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Soil Protozoa from Agriculture Land of Durg District, India

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ABSTRACT

Protozoans are usually very numerus in agriculture soil, with numbers in the magnitude up to thousand cells per gram of soils. Protozoa regulate the bacterial population play an important role in regulating the soil food chain. In the present study, the soil samples were collected from seven different sites of Durg district and were analyzed for their physico-chemical characteristics and protozoan species. Total 23 protozoa were recorded. Out of which 1 genera of rhizopods, 1 genera of actinopods and 21 genera of ciliates were observed during the study period. The density, % frequency and abundance with important value index (IVI) has been calculated. The Simpson index and Shannon-Weiner index were used to evaluate the diversity of protozoan communities. The highest species diversity was found for the Rice field of Basni (site -5) and Bhilai Steel Plant effluent enunded soil (site -7) and lowest species diversity was found for the vegetable field of Teligundra (site-1).

Key words : *Protozoa, Rhizopods, Non-flooded petri dish method, Physico-chemical analysis, Food chain.*

Introduction

All agricultural productions, development of forest and various organism which is present in upper layer of the earth mostly depend upon edaphic factors. Edaphic factors includes soil composition, organic matter, soil water, soil air and soil organism. Soil organisms include the major groups of prokaryotes, plants and animals. Typical numbers of protozoa in soil vary widely from a thousand per teaspoon in low fertility soils to a million per teaspoon in some highly fertile soils (Ingham, 1998). Soil quality may include water holding capacity, plant productivity, waste remediation, and other functions. Protozoa are also an important food source for other soil organisms and regulate the bacterial populations.

Soil protozoa has many distinctive characteristics like they are part of the microbial loop, function as recyclers, remineralizers of organic material in terrestrial and aquatic systems, they prey upon the bacteria and smaller protists and maintain the ecosystem balance. Protozoa are also an important food source for other soil organisms and help to suppress disease in plants by competing with or feeding on pathogens (Ingham, 1998).

The classification of protozoans is mainly based on the locomotory organ. Ciliates are the most important groups in soil protozoa which are morphologically very complex and highly differentiated taxa among single-celled organism. More than 4000 free-living ciliates described till now (Chen, X. *et al.,* 2017). Soil protozoa play an important role in mineralizing nutrients, making them available for use by plants and other soil organisms (Clarholm, 1985).

The identification and taxonomy of soil protozoan approaches different method like, live cell morphology, fixation, staining and morphometrics

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and DNA-based methods. Identification was mainly based on using microscopic technique which involve observation of live or fixed cells with details of the ciliature or silver-line system, detailed descriptions of ciliature, oral apparatus and nuclear apparatus.

Study area and sites

Chhattisgarh state is located in the central part of India, and is bordered by the state of Odisa in the east, in north by the Uttar Pradesh and Jharkhand, in west by the Madhya Pradesh and Maharashtra and in south by the Andhra Pradesh and Telangana. Durg district is located in the central zone of Chhattisgarh. The region is the major producer of paddy crop so it is called as rice bowl of the state. In the present study 6 villages of Durg district and one site near Bhilai Steel Plant was selected. Soil from all the sites were analysed for their physico-chemical characteristics and richness of protozoan species. The study was conducted during October 2021 to February 2022.

Materials and Methods

Sample collection

Soil samples were collected from all the six villages of Durg District, (S1 Teligundra, S2 Dewada, S3 Hanoda, S4 Kotni, S5 Basni, and S6 Raunda) which represent soils of different crop fields like rice field, wheat field, banana field and vegetable field and seventh site near Bhilai steel has plant effluent enunded soil (site -7). Soil samples were collected early in the morning and processed immediately for further analysis. Soil samples from selected fields were collected randomly with 10 feet distance and 15 cm depth, also included all the corners and centre of the sampling sites. Half of each soil samples were mixed thoroughly and half samples were kept separate so that organisms can be identified with specific locations.

Collected soil samples were transported to the laboratory within 2 hrs. in plastic bags for further analysis. Samples were analysed for their chemical composition as early as possible and observation of protozoa has been made within two days.

Physico-chemical and biological analysis of soil samples

Soil samples were analysed for their pH through digital pH meter, electrical conductivity by digital conductivity meter, moisture content was determined by oven dry method and total organic matter was analysed by Walkley and black titrimetric method (Jackson, 1973). Non-flooded petri dish method was use to observe protozoan species. Approximately 100 g of soil was mix with distilled water in Petri dish of 20 cm diameter. A small amount of water was removed from the flooded petri dish at 24, 48 and 72-hours intervals. Protozoans' species were observed with the help of a trinocular research microscope with image capture system while the number of protozoan's species is enumerated by Most Probable Number (MPN) dilution culturing techniques (Darbyshire *et al.*, 1974).

Statistical Analysis

The density, percentage frequency, abundance and importance value index (IVI) of protozoan species in each soil habitat were determined. The Simpson index and Shannon-Weiner index were used to evaluate the diversity of protozoan communities.

