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## An annotated checklist of the collembola (Springtails) of the Rajshahi district, Bangladesh with two new records of collembolan fauna

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### Abstract

This is the first annotated checklist of collembolan fauna from the Rajshahi district of Bangladesh. This study is based on published material and specimen's collection in the years of 2012, 2013, and 2015 from various habitats in Rajshahi district. There are 23 collembolan species in total, divided into 13 genera and 7 families. Among them, *Salina bengalensis* and *Neanura* sp. are identified and recorded for the first time from Bangladesh. Description of new recorded species and geographical information of each species is provided.

**Keywords:** annotated checklist, collembola, new record, Rajshahi district, Bangladesh

### Introduction

Springtails (Hexapoda, Collembola) are little arthropods that live in soil, litter, and other environments all over the world<sup>[1]</sup>. Springtails are a minor pest in agriculture, but they have a critical role as a biological agent in the soil formation process and in improving soil fertility<sup>[2, 3]</sup>. More than 8,800 Collembola species have been identified around the world<sup>[4]</sup>. Collembola is divided into four orders: Entomobryomorpha, Poduromorpha, Symphyleona, and Neelipleona<sup>[5]</sup>. Collembola was first discovered in the Indian subcontinent<sup>[6, 7]</sup>. In Bangladesh, the first collembola was discovered in four genera and four families, according to<sup>[8]</sup>. Collembola taxonomy and habitat diversity have been researched in a variety of natural habitats and locales around the Rajshahi District<sup>[9, 10, 11, 12, 13, 14]</sup>. Collembola possesses well-differentiated ecomorphological life-forms that aid in the decomposition of plant litter and the improvement of soil microstructure. Species definition and identification are required for the study of biodiversity and ecology<sup>[15]</sup>. In light of the foregoing, the present annotated checklist of Collembolan variety in the Rajshahi District of Bangladesh will be useful for future collembola research.

### Materials and Methods

**Study area:** The Rajshahi District (Rajshahi division, Bangladesh) covers an area of 2407.01 square kilometers and is located between the latitudes of 24°07' and 24°43' north and the longitudes of 88°17' and 88°58' east. It is bordered on the north by the Naogaon district, West Bengal state of India, on the south by the Kushtia district and the Ganges River, on the east by the Natore district, and on the west by the Nawabganj district. Barind tract, Diara, and Char lands of the Padma make up the region. Collembola were collected from natural habitats of different study areas. Rajshahi University Campus, Rajshahi City Corporation, Puthia Upazila and the Charland of the Padma River of the Rajshahi district.

**A). Rajshahi University Campus:** RUC is located in Rajshahi, a city in Bangladesh's northwestern region. Rajshahi is located at 24° north latitude and 89° east longitude. It is located in the south-western part of the Rajshahi division between 24°6' M and 25°13' M latitude and 44°02' E and 49°21' E longitude. RU is 753 acres/303 hectares in size. It is situated on the northern bank of the Padma River (Fig 1-A).

**B). Rajshahi City Corporation:** Collembola was collected from four Police Stations of Rajshahi City Corporation (RCC). The geographical location of Rajshahi is 24° North and 89° East. Eight different spots were selected for sampling in each Police Station, four spots were at the four corners and another four were selected at the middle portion of the Police Station (Fig 1-B). These eight spots were selected in such a manner that there were equal distances among these spots. Sampling was performed in four different habitats (leaf litter, open grassland, crop field and shady grassland) at each site. Collembolans at different habitats were collected by using Berlese funnel following the standard procedure).

**C). Puthia Upazila:** Collembola was collected from Puthia upazila. Puthia upazila is located in Rajshahi division of Bangladesh. Collembola were collected from five different maize fields each having one acre area of cultivated land at Puthia upazila; (i) Puthia union (ii) Baneshwar union (iii) Belpukuria union (iv) Silmaria union and (v) Jewpara union (Fig 1-C). The study was conducted in a predominantly agricultural area, in the Puthia upazila 24°22'30.00" N 88°50'60.00" E. Area of puthia upazila is 192.64 sq km that lies on the northern bank of the river Padma and lowland (22 m above sea level), underlain by alluvial soil which results fertile quality soils.

