INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 20, No. 2, p. 268-276, 2022

RESEARCH PAPER OPEN ACCESS

Some Arthroplenoid Collembola (Insecta: Apterygota) from Rajshahi University Campus, Bangladesh

Nur Mohammad[1], Md. Shahinur Islam[2*], Nurul Islam[3], Saiful Islam Faruki[1]

[1]*Department of Zoology, Insect Research Laboratory, University of Rajshahi, Rajshahi-6205, Bangladesh*

[2]*Institute of Food and Radiation Biology, Atomic Energy Research Establishment, G.P.O, Dhaka, Bangladesh*

[3]*Crop Protection and Toxicology Laboratory, University of Rajshahi, Rajshahi-6205, Bangladesh*

Key words: Arthroplenoid, *Collembola*, *Springtail*, Apterygota, Hexapod, Rajshahi University, Bangladesh.

http://dx.doi.org/10.12692/ijb/20.2.268-276 Article published on February 27, 2022

Abstract

Collembola are wingless insects that are widespread and pervasive. These are small agricultural pests, but their impact as biological agents in the soil formation process is enormous. Many species of collembolan have become well-known bio-indicators of soil contamination and fertility. In the present study, *Collembola* were collected from different natural habitats in the Rajshahi University campus area. From this study, the following arthroplenoid collembolan genera were identified: *Lepidocyrtus* sp. and *Salina* sp., which belong to the families Entomobryidae and Paronellidae. In this work, the morphological description with morphometrics, as well as the habitat of those genera, are discussed.

* **Corresponding Author:** Md. Shahinur Islam ✉ islam.shahin89@gmail.com

Introduction

Collembolans, popularly known as "springtails" are small, soft-bodied, wingless (Apterygota) hexapod arthropods with incomplete metamorphosis. Most species are characterized by a forked appendage (furcula) attached at the end of the abdomen and held in place under tension from the tenaculum, a clasplike structure formed by a pair of appendages. The diagnostic feature of collembolans in the presence of a tubular collophore is used primarily in maintaining moisture balance (Hopkin, 1997). There are currently more than 9,000 described Collembolan species worldwide (Bellinger *et al.*, 2022). Arthropleonoid collembola, which has elongated bodies, district abdominal segmentation (Mutt, 1976; Greenslade, 1991). The first *Collembola* were discovered in Bangladesh in four genera and four families (Kabir *et al.*, 2008). Collembolan taxonomy and habitat diversity have been investigated in a number of natural habitats and locations throughout the Rajshahi district. The first two genera, viz., *Rambutsinella* and *Entomobrya* were identified from the Rajshahi University Campus (Hossain 2010). The abundance and habitat diversity of springtails of Rajshahi City Corporation were studied by (Hossain *et al.*, 2012). Six species of collembolan insects in the maize field from Puthia Upazila, Rajshahi district (Hossain *et al.*, 2017) and five species and three genera were identified from the Rajshahi university campus (Islam *et al.*, 2018). For the first time, six collembola species were reported from Padma Charland (Rahman *et al.*, 2018).

The three new collembolan species records from Bangladesh (Islam and Nur 2021). An annotated checklist of the Collembola from the Rajshahi district of Bangladesh (Islam *et al.*, 2021) was published recently. *Collembola* are divided into four orders: Entomobryomorpha, Poduromorpha, Symphypleona, and Neelipleona (Fjellberg, 2007). Among the four orders of Entomobryomorpha, they are an elongated body shape with a clear separation between the thorax and the first abdominal segment. The families Entomobryidae and Paronellidae belong to the order Entomobryomorpha. The Entomobryidae family is the most diversified (Soto-Adames, 2008). Like other Entomobryomorpha, this family's members feature lengthy appendages such as antennae, legs, and furca (Christiansen and Bellinger 1998). Multiciliated setae on the body and abdominal segment IV longer than III, crenulated dens, and a tiny mucro with one or two well-developed teeth distinguish the Entomobryidae from other families (Zeppelini and Bellini, 2006; Soto-Adames *et al.*, 2008). There are more than 1700 described species in the Entomobryidae. Paronellidae (Bomer, 1913) are a medium-to-large-sized family of *Collembola* with two subfamilies, Paronellinae and Cyphoderinae. Imms (1912) described Indian paronellids for the first time. The Paronellidae family contains approximately 90 described species (www.chaosofdelight.org, 2022). The springtail is found in all types of soil and leaf litter throughout the world, from Antarctica (Block, 1984) to the Arctic, and is one of the most widely distributed insects. They are also abundant in the Himalayas ' newly fallen snow at 7,742 meters (Yosii, 1966a). Springtails are biological indicators and they have a critical role as biological agents in the soil formation process and in improving soil fertility (Hazra and Mandal, 2007).

