Indian Journal of Entomology Online published Ref. No. e23206 DoI. No.: 10.55446/IJE.2023.1382

SOIL ARTHROPOD DIVERSITY, RICHNESS AND ABUNDANCE IN AGRICULTURAL ECOSYSTEMS

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ABSTRACT

Soil arthropods play a crucial role in an ecosystem and act as predators, pollinators, parasitoids, herbivores and decomposers. Arthropods are used as biological indicators for agroecosytem integrity. In the present study a total of 1914 species was recorded. Class Arachnida, Insecta and Crustaceans were found. Class Entognatha and Chilopoda were the others recorded. Family Paronellidae from Entognatha, Scarabaeidae from Insecta and Lycosidae from Arachnida revealed highest number of individual species of 189, 114 and 132, respectively. In Chilopoda and Crustacea a total number of 63 and 138 species were recorded. Highest value of Shannon Weiner index 3.12 at familial species and 3.44 at species level and Simpson's index of 20.03 and 25.71 at familial level and species level, respectively was recorded during November.

Key words: Biodiversity, arthropods, agroecosystem, soil, richness, diversity, macroarthropods, microarthropods, Shannon Weiner index, Simpson's index, Arachnida, Insecta and Crustacea

Soil arthropods are a group of soil-inhabited arthropods belonging to the classes of Crustacea, Arachnida, Myriapoda, and Insecta**.** They serve crucial roles in preserving soil quality and health as well as supplying ecosystem services since they are involved in a variety of activities, including the movement of organic matter, decomposition, nitrogen cycling, the creation of soil structure, and water management (Affrin and Goswami, 2019; Menta and Remelli, 2020). Ecosystem health is often equated with a high biodiversity which are seen to be more stable, productive, and able to withstand invasions and other disruptions. For ecological research, habitat management, and conservation programmes in any ecosystem, it is necessary to determine the variety, richness, evenness, and abundance of arthropod fauna (Nahmani et al., 2005). According to Leksono (2017), the agricultural landscape, habitat type, farming method, composition of the landscape and connectivity all have a role in maintaining the richness of species. In an agroecosystem, which are intricate ecosystems, plants interact closely with a variety of other living things. As a result, the population of arthropods is impacted by the fundamental change in the plant community (Lauricella et al., 2017; Zhao et al., 2020; Ramzan et al., 2021). Many of these arthropods also compete with root and foliage-feeders and defend plants from pest attack, which increases crop production. The diversity of soil arthropods is strongly influenced by the plants above it. North eastern hill (NEH) region is rich in terms of flora and fauna and is a geographically hotspot (Chakravarty et al., 2012). Meghalaya is a part of north eastern Himalayas which is rich in biomes of the world, and high in rare species (Anon., 2005). The state lies between 25° 34' 0'' North and 91° 53' 0'' East. The mean annual temperature varies from 4°C during winter and 23°C during summer. Due to its varied climatic conditions, study of soil arthropods gives an idea about its composition of an area and help to identify the tolerant species and also for understanding the information on the distribution, abundance, richness as well as interaction with the various abiotic factors. However, only a small number of studies have compared the soil arthropod composition in the area. Therefore, the present study was undertaken to find out soil arthropod diversity, richness and abundance in agricultural ecosystems.

MATERIALS AND METHODS

Sampling of soil arthropods communities were done by using standard methods. The plot was divided into 100 quadrates measuring 10 x 10 m (100 m^2). The collection of soil arthropods were carried out in agricultural ecosystem. Soil arthropod fauna were collected at weekly intervals from July 2019 to

February 2020. Based on taxon, sorting of collected soil arthropods were done. Soft bodied arthropod species were preserved in 70% ethyl alcohol in glass vials (Abdel et al., 2016). Preservation of soft bodied arthropods were done using Oudeman's fluid (86 parts of 70% alcohol+ 5 parts glycerin+ 8 parts glacial acetic acid (GAA)+ 2 parts distilled water). Other soil arthropods were card mounted and pinned. The most common and important soil arthropods species were identified to the lowest possible taxon. Identification was done based on established taxonomic keys and literature. Cataloguing and documentation was done using images and photographs. Unidentified specimen was sent to AAU, Jorhat; NBAIR, Bangalore; RPCAU and BHU, Varanasi. All the collected data were analyzed using statistical tools in Microsoft Office Excel. The numbers of insects of each family were presented in tabulated form and biodiversity was assessed using diversity-based indices viz., Margalef's D richness index (Clifford and Stephenson, 1975), Shannon Weiner diversity index (Hughes, 1978) and Simpson's index (Simpson, 1949).

