SOME COMMON PROTOZOA IN SOIL

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ABSTRACT

The results of examination of soils from 21 *different areas in Karnataka State and a comparative study of the extensive literature bearing on the protozoa in soils have shown that three of the common protozoa in all soils of the world are the species of* Colpidium, Colpoda *and* Vorticella.

Key words : Protozoa, soil.

1. INTRODUCTION

The occurrence and activity of protozoa in soil were not appreciated for a long time. Thus Stein's report[1] in 1878 of the existence of protozoa as cysts in soil influenced the development of a general view that the protozoa were brought into soil " accidentally " and that they were inactive as cysts in soil,[1] although there were earlier reports of protozoa in soils, in fact, from the early days of the invention of the microscope.[2]

Earlier attention to pathogenic protozoa, like the malarial parasite *Plasmodium* sp. discovered by Laveran in 1880,[3] and the phagocytic activity of the species of *Amoeba* (Metchnikoff in 1882[4]) led to the view that protozoa were generally detrimental to useful bacteria in soils.[5] This view still is of considerable current interest.[6,7]

Report of detrimental activity of the soil protozoa,[5] however, evoked extensive work on these animals in soils. Sandon[8] studied the soil protozoa for 17 years, from 1910, collecting and examining 148 samples of soil from different parts of the world, including those from India (near Madras, Coimbatore, Kanara, Poona, Gurdaspur in the Punjab, Jullunder, Pusa and Cinnamara, near Jorhat, Assam) and recording 250 different forms of protozoa. The work of Sandon stimulated further work on the occurrence of protozoa in soils[9]–[15] and thus a large volume of literature has accumulated, which has

been periodically reviewed[16-24] with a view to obtaining some evidence on the protozoa in relation to soil economy. The questions that have intrigued soil scientists are mainly : are there any common form or forms of protozoa in all soils of the world ? and what is their role in soil processes ?

A study of the recent literature on the subject shows that the soil protozoa are ubiquitous[25,26] and, in general, are not detrimental to soil fertility or productivity.[27] But, on their functional activity or on their role in soil fertility or productivity there is little information.

In this paper we have briefly given our evidence on some common forms of protozoa in soil.

2. Materials and Methods

Materials

Twenty-one sets of soil samples were obtained from different parts of Karnataka State through the courtesy of Dr. R. S. Murti, Soil Correlator, All India Land Use and Soil Survey, Hebbal, Bangalore, and Dr. S. S. Rodgi, Reader in Zoology, Karnatak University, Dharwar.

Culture media used for the cultivation of protozoa

Generally soil protozoa have been cultivated in "hay infusion". We used autoclaved sewage and another medium consisting essentially of the materials added to agricultural soils as manures and fertilizers, which we have termed "agricultural medium", the composition of which is given below :

The "agricultural medium" contains the following in one litre of distilled water :

Straw powder	3·5 g
Leaf powder	3·5 g
Cow dung	3·5 g
Defatted groundnut cake	1·0 g
Ammonium sulphate	100 mg
Superphosphate	50 mg.

This liquid is refluxed, filtered (through No. 1 filter paper) and autoclaved. Into the filtrate the soil sample is inoculated.

The idea of using autoclaved sewage was based on our earlier observation that a variety of protozoa naturally develop in sewage under aerobic conditions. Sewage contains carbonaceous and nitrogenous matter and other nutrients. Also, continuous studies on the protozoa in sewage have shown that they have a definite role in the oxidative changes in the medium.[28–30] Further, sewage and soil have been considered as similar systems.[31–35]

Method of cultivation of the protozoa

Samples of soil (1 g) were added to autoclaved sewage or " agricultural medium " (100 ml) in conical flasks (250 ml). The flasks were shaken on a rotary shaker (200 r.p.m.) for 5 days. It may be pointed out that aeration of the medium has not been tried by the earlier investigators.

At the end of aeration for every 24 hours, the contents of the flasks were allowed to settle for half an hour. Samples of 0·05 ml of the sediment or deposit were carefully examined under the microscope for protozoa, and the average numbers of the different protozoa were recorded. Thus, microscopic examination of 840 samples was carried out.

