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POPULATION DYNAMICS OF COLLEMBOLA AND ACARI IN WETLANDS AND CROPLANDS IN INDO-GANGETIC PLAINS OF NORTH BIHAR

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ABSTRACT
Twelve genera of Collembola belonging to four different families were recorded from cropland field, whereas only eight genera of three different families of Collembola could be recorded from the wetland field. Similarly sixteen different species of mites and a *Nova species* were found in cropland field whereas only eight species of mites were present in wetland field implying thereby that inundation is not favored by certain species of Collembolans and mites. The impact of water logging on population densities of both the groups of fauna was clearly evidenced. Out of the two peaks exhibited by Collembolan one was more pronounced in the month of September while the other was less pronounced in the month of March in cropland. In wetland higher numbers was observed in the month of March but Water logging rendered zero population of both the groups of soil fauna in the month of August and September. Mites had also a peak in the month of August and March in cropland and wetland fields respectively.

INTRODUCTION

Muller (1879) was the first to recognize that soil animals play an important role in the development of soil. In fact soil fauna represents the most rewarding area of current biological exploration. Soil biota, constitutes the driving force of terrestrial ecosystems because they control the rate of turnover and mineralization of substrates. Yet they remain one of the least known biological frontiers, particularly in terms of soil zoological systematic, taxonomy and ecology. They also act as an indicator of soil conditions and can be used for soil diagnosis (Ghilarov, 1965; Choudhuri and Roy, 1967). Mites are predominantly soil dwelling and there is no sample of humus that does not contain a mass of herbivorous beetle mites (Oribatids). The same is true to springtails (Collembola) too. Both are among important producers of humus. They are either saprophagous or carnivorous forms. The saprophagous forms are of direct relevance to decomposition process. Soil fauna favours microbial activity, increase enzymatic activity and stimulate root development and maintain a control over plant damaging species. In agro-ecosystem they play vital role in distribution and flow of carbon within the soil system by creating galleries, chambers, burrows, mounds and nests and producing faecal matters. They decompose the organic residues which are essential for primary production.

Our knowledge of the soil biota in the fields of Khagaria (Bihar) lags far behind. The present paper is aimed at to present briefly an overview of soil fauna studies from Khagaria district of north Bihar. A census of their species composition and population density fluctuation in relation to the seasonal changes is of great relevance in order to focus the ecological significance of soil fauna in the ecosystem functions and dynamism in agriculture and stressed conditions so that this discipline could attract more Indian pedologists to pursue serious research. Scanty literature on the subject speaks of its poor attention received from Indian pedologists. Singh (1978) has reviewed soil fauna studies in India. The proceedings of two national symposia *"Soil Biology and Ecology in India"* (Edwards and Veeresh, 1978) and *"Progress in Soil Biology and Ecology in India"* (Veeresh, 1981), followed by *"Applied Soil Biology and Ecology"* (Veeresh and Rajagopal, 1983) and *"Advances in Management and Conservation of Soil Fauna"* (Veeresh *et al.*, 1991), indicates the gradual maturity of soil faunal studies in India. These publications attempted to bridge the gap in the knowledge on soil biology and ecology in our country, which is, as yet insignificant as compared to her vast landscape variation and severe pressures on fragile soils. Qualitative and quantitative studies of micro-arthropods from Indian soils began from the mid-sixties, although studies were initiated much earlier by Trehan in 1945. However, major contributions have been from the agricultural fields, abandoned fields, grasslands, and tea garden, and very few from wetland fields. Banerjee (1972), Hazra (1978), Annadurai *et al.* (1988), Reddy and Reddy (1996); Bisht and Chattoraj (1998) etc. have reviewed from different agro-ecosystems. Sanyal (1995) has reviewed the ecological studies of soil oribatid mites in India. Choudhuri and Roy, (1971, 1972) studied the distribution and ecology of Collembola of West Bengal. Singh and Singh (1975), Prabhoo (1976) and Hazra (1982) have studied the soil micro-arthropods from the tropical forest soils and litters of India. Kevan (1955, 1962), Farb (1959), Macfadyen (1953), Doeksen and Drift (1963), Burges and Raw (1967), Graff and Satchell (1967), Wallwork (1976), and Singh and Raghuraman (2009). have contributed a considerable amount of information on the general biology and ecology of soil animals. Filser (2002) has evaluated the role of collembolans in cycling of C and N in soil. Hattar and Alfred (1984) studied the population and community structure of Collembola in pine forest soils of Meghalaya. Hattar *et al*. (1992) compared the population dynamics of soil Acarina and Collembola in forest and cultivated land of Khasi Hills, Meghalaya. Hattar *et al*. (1998) analysed the diversity of soil fauna in some managed and protected forests of North-East India. Paul and Alfred (1995) compared the soil arthropod fauna of three agro-ecosystems with undisturbed forests of Meghalaya. Sarkar (1990) studied the Oribatid mites population in undisturbed habitat of Tripura (India). Owing to the fragmentary rather no information on soil biota of interest and importance particularly with reference to collembolans, and mites of this region, the present investigation, in the context of cropland and wetland, was aimed at to explore species composition and population density fluctuation and their precise role.

