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First Record of Collembola and their Diversity in the Charland of the Padma River Rajshahi, Bangladesh

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Abstract: In this study Nine hundred ninety nine individual collembolans were collected during February to August 2016. The collected specimens belonged to four families such as Entomobryidae, Isotomidae, Hypogastruridae and Poduridae. They were six species *viz Isotomina* sp., *Entomobrya griseolivata, Entomobrya gisini, Isotoma viridis, Hypogastrura armata, and Podura aquaticaa*. Among them, the highest population found *Isotomina* sp (229) and the lowest population was *Podura aquatica* (70). In the present study the morphological parameters were different in each species. According to the total length, *E. griseolivata>P. aquaticaa> Isotomina sp> I. viridis> H. armata> E. gisini* were 708.82, 700.95, 694.32, 619.76, 492.10, 472.80µm respectively. However, the highest antennal length found in *E. griseolivata* (204.34µm) and the lowest was in *E. gisini* (62.33µm). The highest Shanon-Weiner diversity index of Collembola was found 1.750 in the month of April and the lowest was 1.674 in July. This study identified Collembola species are diversified in Charland soil have important roles in soil fertility may help to understand the ecological aspect in these habitats.

Key words: Collembola, Springtails, Insect survey, Diversity, Rajshahi, Padma River

Introduction

Collembola are hexapods with antennae commonly known as 'Springtails' that derived from the springing organ furcula that arose during evolution form a pair of appendages (Lubbok, 1873). Springtails are highly diverse group of arthropods living in vegetation, leaf litter and in soil, especially found to a depth of 10-15cm (Hopkin, 1997; Lagerlof & Andren, 1991; Ponge, 2000). This ventral projection, the ventral tube or collophore, plays an extremely important role in the fluid and electrolyte balance, and the ventral tube may also be used as a source of grooming fluid and help collembolans in adhering to smooth surfaces (Hopkin, 1997).

However, in Anurida, that do not have a furcula, the eversible vesicles of the ventral tube may adhere to the surface water film on which they can walk and deform it in such a way that it is spring loaded, when the water film is released the animal is launched upwards into the air (Bush & Hu, 2006). Many factors including food availability, soil type, microclimate, and species composition in adjacent habitats influence the total distribution of springtails within a specific site. The group comprises diversity of species, and springtails may be found in almost all habitats in ecosystem except in water (Fjellberg, 1998; Hopkin, 2007). Their distribution in soil varies with season and between species, and springtails have been reported down to 3 meter soil depth in (irrigated) agricultural land in California (Price &Benham, 1977). Mostly they dwelling above ground and in the upper 5 cm of soil/litter layer (Fjellberg, 2007; Bardgett & Cook, 1998). On a global scale, the current number of species described is approximately 8000 (Bellinger *et al.,* 2015). In Bangladesh, few studies on taxonomy and habitat diversity have been studied only in Rajshahi region in natural habitats and in cropland (Hossain, 2010; Hossain *et al.*, 2014; Islam *et al.,* 2014; Hossain *et al.,* 2017). Many species of Collembolans are now established bio-indicator of soil pollution as well soil fertility. Collembolans are generally sensitive indicator of disturbance and therefore of value in environmental assessment. Springtail are minor pest in agriculture but their importance as a biological agent in the soil forming process are immense as well as enhancing soils fertility. In India about 230 species of

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Collembola under 86 genera, 8 families and 2 sub-orders are known. In Bangladesh, only 4 genera under 4 families are recorded (Kabir *et al*., 2008, Encyclopedia of flora and fauna of Bangladesh). Collembola have well differentiated ecomorphological life-forms and feeding guilds which enable the functional role that Collembola plays in the ecosystem to be recognized in some degree. Collembola play an important role in plant litter decomposition processes and in forming soil microstructure. However, in the present study confirm few springtails presence by the morphometries and their abundance in the Charland alluvial soil of the Padma River.

Materials and Methods:

Study area

Springtails were collected from the alluvial soil of the Charland of the river Padma. The study area is located from $24^0$30'N to $24^0$40'N and from $80^0$25'E to $80^0$55'E (Fig. 1). Every year 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 is 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 river. Because of high fertility, grass and crops grows 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 (Shamsuzzoha *et al.*, 2014). The hot season commences early in March and continues till the middle of July. Studied areas are; Char Taranagar, Char Shibnagar, Char Khidirpur and Char Diyar khidirpur (Fig. 1) which occupied by seasonal crops and small shrubs.

