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ECOLOGY AND DISTRIBUTION OF SOIL PROTOZOA IN THE BELLANWILA WETLAND

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Abstract

The present investigation into the protozoan population and distribution in a wetland ecosystem revealed that the wetland soil facilitates a large number of species to live. Most probably due to the continuous moisture condition which enhance the appearance of additional species.

29 species of protozoa have been reported during this study period. Of them 8 species were amoebae, 14 species were ciliates and 7 species were flagellates. Of the amoebae *Arcella* sp. was the most widespread, being found in all 3 soil environments. Of the flagellates, *Astasia* sp. was the predominant type. *Colpoda* sp. was the commonest ciliate found during the whole study period. Not all the 29 species of protozoa occurred at the same time and in all the 3 selected study areas.

Of the measured abiotic factors, temperature and soil moisture exerted general effects but pH and other chemical parameters showed no direct correlation. Also high content of organic matter in wetland soil influenced the growth of testaceans. Seasonal and spatial variations of protozoa both in number and types were seen.

Key words: Soil Protozoa, Wetland habitat, ecology, abiotic and biotic factors.

1. Introduction

The Bellanwila Attidiya wetland is a freshwater wetland system situated on the south-Eastern outskirts of Colombo. The area comprises of about 60 ha of shallow water ponds, marshes and seasonally flooded grasslands, with scattered pockets of shrubs and small trees. It acts as a flood detention area. Two soil groups can be distinguished here; bog soils and half bog soils (Wilson, 1992). The ground water table in the marsh is high and usually lies only a few centimeters below ground level.

The soil contains a remarkably diverse population of animal life ranging from the smallest organisms such as protozoa to large burrowing vertebrates. Free living protozoa constitute a small but significant part of the microbial population of most soils. Current opinion sees their prime importance as micropredators serving to accelerate nutrient turnover. Protozoa are the third most abundant group of organisms in the soil. Four main taxonomic groups of protozoa are recognized; the amoeba (naked and testate), the flagellates, the ciliates and the wholly parasitic sporozoa. (Grell; 1973)

No arable soil examined to date has been entirely devoid of protozoa although some localities yield but a single species while others contain a great diversity of types. This habitat preference is related to size or shape of the species, ability on encyst or to move through the soil, nutrition or tolerance of adverse environmental factors like high salinity, acid pH, low O_2 or high CO_2 tensions. The moisture regime is probably the most selective attribute of the soil environment to which protozoans must be adapted. Temperature is another important ecological determinant, the most favorable environments being both cool and damp. Also the biotic factors like natural enemies, food supply, vegetation and channels provided by other organisms influence the growth of organsms.

Therefore the present investigation was primarily designed to study the ecology and distribution of soil protozoa in a wetland habitat.

2. Material and methods

The study was carried out from March 1993 to September 1993. Three different study areas within the wetland habitat were selected by a frame survey. These 3 selected areas differed in plant types, soil conditions and the level of the supernatent water. (Figure 1).

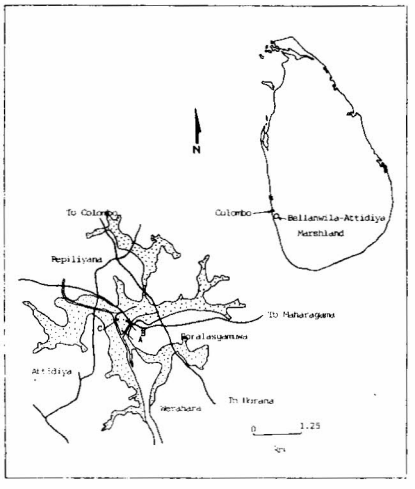


Figure 1 Location of the Bellanwila - Attidiya Marshland. Dotted area represents the sampling stations as A, B, & C. (Source - Wetland Conservation Project, CEA)

Sampling was carried out twice a month. At least 3 samples were taken from both supernatent water and upper 5 cm of soil. Different depths were sampled seasonally. Standard methods were used to collect, extract and culture the soil protozoa. Protozoa in each sample were studied and numbers estimated by using culture techniques {Reference - A Catalogue of laboratory strains of freeliving and parasitic protozoa, prepared by The Committee on Cultures, Society of Protozoologists, J. Protozool, 5 (1), 1-38 (1958)

Certain physical, chemical and biological parameters were measured. Physical parameters like temperature, moisture, soil texture, pH ; chemical parameters like total alkalinity, total hardness, total sulphide, salinity and the biological parameters of organic matter in the soil were measured.