Observations

The pH, conductivity, water holding capacity and organic carbon percentage varies in all the soil samples. Total number and variety of protozoan species also showed variation in different fields. In the present study 23 species of protozoa were found from 17 classes, 20 orders, 22 families and 23 genera. The physico-chemical values of different sample and protozoan species found are shown in Table 1 and 2 respectively.

Results and Discussion

All over the world including India several studies have been conducted on physico-chemical analysis of soil sample and its correlations with microbial diversity (Das and Bindi, 2014; Asema *et al.*, 2015; Vyas *et al.*, 2015). Hydrogen ion concentration (pH) plays an important role in any type of soil, which ensures the quality of the soil and the availability of nutrition for the organism living in it. Protozoan distribution and/or activity are typically affected by conductivity and hydrogen ion concentration (pH) (Ekelund and Rønn, 1994).

In the present study physico-chemical factors varied between the seven sites. The texture of soil were loamy in site 1,3,4,5 and 7, while site 2 and 6 have

clay soil. pH was varied from 7.31 to 8.39. Site 1 having the highest pH with the value of 8.39 and lowest pH was found in site 3 with a value of 7.31. electrical conductivity was found highest in site 3 with a value of -026 dS/m and sites 5 having the lowest conductivity value of -076 dS/m. The highest total organic carbon % found in site 3 with a value of 1.5 and the lowest total organic carbon % found in site 1 with a value of 0.45. and highest organic matter % was found in site 3 with the value of 2.58 and lowest organic matter found in site 1 with a value of 0.77. The highest moisture content found in site 3 with the value of 38.29 and the lowest moisture content found in site 6 with the value of 18.74.

The physical characteristics of the soil play a significant role in defining the organisation of protozoan communities. In the present study total 23 species of protozoa were found from 17 classes, 20 orders, 22 families and 23 genera. Ciliates species were present at nearly all of the sampling sites. V*orticella* sp. was the most common species, occurring at all seven sites. The highest protozoan diversity was found in Basni rice field (site -5) and Bhilai Steel Plant effluent enunded soil (site -7) with 10 species, whereas protozoan diversity was lowest in Teligundra vegetable field (site -1) had just 5 inhabitant species. Organic matter and carbon content have an indirect effect on soil protozoa because they

Table 1. Physico-chemical property of the soil from different sites.

Parameter	Site -1	Site -2	Site -3	Site -4	Site -5	Site -6	Site -7
Colour	Black	Black-Brown	Black	Black	Black	Red-Yellow	Black
Texture	Loamy	Clay	Loamy	Loamy	Loamy	Clay	Loamy
Temperature	22^0C	20^0C	19^0C	21^0C	21^0C	22^0C	23^0C
pH	8.39	8.04	7.31	7.40	8.15	7.6	7.55
E.Conductivity (ds/m)	-075	-071	-026	-030	-076	-042	-040
Organic Carbon (%)	0.45	1.2	1.5	0.75	1.35	1.05	1.14
Organic Matter (%)	0.77	2.06	2.58	1.29	2.32	1.81	1.96
Moisture Content (%)	28.22	25.12	38.29	23.54	25.14	18.74	38.11

Table 2. List of Soil Protozoa in the soil samples collected from the seven different sites indicated by their presence (+).

Taxa	Site -1	Site -2	Site -3	Site -4	Site -5	Site -6	Site -7
Amoeba sp.			+	+		+	+
Actinophrys sp.		+	+	+	+	+	+
Podophrya sp.			+				
Amphisiella sp.					+		
Myxophylum sp.		+					
Mycterothrix sp.				+	+		
Maryna sp.	+						
Rigchostomata sp.						+	
Saprophilus sp.						+	
Trochochilodon sp.						+	
Stokesia sp.			+				
Euplotes sp.					+		+
Colpoda sp.	+	+	+	+	+		+
Exocolpoda sp.				+			
Dileptus sp.							+
Lacrymaria sp.					+		
Vorticella sp.	+	+	+	+	+	+	+
Onichodromopsis sp.				+			
Tilina sp.	+	+	+	+	+	+	
Paramecium sp.					+		+
Halteria sp.	+	+	+		+	+	+
Aspidisca sp.						+	+
Paruroleptus sp.							+

affect the bacterial population that lives there's (Ekelund *et al.*, 2002).

The highest richness and evenness (Shannon-Weiner index) of species were found in site -7 with the value of 2.28, and lowest richness and evenness of species were found in site -1 with the value of 1.43. The highest Simpson index were found in site -1 with the value of 0.26, whereas the lowest Simpson index were found in site -7 with the value of 0.10. It means site -1 have lowest species diversity and site -7 has highest species diversity.

Conclusion

Species composition and community organisation of the soil protozoa are directly related to the texture, physical properties and chemical composition of the soil. The diversity of protozoa is a bioindicator for evaluating soil quality (Abraham *et al.*, 2019 and Foisner, 1987).

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