

Article

Oribatid mites (Acari: Oribatida) from Bethuadahari Wildlife Sanctuary of West Bengal, India

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Abstract

An annotated checklist of oribatid mite taxa from Bethuadahari Wildlife Sanctuary of West Bengal, India, is presented on the basis of a faunistic survey carried out inside the sanctuary from January, 2011 to December, 2012. A total of 44 oribatid species, belonging to 37 genera in 24 families, have been identified. The present study has also documented nine species as the new records from India. The most frequent species of this sanctuary are *Protoribates (P.) magnus* (Aoki, 1982), *Lamellobates (L.) molecula* (Berlese, 1916), *Perscheloribates (P.) albialatus* (Hammer, 1961), *Lamellobates (Paralamellobates) bengalensis* Bhaduri & Raychaudhuri, 1968, *Tectocephus velatus sarekensis* Trägårdh, 1910, *Multioppia radiata* Hammer, 1961, and *Hoplophorella cuculata* (Ewing, 1909). Additionally, the most species rich families of the study area are Oppiidae Sellnick, 1937 and Scheloribatidae Grandjean, 1933.

Key words: Checklist, conservation area; forest; leaf litter; new records; soil; taxonomy.

Introduction

Forest as a biological community constitutes the biotic part of ecosystem and the species composition influences the structural and functional aspects of the forest. Each community consists of a defined set of animal and plant species living in it, therefore, the ecological communities are an interactive assemblage of species whose ecological function and dynamics are in some way interdependent. Soil-inhabiting microarthropods are the essential components of the decomposer food web and as decomposers actively participate in humification processes, nutrient cycling pathways, energy flow processes and augmentation of soil fertility and productivity (Edwards *et al.* 1970; Crossley 1977; Seastedt 1984; Groombridge and Jenkins 2000).

The Bethuadahari Wildlife Sanctuary (Latitude: 23° 35' N, Longitude: 88° 23' E and Altitude: 5 m above sea level), a tropical humid deciduous forest, is situated in the moribund Delta zone of the lower Gangetic plain of West Bengal, India and the tropic of cancer passes just about 20 km south of this sanctuary. This sanctuary extends over an area of 165.15 acre with mean annual precipitation of about 1400 mm and mean annual temperature ranges from 9° to 40 °C. The upper canopy in the forest is mainly comprised of Teak (*Tectona grandis*), Arjun (*Terminalia arjuna*), Siris (*Albizia*

lebbeck), Sissoo (*Delbergia sissoo*), Sal (*Shorea robusta*), Mahogany (*Swietenia macrophylla*) and Ficus (*Ficus* sp.). The middle and lower canopies are not well demarcated; they are made of Jamun (*Syzigium cumit*), Minjiri (*Cassia* sp.), Bael (*Aegle marmelos*), Atha (*Annona squamosa*), Hamjam (*Polyalthia suberosa*), etc. The major ground vegetations are dominated by *Cassia tora*, *Ageratum* sp., *Polygonum* sp. and various species of *Colocasia*. Grasses like *Imperata* sp., *Paspalum* sp., *Panicum* sp., *Cynodon* sp., *Brachiaria* sp. also occur sparsely (Basu *et al.* 2013). The geographical position as well as the habitat conditions of this Sanctuary are very important matters of concern due to habitat loss by expansion of agricultural field, pollution causing by the vehicles moving through the adjacent National Highway and human interferences and thus deserve our attention for conservation of the biodiversity. According to Hanski *et al.* (2007) monitoring of forest degradation and adequate planning of forest conservation measures depend on the documentation and characterization of general biodiversity including inhabitant arthropod species. The aim of this research was to provide a taxonomic inventory of the soil oribatid mites of Bethuadahari Wildlife Sanctuary.

Various studies on diversity, richness and functional roles of soil mites in different types of forest ecosystems are being explored for assessment of prospective functions and the sustenance of the concerned ecosystem. This proposition is supported by the observations of the assemblages of soil mites in pine forests of Poland (Sylwestrowicz and Kostecka 1991), subtropical forests in South Eastern Queensland, Australia (Plowman 1981), natural forest and planted birch forest in central Finland (Huhta and Niemi 2003), Babia Gora National Park in Poland (Skubala and Sokolowska 2006), Oak forest in Hungary (Gergocs *et al.* 2011), five different forests in Ireland (Arroyo *et al.* 2012), broad-leaved regeneration forests and conifer plantations in Japan (Hasegawa *et al.* 2013), Borjom-Kharagauli and Mtirala National Parks in Georgia (Murvanidze and Mumladze 2014; Murvanidze and Arabuli 2015); Western Lesser Caucasus (Sairme gorge) in Georgia (Mumladze *et al.* 2015).

In India, studies on soil acarofauna from different forest ecosystems were provided by various scientists. Prabhoo *et al.* (1988) studied the acarofauna of fire prone tropical forests in the Western Ghats, Kerala; Chakrabarti and Bhattacharya (1992) studied the soil oribatid community of a Rubber Plantation in Tripura; Banerjee and Roy (1981) studied the acarine community of Baburbag reserve forest ecosystem in Burdwan; Banerjee (Moitra) *et al.* (2009) studied the acarine community of Chintamani Kar Sanctuary.

Material and Methods

Sampling

As the floral composition of the sanctuary is more or less homogeneous, soil samples were obtained randomly from whole territory of the sanctuary from January, 2011 to December, 2012 on a monthly basis. 25 soil samples, with a fixed volume of 500 gm, were collected at each month with a shovel from the upper 10 cm soil profile.

Extraction of oribatid mites and laboratory treatment

Oribatid mites were extracted in 70% alcohol by Berlese-Tullgren funnel apparatus, at the laboratory of the Acarology Section of the Zoological Survey of India, Kolkata. The duration of the extraction period varied from 3–4 days depending on the moisture content of soil. Specimens were mounted on temporary cavity slides by lactic acid for measurement and illustration.