**D). Charland of the Padma River:** Springtails were collected from the alluvial soil of the Charland of the river Padma. The study area is located from 24030'N to 24040'N and from 80025'E to 80055'E. Studied areas are; Char Taranagar, Char Shibnagar, Char Khidirpur and Char Diyar khidirpur (Fig 1-D) Which are occupied by seasonal crops and small shrubs. Every year the water level of the Padma River decreases in the summer season. Sediments are formed and deposited, which creates a wide and lengthy alluvial land beside the river called locally 'Char'. This also includes fine particles of silt and clay and larger particles of sand. These particles are carried out by the perennial streams of rivers. Because of high fertility, grass and crops grow well in the alluvial lands. Rajshahi has a tropical wet and dry climate and

the Charland remains dry in May to August. The climate of Rajshahi is generally marked with monsoons, high temperature, considerable humidity and moderate rainfall ranges 1542.1 to 2235.8 mm <sup>[16]</sup>. The hot season commences early in March and continues till the middle of July.

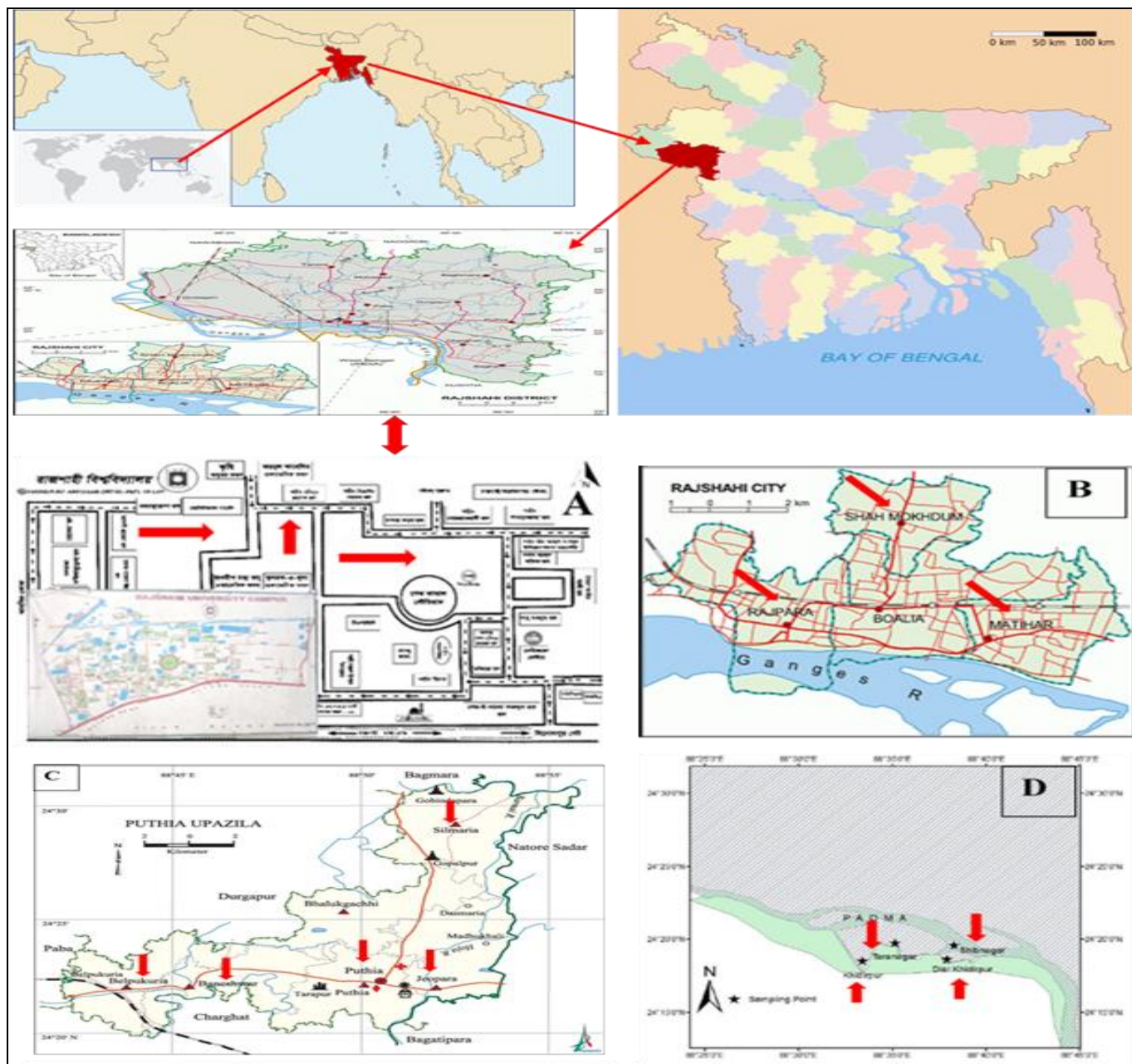
**Collection of Collembola:** Collembola were collected by using the Aspirator and Berlese funnel. Collembola from living vegetation was collected using an aspirator, while Collembola from soil was collected by using a Berlese funnel. Soil cores of 100 cm<sup>3</sup> were taken from each habitat. Every sample was collected in a separate polythene bag and brought to the laboratory. The extraction process was done through Berlese-Tullgren's funnel. Soil samples were put in separate funnels fitted with mesh on the lower side and were placed in funnels. During extraction, the samples were exposed to less intensity of light to give low heat initially for a period of 10-12 hours, and later on the samples were given more intensity of light and heat for full extraction.