RESULTS AND DISCUSSION

Five classes of soil arthropods were collected viz., Entognatha, Arachnida, Insecta, Crustacea and Chilopoda. A total of 1914 individuals were collected and out of these, highest number of individuals was recorded from Entognatha class (858) under 7 family followed by Insecta (508) under 8 family, Arachnida (347) under 10 family, Crustacea (138) under 1 family and the least was of Chilopoda with 63 individuals under 2 family. Under class Entognatha, Paronellinae family recorded highest individuals of 188 representing from two different species namely *Salina* sp. 1 with 98 individuals and *Salina* sp. 2 with 90 individuals followed by Onychiuridae family with 148 individuals of *Onychiurus* sp. and the least family was Campodeidae of genus *Campodea* sp. with 64 individuals as shown in Table 1. Under class Insecta, Scarabaeidae family recorded maximum individuals of 132 and *Omorgus* sp. of Trogidae family recorded the least maximum (14). In class Arachnida, Lycosidae family recorded maximum of 132 followed by Laelapidae with 50 individuals and the least individuals of 8 was recorded in Theridiidae family of genus *Nesticodes*. Crustacea class recorded 138 individuals belonging to *Amphilocus* sp. under family Amphilochidae and *Scutigera* sp. and *Scolopendra* sp. of Scutegeridae and Scolopendridae family under class Chilopoda recorded 36 and 27 individuals respectively. The diversity analysis reveals that the Shannon-Wiener index values was more or less similar and varied from 1.69 to 3.12 and 1.88 to 3.44 at family and species level respectively, with maximum diversity accounted for during November (H=3.12) at family level as well as at species level (H= 3.44) and the least diversity during February (H= 1.69) at family level and H= 1.88 at species level. From the values of the Margalef's richness index, it was observed that the ecosystem was very rich during November with a richness value of 4.93 and 6.98 both at family and species level, respectively. The biodiversity analysis revealed that Margalef richness index varied from 1.41 to 4.93 and 1.70 to 6.98 at family and species level, respectively. Simpson's index at family level varied from 5 to 20.03 and species level from 7.58 to 26.30 and maximum Simpson's index value was recorded November (20.03) at family level and at species level during October (26.30). The highest index values of Margalef richness index, Shannon Weiner index and Simpson index was recorded during November (Fig. 1).

The present finding is in conformity with Angurana et al. (2019), who recorded a total of 1033 individuals of soil arthropods from agricultural field. Similar observation was also reported by Sharma and Pawez, (2017) where 58% of the total population collected from the soil belonged to micro and macro arthropods. In a study conducted by Eni et al. (2014), soil arthropod belonging to class Chilopoda, Arachnida, Insecta and Entognatha were recorded and found to be in abundance to a depth of 10 cm. The result based on diversity analysis from the present study reveals a high value of Simpsons index almost throughout the study denoting high diversity of the area. This finding is in accordance with Raghul and Kumar (2022) who reported a high diversity of insect fauna during their study in warmer part of the year. Hazarika et al. (2019) and Ratnayake et al. (2019) also reported higher values of shannon weiner index during a study with similar topography and soil condition. The diversity of the soil arthropod