A wide field stereoscopic binocular microscope with 40x magnification and *Nikon Eclipse, 50i & 80i* microscopes were used for sorting, mounting, camera lucida drawing and identification of oribatid mites. Identifications were carried out using published taxonomic literature, mainly Balogh (1958, 1965, 1972), Balogh and Balogh (1988, 1990, 1992 a, b), Hammer (1958, 1961, 1962 a, b). The classification system adopted was based on Subías (2004, electronically update in 2016).

After microscopic observations, the specimens were transferred into small glass vials containing 90% alcohol. Properly labeled specimens are deposited under National Zoological Collection of Zoological Survey of India, HQ, Kolkata.

Results

The survey of the forest ecosystem revealed the presence of 44 species of oribatid mites belonging to 37 genera and 24 families (Table 1 and 2). In the list provided below nine species are new records for India and four for the state of West Bengal. Scheloribatidae and Oppiidae were the two most diverse families of the Sanctuary. Families such as Epilohmanniidae, Trhypochthoniidae, Eremulidae, Basilobelbidae, Tectocephidae, Phenopelopidae, Mochlozetidae, Oribatulidae and Oripodidae were represented by single morphospecies each.

The dominant and frequent species of the study area were *Protoribates (P.) magnus* (Aoki, 1982), *Lamellobates (L.) molecula* (Berlese, 1916), *Perscheloribates (P.) albialatus* (Hammer, 1961), *Lamellobates (Paralamellobates) bengalensis* Bhaduri & Raychaudhuri, 1968, *Tectocephus velatus sarekensis* Trägårdh, 1910, *Multioppia radiata* Hammer, 1961 and *Hoplophorella cucullata* (Ewing, 1909) while the species like *Suctobelbilla sexnodosa* Balogh and *Suctobelbella (Flagrosuctobelba) ponticula* (Hammer) were least frequent (Table 2). The seven most dominant species constituted 53.61% of the total sampled oribatid whereas 46.39% was represented by the rest.

Table 1. Family of Oribatida with ascertained species numbers.

Suborder	Family (Number of species)
Oribatida	Cosmochthoniidae (2); Haplochthoniidae (2); Hypochthoniidae (1); Lohmanniidae (2); Epilohmanniidae (1); Euphthiracaridae (2); Phthiracaridae (2); Trhypochthoniidae (1); Nanhermanniidae (2); Eremulidae (1); Basilobelbidae (1); Oppiidae (4); Suctobelbidae (2); Tectocephidae (1); Cymbaeremaeidae (2); Phenopelopidae (1); Heterozetidae (3); Mochlozetidae (1); Oribatulidae (1); Scheloribatidae (4); Oripodidae (1); Protoribatidae (2); Haplozetidae (2); Galumnidae (3)

Table 2. Species of Oribatida and the relative proportion of the species collected in the total sample during the study period of 2011 and 2012. N^o: order number of species found arranged according to Subías (2004, electronically updated in 2016).

N ^o	SPECIES	n _i	N ^o	SPECIES	n _i
1	<i>Cosmochthonius bengalensis</i>	0.00405	6	<i>Annectacarus longisetosus</i>	0.0039
2	<i>Cosmochthonius reticulatus</i>	0.009	7	<i>Javacarus kuehnelti</i>	0.02115
3	<i>Haplochthonius clavatus</i>	0.0038	8	<i>Epilohmannia minuta minuta</i>	0.0095
4	<i>Haplochthonius intermedius</i>	0.0015	9	<i>Acrotritia ardua ardua</i>	0.00955
5	<i>Malacoangelia remigera indica</i>	0.00255	10	<i>Acrotritia brasiliana</i>	0.0083

Table 2. Continued.

N ⁰	SPECIES	n _i	N ⁰	SPECIES	n _i
11	<i>Hoplophorella cucullata</i>	0.0546	28	<i>Allozetes africanus</i>	0.026
12	<i>Hoplophthiracarus nepalensis</i>	0.0288	29	<i>Lamellobates (Paralamellobates) bengalensis</i>	0.0763
14	<i>Masthermannia mammillaris</i>	0.00225	30	<i>Lamellobates (L.) molecula</i>	0.09465
15	<i>Cyrthermannia vicinicornuta</i>	0.0034	31	<i>Unguizetes clavatus</i>	0.01885
16	<i>Eremulus flagellifer</i>	0.013	32	<i>Paraphauloppia altimontana</i>	0.00395
17	<i>Basilobelba indica</i>	0.0104	33	<i>Perscheloribates (P.) albialatus</i>	0.08165
18	<i>Multioppia radiata</i>	0.0584	34	<i>Scheloribates (S.) curvialatus</i>	0.0117
19	<i>Lasiobelba (L.) kuehnelti</i>	0.00505	36	<i>Scheloribates (S.) latoincisus</i>	0.02095
20	<i>Striatoppia machadoi</i>	0.0123	37	<i>Truncopes optatus</i>	0.00665
21	<i>Ramusella (R.) chulumaniensis</i>	0.0304	38	<i>Setoxylobates foveolatus</i>	0.0044
22	<i>Suctobelbella (Flagrosuctobelba) ponticula</i>	0.00105	39	<i>Protoribates magnus</i>	0.11305
23	<i>Suctobelbilla sexnodosa</i>	0.0011	40	<i>Pilobatella punctulata</i>	0.0045
24	<i>Tectocephus velatus sarekensis</i>	0.0735	41	<i>Trachyoribates (Rostrozetes) ovulum ovulum</i>	0.03765
25	<i>Scapheremaeus fisheri</i>	0.00215	42	<i>Trichogalumna chitralensis</i>	0.00915
26	<i>Scapheremaeus balazsi</i>	0.00585	43	<i>Galumna crenata crenata</i>	0.03085
27	<i>Eupelops acromis minor</i>	0.0024	44	<i>Pergalumna tahitiensis</i>	0.00485

Species identified

Cosmochthoniidae Grandjean, 1947

***Cosmochthonius* Berlese, 1910**

***Cosmochthonius reticulatus* Grandjean, 1947**

Type locality: Originally described from Brazil (Grandjean 1947).