**Preservation and slide preparation:** For identification collembola specimens were brought to the laboratory for further analysis, and were preserved in vial with 70% alcohol. The specimens were mounted on slides with Canada balsam after the serial dehydration method and prepared for identification with photography. The photographs were taken through an Olympus IX-71, USA microscope mounted on an XTD-20C microscope. Collected specimens were preserved in the Insect Entomology Research Laboratory, Department of Zoology, and University of Rajshahi, Bangladesh.

**Taxonomic identification:** Springtails were described at the genera and species level in this report, according to Key. The morphological characteristics were compared with the pictorial key, and standard key for the identification from internet sources <sup>[3, 4]</sup>. Most of the adult springtails were identified to species, while most juvenile and some adult individuals were identified only to genus by using the key <sup>[17, 18]</sup>. Standard keys to the families of Collembola were also used for taxonomic identification <sup>[19, 20]</sup>.

**Table 1:** Details of survey locality in Rajshahi district, Bangladesh

Serial no.	Location/Site name	Coordinates
1	Rajshahi University Campus	24.370°N & 88.637°E
2	Rajshahi City Corporation	24.40°N & 88.50°E
3	Puthia Upazila	24°22.5' N & 88°51'E
4	Charland of the Padma River	24°30'N to 24°40'N & 80°25'E to 80°55'E



**Fig 1:** Map of the study area- Rajshahi district, Bangladesh: A- Rajshahi University Campus, B- Rajshahi City Corporation, C- Puthia Upazila and D- Charland of the Padma River. [Red arrow indicating the study area]

## Results and Discussion

In the present study, a total 23 species belonging to 13 genera from 7 different families were recorded from different localities of Rajshahi District, Bangladesh (Table 1). At first two genera i.e., *Rambutsinella* and *Entomobrya* were identified from the Rajshahi University Campus of Rajshahi District <sup>[9]</sup> (Hossain, 2010). Hossain *et al.*, reported six species, viz., *Podura aquatica*, *Hypogastrura armata*, *Entomobrya nivalis* & *Orchesella* sp., *Dicranocentroides gisini*, and *Tomocerus minor* in the year of 2017<sup>[13]</sup>. Five species and three genera, viz., *Entomobrya albocincta*, *Dicranocentroides indicus*, *Seira indica*, *Lepidocyrtus lignorum*, *Lepidocyrtus* sp., *Salina* sp. & *Salina tricolor*, and *Tomocerus* sp. were identified from Rajshahi university campus in the year of 2018 <sup>[12]</sup>. In the year of 2018, six collembolan species viz., *Isotomina* sp., *Entomobrya griseolivata*, *Entomobrya gisini*, *Isotoma viridis*, *Hypogastrura armata*, and *Podura aquatica* were first reported from Padma Charland and <sup>[14]</sup>. In the present study