These insects have varied feeding strategies and functional roles within the soil processes. They affect nutrient availability through interactions with soil microorganisms, such as the rate of bacterial and fungal consumption and spore transfer (Cassagne *et al.*, 2004; Stork and Eaggleton, 1992). The present study, therefore, aimed to confirm the taxonomic identification of collembolan fauna from different natural habitats of the Rajshahi University campus area, Bangladesh.

Material and methods

Study area

Collembola specimens were collected from the Rajshahi University Campus area located about 4.8km from Rajshahi City. It is located at 24°22′26″N and 88°36′04″E with an altitude 23m above sea level. Rajshahi University Campus is 753acres/303 hectares in size. It is situated on the northern bank of the Padma River (Fig.1).

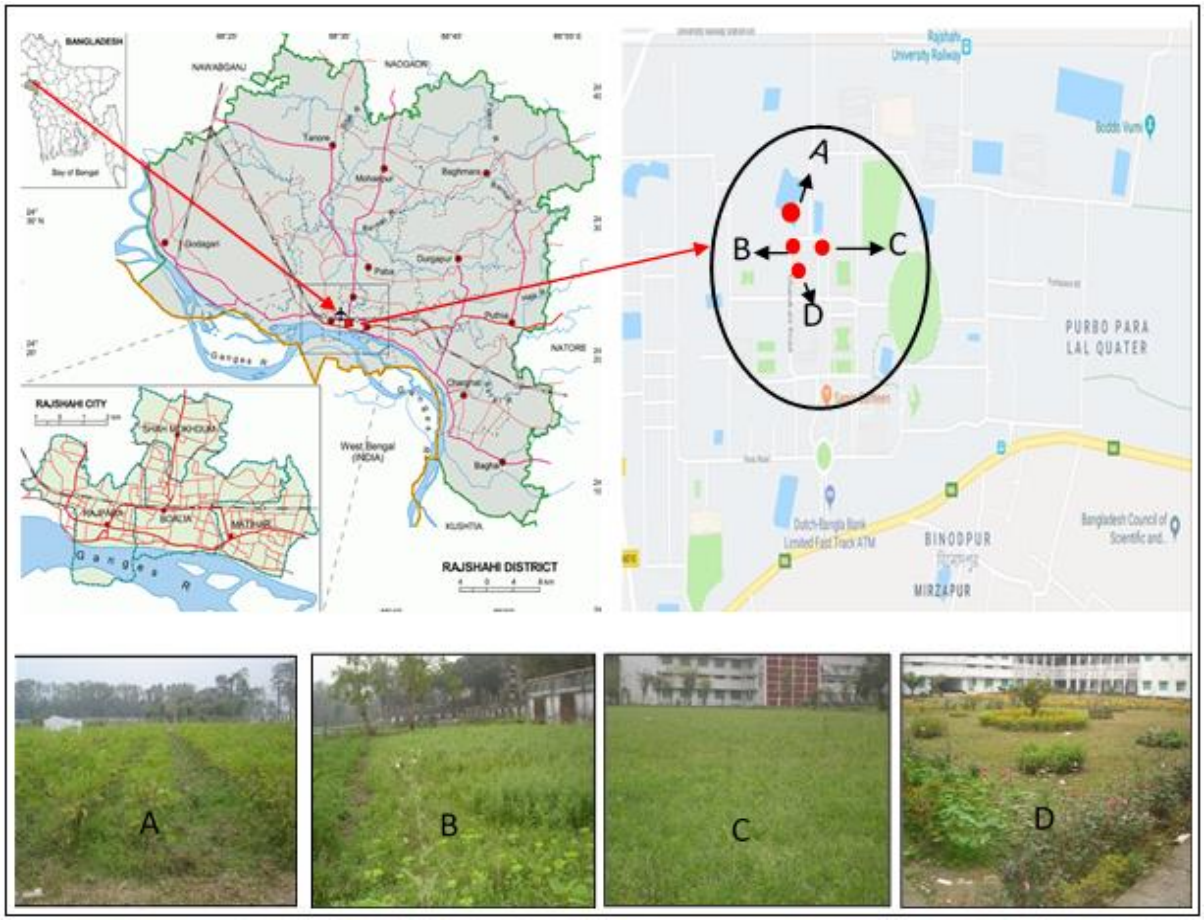

Fig. 1. Showing the study area and sampling sites: A-Mulberry garden, B-Crop field C-Grassland, and D-Flower garden.