Remarks

The species is a new record for the oribatid fauna of India.

***Cosmochthonius bengalensis* Chakrabarti, Bhaduri & Raychaudhuri, 1972**

Type locality: Originally described from Bethuadahari Wildlife Sanctuary, Nadia and Kolkata of West Bengal, India (Chakrabarti *et al.* 1972).

Indian localities: Reported previously only from the state of West Bengal (Chakrabarti *et al.* 1972; Sengupta and Sanyal 1991; Sanyal 2006).

Remarks

It is the only described species formerly reported from Bethuadahari WLS, from rotten leaves of *Shorea robusta*. The species is endemic to India.

Haplochthoniidae Hammen, 1959
***Haplochthonius* Willmann, 1930**

***Haplochthonius clavatus* (Hammer, 1958)**

Type locality: Originally described as *Tetrochthonius clavatus* from Quebrada de Gallinato of Argentina (Hammer 1958).

Indian localities: Reported earlier from the states of West Bengal (Chakrabarti and Bhaduri 1972), Tripura (Sarkar and Subías 1982; Sarkar 1986), Arunachal Pradesh (Sanyal *et al.* 2006), Mizoram (Sanyal 2009) and Andhra Pradesh (Sanyal 2007).

***Haplochthonius intermedius* Chakrabarti, Bhaduri & Raychaudhuri, 1977**

Type locality: Originally described from the state of West Bengal, India (Chakrabarti *et al.* 1977a).

Indian localities: Previously reported only from the state of West Bengal (Sanyal 1981b, 1982, 1991a, 2006; Sanyal and Sarkar 1983).

Remarks

The species is endemic to India.

Hypochothoniidae Berlese, 1910
***Malacoangelia* Berlese, 1913**

***Malacoangelia remigera indica* Chakrabarti, Bhaduri & Raychaudhuri, 1972**

Type locality: Originally described from the districts of Nadia and 24 Parganas (North) of West Bengal, India (Chakrabarti *et al.* 1972).

Indian localities: It was reported earlier only from the state of West Bengal (Chakrabarti *et al.* 1972) from soil.

Remarks:

The species is endemic to India.

Lohmanniidae Berlese, 1916
***Annectacarus* Grandjean, 1950**

***Annectacarus longisetosus* Bhattacharya, Bhaduri and Raychaudhuri, 1974**

Type locality: Originally described from West Bengal, India (Bhattacharya *et al.* 1974).

Indian localities: Previously reported from the states of West Bengal (Bhattacharya 1979; Sanyal *et al.* 1999) and Tripura (Bhattacharya and Halder 1984).

Remarks

The species is endemic to India.

***Javacarus* Balogh 1961**

***Javacarus kuehnelti* Balogh, 1961**

Type locality: Originally described from Java by Balogh (1961).

Indian localities: Previously reported from the states of West Bengal (Bhattacharya 1979; Bhattacharya *et al.* 1974; Chakrabarti and Bhaduri 1972; Pandit and Bhattacharya 2000; Sanyal and Hazra 2000), Orissa (Mishra *et al.* 1980), Maharashtra (Sanyal 1984), Tripura (Bhattacharya and Halder 1984; Sarkar 1986), Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009), Uttarakhand (Sanyal 2010).

Epilohmanniidae Oudemans, 1923

***Epilohmannia* Berlese, 1910**

***Epilohmannia minuta minuta* Berlese, 1920**

Type locality: Originally described as *Epilohmannia minuta* from North America (Berlese 1920).

Synonyms: Previously reported by Banks (1947) as *Epilohmannia elongata*, from Duke University forest of North Carolina; by Wallwork (1962) as *Epilohmannia pallida* from Ghana; and by Balogh and Mahunka (1981) as *Epilohmannia pallida americana* from Paraguay, South America.

Indian localities: It was reported earlier from the states of West Bengal (Banerjee 1974a; Banerjee and Roy 1981; Sengupta and Sanyal 1991; Sanyal 1992), Himachal Pradesh (Sengupta and Sanyal 1990; Sengupta *et al.* 1997) and Kerala (Sheela and Haq 1991).

Euphthiracaridae Jacot, 1930

***Acrotrititia* Jacot, 1923 (Syn.: *Rhysotrititia*)**

***Acrotrititia ardua ardua* (Koch, 1841)**

Type locality: Originally described as *Hoplophora ardua* from Germany (Koch 1841).

Synonyms: Previously reported by Ewing (1909a) as *Phthiracarus americanus*, from Illinois, America; by Riley (1874) as *Hoplophora arctata*; by Jacot (1933) as *Pseudotrititia ardua antetriheterodactylum*, from Florida, America; by Michael (1898) as *Phthiracarus canestrinii* and by Ewing (1917) as *Phthiracarus pectinatus* from Illinois, America.

Indian localities: Reported previously from the states of Orissa (Mishra *et al.* 1980), Uttar Pradesh (Singh and Mukherjee 1971), Kerala (Sanyal 1990), Himachal Pradesh (Sengupta and Sanyal 1990; Sary 1992; Sengupta *et al.* 1997; Sanyal and Sengupta 2005), Meghalaya (Alfred *et al.* 1991; Darlong and Alfred 1993), West Bengal (Sanyal 1992; Moitra *et al.* 2007), Tripura (Sanyal 2000), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003),

Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Uttar Pradesh (Sanyal *et al.* 2015).

***Acrotritia brasiliiana* (Mahunka, 1983)**

Type locality: Originally reported from the soil collected from Albina province of Surinam and described as *Rhysotritia brasiliiana* by Mahunka (1983).

