dozen valid species known globally (Segers, 2007) while Jersabek and Leitner (2013) raised totally tally to 60+ species. The richness of the Indian *Testudinella* spp. is higher than 10 species reported (Sa-Ardrit et al., 2013) from otherwise well studied Thai Rotifera.

Testudinella insinuata is a new record from India; originally described from Botanical Garden in Buitenzorg, Java, Indonesia, this species was considered a synonym of *T. parva* (Ternetz) by Sanoamuang and Savatentalinton (2001), Segers et al.

(2004) and Segers (2007). We designate it as a valid species following Jersabek and Leitner (2013) and in view of distinct morphological differences between two species. This Oriental endemic is observed in our collections from the floodplains of the Kashmir valley of Jammu and Kashmir state (BKS, unpublished) of western Himalayas.

The Australasian *T. walkeri* is an interesting recent addition to the Indian fauna from Mizoram state (Sharma and Sharma, 2015a). The report of this species endorsed affinity of Rotifera assemblage of NEI (Sharma and Sharma, 2014a, 2014b, 2017) with the faunas of Southeast Asia and Australia. The palaeotropical *T. brevicaudata* and *T. greeni* are other two species of global distribution interest; the former was described from Japan and is now known from the Afrotropical, Oriental and Palearctic regions (Segers, 2007). *Testudinella greeni*, described from Australia, is reported from the Afrotropical, Australian, Neotropical and Oriental regions (Segers, 2007). Interestingly, this species was noticed to be restricted to the floodplain lakes of the Brahmaputra river basin of Assam (Sharma and Sharma, 2014a, 2014b) while it is now observed from certain small wetlands of Mizoram (Sharma and Sharma 2015a) and Nagaland (Sharma et al., 2017) states thus indicating distinct distribution in NEI.

Testudinella amphora, *T. dendradena*, *T. incisa*, *T. parva parva*, *T. parva bidentata*, *T. parva semiparva*, *T. mucronata* and *T. tridentata* are examples of the regional distribution interest in the Indian subcontinent. Of these, *T. amphora*, *T. brevicaudata*, *T. dendradena*, *T. greeni*, *T. parva bidentata*, *T. parva semiparva*, *T. tridentata* and *T. walkeri* are characterized by distribution exclusively restricted to northeast India (NEI). Further, *T. parva semiparva* recorded rare occurrence with the sole report from Assam (Sharma, 1990) and *T. parva bidentata*, is known till date from Assam (Sharma, 1990; Sharma and Sharma, 2001, 2008, 2014a) while *T. dendradena* is observed from Assam (Sharma and Khan 2016; Sharma et al., 2017) and Nagaland (Sharma et al., 2017). *Testudinella mucronata* is validly known only from Jammu and Kashmir (Edmondson and Hutchinson, 1934); this species is also observed in our collections from the

Kashmir valley. On the other hand, we categorize questionable its 'routine' invalidated listings from Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu and West Bengal. In addition, *T. incisa* is reported only from Tamil Nadu (Edmondson and Hutchinson, 1934) but was not noticed in our collections from this state (Sharma and Sharma, 2009).

Our collections from NEI revealed two undescribed species of *Testudinella* awaiting descriptions pending examination of more specimens. In addition, we consider *T. emarginula*, *T. patina* and *T. tridentata* to be variable morphospecies that probably represent cryptic species-complexes and thus recommend ecological and genetic analysis of local Indian populations vis-à-vis cryptic diversity following Jersabek and Leitner (2013) and Fontaneto (2014).

We report species-rich *Testudinella* (11 species) from northeast India (NEI); this salient feature reiterates importance of this region as a part of the Himalayan and the Indo-Myanmar biodiversity 'hot-spots'. High richness of the taxon is also endorsed by individual reports from seven states of NEI with high records from Arunachal Pradesh (6 spp.: BKS unpublished), Assam (8 spp.: Sharma and Sharma, 2014a; BKS unpublished); Manipur (7 spp.: Sharma et al., 2016; BKS unpublished); Nagaland (7 spp.: Sharma and Kensibo, 2017; Sharma et al., 2017); Meghalaya (7 spp.: Sharma and Sharma, 1999; Sharma et al., 2016); Tripura (7 spp.: Sharma and Sharma, 2000; BKS unpublished) and Mizoram (7 spp.: Sharma and Sharma, 2015a; BKS unpublished).

Interestingly, all *Testudinella* spp. known from NEI are observed from the floodplain lakes of Assam (commonly called as beels) and Manipur (commonly called as pats) and thus highlight ecosystem diversity interest of these wetlands. This salient feature is well supported by the report of high richness (7 spp.) from three beels of the Dibru-Saikhowa biosphere reserve, upper Assam as well as the reports of 6 spp. each from two Ramsar sites located in NEI namely Deepor beel (Sharma and Sharma, 2015b; BKS unpublished) and Loktak Lake (Sharma et al., 2016; BKS unpublished). On the other hand, our collections from the floodplains of the Kashmir valley, Jammu and

Kashmir State of western Himalayas revealed 4 spp. with *T. insinuata* as a new record from India while *T. emarginula* is a new record from north India.

Testudinella is represented by lower richness in the collections from eastern India with only two species each known from West Bengal (Sharma, 1998) and Bihar (Sharma et al., 1992), and 3 species recorded from Orissa or Odisha state (Sharma and Sharma, 2005). Further, we report (BKS, unpublished) 2 species from Madhya Pradesh and 3 species from Maharashtra from central India while we observed (BKS, unpublished) 3 species from Tamil Nadu and two species each in our collections from Andhra Pradesh, Telangana, Karnataka and Kerala of southern India. We caution on over-emphasis of the stated comparisons because of the differences in the sampling intensity. Nevertheless *Testudinella* is more species-rich in NEI and in even our limited collections from the Kashmir valley of the western Himalayas than elsewhere from India.

To sum up, this study provides interesting information on biodiversity, distribution and ecosystem diversity of the Indian species of *Testudinella*. We estimate richness of the taxon to be still higher pending analysis of more collections from the Indian Himalayas (western, central and eastern) with emphasis on samples from the states Himachal Pradesh, Uttarakhand, Jammu and Kashmir, Sikkim and higher latitudes of Arunachal Pradesh as well as Western Ghats. Ecological and genetic analysis of cryptic diversity of *T. emarginula*, *T. patina* and *T. tridentata* species-complexes shall merit interest for analysis of genetic diversity of the Indian Rotifera.

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