Collection of Collembola

Collembola were collected by using the Aspirator (Lim *et al*., 2007) and Berlese funnel (Beck *et al*., 1998). In the field white plate and aspirator were used. Soil collembola was collected by using a Berlese funnel in the laboratory.

Preservation and slide preparation

Collembola specimens were preserved in a vial with 70% alcohol. Hoyer's mounting medium was used for slide-mounting of the specimens. A fluorescent microscope (OLYMPUS IX-71, USA) was used for photographic documentation following methodology (Christiansen and Bellinger, 1998), and Camera Lucida (10x) was utilized to prepare line diagrams.

Taxonomic identification

Springtails were described at the genera level in this report, according to the key. The morphological characteristics were compared with the pictorial key and standard key for identification. *Collembola* were identified at the genera level with the help of the following keys (Fjellberg, 1998; Fjellberg, 2007; Greenslade, 1991; Hazra and Mandal, 2007; Snider, 1967; Hazra, 2015).

Results and discussion

The Collembolans are divided into two suborders, each characterized by a distinct body form. The Collembolans, which have an elongated body, distinct segmentation in the abdomen come under the suborder Arthropleona. The morphological and morphometrics of these collected genera are described below.

Lepidocyrtus sp**.**

Body-color with distinct dark pigmented patches with scales. The first abdominal segment with a dark

transverse banding pattern. A deep dark-brown longitudinal patch runs through the first thoracic segment to the last part of the abdominal segment.

The 1st and 2nd antennal segments are transparent with a brown color, and the 3rd and 4th antennal segments are dense with a dark brown color. At the beginning of the last abdominal segment, with a dark-brown rounded circle. The fourth abdominal segment at the midline is more than twice as long as the third, with simple or absent dental spines. Dens crenulate and mucro bidentate. Eye pigment is present with eyes 8 + 8 on each side. All of the characteristics discussed here are based on Fig. 2 (A-B).

Table 1. Morphometric measurements of recorded *Collembolan* genera.

Parameters: Length (µm)		*Lepidocyrtus* sp.	*Salina* sp. (i)	*Salina* sp. (ii)
Antenna	1st segment	54.21	68.86	15.69
	2nd segment	53.19	109.92	129.04
	3rd segment	38.18	78.71	183.59
	4th segment	45.67	89.92	172.97
Total antennal length		191.25	347.41	501.24
Head		87.17	75.27	94.00
Thorax		113.47	84.88	116.49
abdomen		204.30	198.19	244.75
Furcula	Manubrium	102.22	98.25	108.29
	Dentes	160.54	123.30	147.93
Total length of Furcula		262.76	221.55	256.22
Total body length		858.95	927.29	1212.7

Morphometric measurements

Body length is 858.95µm (antennae to furcula). The total antennal length is 191.25µm, and the fourth antennal segment is longer (45.67µm) than the third antennal segment. Head, thorax and abdominal length is 87.17µm, 113.47µm, 204.30µm, respectively. Dentes are larger (160.54µm) than the marubrium (102.22µm), and the total furcula length is 262.76µm—the morphometric data mentioned in Table 1.

Habitat

This genus is very rare and is found in leaf litter, soil, and open grassland.

Salina sp. (i)

The body is orange in color. The body is a slender type. Anteriorly, the head capsule has a dark band that runs through the bases of the antennae and connects two ocellar fields. The eye patch is normal and appears as eight isolated black circles, each corresponding to an ocellus. 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 with four segments. In comparison to its body size, antenna 4 is segmented and elongated. Antennal segments I, II, and III are distally dark. Dentes are smooth and free of dental spines, and mucro is about one-quarter the length of dens. Dentes are larger than manubrium. All of the characteristics discussed here are based on Fig. 2 (C-D).