Indian localities: In India it was reported from the states of West Bengal (Sanyal 1992; Sengupta *et al.* 1997) and Uttar Pradesh (Sanyal *et al.* 2015).

Phthiracaridae Perty, 1841

***Hoplophorella* Berlese, 1923**

***Hoplophorella cucullata* (Ewing, 1909)**

Type locality: Originally described as *Hoploderma cucullatum* from America (Ewing 1909b).

Synonyms: Previously reported by Berlese (1913) as *Hoploderma licnophorum*, from Columbia and by Jacot (1933) as *Hoplophorella cucullata cuculoides*, from West Florida, America.

Indian localities: It was reported previously from the state of Uttar Pradesh (Sanyal *et al.* 2015).

Remarks

The species is a new record for the oribatid fauna of the state of West Bengal.

***Hoplophthiracarus* Jacot, 1933**

***Hoplophthiracarus nepalensis* Sheals, 1965**

Type locality: The species originally described from Nepal (Sheals 1965).

Remarks

The species is a new record for the oribatid fauna of India.

Trhypochthoniidae Willmann, 1931

***Allonothrus* Hammen, 1953**

***Allonothrus indicus* Bhaduri & Raychaudhuri, 1968**

Type locality: Originally described from Kolkata, West Bengal, India (Bhaduri and Raychaudhuri 1968).

Indian localities: Previously it was reported from India in the states of West Bengal (Bhaduri and Raychaudhuri 1968; Sanyal 1992, 2006), Manipur (Sanyal 2004) and Uttarakhand (Sanyal 2010).

Remarks: The species is endemic to India.

Nanhermanniidae Sellnick, 1928

***Masthermannia* Berlese, 1913**

***Masthermannia mammillaris* (Berlese, 1904)**

Type locality: Originally described as *Angelia mammillaris* from Italy (Berlese 1904).

Synonyms: Previously reported by Grandjean (1954) as *Posthermannia nematophora*, from Italy.

Indian localities: The species was reported from the states of West Bengal (Chakrabarti and Bhaduri 1972; Chakrabarti *et al.* 1977b; Sanyal, 1992), Tripura (Sarkar 1986), Sikkim (Sanyal 2003) and Uttarakhand (Sanyal 2010).

***Cyrthermannia* Balogh, 1958**

***Cyrthermannia vicinicornuta* Aoki, 1965**

Type locality: Originally reported from Doi Suthep of Thailand by Aoki (1965).

Indian localities: It was reported earlier from the states of West Bengal (Bhattacharya *et al.* 1981; Chakrabarti and Bhaduri 1972; Joy and Bhattacharya 1981), Mizoram (Sanyal 2009) and Uttarakhand (Sanyal 2010).

Eremulidae Grandjean, 1965

***Eremulus* Berlese, 1908**

***Eremulus flagellifer* Berlese, 1908**

Type locality: Originally described from the USA (Berlese 1908).

Indian localities: In India it was reported previously from the states of West Bengal (Bhattacharya 1979; Bhattacharya *et al.* 1981; Chakrabarti *et al.* 1973; Joy and Bhattacharya 1981) and Kerala (Ramani and Haq 1983; Sheela and Haq 1991).

Basilobelbidae Balogh, 1961

***Basilobelba* Balogh, 1958**

***Basilobelba indica* Bhaduri, Chakrabarti & Raychaudhuri, 1974**

Type locality: Originally described from North-East India (Bhaduri *et al.* 1974).

Indian localities: Previously reported from the states of West Bengal (Bhaduri *et al.* 1974; Choudhuri and Banerjee 1977; Banerjee, 1984; Sanyal 2006) and Orissa (Mishra *et al.* 1980).

Remarks

The species is endemic to India.

Oppidae Sellnick, 1937
***Multioppia* Hammer, 1961**

***Multioppia radiata* Hammer, 1961**

Type locality: Both the genus and species originally described from Cajamarca Valley of Peru, by Hammer (1961).

Indian localities: Reported from the states of West Bengal (Ghatak and Roy 1981; Banerjee 1991), Arunachal Pradesh (Sanyal *et al.* 2006) and Uttar Pradesh (Sanyal *et al.* 2015).

***Lasiobelba* Aoki, 1959**

***Lasiobelba (L.) kuehnelti* (Csiszár, 1961)**

Type locality: Originally described as *Oppia kuehnelti* from Java (Csiszár 1961).

Synonyms: Previously reported by Aoki (1965) as *Oppia yodai* from Thailand.

Indian localities: Reported previously from the states of West Bengal (Banerjee 1973, 1974a, 1974b, 1984, 1988; Chakrabarti *et al.* 1977a; Choudhuri and Banerjee 1975, 1977; Sanyal 1981a, 1991a, 1992, 2006; Banerjee and Sanyal 1991; Sanyal *et al.* 1999; Sanyal and Hazra 2000), Assam (Chakrabarti and Roy Talukdar 1979), Kerala (Haq 1981), Tripura (Sanyal 2000), Sikkim (Sanyal 2003), Manipur (Sanyal 2004), Gujarat (Sanyal and Basak 2004), Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009).

***Striatoppia* Balogh, 1958**

***Striatoppia machadoi* Balogh, 1958**

Type locality: Originally described from Africa (Balogh 1958).

Indian localities: Previously reported from India in the state of West Bengal (Chakrabarti *et al.* 1973; Sanyal 1992).

***Ramusella (Ramusella)* Hammer, 1962**

***Ramusella (R.) chulumaniensis* (Hammer, 1958)**

Type locality: Originally described as *Oppia chulumaniensis*, from Bolivia (Hammer

1958).

Indian localities: Previously reported from India in the states of Tripura (Chakraborti and Bhattacharya 1991), Uttarakhand (Sanyal 2010).

Remarks

The species is a new record for the oribatid fauna of the state of West Bengal.