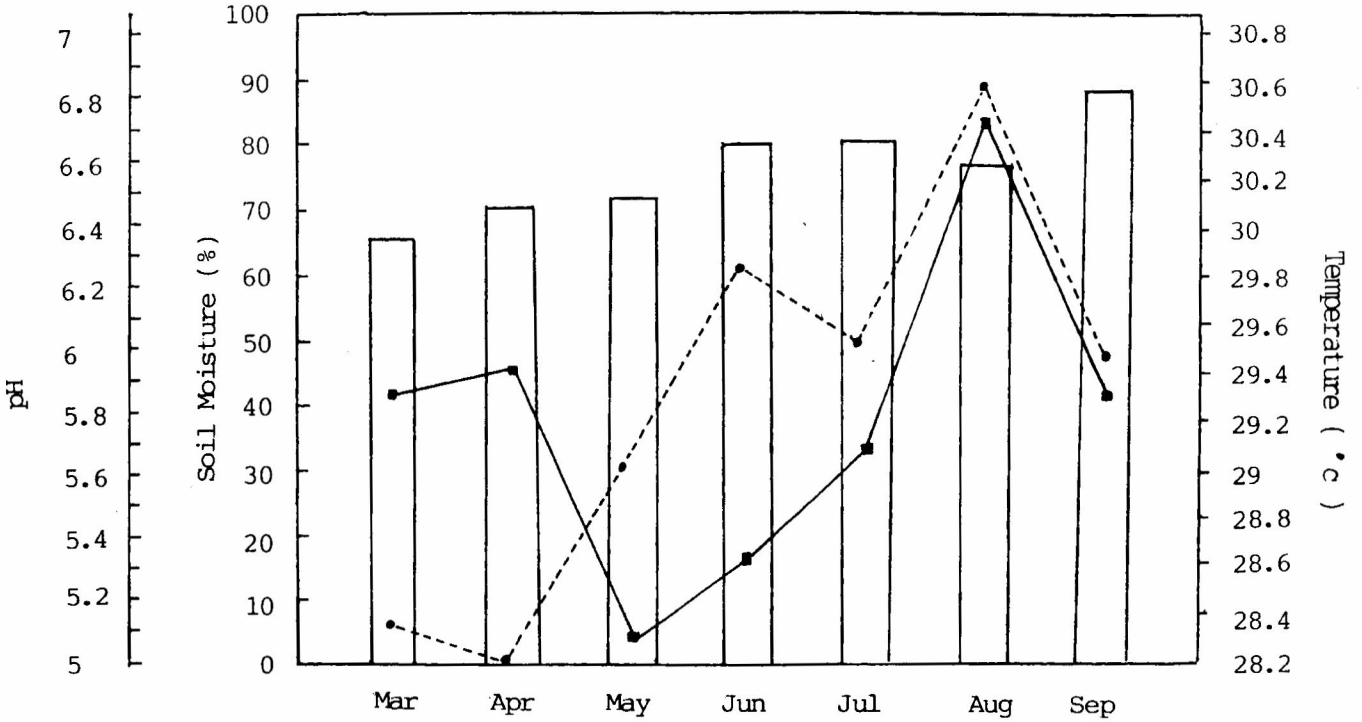
3. Results

Ecological factors-

Environmental conditions such as water content, plant conditions etc. changed very remarkably within the study areas during this study period. At the beginning of the study dry conditions prevailed in the area. Therefore the level of the supernatent water reduced gradually. Also a brown scum was seen on the surface of wet soil and supernatent water which indicates the high iron content in the marsh ground water. During the months of May and June, the area received the highest rainfall. As a result the whole study area was completely covered with water for few days. Also a secondary growth of plants was seen.

Temperature of the soil, water and air were normally in the range of 28-31 ^{0}c. They got the minimum values during the rainy season. Soil moisture content (%) was high in the area throughout the study period. Soil texture of all the selected study areas was of fine textured. Usually pH values were in between 5-7. Figure 2 indicates the changes of these parameters during the study period.

Following readings were obtained by analysing water quality of the marshland waters. Dissolved and total sulphide 0.004 - 0.01 mmoll^{-1}; Salinity of the marsh soils was equalled to zero. 16-30% of organic matter was in the marshland soil during the investigation period.



(•-------• pH; •——• Temperature; □ (bars) soil moisture (%)).

Figure 2 Changes of ecological factors in soil during the study period.

Composition and abundance of Protozoa -

29 specis of protozoa were reported during this study period. Of them 8 species were amoebae, 14 species were ciliates and 7 species were flagellates.