Morphometric measurements**:** The total length of the body (antennae to furcula) is 927.29 µm**.** The antennal length is 347.41µm. The lengths of the head, thorax, and abdomen are 75.27µm, 84.88µm, and 198.19µm, respectively. Dentes are longer (123.30µm) than marubrium (98.25µm), and the total length of the furcula is 221.55mµm. The morphometric data mentioned earlier is shown in Table 1.

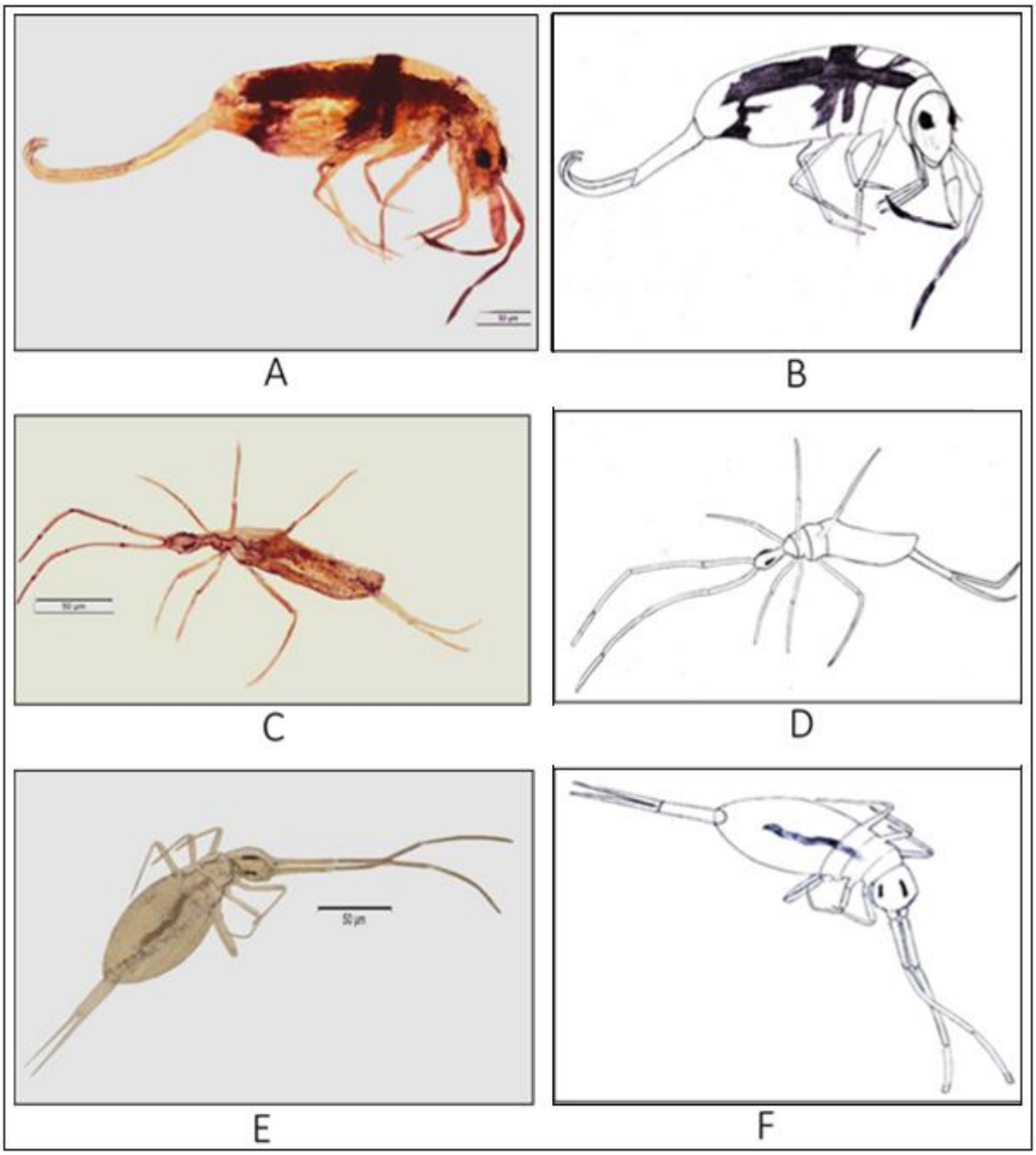

Fig. 2. Microphotograph and line diagram: A-B. *Lepidocyrtus* sp., C-D. *Salina sp*. (i) and E-F. *Salina* sp. (ii).