Suctobelbidae Jacot, 1938

Suctobelbella (Flagrosuctobelba) Hammer, 1979

Suctobelbella (Flagrosuctobelba) ponticula (Hammer, 1971)

Type locality: Originally described as *Suctobelba ponticula*, from Fiji (Hammer 1971).

Indian localities: Reported from the country in the state of West Bengal (Chakrabarti *et al.* 1977a).

Suctobelbila Jacot, 1937

Suctobelbila sexnodosa Balogh, 1968

Type locality: *Suctobelbila sexnodosa* originally described from the valley of river Markham, New Guinea (Balogh 1968).

Remarks

The species is a new record for the oribatid fauna of India.

Tectocephidae Grandjean, 1954

Tectocephus Berlese, 1896

Tectocephus velatus sarekensis Trägårdh, 1910

Type locality: *Tectocephus velatus sarekensis* originally described from Sweden by Trägårdh (1910).

Synonyms: Previously reported by Berlese (1914) as *Tectocephus minor expanses* from America; by Knülle (1954) as *Tectocephus concurvatus* from the shores of Lake Zwischenahn, Germany; by Mihelčič (1957) as *Tectocephus velatus angulatus*, *Tectocephus velatus ibericus* and *Tectocephus velatus inflexus* from Southern Europe; by Kardar (1974) as *Tectocephus latilamellaris* from India; by Pérez-Íñigo and Baggio (1989) as *Tectocephus depressus* from São Paulo, Brazil.

Indian localities: In India it was reported previously from the states of West Bengal (Bhattacharya 1979; Bhattacharya *et al.* 1981; Joy and Bhattacharya 1981; Sanyal 1992; Pandit and Bhattacharya 2000), Tripura (Chakraborti and Bhattacharya 1991, 1992; Bhattacharya and Chakraborti 1995), Sikkim (Sanyal and Sarkar 2000), Uttarakhand (Sanyal 2010), Uttar Pradesh (Sanyal *et al.* 2015).

Cymbaeremaeidae Sellnick, 1928
***Scapheremaeus* Berlese, 1910**

***Scapheremaeus fisheri* Aoki, 1966**

Type locality: Originally described from Midway Island (Aoki 1966), from bird's nests.

Indian localities: In India it was reported from the state of West Bengal (Chakrabarti and Bhaduri 1972).

***Scapheremaeus balazsi* Mahunka, 1983**

Type locality: Originally described from Brazil (Mahunka 1983), from soil.

Remarks

The species is a new record for the oribatid fauna of India.

Phenopelopidae Petrunkevitch, 1955
***Eupelops* Ewing, 1917**

***Eupelops acromios minor* Chakrabarti, Bhaduri & Raychaudhuri, 1973**

Type locality: Originally described from Nadia district of West Bengal, from rotten leaves and humus (Chakrabarti *et al.* 1973).

Indian localities: Previously reported in India from the states of West Bengal (Chakrabarti *et al.* 1973) and Uttarakhand (Sanyal 2010).

Heterozetidae Kunst, 1971
***Allozetes* Berlese, 1913**

***Allozetes africanus* Balogh, 1958**

Type locality: Originally described from Angola, Africa, from soil (Balogh 1958).

Remarks

The species is a new record for the oribatid fauna of India.

***Lamellobates (Paralamellobates)* Bhaduri & Raychaudhuri, 1968**

***Lamellobates (Paralamellobates) bengalensis* Bhaduri & Raychaudhuri, 1968**

Type locality: Originally described from Kolkata, India by Bhaduri and Raychaudhuri (1968), from humus and compost heaps.

Indian localities: Previously reported from India in the states of West Bengal (Bhaduri and Raychaudhuri 1968; Banerjee 1974a, 1984; Bhattacharya 1979; Bhattacharya *et al.*

1980; Joy and Bhattacharya 1981; Sanyal and Das 1989; Sanyal 1991b, 1992; Sanyal *et al.* 1999; Pandit and Bhattacharya 2000), Sikkim (Dhali *et al.* 1980; Sanyal 2003; Sanyal and Sarkar 2004), Orissa (Mishra *et al.* 1980) Kerala (Ramani and Haq 1983, 1984, 1991; Haq and Ramani 1984; Neena and Haq 1991), Meghalaya (Sanyal 1995), Tripura (Sanyal 2000), Arunachal Pradesh (Sanyal *et al.* 2006) and Uttar Pradesh (Sanyal *et al.* 2015).

Lamellobates (Lamellobates) Hammer, 1958

Lamellobates (L.) molecula (Berlese, 1916)

Type locality: Originally described as *Achipteria molecula* from Somalia (Berlese 1916).

Synonyms: Previously reported by Balogh (1958) as *Lamellobates angolensis* from Angola, by Hammer (1958) as *Lamellobates palustris* from Argentina; by Balogh and Mahunka (1977) as *Lamellobates botari* and *Lamellobates gyoergyi* from Brazil; by Mahunka (1977) as *Lamellobates hauseri* from Malaysia; by Scull *et al.* (1984) as *Lamellobates rotundatus* from Cuba; by Pérez-Íñigo and Baggio (1985) as *Lamellobates quadricornis* from Brazil.

Indian localities: Previously reported from the states of West Bengal (Bhaduri and Raychaudhuri 1968; Banerjee 1973, 1988, 1991; Choudhuri and Banerjee 1975; Bhattacharya *et al.* 1981; Sanyal 1981a, b, 1982, 1988, 1991a, b, 1992, 2006; Sanyal and Bhaduri 1982; Chakrabarti and Mondal 1983; Sanyal and Sarkar 1983; Joy and Ray 1986; Hazra and Sanyal 1989; Sanyal and Das 1989; Sengupta and Sanyal 1991; Sanyal and Sarkar 1993; Sen *et al.* 1999; Pandit and Bhattacharya 2000; Sanyal and Hazra 2000; Moitra *et al.* 2007; Banerjee and Sanyal 2009), Orissa (Mishra *et al.* 1980), Kerala (Ramani and Haq 1983, 1991), Tripura (Bhattacharya and Halder 1984; Bhattacharya *et al.* 1985; Chakraborti and Bhattacharya, 1991, 1992; Bhattacharya and Chakraborti 1995; Sanyal 2000), Bihar (Sengupta and Sanyal 1986), Meghalaya (Sanyal 1995), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003), Rajasthan (Sanyal and Bhattacharyya 2004;), Gujarat (Sanyal and Basak 2004), Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009), Uttarakhand (Sanyal 2010) and Uttar Pradesh (Sanyal *et al.* 2015).