we were identified the following species of collembola i.e., *Neanura* sp., *Lepidocyrtus lignorum*, *Lepidocyrtus* sp., *Seira indica*, *Seira* sp., *Entomobrya* sp., *Orchesella* sp., *Salina bengalensis*, *Salina* sp., *Tomocerus minor*, *Tomocerus* sp., and among them *Salina bengalensis* and genus *Neanura* sp. identified, recorded and reported for the first time from Bangladesh. After all, a few studies of habitat diversity have been studied of Collembola fauna of Rajshahi District in the last decade. The abundance and habitat diversity of Collembola in Rajshahi City Corporation were studied in the year of 2012 <sup>[10]</sup>. The taxonomic coverage of identified and recorded families were contained collembolan species as follows i.e., Poduridae (4.0%), Hypogastruridae (4.0%), Neanuridae (4.0%), Isotomidae (9.0%), Entomobryidae (57.0%), Paronellidae (13.0%), and Tomoceridae (9.0%) respectively. The family Entomobryidae has the highest number of species (57.0%) and the family Poduridae, Hypogastruridae, Neanuridae has the lowest number of species (4.0%) for the study area.

**Description of new recorded species*****Salina bengalensis***Type species: *Salina bengalensis* (Mitra, 1973)

**Morphological characteristic:** General ground colour of body pale yellow. This species does not have scales. Traditionally, species have been diagnosed based on color pattern, mucronal and unguicular shape, number of ungula teeth and dorsal chaetotaxy. This species has large antennae present with 4 segments. The eye patch is normal and appears as eight isolated black circles, each corresponding to an ocellus. Dentes longer than manubrium.

**Identifying characteristic:** Head capsule anteriorly with a dark band passing through the bases of antennae and joining two ocellar fields; antennae brown. Ants. I, II and III distally dark (Fig 3: F). Tergal margins of Ths. II, III dark with orange suffusion (Fig 3: G), and Pigment also continuing on Abds. I, II. Thorax. III. Abdominal segments. II, III, IV, V, VI with orange to dark brown patches (Fig 3: H). Furcula proximally at manubrium with slight orange suffusion, the rest non pigmented (Fig 3: I). Similar identifying characteristics were found by Mitra, 1973<sup>[21]</sup>.

**Morphometric analysis:** Body length was 1067.09µm with antennae to furcula. Total antennal length was 440.82 µm (1<sup>st</sup>:89.64µm, 2<sup>nd</sup>: 136.01µm, 3<sup>rd</sup>: 98.81µm, 4<sup>th</sup>:116.36µm). The 2<sup>nd</sup> and 4<sup>th</sup> antennal segment larger than the 1<sup>st</sup> and 3<sup>rd</sup>, and 4<sup>th</sup> antennal segment smaller than the 2<sup>nd</sup> antennal segment. Head, thorax and abdomen were measured with 71.0µm, 81.07µm and 217.33µm respectively. Furcula

consists of Manubrium and dentes which were measured with 103.46µm and 153.41µm respectively, and the total length of Furcula was 256.87µm. Habitat: This species is found especially in leaf litter.

***Neanura* sp.**Type species: *Neanura* (MacGillivray, 1893)

**Morphological characteristic:** The body color is usually yellowish, bright liver wish, grey etc. Mouthparts more or less adapted for piercing. Pseudocelli absent; Mandible present without molar plate. Antennae four segments, and Furcula present and very short.