Habitat

This species is found almost everywhere.

Salina sp. (ii)

The color is very significant for the identification of this species. The body is a solid color, and the antenna has four segments. The eye patch is normal and appears as eight isolated black circles, each corresponding to an ocellus. Body is without scale. Each side of the thoracic tergal margins (Thorax-I to Thorax-III) has two thin pale brown lines. The pigment is usually present in the form of a faint purple in the middle of the abdomen, and a visible brown patch runs from the thoracic segment II to the abdominal segment IV. Dentes are smooth, dental spines are absent, mucro is less than a quarter the length of dentes, and manubrium is smaller than dentes. All of the characteristics discussed here are based on Fig. 2(E-F).

Morphometric measurements

The length of the body from antennae to furcula is 1212.7µm.Total antennal length is 501.24µm, head, thorax, and abdominal length are 94.00µm, 116.49µm, and 244.75µm, respectively. Dentes are longer (147.93µm) than marubrium (108.29mµm), and the total length of the furcula is 256.22µm. The morphometric data mentioned earlier is shown in Table 1.

Habitat

This species is found in leaf litter and open grassland. In the present study, three genera were recorded. The first is a genus of *Lepidocyrtus*, and the other two are genera of *Salina*. *Lepidocyrtus* is a slender springtail and the second biggest genus (Bourlet *et al*., 1939) in the Lepidocyrtinae subfamily (Wahlgren, 1906) of the family Entomobryidae. At least 30 described species of *Lepidocyrtus* exist. This genus is distinguished by four-segmented antennae, eight eyes, and a bi-dentate mucro with a basal spine, finely ciliate scales, and a lack of dental spines (Hazra and Mandal, 2007), which is similar to our present findings. *Salina* (MacGillivray, 1894) is a medium-sized (Bellinger *et al*., 2022) genus of Paronellidae with approximately 200 species described worldwide. Members of *Salina* show a very homogenous morphology that makes the separation of species difficult. Species have been diagnosed based on color pattern, mucronal and unguicular shape, number of ungula teeth, and dorsal chaetotaxy. Body scale-like setae, the eye patch is normal and appears as eight isolated black circles, each corresponding to an ocellus and dark pigment usually present (Greenslade, 1991).

The body is mostly dark or variably pigmented, with thoracic tergites II, III, and abdominal tergites I, II, and margins darker, and II, occasionally, with faint violet pigment (Hazra and Mandal, 2007). Our described genus characteristics are based on the above-mentioned pattern of characteristics.

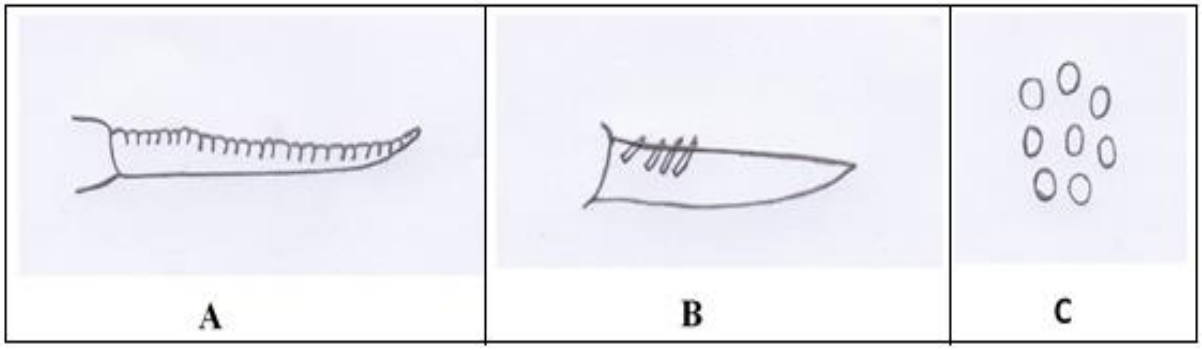

Fig. 3. A-B. Dentes structure pattern of the genera *Lepidocyrtus* and *Salina*. **C.** Eye arrangement of the genus *Lepidocyrtus*.

Key to the genera of Lepidocyrtus sp.

1. Dentes crenulate (Fig. 3A)... 2
2. Body with scales.....3
3. Mucro bidentate.....4
4. Dentes with scales on ventral surface.....5
5. Forth abdominal segment at midline more than twice as long as third.....6
6. Eyes 8 + 8(Fig. 3C).....*Lepidocyrtus*

Key to the genera of Salina sp.