Mochlozetidae Grandjean, 1960

Unguizetes Sellnick, 1925

Unguizetes clavatus Aoki, 1967

Type locality: The species originally described from Thailand (Aoki 1967).

Indian localities: Previously reported from the states of West Bengal (Chakrabarti *et al.* 1977a; Sanyal 1992), Kerala (Sanyal 1990), Meghalaya (Sanyal 1995), Tripura (Sanyal 2000), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003) and Uttar Pradesh (Sanyal *et al.* 2015).

Oribatulidae Thor, 1929

Paraphauloppia Hammer, 1967

***Paraphauloppia altimontana* (Hammer, 1958)**

Type locality: Originally described as *Oribatula altimontana* from the Argentina and Bolivia, South America (Hammer 1958).

Remarks

The species is a new record for the oribatid fauna of India.

Scheloribatidae Grandjean, 1933

***Perscheloribates* Hammer, 1973**

***Perscheloribates* (*P.*) *albialatus* (Hammer, 1961)**

Type locality: Originally described as *Scheloribates albialatus* from Tambomachay in Peru (Hammer 1961).

Indian localities: It was reported from the states of West Bengal (Banerjee 1973, 1988; Choudhuri and Banerjee 1975; Bhattacharya 1979; Bhattacharya *et al.* 1980; Banerjee and Roy 1981; Ghatak and Ray 1981; Joy and Bhattacharya 1981; Chakraborty and Mondal 1983; Hazra and Sanyal 1989; Sanyal 1991a, 1992; Gupta and Paul 1992; Sanyal and Sarkar 1993; Sanyal *et al.* 1999; Sen *et al.* 1999; Sanyal and Hazra 2000; Banerjee and Sanyal 2009; Banerjee *et al.* 2009), Meghalaya (Alfred *et al.* 1991; Darlong and Alfred 1993), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003), Gujarat (Sanyal and Basak 2004), Rajasthan (Sanyal and Bhattacharyya 2004). Arunachal Pradesh (Sanyal *et al.* 2006), Mizoram (Sanyal 2009), Uttarakhand (Sanyal 2010).

***Scheloribates* Berlese, 1908**

***Scheloribates* (*S.*) *latoincisus* Hammer, 1973**

Type locality: Originally described from Tongatapu Island and Eua Island (Hammer 1973).

Indian localities: Previously reported from India in the state of Tripura (Sarkar 1986).

Remarks

The species is a new record for the oribatid fauna the state of West Bengal.

***Scheloribates* (*S.*) *thermophilus* Hammer, 1961**

Type locality: Originally described from Cajamarca in Peru (Hammer 1961).

Indian localities: Reported from the states of West Bengal (Banerjee 1974b, 1984; Choudhuri and Banerjee 1977; Banerjee and Sanyal 1991; Sanyal 1991b, 1992; Sen *et al.* 1999; Sanyal and Hazra 2000), Meghalaya (Sanyal 1995), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003), Manipur (Sanyal 2004), Gujarat (Sanyal and Basak 2004), Rajasthan (Sanyal and Bhattacharyya 2004), Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009), Uttarakhand (Sanyal 2010).

***Scheloribates (S.) curvialatus* Hammer, 1961**

Type locality: Originally described from Cajamarca in Peru (Hammer 1961).

Indian localities: Previously reported from the states of West Bengal (Chakrabarti and Mondal 1983; Sanyal and Das 1989) and Uttar Pradesh (Sanyal *et al.* 2015).

Oripodidae Jacot, 1925
***Truncopes* Grandjean, 1956**

***Truncopes optatus* Grandjean, 1956**

Type locality: Originally described from Morocco (Grandjean 1956).

Remarks

The species is a new record for the oribatid fauna of India.

Protoribatidae J. & P. Balogh, 1984
***Setoxylobates (Setoxylobates)* Balogh & Mahunka, 1967**

***Setoxylobates foveolatus* Balogh & Mahunka, 1967**

Type locality: Originally described from Vietnam (Balogh and Mahunka 1967a).

Indian localities: In India it was reported from the states of Tripura (Sarkar 1986), West Bengal (Sanyal 1992), Rajasthan (Sanyal 1996), Sikkim (Sanyal 2003), Gujarat (Sanyal and Basak 2004), Uttarakhand (Sanyal 2010) and Uttar Pradesh (Sanyal *et al.* 2015).

***Protoribates* Berlese, 1908 (Syn.: *Xylobates*, Jacot, 1929)**

***Protoribates (P.) magnus* (Aoki, 1982)**

Type locality: Originally described as *Xylobates magnus* from Minami-Iwojima Island, Tokyo, Japan (Aoki 1982).

Indian localities: Reported previously from the states of Maharashtra (Acharya and Basu, 2014a) and Himachal Pradesh (Acharya and Basu, 2014b).

Haplozetidae Grandjean, 1936
***Pilobatella* Balogh & Mahunka, 1967**

***Pilobatella punctulata* Balogh & Mahunka, 1967**

Type locality: Originally described from Brazzaville-Congo (Balogh and Mahunka 1967b).

Remarks

The species is a new record for the oribatid fauna of India.

Trachyoribates (Rostrozetes) Sellnick, 1925***Trachyoribates (Rostrozetes) ovulum ovulum Berlese, 1908***

Type locality: Originally described as *Trachyoribates ovulum* from Italy (Berlese 1908).