3, Results and Discussion

The numbers of ciliates, which were the main forms of protozoa (Fig. 1) that developed in the two media, given in Tables I and II, are the averages of four values. The protozoa attained maximum development on aeration for 48 to 72 hours as their numbers increased during that period and decreased at the end of 120 hours.

A survey of the literature (Table III) on the occurrence of protozoa in different soils shows that ciliates of the species of *Colpidium, Colpoda* and *Vorticella* are commonly found in all soils of the world.

In addition to the ciliates mentioned above, there are other protozoa such as *Naegleria gruberi, Hartmanella* sp. (Rhizopoda) and *Oikomonas termo, Cercomons* sp. (Flagella) which are common to many soils of the world.

In the soils used in the present study, a ciliate *Chilophrya* sp. was found in relatively large numbers; and this protozoan does not seem to have been reported from any soil.

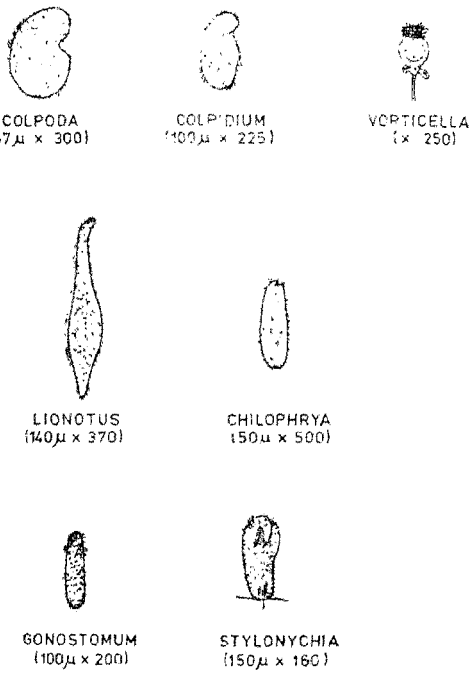

FIG. 1. Some common forms of protozoa in soil. (Figures are reduced to half the original size.)

It should be pointed out that although many investigators have listed the types of protozoa present in the soils they had examined, a comparative account of the protozoa in different soils has not been provided. This has now been done (Table III), together with the results of examination of the soils from 21 areas in India (Tables I and II). Thus our results and the results of others show that three of the commonest protozoa in all soils of the world are the species of *Colpidium*, *Colpoda* and *Vorticella*.

Finally, reference may be made to the investigations on the influence of the protozoa in soil processes[35, 36, 45] which showed for the first time that

TABLE I

Number of protozoa in different soils of Karnataka

Place from where the soil sample was collected	*Number of protozoa*: × 10^2/*g soil*					
	Colpidium sp.		*Colpoda* sp.		Total†	
	A*	B**	A*	B**	A	B
1. Amarapur	200	700	800	700	1,250	1,600
2. Bellathi	100	50	1,000	1,700	1,200	1,900
3. Devihosur	20	400	1,000	120	1,200	1,370
4. Koradur	20	40	1,200	20	1,330	140
5. Lakmapur	40	20	40	20	780	420
6. Magalam	40	600	150	800	930	1,600
7. Ramathirtha	30	450	120	500	1,300	1,250
8. Timmapur	30	400	300	150	900	1,250
9. Varada	20	60	700	500	1,600	1,200
10. Virapuram	200	20	600	60	1,050	140
11. Yadgod	200	150	400	300	1,500	650

† Total includes species of other protozoa (ciliates) such as *Vorticella, Lionotus, Chilophrya, Gonostomum* and *Stylonychia*, apart from the species of *Colpidium* and *Colpoda*.

* A Autoclaved sewage. ** B "Agricultural medium".

TABLE II

Number of protozoa in different soils of Dharwar, Karnataka

Place from where the soil sample was collected	*Number of protozoa*: × 10^2/*g soil*					
	Colpidium sp.		*Colpoda* sp.		Total†	
	A*	B**	A	B	A	B
1. Belgaum Road	600	400	200	500	1,000	1,150
2. Botanical Garden	140	60	80	70	350	250
3. Gawler Daddi Village	350	80	60	30	550	200
4. Hubli Road	1,200	350	50	450	1,400	1,000
5. Kalekeri Garden	280	150	100	130	440	350
6. Kyrakoppa	1,000	90	130	160	1,420	340
7. Madihal	180	200	180	400	440	720
8. Police Headquarters	800	500	90	150	1,000	800
9. Soudatti	100	100	80	120	250	300
10. Tapowad	300	100	20	260	520	460

† Total includes species of other protozoa (ciliates) such as *Vorticella, Lionotus, Chilophrya, Gonostomum* and *Stylonychia*, apart from the species of *Colpidium* and *Colpoda*.