1. Dentes smooth (Fig. 3B).....2
2. Dental spines absent.....3
3. Mucro less than ¼ as long as dens (Subfamily Paronellinae).....*Salina*

Conclusion

Collembolans are a major part of the soil biota. The genera described above are usually found in different natural habitats of the Rajshahi University campus area. Three genera are described in this paper, and common characteristics like body length, color, head position, eye pattern, antennae, thorax, abdominal length, furcula structure, etc., are used for the determination of genera. This preliminary report on

some Arthroplenoid Collembolan genera will help the researcher to explore the ecology and distribution of species in Bangladesh.

Acknowledgements

The author expresses his gratitude to the Chairman, Department of Zoology, University of Rajshahi, for providing the necessary laboratory facilities, as well as to the late Professor Dr. Md. Mosharrof Hossain, Department of Zoology, University of Rajshahi, for his guidance, constant inspiration, and invaluable suggestions.

References

Beck L, Hofer H, Mlu-tius C, Garcia MB, Franklin E, Rombke J. 1998. Soil fauna and litter decomposition in primary and secondary forests and a poly culture system in Amazonia- study design and methodology. Proceeding of the third shift-workshop Manaus, Bundesministerium für Bildung und Forschung, and Bonn.

Bellinger PF, Christiansen KA, Janssens F. 1996-2022. Checklist of the Collembola of the World. (Last access: January 2022). Available online at http://www.collembolaorg.

Block W. 1984. Terrestrial microbiology: Invertebrates and Ecosystem. In: Law, R.M. (Ed.). Antarctic Ecology. Academic Press, London **1,** 163-236.

Bomer C. 1913. Die Familien der Collembolan. Zoologischer Anzeiger **41,** 315-322.

Bourlet C. 1939. Mémoire sur les Podures. Mémoires de la Société Royale des Sciences, Del'Agriculture etdes Arts, de Lille, Annee. 377-418.

Cassagne N, Bal-serin, MC, Gers C, Gauquelin T. 2004. Changes in humus properties and collembolan communities following the replanting of beech forests with spruce. Pedobiologia **48,** 267-276. http://dx.doi.org/10.1016/j.pedobi.2004.01.004.

Christiansen KA, Bellinger PF. 1998. The Collembola of North America. North of Rio Grande. Grinnell College, Grinnell, Iowa. 1322.

Fjellberg A. 1998. The Collembola of Fennoscandia and Denmark. Part:I Poduromorpha. Fauna Entomologica Scandinavica **35**, 1–184.

Fjellberg A. 2007. The Collembola of Fennoscandia and Denmark. Part II: Entomobryomorpha and Symphypleona. Fauna Entomologica Scandinavica **42,** 1–266.

Greenslade PJ. 1991. Collembola (Springtails). In: Insects of Australia: A Textbook for Students and Research Workers (ed. Neumann, I.D.). Melbourne University Press, Australia. 252-264.

Hazra AK, Mandal GP. 2007. Pictorial Handbook on Indian Collembola (Part-1). Zoological Survey of India, Kolkata. 8-21.

Hazra AK. 2015. A review on Paronellinae (Collembola: Paronellidae) of India. Records of the Zoological Survey of India, Occasional Paper No **368,** 1-63. (Last access: January 2022). https://www.chaosofdelight.org/all-about-collembola-entomobryomorpha.2022.

Hopkin SP. 1997. Biology of the Springtails (Insecta: Collembola). Oxford University Press, UK. 330.

Hossain M.2010. Collembolan Fauna of Rajshahi University Campus. Journal of Life Earth Science **5,** 33-35. http://dx.doi.org/10.3329/jles.v5i0.7347.

Hossain M, Mirjahan, Faruki SI. 2012. Abundance and habitat diversity of springtails (Insecta: Collembola) of Rajshahi City Corporation. Journal of Life and Earth Science **7,** 119-120. https://doi.org/10.3329/jles.v7i0.20132.

Hossain M, Rahman S, Islam MS, Papia S, Faruki SI. 2017. Prevalence of springtail

(Collembola) in the cultivated maize fields at Puthia Upazila, Rajshahi district, Bangladesh. Journal of Entomology and Zoology Studies **5(1)**, 186-190. http://dx.doi.org/10.22271/j.ento.