MATERIALS AND METHODS

Site description and techniques employed

Khagaria district is bounded by sister of seven rivers Ganga, Bagmati, Budhi Gandak, Kareh, Kamala, Koshi and Kali Koshi. Before embankment a vast tract of the district was flat alluvial plain and was abound in marshy and swampy land. Climate of the region is moderate and rainy season is the most favourable season. The district does not comprise any forest area. It also lacks in mineral resources. The study site, Khagaria district, is in the Gangetic bio-geo-climatic zone of north Bihar and is located between longitude 25 degree 15 minutes to 25 degree 44 minutes and latitude 86 degree 17.14 minutes to 86 degree 52.5 minutes. Total area occupied by this district is 1485.8 km^2.

The soils of the site have been classified as a sandy loam developed by periodic inundation from river Koshi, Bagmati, Gandak, and Ganga. Geographically soil moisture is also supposed to be altered due to change in precipitation, percolation, evaporation and rainfall distribution. The south-west monsoon arrives between June and September. Typically the hottest month is May. Cyclones occur in October and November after the monsoon (Takahashi and Arakawa, 1981). Khagaria district experiences three climatic seasons (i) Summer season from late March to mid June, (ii) Rainy season from mid June to October and the (iii) Winter season from November to February. Community structure with reference to collembolans and mites were investigated in wetland and cropland ecosystems. Both the ecosystems are exposed to different conditions either being inundated by periodic flood or remains dry, thus give an idea of their impact on the faunal community.

Five soil samples were collected every month from each fields for a period of 12 months March 2009 to February 2010 by a rectangular sampler 7.5 x 22.5 x 10 cm (1760 cm by volume) and brought to the laboratory in polythene bags tagged with sampling site, date, vegetation *etc.* for processing and analysis. Tullgren dry funnel extraction technique was employed to drive out the soil mites and Collembola from the soil sample and collected in alcohol with glycerol solution. Sorting was done under zoom stereoscopic microscope and then preserved in separate vials with absolute alcohol and one or two drops of glycerol for further processing. Data collected were subjected to computerized evaluation for statistical analysis.

RESULTS AND DISCUSSION

The present investigation does not comply with all taxonomic requirements, so it could be treated as an overall composition of the Collembolans and soil mites in two different fields. Specific identification were done during routine sampling as far as possible and later confirmed by the expert. Acari of three orders (Cryptostigmata, Prostigmata and Mesostigmata) and Collembolans of four families Isotomidae, Entomobryidae, Sminthuridae and Poduridae were observed throughout the investigation period in both the study sites. Table 1 and 2 depicts the qualitative composition of Collembolan and mites observed in two different ecological fields. Assessment of the seasonality of population of Collembola and Acari showed a declining trend in winter (Nov to Jan) which in conformity to the data recorded by Loots and Ryke (1966) but shows dissimilarity with findings of Sanyal and Sarkar (1993). Overall occurrence of Collembolans and mites in present investigation is higher in cropland than in stressed wetlands which implies that waterlogging affects adversely their population density. Domination of the mites in both the fields agrees with the report of Luxton (1981).

Out of the two peaks exhibited by Collembolan one was more pronounced in the month of September while the other was less pronounced in the month of March in cropland. In wetland higher numbers was observed in the month of March but were reduced to zero in August and September. Mites had also a peak in the month of August and March in cropland and wetland fields respectively. Water logging rendered zero population of both the groups in the month of Aug and Sep.

In cropland field of *Zea mays*, (Fig. 1) Collembolan population were minimum in the month of May'09, 658/m^3 ($\pm$0.3735) and January'10, 898/m^3 ($\pm$0.582). Their maximum population density was recorded in the months of September'09, 2047/m^3 ($\pm$0.489) and March'09, 1654/m^3 ($\pm$0.509). In wetland fields their population density attained the peak in the month of March' 2009, 1040/m^3 ($\pm$0.489) only. No second peak was observed, instead a restoration trend was apparent. Mites in the cropland fields also exhibited two peaks, one in the month of March'09, 2003/m3 ($\pm$0.521) and the other in the month of August'09, 2568/m3 ($\pm$0.487). They were minimum in numbers during May-June. Waterlogging had adverse effect on mites too but their restoration was fast with maximum density attaining in the month of March'09, 2879/m3 ($\pm$0.231).