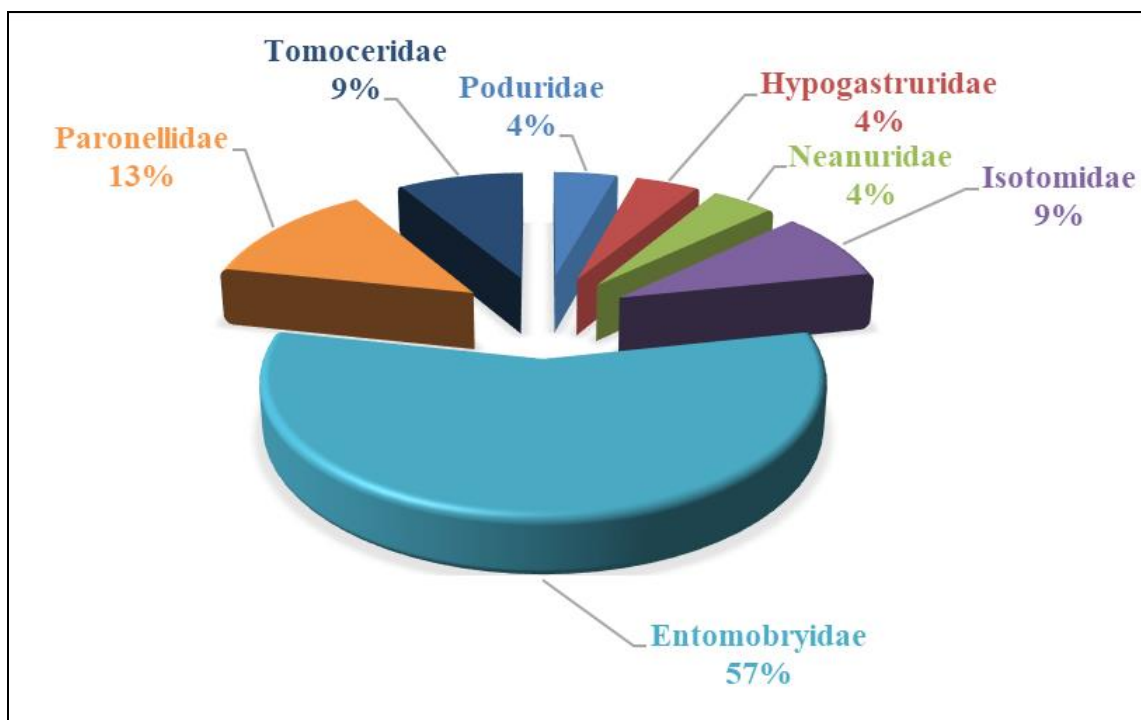
**Identifying characteristic:** Cylindrical antenna with globular head (Fig 4: L). Body tubercate which are angular and have small bumps or growths protruding at the angles (Fig 3: M), and anal bilobed (Fig 4: N). Snider, Richard J. 1967 observed the above mentioned diagnostic characteristic<sup>[22]</sup>.

**Morphometric analysis:** Body length was 381:65 µm with antennae to furcula. Total antennal length was 53.48 µm (1<sup>st</sup>:11.36µm, 2<sup>nd</sup>: 14.21µm, 3<sup>rd</sup>: 12.22µm, 4<sup>th</sup>:15.69 µm). The 2<sup>nd</sup> and 4<sup>th</sup> antennal segment larger than the 1<sup>st</sup> and 3<sup>rd</sup>, and 4<sup>th</sup> antennal segment larger than the 2<sup>nd</sup> antennal segment. Head, thorax and abdomen were measured with 61.81 µm, 88.20 µm and 145.51 µm respectively. Furcula consists of Manubrium and dentes which were measured with 18.21 µm and 14.44 µm respectively, and total length of Furcula was 32.65 µm. Habitat: The species are found in moss, under bark, in leaf litter, especially in damp soil under bricks, stones etc.

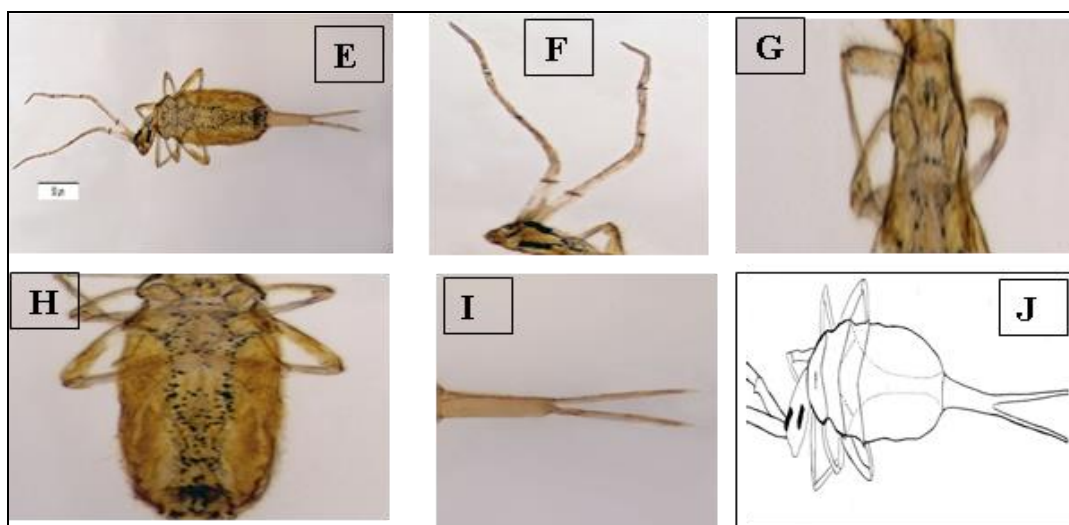
**Table 2:** An annotated checklist of Collembola fauna of Rajshahi District, Bangladesh.