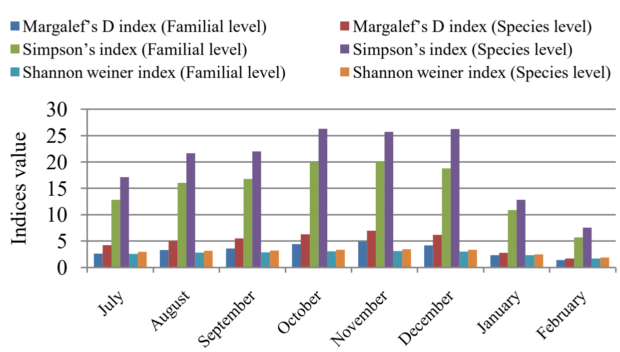

Fig. 1. Soil arthropods diversity in agricultural ecosystems

Table 1. Soil arthropods in agricultural ecosystem

Class	Family	Genus	Species	No. of individuals
Insecta	Scarabaeidae	*Onthophagus* (Latreille)	*Onythophagus* sp.1	37
		Onthophagus	*Onythophagus* sp.2	27
		Heteronychus (Dejean)	*Heteronychus* sp.	31
		Aphodius (Illiger)	*Aphodius* sp.	19
		Scarabaeus (Linnaeus)	*Scarabaeus* sp.	18
	Carabidae	*Carabus* (Linnaeus)	*Carabus* sp.	47
		Amblytelus (Erichson)	*Amblytelus* sp.	29
		Bembidion (Latreille)	*Bembidion* sp.	21
	Chrysomelidae	*Lema* (Fabricius)	*Lema* sp.	21
		Chaetocnema	*Chaetocnema pusaensis* (Maulik)	31
	Staphylinidae	Paederus	*Paederus fuscipes* (Curtis)	29
	Trogidae	*Omorgus* (Erichson)	*Omorgus* sp.	14
	Gryllotalpidae	Gryllotalpa	*Gryllotalpa orientalis* (Burmeister)	46
	Forficulidae	*Forficula* (Linnaeus)	*Forficula* sp.	29
	Termitidae	Microtermes	*Microtermes obesi* (Holmgren)	109
Arachnida	Lycosidae	Lycosa	*Lycosa barnesi* (Gravely)	54
			Lycosa bistriata (Gravely)	34
			Lycosa himalayensis (Gravely)	44
	Thomisidae	*Indoxysticus* (Benjamin and Jaleel)	*Indoxysticus* sp.	14
	Gnaphosidae	*Zelotes* (Gistel)	*Zelotes* sp.	10
		Sosticus	*Sosticus insularis* (Banks)	22
	Zodariidae	*Acanthinozodium* (Denis)	*Acanthinozodium* sp.	12
	Theridiidae	*Nesticodes* (Archer)	*Nesticodes* sp.	8
	Eutichuridae	*Cheiracanthium* (Koch)	*Cheiracanthium* sp.	28
	Trombidiidae	*Trombidium* (Fabricius)	*Trombidium* sp.	24
	Cocceupodidae	*Linopodes* (Linnaeus)	*Linopodes* sp.	10
	Laelapidae	*Hypoaspis* (Canestrini)	*Hypoaspis* sp.	50
	Erythraeidae	*Balaustium* (Heyden)	*Balaustium* sp.	37
Entognatha	Paronellinae	*Salina* (MacGillivray)	*Salina* sp.1	98
		Salina	*Salina* sp.2	90
	Entomobryidae	*Entomobrya* (Rondani)	*Entomobrya* sp.	74
	Cyphoderidae	*Cyphoderus* (Nicolet)	*Cyphoderus* sp.	145
	Hypogastruridae	*Ceratophysella* (Börner in Brohmer)	*Ceratophysella* sp.	125
	Onychiuridae	*Onychiurus* (Gervais)	*Onychiurus* sp.	148
	Sminthuridae	*Sminthurus* (Latreille)	*Sminthurus* sp.	114
	Campodeidae	*Campodea* (Westwood)	*Campodea* sp.	64
	Scutegeridae	*Scutigera* (Lamarck)	*Scutigera* sp.	36
Chilopoda	Scolopendridae	*Scolopendra* (Linnaeus)	*Scolopendra* sp.	27
Crustacea	Amphilochidae	*Amphilochus* (Bate)	*Amphilocus* sp.	138

varied widely during the study period, shannon weiner index value and Margalef's richness was almost same throughout the period, similar study was reported by Bany and Joseph (2017) who revealed that the shannon weiner diversity index was more or less high during the research period. Similarly, in a study conducted by Ababsa et al. (2017) and Anitha and Vijay (2016), they adopted various diversity indices to measure the diversity of soil arthropods and concluded that richness and diversity of the soil arthropod remained moderately high in almost part of the year. These results also corroborate with the findings of Prabaningrum and Moekason (2020) and Sharma et al. (2020) who observed a moderately high diversity during the study and recorded Shannon weiner index of minimum 0.86 and maximum 2.30. However, during the colder part of the region, species richness and biodiversity recorded was less which created a variation in biodiversity at familial level and species level and we concluded the possible factor underlying the variation were due to regional topography and low temperature. Finding of Sheik et al. (2016) shows that shannon diversity index value was recorded lowest in the month of February (0.86) which is in agreement with our present finding. These changes in soil arthropod communities in the ecosystem may also be due to agricultural practice, habitat deterioration and climate change (Honek et al., 2017).

ACKNOWLEDGEMENTS

The authors are highly thankful to the Dean, College of Post Graduate Studies in Agricultural Sciences, Chairman of School of Crop Protection, Umiam, Meghalaya for support and encouragement. The authors would like to extend their inmost thanks to Professor (Entomology) of AAU, Jorhat, NBAIR, Bangalore, RPCAU and BHU, Varanasi for identifying and monitoring the soil arthropods specimen and also for sharing there valuable knowledge during their investigation.

AUTHOR CONTRIBUTION STATEMENT

GP and NK conceived the research work plan. GP and NK conducted the experiment. IYL contributed in species identification. IYL wrote the manuscript. All authors approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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(Manuscript Received: March, 2023; Revised: September, 2023;
Accepted: September, 2023; Online Published: September, 2023)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e23206