Collection of Collembola

Springtails were collected from the different parts of alluvial lands of Padma River by using glass vial aspirator and white colored board. Springtails are mainly found in leaf litters and grassy lands. For collection specimens dry seasons was chosen because in rainy season the Charland areas decreased due to inundate. After collecting, springtails were preserved in glass vials with 70% alcohol to preserve them for a long period. The collected specimens were taken to the Insect Research Laboratory, Department of Zoology, University of Rajshahi and grouped according to morphology, finally slides were prepared for their identification. The Springtails were counted properly to get an idea about their abundance and diversity of species in the study area for the statistical analysis.

Species identification

The prepared slides were observed under a light microscope for identification. For close observation, the magnified pictures of the specimens were taken by using fluorescence microscope (Model- OLYMPUS IX-71, USA). The picture of different body parts were measured. The morphological characteristics were compared with the pictorial key, and standard key for the identification from internet sources (www.collembola.org). Most of the adult springtails were identified to species, while most juvenile and some adult individuals were identified only to genus by using the keys of Arne Fjellberg (Fjellberg, 1998; Fjellberg, 2007). Standard keys to the families of Collembola were also used for taxonomic identification (Greenslade, 1991; Hazra *et al.,* 2007).

Data analysis and diversity calculation

The characteristics of Collembolan community structure were analyzed by using different diversity indices, Anova was calculated by using IBM SPSS (version 20). The diversity index was calculated by using the Shanon-Weiner diversity index (Shannon & Weiner, 1949).

Diversity index calculate as, $H = \sum - (P_i * \ln P_i)$

Where;

H = the Shannon diversity index

P_i = fraction of the entire population made up of species i

S = numbers of species encountered

$\sum$ = sum from species 1 to species S

ln = **Natural logarithm** of the number

Results and discussion

In the present study total 999 individual springtails were collected that identified into six species. The collected specimens belongs four families (Entomobryidae, Isotomidae, Hypogastruridae and Poduridae), and species, v*iz. Isotomina sp., Entomobrya griseolivata, Entomobrya gisini, Isotoma viridis, Hypogastrura armata, and Podura aquatica* (Fig. 2 & Table 1). However, *Isotomina* was

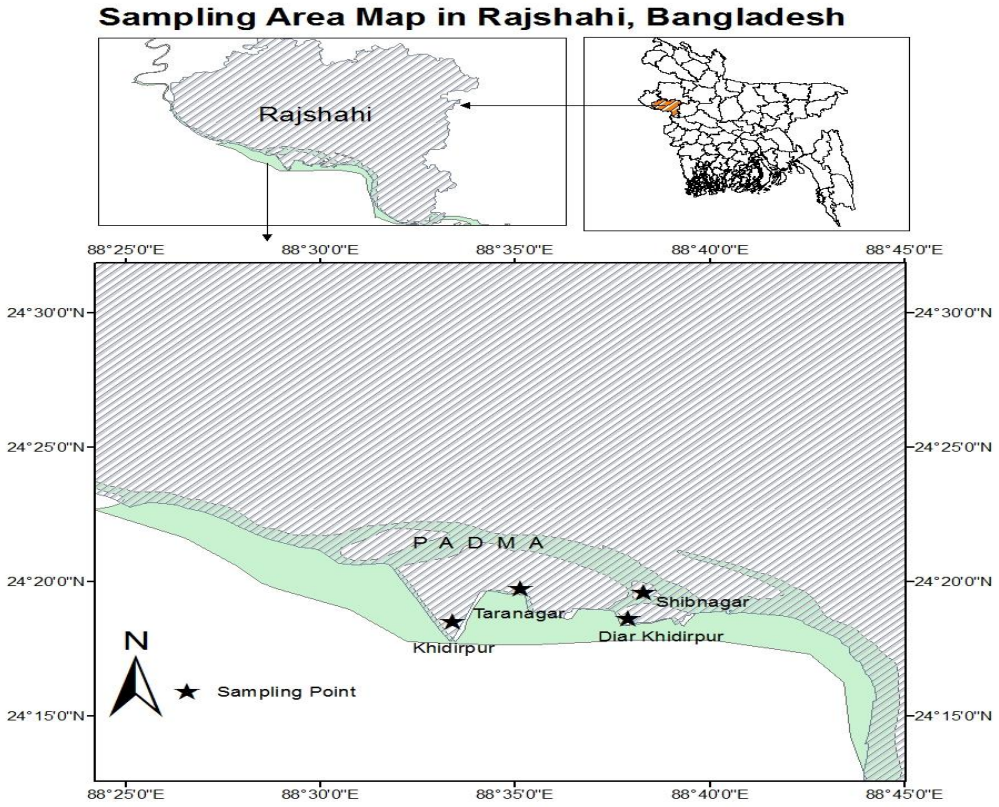

Figure 1. Map showing sampling areas in the Padma River charland (filled black star) of Rajshahi.