Table 1 - Indicates the types found in the wetland soil

(a) Rhizopoda (amoebae,)	(b) ciliophora (ciliates)	(c) Mastigophora (Flagellates)
1. *Arcella* sp.	1. *Stylonicia* sp	1. *Astasia sp*
2. *Trinema* sp.	2. *Oxytricha* sp	3. *Peranema* sp
3. *Centrophyxis* sp	3. *Colpoda* sp	3. *Euglena* sp
4. *Nuclearia* sp	4. *Halteria* sp	4. *Phacus* sp.
5. *Acanthamoeba* sp	5. *Vorticella* sp	5. *Synura* sp
6. *Neagleria* sp	6. *Urocentrum* sp	6, *Chamydomonas* sp
7. *Actinosparium* sp.	7. *Paramecium* sp.	7. *Eudorina* sp.
8. *Actinophrys* sp	8. *Prorodon* sp.	
	9. *Spirostomum* sp	
	10. *Coleps* sp	
	11. *Dileptus* sp	
	12. *Lacrymaria* sp	
	13. *Euplotes* sp.	
	14. *Loxodes* sp.	

Enumeration of protozoa had usually shown that both ciliate numbers and species were higher than the others in the wetland soil. Amoeba and flagellate numbers were low. But the types found were very high. Of the amoebae. testaceans *Arcella* sp. and *Centrophyxis* were the most dominant types. *Paramecium* sp., *Euplotes* sp. and *Colpoda* sp. were the commonest ciliates found. Flagellate types, *Astasia* sp. and *Euglena* sp. were numerous in the wetland soils.

When compared with the 3 stations, station A fairly rich in 3 types of protozoa within the whole study period. But station B got the highest ciliate and flagellate numbers during the months of June and July. In station C the types and numbers were reached to the highest peak from the month of May. Table II indicates the variation in numbers of protozoa during the study period.

Table II : Abundance of soil protozoa in the 3 selected study areas.

(only trophic numbers/mlx10^3)

Protozoan Type	23.03	09.04	22.04	12.05	02.06	27.06	16.07	31.07	10.08	21.08	08.09
Station A											
Amoebae	0.032	0.04	0.038	0.066	0.254	0.32	0.195	0.067	0.057	0.46	0.036
Ciliates	15.9	15.75	18.39	27.345	34.151	37.276	36.488	35.413	31.532	31.303	29.926
Flagellates	3.3	3.5	2.3	6.8	24.3	25.7	22.3	16.1	14.4	12.7	15.8
Station B											
Amoebae	0.022	0.074	0.065	0.09	0.14	0.116	0.114	0.063	0.04	0.033	0.047
Ciliates	5.5	6.7	9.519	16.629	19.324	19.451	19.63	23.106	17.776	15.065	17.312
Flagellates	3.5	3.9	5.9	7.1	14.9	17.5	18.3	12.0	8.8	5.9	8.4
Section C											
Amoeba e	0.00	0.00	0.062	0.018	0.94	1.33	2.668	2.4	0.671	0.521	1.436
Ciliates	2.6	3.5	11.0	17.7	26.78	29.304	31.1	31.4	31.4	28.5	27.1
Flagellates	0.03	0.04	0.5	3.65	17.733	17.6	15.8	13.3	10.9	4.525	7.3

Spatial distribution:

Distribution of protozoan types in 3 studied soil depths was changed during the dry and rainy season. During the dry period, most of the types were confined to upper few centimetres. But this condition changed significantly during the wet season. (Figure 3)

Acanthamoeba sp. was the commonest type found for each depth concerned. Some of the ciliates which were confined to upper few centimeters during dry period, found in lower depths during wet season. *Stylonichia* sp., *Colpoda* sp., and *Euplotes* sp. were common to all 3 depths, but the numbers were decreased with depth. *Spirostomum* sp. were confined to surface soils mostly.

Seasonal variation :

Present study was done during both dry (March - April) and wet (May-Aug) seasons. Therefore organisms found in the marshland were changed and the population counts varied. Protozoan counts indicated that number of Amoeba in both supernatent water and soil were very few during this whole study period. One of the testacean amoebae, *Arcella* sp. were appeared in high numbers after the rainfall. A remarkable increase in ciliate sp. was recorded after the rainfall, which was the contributory factor in increasing ciliate numbers. *Dileptus* sp. *Loxodes* sp., *prorodon* sp., *Spirostomum sp., Urocentrum sp.* were the some of ciliate species occurred only after the rainfall. When considering about the flagellates, in them too, the numbers were increased as the flagellate species found were increased.