Table 1: Qualitative composition of collembola in two different ecosystems

Ecosystems collembola systematic position		
Cropland field	*Cryptopygus* sp., *Isotoma* sp., *Proistoma* sp.	Fam. : Isotomidae
	New sp.	
	Seira sp., *Lepidocyrtus* sp., *Cyphoderus* sp., *Sinella* sp., *Oncopodura* sp.	Fam. : Entomobryidae
	Dicyrtomina sp., *Sminthurus* sp.,	Fam. : Sminthuridae
	Poduromorpha sp.	Fam. : Poduridae
Wetland field	*Entomobrya* sp.	Fam. : Entomobryidae
	Dicyrtomina sp., *Neosminthurus* sp., *Sminthurus* sp.	Fam. : Sminthuridae
	Ceratophysella sp., *Isotoma* sp., *Folsomids* sp., *Proistoma* sp.	Fam. : Isotomidae

Table 2: Qualitative composition of mites in two different ecosystems

Ecosystems mites systematic position			
Cropland field	*Galumna* sp.	Order : Cryptostigmata	Fam. : Galumnidae
	Sphaerolophus sp.	Order : Prostigmata	Fam. : Erythracidae
	Styloribates sp.	Order : Cryptostigmata	Fam. : Oribatulidae
	Blattosocious sp.	Order : Mesostigmata	Fam. : Ascidae
	Ixodorhynchus sp.	Order : Mesostigmata	Fam. :Ixodorhynchidae
	Entonyssus sp.	Order : Mesostigmata	Fam. : Entonyssidae
	Myrmonyssus sp.	Order : Mesostigamata	Fam. : Mycoptinae
	Ololaelaps sp. *Near Venata*	Order : Mesostigmata	Fam. : Laelapidae
	Pachylaelaps sp.	Order : Mesostigmata	Fam. : Pachylaelaptidae
	Tetranychus urticae	Order : Trombidiformes	Fam. : Tetranychidae
	Aceoseius sp.	Order : Mesostigmata	Fam. : Aceosejidae
	Nova species	Unidentified	
	Nova species	Unidentified	
	Cunaxa sp.	Order : Prostigmata	Fam. : Cunaxidae
	Dermanyssus sp.	Order : Mesostigmata	Fam. : Dermanyssidae
	Fedrizzia sp.	Order : Mesostigmata	Fam. : Fedrizzidae
Wetland field	*Galumna* sp.	Order : Cryptostigmata	Fam. : Galumnidae
	Sphaerolophus sp.	Order : Prostigmata	Fam. : Erythracidae
	Suctobelba sp.	Order : Cryptostigmata	Fam. : Suctobelbidae
	Styloribates sp.	Order : Cryptostigmata	Fam. : Oribatulidae
	Eutetranychus orientalis Tetranychus urticae,	Order : Trombidiformes	Fam. : Tetranychidae
	Ixodorhynchus sp.	Order : Mesostigmata	Fam. : Ixodorhynchidae
	Cunaxa sp.	Order : Prostigmata	Fam. : Cunaxidae
	Dermanyssus sp.	Order : Mesostigmata	Fam. : Dermanyssidae

Months of peak population may be attributed to the fact that litter falls and consequent humus production makes the soil rich in organic matter. Mesofauna are known to be litter feeders, thus flourish in number with increasing organic matter (Webb, 1994; Heneghan and Bolger, 1998; Irmler, 2000; Reynolds *et al*., 2003; Ponge, 2003; Ponge, and Chevalier, 2006 ; Graefe and Beylich, 2006; Galvan *et al*., 2008). In fact, humus forms a tool for upscaling soil biodiversity and density. Population buildup of soil microarthropods is influenced by both abiotic and biotic factors and their interaction (Narula *et al.,* 1998). Many workers have reported higher population buildup during rainy season and a sharp decline during summer months (Jam *et al.,* 1986; Reddy and Venkataish, 1990; Reddy *et al.,* 1992; Hazra and Sanyal, 1996). In present investigation a similar result was found in the cropland fields but the wetland field showed a different result where population of both Collembolans and mites became zero (0) due to inundation. The whole spectrum of population dynamics in the flood affected or water logged areas was quite different. Population of mites and collembolans were reduced to Zero (0) in the months of August and September. Restoration of the population began from October and attainted the maximum density in Feb.'10. Ploughing, rotovation and inundation affects population density was apparent in both the cropland (*Zea mays*) and wetland fields (Fig. 1). Edwards and Lofty (1969) suggested that crop rotation decreases density and diversity even to a greater extent than monocultures eliminating those species which are associated with other plants. Both Collembola and Acari seem to respond to chemical residues of fertilizers insecticides and other environmental stresses

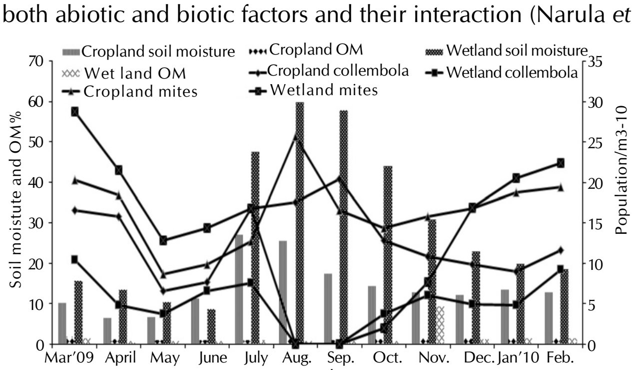

Figure 1: Population of mites and collembola in cropland and wetland fields

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