Synonyms: Previously reported by Sellnick (1925) as *Rostrozetes foveolatus* from Sumatra; by Balogh (1958) as *Peloribates areolatus*, *Peloribates punctulatus* and *Trachyoribates dorsalis* from Angola; by Hammer (1958) as *Trachyoribates nodosus* from Peru; by Balogh (1961) as *Rostrozetes pulcherrimus*; by Woodring (1965) as *Rostrozetes flavus* from Louisiana; by Balogh and Mahunka (1979) as *Rostrozetes punctulifer* and *Rostrozetes trimorphus*, from Cuba; and by Mahunka (1985) as *Rostrozetes geneuxi* from Guadeloupe Island.

Indian localities: Reported previously from the states of West Bengal (Chakrabarti and Bhaduri 1972; Chakraborti and Mondal 1983; Sanyal and Das 1989; Sengupta and Sanyal 1991; Sanyal 1992; Pandit and Bhattacharya 1999, 2000), Tripura (Bhattacharya and Halder 1984; Bhattacharya *et al.* 1985; Sarkar 1986; Chakraborti and Bhattacharya 1991, 1992; Sarkar 1991; Bhattacharya and Chakraborti 1995; Sanyal 2000), Bihar (Sengupta and Sanyal 1986), Meghalaya (Sanyal 1995), Sikkim (Sanyal and Sarkar 2000; Sanyal 2003), Manipur (Sanyal 2004), Rajasthan (Sanyal and Bhattacharyya 2004), Himachal Pradesh (Sanyal and Sengupta 2005), Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009) and Uttar Pradesh (Sanyal *et al.* 2015).

Galumnidae Jacot, 1925***Trichogalumna* Balogh, 1960*****Trichogalumna chitralensis* Hammer, 1977**

Type locality: Originally described from the Chitral valley of Pakistan (Hammer 1977).

Remarks

The species is a new record for the oribatid fauna of India.

Galumna (Galumna) Heyden, 1826***Galumna (G.) crenata crenata* Deb & Raychaudhuri, 1975**

Type locality: Originally described as *Galumna (G.) crenata* from West Bengal, India (Deb and Raychaudhuri 1975).

Indian localities: The species was reported from the states of West Bengal (Deb and Raychaudhuri 1975; Sanyal, 1992 2006; Pandit and Bhattacharya 2000), Meghalaya (Sanyal 1995), Sikkim (Sanyal 2003; Sanyal and Sarkar 2004), Manipur (Sanyal 2004),

Arunachal Pradesh (Sanyal *et al.* 2006), Andhra Pradesh (Sanyal 2007), Mizoram (Sanyal 2009), Uttarakhand (Sanyal 2010).

***Pergalumna* Grandjean, 1936**
***Pergalumna tahitiensis* Balogh & Balogh, 2002**

Type locality: Originally described from Tahiti (Balogh and Balogh 2002).

Remarks

The species was recorded first time from the state of West Bengal.

Key to the families of oribatid mites known from Bethuadahari Wildlife Sanctuary

1. Body ptychoid, propodosoma articulated movably with the hysterosoma; body generally laterally compressed 2
 - Body not ptychoid, propodosoma is not articulated movably with the hysterosoma; body never laterally compressed 3
2. Anogenital region wide; body not much compressed laterally Phthiracaridae
 - Anogenital region narrow; body considerably compressed laterally Euphthiracaridae
3. Anogenital region macropyline type (genital and anal plates, large not well separated) 4
 - Anogenital region brachypyline type (genital and anal plates separated) 8
4. Notogaster with 1-3 transverse sutures 5
 - Notogaster without transverse suture 7
5. Notogaster divided by 1 suture into 2 shields Hypochthoniidae
 - Notogaster divided by 3 sutures into 4 shields 6
6. Three sutures closely adjacent; notogastral setae *e1*, *e2*, *f1* and *f2* rigid and movable, longer than the rest and positioned close to or on the transverse sutures Cosmochthoniidae
 - Three sutures spaced apart from each other; all notogastral setae simple, positioned on shields, no setae on transverse sutures Haplochthoniidae
7. Body dichoid; preanal plate present Lohmaniidae
 - Body holooid; preanal plate absent; epimeral neotrichy absent Trhypochthoniidae
8. Notogaster pycnonotic i.e., areae porosae, sacculi or pori absent; usually without pteromorphae 9
 - Notogaster poronotic i.e., areae porosae, sacculi or pori present 16
9. Anogenital region either diagastric type (genital and anal plates separated by a medially incomplete curved line) or schizogastric type (genital and anal plates separated by a straight continuous line) 10
 - Ventral plate without transverse suture (hologastric type) 11
10. Anogenital region of schizogastric type; 14 pairs of notogastral setae; eight pairs of genital setae arranged in two longitudinal rows Epilohmanniidae
 - Anogenital region of diagastric type; 15 pairs of notogastral setae; nine pairs of genital setae aligned in a single longitudinal row Nanhermanniidae