Family	Species	Habitat	Reference	Localities	General distribution
Poduridae	1. <i>Podura aquatica</i> (Linnaeus, 1758)	Still water bodies	Hossain <i>et al.</i> , 2017 Rahman <i>et al.</i> , 2018	Puthia Upazila, Padma Charland	Abundant species with Holarctic distribution [23]
Hypogastruridae	2. <i>Hypogastrura armata</i> (Nicolet, 1842)	Leaf litter	Hossain <i>et al.</i> , 2017; Rahman <i>et al.</i> , 2018	Puthia Upazila, Charland	Holarctic distribution <sup>[24]</sup>
Neanuridae	3. <i>Neanura</i> sp. (MacGillivray, 1893)	Under bricks and stone pile	<b>New record</b> Present study	Rajshahi University	
Isotomidae	4. <i>Isotoma viridis</i> (Bourlet, 1839)	Soil, leaf litter	Rahman <i>et al.</i> , 2018	Padma Charland	Holarctic distribution [4]
	5. <i>Isotomina</i> sp. (Borner, 1903)	Soil	Rahman <i>et al.</i> , 2018	Padma Charland	
Entomobryidae	6. <i>Lepidocyrtus lignorum</i> (Fabricius, 1775)	Soil and leaf litter	Islam <i>et al.</i> , 2018 Present study	Rajshahi University	Holarctic distribution [5]
	7. <i>Lepidocyrtus</i> sp. (Bourlet, 1839)	Soil and leaf litter	Islam <i>et al.</i> , 2018	Rajshahi University	
	8. <i>Seira indica</i> (Ritter, 1911 )	soil	Islam <i>et al.</i> , 2018 Present study	Rajshahi University	India <sup>[6]</sup>
	9. <i>Seira</i> sp. (Lubbock, 1869)	soil	Present study	Rajshahi University	
	10. <i>Entomobrya albocincta</i> (Templeton, 1835)	Open grassland, leaf litter	Islam <i>et al.</i> , 2018	Rajshahi University	Holarctic distribution [4]
	11. <i>Entomobrya nivalis</i> (Linnaeus, 1758)	Open grassland, leaf litter	Hossain <i>et al.</i> , 2017	Puthia Upazila	Holarctic distribution <sup>[4]</sup>
	12. <i>Entomobrya griseolivata</i> (Packard, 1873)	Grassland, leaf litter, soil	Rahman <i>et al.</i> , 2018	Padma Charland	Nearctic including temperate region <sup>[4]</sup>
	13. <i>Entomobrya gisini</i> (Christiansen, 1958)	Grassland, leaf litter, soil	Rahman <i>et al.</i> , 2018	Padma Charland	Tropical and sub- tropical parts of the world <sup>[4]</sup>
	14. <i>Entomobrya</i> sp. (Rondani, 1861)	Open grassland, leaf litter	Hossain, 2010 Present study	Rajshahi University	
	15. <i>Dicranocentroides indicus</i> (Handschin, 1929)	Grassland, leaf litter.	Islam <i>et al.</i> , 2018	Rajshahi University	Odisha, India <sup>[25]</sup>
16. <i>Dicranocentroides gisini</i> (Mitra, 1976)	Soil, open grassland, leaf	Rahman <i>et al.</i> , 2018	Puthia Upazila	India <sup>[26]</sup>	