* A Autoclaved sewage. ** B "Agricultural medium".

TABLE III

Observations of earlier investigators on the dominant species of protozoa in soil

Investigators	Rhizopoda	Protozoa Flagellata	Ciliata	Observations
E. J. Russell and H. B. Hutchinson (1909) Ref. No. 5			*Colpoda cucullus*	Widely distributed and capable of living and multiplying in the soil, U.K.
J. M. Sherman (1916) Ref. No. 37			*Colpoda cucullus*	Appears to be most widely distributed in soil, U.S.A.
C. R. Fellers and F. E. Allison (1920) Ref. No. 38	*Naegleria gruberi* *Monas termo*	*Cercomonas crassicauda* *Enchelya farcimen*	*Colpoda cucullus* *Vorticella striata*	Very abundant, U.S.A.
H. Sandon (1927) Ref. No. 8	*Naegleria gruberi* *Hartmanella hyalina*	*Oikomonas termo* *Heteromita globosa* *Cercomonas* sp.	*Colpoda cucullus* *Colpoda steinii*	Found in almost every soil examined from different parts of the world, often in very large numbers, can be regarded as dominant forms.
E. Gray (1948) Ref. No. 39			Species of *Colpoda* *Halteria* *Holophorya* *Oxytricha*	Ciliates found in water and in the soils, U.K. Water ciliates are identical with those of the soil, one habitat being the source of the other
W. Kuhnelt (1955) Ref. No. 40			*Colpoda cucullus*	Most commonly found in the

(Contd.)

TABLE III (*Contd.*)

Investigators	Rhizopoda	Protozoa Flagellata	Ciliata	Observations
			Colpoda steinii *Colpodium colpoda* *Chilodon* sp. *Vorticella* sp.	water filled spaces of normal soils, Europe
V. F. Nikoljuk (1956) Ref. No. 41	*Amoeba limax*	*Bodo globosus* *Oikomonas termo* *Oikomonas steinii*	*Colpoda cucullus* *Colpoda steinii* *Colpoda maupasii*	Most typical protozoa found in water-filled capillaries in the soil, USSR. All depend upon bacteria as food
O. Atlavinyte *et al.* (1967) Ref. No. 42	11 species *Amoeba albida* *Amoeba lacustris* *Amoeba horticola* *Amoeba limax* *Monas elongata*	24 species *Bodo globosus* *Bodo mutabilis* *Bodo uncinatus* *Cercoboda longicauda* *Oikomonas termo*	16 species *Balantiophorus elongata* *Colpoda cucullus* *Colpoda maupas* *Colpoda steinii*	Commonest species in the four different soils from Vilnius
R. H. Wegner and J. G. Engerman (1968) Ref. No. 43	Species of *Naegleria* *Hartmanella* *Amoeba* *Difflugia*	Species of *Cercomonas* *Oikomonas* *Heteromita* *Spiromonas*	Species of *Enchelya* *Colpidium* *Colpoda* *Gonostomum*	Common genera in soil
A. Bhattacharya *et al.* (1975) Ref. No. 14			*Colpoda cucullus*	Usually over 80 % of the protozoa in the two soils of Calcutta, India.
S. S. Bamforth (1975) Ref. No. 15		*Oikomonas termo* *Bodo* sp. *Cercobodo* sp.	*Colpoda cucullus* *Golpoda steinii*	Principal species in the rhizosphere soil of cacti of Arizona, U.S.A.
E. T. Elliott and D. C. Coleman (1977) Ref. No. 44		*Colpoda* sp.		Most numerous (Colorado, U.S,A.)

they were mainly responsible for the formation and stabilization of water stable aggregates in soil so essential for the aeration of the soil for proper development of plant roots.

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