11. Prodorsum having lamellae with cuspides; dorsosejugal suture medially interrupted; lamellar-interlamellar complex H-shaped; notogastral setae hardly visible Tectocepheidae
 – Prodorsum without true lamellae; either thin crest-shaped lamellae or thin costulae present or both lamellae and costulae absent 12
12. Ventral neotrichy present, more than four pairs of aggenital and adanal setae 13
 – Ventral neotrichy absent 14
13. Exuvia or at least tritonymphal exuvia affixed to one tubercle on notogaster Basilobelbidae
 – Exuvia absent; some of the epimeral and aggenital setae 3 to 6 branched; prodorsum with two distinct, longitudinal costulae Eremulidae
14. Chelicerae without teeth; prodorsum often with oval hollow and sharply incumbent rostral hair Suctobelbidae
 – Chelicerae with teeth 15
15. Costulae absent; notogastral setae very small, hardly visible; notogaster with wholly homogenous rough sculpture Cymbaeremeidae
 – Costulae present or absent; costulae when present almost parallel; anal and genital plates small, placed far from each other; notogastral setae small or large, easily visible; notogaster without rough sculpture Oppiidae
16. Pteromorphae absent; two pairs of genital setae and two pairs of anal setae; rostrum truncate Oripodidae
 – Pteromorphae present 17
17. Notogaster poronotic i.e. with true areae porosae 18
 – Notogaster pycnonotic i.e. true areae porosae absent, notogaster with sacculi or pori 24
18. Pteromorphae movable, articulate or semicircular; prodorsum without true projecting lamellae; some chitinous lines present on the prodorsum Galumnidae
 – Pteromorphae movable or not movable but never articulate 19
19. Prodorsum with tutorium; usually six pairs of genital setae (exceptionally five or four pairs) Pteromorphae immovable; lamellae broad, sometimes synlamella type Heterozetidae
 – Prodorsum without tutorium; usually three to five pairs of genital setae (exceptionally six pairs) 20
20. Mandibulae peloptoid; interlamellar setae usually very large, leaf-shaped Phenopelopidae
 – Mandibulae not peloptoid 21
21. Legs generally monodactylous or bidactylous (exceptionally tridactylous) Protoribatidae
 – Legs tridactylous 22
22. Five to six pairs of genital setae; dorsosejugal suture interrupted medially Mochlozetidae
 – Three to four pairs of genital setae (exceptionally five pairs); dorsosejugal suture not interrupted Oribatulidae
23. Pteromorphae movable, hinged Haplozetidae
 – Pteromorphae immovable or reduced Scheloribatidae

Discussion

The taxonomic studies of soil oribatid fauna of Bethuadahari Wildlife Sanctuary have exposed 44 species from 37 genera and 24 families. Among them, 15 species, 11 genera and nine families belong to primitive oribatid mites, 17 species in 14 genera and eight families to pycnonotic Oribatida and 13 species in 11 genera and seven families belong to poronotic oribatid mites group.

The geographical analysis of oribatid mites of this sanctuary has shown that the majority of species (35 spp.) have oriental distribution. The other groups are presented by species with Neotropical (15), Palearctic (6 spp.), Ethiopian (6 spp.) and Australian (3 spp.) distribution. Three cosmopolitan species found in this study are *Acrotritia ardua ardua*, *Eremulus flagellifer*, and *Tectocephus velatus sarekensis*. The following nine species *Cosmochthonius reticulatus*, *Hoplophthiracarus nepalensis*, *Suctobelbila sexnodosa*, *Scapheremaeus balazsi*, *Allozetes africanus*, *Paraphauloppia altimontana*, *Truncopes optatus*, *Pilobatella punctulata*, *Trichogalumna chitralensis* are recorded first time from India. Again this study also documented four species, namely *Hoplophorella cucullata*, *Ramusella (R.) chulumaniensis*, *Scheloribates (S.) latoincisus* and *Pergalumna tahitiensis* as new records from the state of West Bengal. The rate of endemism of species (those species recorded only from India) is nearly 14% (Six spp.) and the endemic species are *Cosmochthonius bengalensis*, *Haplochthonius intermedius*, *Malacoangelia remigera indica*, *Annectacarus longisetosus*, *Allonothrus (A.) indicus* and *Basilobelba indica*.

This is a pioneer study in assessing the diversity and community structure of soil oribatid mites of Bethuadahari Wildlife Sanctuary. The results suggest that the acarofauna of the Sanctuary is very diverse and that may be related to the rich floral diversity of this sanctuary which in turn is helpful in the maintenance of ecosystem integrity of this conservation area.

Acknowledgements

The authors are grateful to the Director, Zoological Survey of India, Kolkata, for providing research facilities and encouragements. Authors are also grateful to Dr. Shelley Acharya, Scientist -D and the staffs of Acarology Section, Zoological Survey of India, Kolkata, for their kind help and valuable suggestions.

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Received: 1 June 2016

Accepted: 18 September 2016

Published: 15 October 2016

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کنه‌های اریباتید (Acari: Oribatida) منطقه محافظت شده بتوآداهاری حیات وحش بنگال غربی، هند

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چکیده

فهرست مشروح کنه‌های اریباتید منطقه محافظت شده حیات وحش بتوآداهاری بنگال غربی بر اساس بررسی فون انجام شده از ژانویه ۲۰۱۱ تا دسامبر ۲۰۱۲، ارایه می‌شود. در مجموع ۴۴ گونه کنه اریباتید متعلق به ۳۷ جنس از ۲۴ خانواده شناسایی شدند. در این مطالعه، نه گونه برای نخستین بار از هند گزارش می‌شود. فراوان‌ترین گونه این منطقه عبارتند از: *Protoribates (P.) magnus* (Aoki, 1982)، *Perscheloribates (P.) albialatus* ، *Lamellobates (L.) molecula* (Berlese, 1916)، *Lamellobates (Paralamellobates) bengalensis* Bhaduri & (Hammer, 1961) ، *Multioppia* ، *Tectocephus velatus sarekensis* Trägårdh, 1910 ، Raychaudhuri, 1968 و *radiata* Hammer, 1961 و *Hoplophorella cuculata* (Ewing, 1909) . افزون بر این، غنی‌ترین خانواده‌ها از نظر گونه در منطقه مورد مطالعه *Schelorbitidae* و *Oppiidae* Sellnick, 1937 و *Grandjean*, 1933 هستند.

واژگان کلیدی: فهرست؛ منطقه محافظت شده؛ جنگل؛ خاکبرگ؛ گزارش‌های جدید؛ خاک؛ آرایه‌شناسی.

تاریخ دریافت: ۱۳۹۵/۳/۱۲

تاریخ پذیرش: ۱۳۹۵/۶/۲۸

تاریخ چاپ: ۱۳۹۵/۷/۲۴