Table-1. Measurements of comparative morphological characters (µm) of different species of Collembola.

Species	HL (µm)	Th + Abd. (µm)	AnL (µm)	FL (µm)	TL (µm)
Entomobrya griseolivata	68.37	98+128.85	204.34	207.26	708.82
Entomobrya gisini	49.70	90.52+160.09	62.33	110.16	472.80
Isotomina sp	72.50	76.80+147.81	201.76	195.45	694.32
Isotoma viridis	63.69	80.52+119.13	107.25	249.17	619.76
Hypogastrura armata	82.46	98.15+200.66	110.83	-	492.10
Podura aquatica	69.12	105.62+141.20	175.70	209.31	700.95

HL, Head length; Th, Thorax; Abd, Abdomen; AnL, Antenna length; FL, Furcula length, TL, Total length.

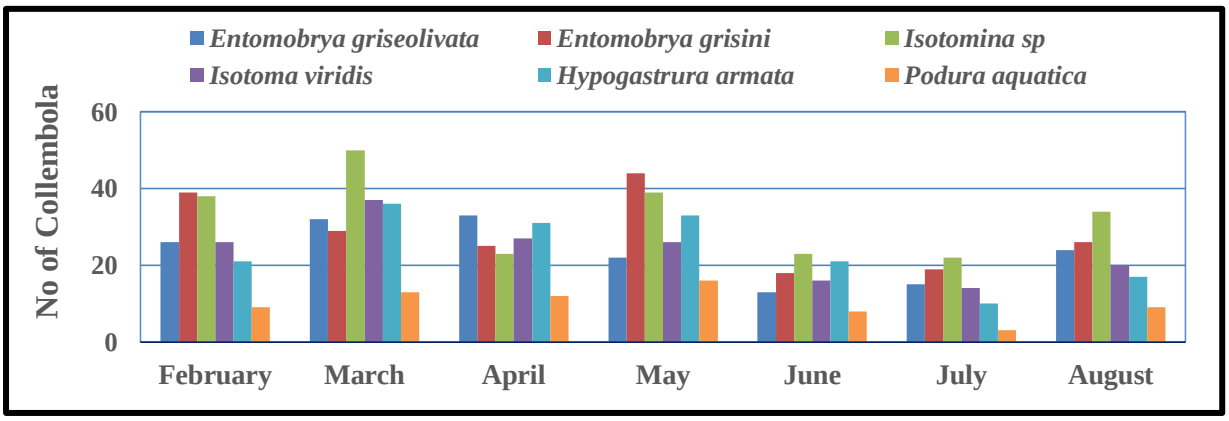

Figure 2. Monthly prevalence of Collembolans in the Charland during the study period of the river Padma at Rajshahi.

unable to identify up to species level that belongs to Isotomidae family. Among them, highest population was *Isotomina* sp (229) and lowest population was *Podura aquatica* (70). The highest number of population was found in the month March (197) and lowest was in the July (83). Interestingly, their abundance was high in the spring was unknown reason although many researcher find their diversity in this season at Aligarh in India (Abbas, 2012). Winter and spring both are the favorable seasons for growth of agriculture soil Collembolan (Abbas & Parvez, 2012) which is similar to this study. The percent diversity was highest among the *Isotomina* sp (23%), *E. gisini* (20%), *Isotoma viridis* (17%) respectively.