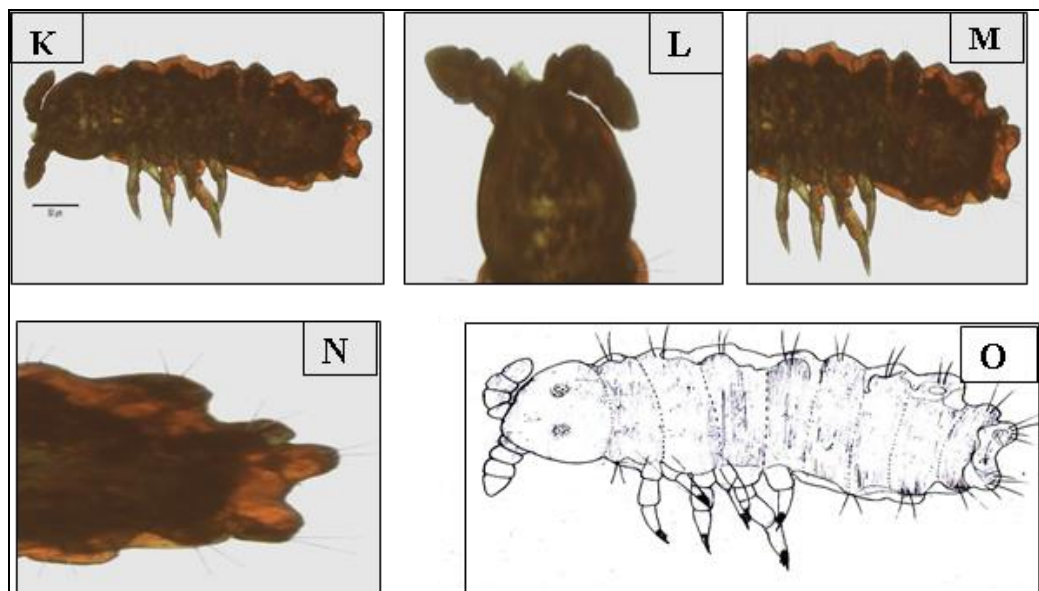
		litter			
	17. <i>Orchesella</i> sp. (Templeton, 1836)	Open grassland, leaf litter	Hossain <i>et al.</i> , 2017 Present study	Puthia Upazila, Rajshahi University	
	18. <i>Rambutsinella</i> sp. (Deharveng and Bedos, 1996)	Open grassland, leaf litter	Hossain, 2010	Rajshahi University	
Paronellidae	19. <i>Salina tricolor</i> (Handschin, 1928)	Open grassland, leaf litter	Islam <i>et al.</i> , 2018	Rajshahi University	Manipur, South India [22]
	20. <i>Salina</i> sp. (MacGillivray, 1894)	Open grassland, leaf litter	Islam <i>et al.</i> , 2018 Present study	Rajshahi University	
	21. <i>Salina bengalensis</i> Mitra, 1973	Open grassland, leaf litter	<b>New record</b> Present study	Rajshahi University	West Bengal, India [22]
Tomoceridae	22. <i>Tomocerus minor</i> (Lubbock, 1862)	Open grassland, leaf litter	Hossain <i>et al.</i> , 2017 Present study	Puthia Upazila	Cosmopolitan Distribution [5]
	23. <i>Tomocerus</i> sp. (Nicolet, 1841)	Open grassland, leaf litter	Islam <i>et al.</i> , 2018 Present study	Rajshahi University	



**Fig 2:** Taxonomic coverage of Collembola species per family recorded in Rajshahi district, Bangladesh



**Fig 3:** **E-** Micro photograph of *Salina bengalensis* (Identified by: Md. Shahinur Islam and Nur Mohammad), **F-** Dark band passing through the bases of antennae and joining two ocellar fields, **G-** Tergal margins of Thorax. II. III dark with orange suffusion, **H-** Thorax. III. Abdominal segments. II, III, IV, V, and VI with orange to dark brown patches **I-** Furcula proximally at manubrium with slight orange suffusion, **J-** Schematic diagram of *Salina bengalensis* (by Camera Lucida)



**Fig 4:** K- Micro photograph of *Neanura* sp., (Identified by: Md. Shahinur Islam and Nur Mohammad) L-Globular head with cylindrical antennae, M- Tubercate body, N- Bi-lobed anus and O-Schematic diagram of *Neanura* sp. (by Camera Lucida)

### Conclusion

The present study findings suggest that more research is needed to identify and describe Collembolan fauna from the Rajshahi district of Bangladesh.

### Acknowledgements

This study, which is respectfully dedicated to the memory of the late professor Dr. Md. Mosharrof Hossain who is the pioneer researcher on collembolan fauna, as well as first reported on Collembola from Rajshahi District, Bangladesh.

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