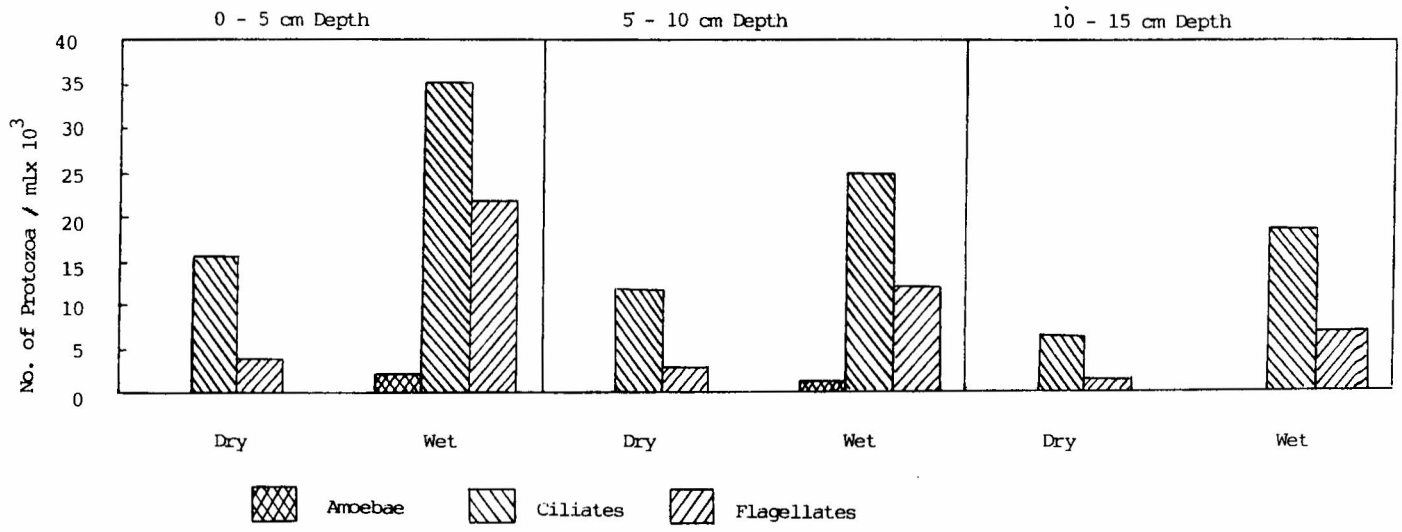


Figure 3. Spatial distribution of soil protozoa during dry and wet seasons.

One of the colonial flagellate types, *Synura* sp., were the dominant type during the months June and July. Counts were made upto 4.2 x 10^3/ ml of them. *Pheranema* sp., *Chlamydomonas* sp., *Phacus* sp. were the other flagellate types noticed during the wet season.

4. Discussion

It appears that the wetland soil consists of a fairly large species of protozoa. Protozoa are known to differ in physiological (Holz et at. 1959) and ecological properties (Harisun, 1958). This suggests that similar ecological niches carry different fauna.

There were 29 species of protozoa recorded in the wetland soil during this investigation period. Turner (1978) pointed out, that the source, velocity, renewal rate and timing of the water in a wetland ecosystem directly control or modify the wetland characteristics which in turn affects the species composition and richness. Out of 29 species of protozoa, 8 species were Amoebae, 14 species were Ciliates and 7 species were Flagellates. Thomas (1960). Kahl (1930-35) have shown that the numbers and the types of species in a particular type of soil - greatly depend on both biotic and abiotic factors of the soil environment.

Enumeration of protozoa had usually shown that both ciliate numbers and species were higher than the others in the wetland soil. But the recorded number for amoebae was very low.

Populations of 10^3 - 10^6 / g wet soil are commoly recorded for temperate soils of moderate fertility (Singh, 1946, 1949; Singh and Crump, 1953), but amoeba counts of over 10^6 / g wet soil have been recorded (Brezezinska - Dudziak. 1954).

Of the measured ecological factors (abiotic), temperature and pH were not changed significantly. But soil moisture content was changed periodically, most preferably due to the rainfall. Although the present investigrtion did not show any correlation between pH and protozoan fauna, it was found that most flagellates, amoebae and ciliates possess optimum values which were responsible for their existence in a particular type of soil

Of the measured biotic factor, organic matter content of the wetland soil was higher than the normal soil. This may have influenced the testaceans which indicated their presence in the wet land soil in high numbers. Investigations carried out by Bamforth (1971) also noted that nomally testacea are associated with soils of slow decomposability which contain

high organic matter. In general, as confirmed by Stout on 1965, amoebae, flagellates and ciliates favour conditions of high base status and a mellow humus with a high rate of mineralization.

When considering the spatial distribution, it seems likely that most of the species were confined to the upper few centimeters. Wickle (1963) also noted that the population size with depth affected by compaction or by differences in the level of the water table. According to Alexander (1977) the population is most dense where the bacteria are especially numerous in the profile. It appears that the abundance of protozoa in each selected study site did not differ markedly. The hydrologic regime can lead to either uniformity or to diversity, as the wetland subjects to sheet flow by flooding waters.

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