The Charlands are fully silted alluvial soils deposition from the tributaries of the mighty Ganges that named Padma in Bangladesh inter into Rajshai about 145km the Ganges border in India. The river forms the western boundary between India and Bangladesh before it enters Bangladesh at the northern edge of the Kustia districts as the upper segment of the Padma River (www.britannica.com). It is important that there are many important linkages between Collembolan and nutrient cycling in soils. Collembola increases nitrogen mineralization, soil respiration, leaching of dissolved organic carbon, and plant growth (Filser, 2002; Addison *et al.,* 2003; Nielsen *et al.,* 2011). The present study deals the presence of six species may effects on nutrient cycling are mediated by grazing on lower trophic positions, whereby Collembola increase fungal growth and microbial respiration also may prey on nematodes (Kalironomos *et al.,* 1992; Filser *et al*., 2002; Sylvain & Wall, 2011). The lowest population of Collembolan in June (99) and July (83) in this study (Fig.2 & 3) may be due to increase precipitation, because researcher have shown that increased precipitation severity decreased the density and richness of Collembola, which contrasts with previous studies that have found decreased Collembolan abundance under drought regimes (Pflug & Wolters, 2001; Kardol *et al.,* 2011; Makkonen *et al.,* 2011).

Fjellberg found a reasonably good accordance between easily detectable morphological characteristics and established taxonomical classification (Fjellberg 1998, 2007). In our study the morphological parameters were different in each species. According to total length they were *E. griseolivata*>*P. aquatica*> *Isotomina sp*> *I. viridis*> *H. armata*> *E. gisini* were 708.82, 700.95, 694.32, 619.76, 492.10, 472.80µm respectively (Table 1). However, the highest antennal length found in *E. griseolivata* (204.34µm) and lowest was in *E. gisini* (62.33µm). Interestingly head length showed *H. armata* (82.46 µm) largest, and smallest was in *E. gisini* (49.70 µm). Furcular length measured 249.17, 209.31, 207.26, 195.45, and 110.16 µm in *I. viridis, P. aquatica, E. griseolivata, Isotomina* sp and *E. gisini* respectively. These morphometries showed similarity in comparing many researchers' works on globally (Christiansen 1980; Jordana & Baquero 1999). The presence of these collembolan species in this areas indicate ecosystem balance because springtails are the prey of many arthropods, particularly ants, beetles and mites, and thereby from a fundamental element of trophic interactions (Palacios-vargas, 2000).

The outcome of total abundance of families is the sum of many species behaving and responding differently as Isotomidae> Entomobryidae>Hypogastruridae>Poduridae were 395, 365, 169 and 70 respectively (Fig.4). The total number of Collembola culminates in early summer and late rainy season and this was the case with Isotomidae and Entomobryidae whereas Hypogastruridae and Poduridae are most abundant in spring and summer (Fig.4) showed similar data of Gudleifsson & Bjarnadottir (2008).

It might be argued that the fauna of springtails in cultivated soil, where disturbances occurs regularly due to soil tillage, manure application, harvesting and pesticide applications, will be limited and low in diversity of species. Compaction of soil tillage and other mechanical operations seem to affect especially density of springtail in cultivated land negatively (Heisler &Kaiser, 1995). However, in this study the results of species diversity index was 1.750 highest in the month of April at tillage time and lowest was 1.674 diversity (Fig.5) in July during crop harvesting time is interesting, but contradictory to North-European arable agricultural land studies (Filser *et al*., 2002). Sabais *et al*. (2011) reported that the diversity of plant species, and inclusion of grasses and legumes in the cropping systems, beneficially affected both the density and diversity of springtails in grassland study are similar to our charland vegetation. Therefore, this study on the diversity of Collembola species was identified in Padma River silted alluvial soil may help to understand the ecological importance of Collembola in the respective habitats and more study on their role in ecosystem should be studied in future.