Imms AD. 1912. On some Collembola from India, Burma and Ceylon with a catalogue of the Oriental species of the order. Processidings of the Zoological Society of London, 80-125.

Islam MS, Alim MA, Hossain M. 2014. Taxonomy of Collembola (Insecta: Apterogota) using morphological and chaetotaxy characters. University Journal of Zoology, Rajshahi University **33,** 107-111.

Islam MS, Hossain M, Hossain M, Yasmin M. 2018. Impact of climatic factors and soil quality on the abundance and population density of Collembola in the Rajshahi University Campus, Bangladesh. Journal of zoology and Entomology studies **6(1),** 1119-1125.
http://dx.doi.org/10.22271/j.ento.

Islam MS, Nur M, Rahman MA, Yasmin M, Hossain M, Faruki SI. 2021. An annotated checklist of the Collembola (Springtails) of the Rajshahi district, Bangladesh with two new records of collembolan fauna. Journal of Entomology and Zoology Studies **9 (6)**, 66-72.
http://dx.doi.org/10.22271/j.ento.

Islam MS, Nur M. 2021. Three new records of Entomobryidae Collembola (Arthropoda: Hexapoda) species from Bangladesh. Uttar Pradesh Journal of Zoology **42 (24),** 367-372.

Kabir SMH, Ahmad M, Ahmed ATA, Rahman AKA, Haque EU, Ahmed ZU. 2008. Encyclopedia of Flora and Fauna of Bangladesh Apterygota and Pterygota (Part). Asiatic Society of Bangladesh, Dhaka **19,** 275.

Lim C, Lim S. 2007. A hand operated aspirator for collecting springtails (Collembola) and other small arthropods. International Journal of Tropical Insect Science **27 (3-4)**, 236-238.

MacGillivray AD. 1894. New species of N*othochrysa*. Canadian Entomologist **26,** 169-171.

Mitra SK. 1993. Chaetotaxy, Phylogeny and Biogeography of Paronellinae (Collembola: Entomobryidae). Calcutta Laser Graphics Pvt. Ltv. India 100.

Mutt JAM. 1976. The Genera of Collembola (Insecta) in Puerto Rico: Keys, Diagnoses and General Comments. The Journal of agriculture of the University of Puerto Rico **60 (1),** 113-127.

Rahman MA, Akthar B, Moniruzzaman M, Islam MM, Mohammad N, Islam MS, Hossain M. 2018. First Record of Collembola and their Diversity in the Charland of the Padma River Rajshahi, Bangladesh. University Journal of Zoology, Rajshahi University **37**, 1-7.

Richard JS. 1967. An Annotated List of the Collembola (Springtails) of Michigan," The Great Lakes Entomologist **1(6)**, 188-189.
https://scholar.valpo.edu/tgle/vol1/iss6/1.

Soto-Adames FN. 2008. Postembryonic development of the dorsal chaetotaxy in *Seira dowlingi* (Collembola, Entomobryidae); with an analysis of the diagnostic and phylogenetic significance of primary chaetotaxy in *Seira*. Zootaxa **1683,** 1–31.
https://doi.org/10.11646/zootaxa.1683.1.1.

Soto-Adames FN, Barra JA, Christiansen KA, Jordana R. 2008. Supra generic Classification of Collembola Entomobryomorpha. Annals of the Entomological Society of America **101,** 501–513.
https://doi.org/10.1603/00138746(2008)101[501:SCOCE]2.0.CO;2.

Stork NE, Eggleton P. 1992. Invertebrates as indicators of soil quality. American Journal of Alternative Agriculture **7,** 38-47.

https://www.jstor.org/stable/44479649.

Wahlgren E. 1906. Apterygoten aus Ägypten und dem Sudan nebst Bemerkungen zur Verbreitung und Systematik der Collembolen. Results of the Swedish Zoological Expedition to Egypt and the White Nile 1901 under the Direction of L.A. Jägerskiöld, Uppsala. 1–72.

Yosii R. 1966a. Collembola of Himalaya. Journal of the College of Arts and Science, Chiba University **4(4),** 461-531.

Zeppelini DF, Bellini BC. 2006. Two *Seira* Lubbock 1869 (Collembola, Arthropleona, Entomobryidae) new to science, with remarkable secondary sexual characters. Zootaxa **1185,** 21–35. https://doi.org/10.11646/zootaxa.1185.1.2.