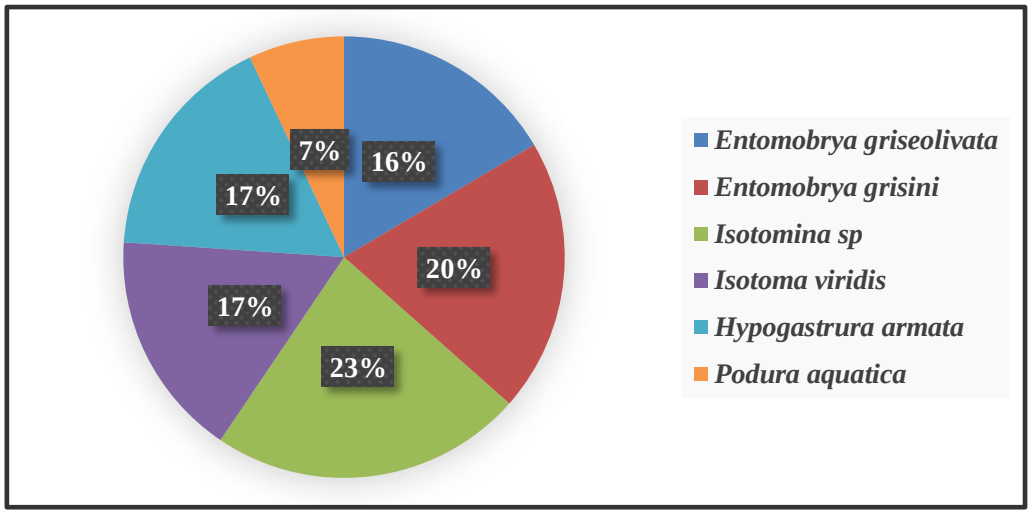

Figure 3. Relative abundance (% of the total abundance) of Collembolans in the Charland during the study period of the river Padma at Rajshahi.

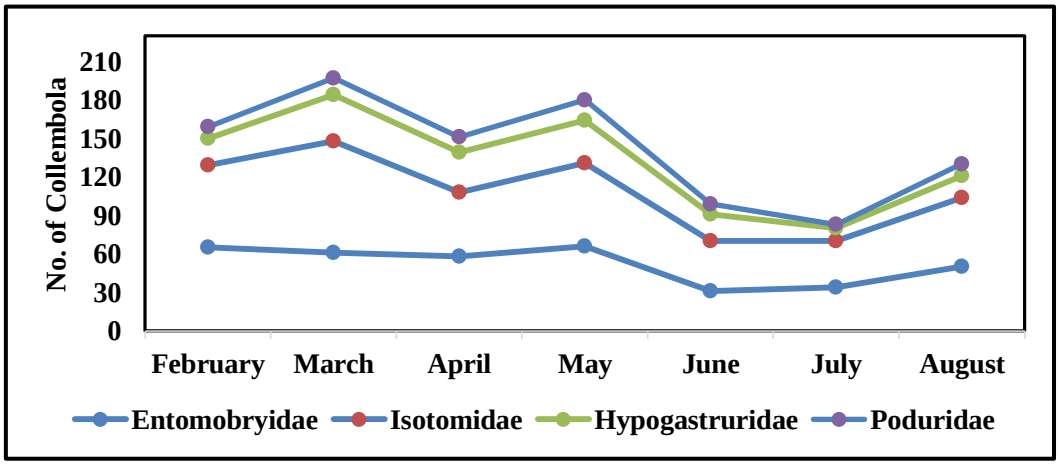

Figure 4. Number of trapped specimens of Four families throughout the survey period of the Charland of the Padma River.

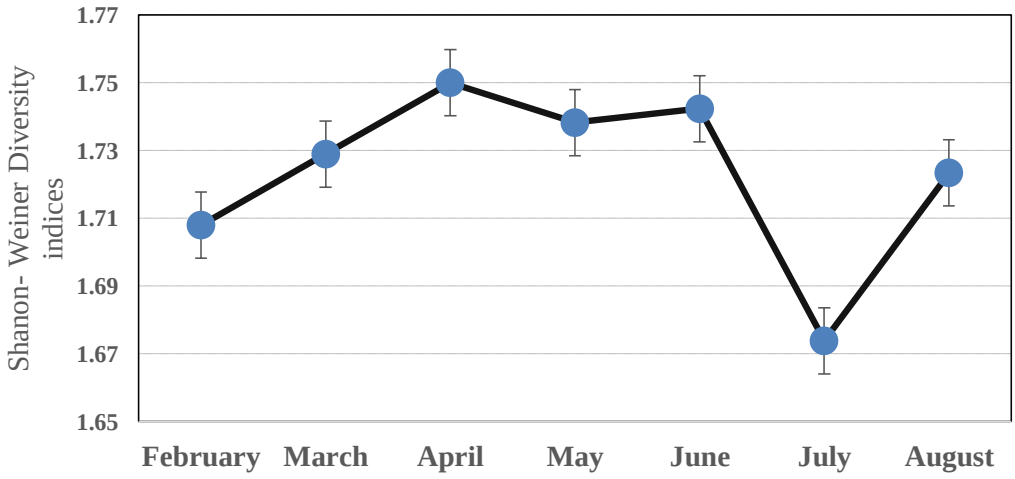

Figure 5. Monthly Shanon-Weiner diversity index of the Charland Collembolans populations.

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