OCCURRENCE OF *NITZSCHIA*, *NAVICULA* AND *PINNULARIA* IN RELATION TO SOIL PHYSICO-CHEMICAL PROPERTIES AND THE RELATIVE ABUNDANCE OF DIATOMS IN CULTIVATED SOILS OF KARNATAKA STATE (INDIA)

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Abstract

The relative frequency occurrence of 14 diatom genera in 144 samples of cultivated soils from six districts of Karnataka State is given. Three genera, viz. *Nitzschia*, *Navicula* and *Pinnularia* found in 71, 43 and 25 soil samples respectively, were most frequent. These were followed by *Stauroneis* and *Achnanthes* in 16 and 13 soil samples respectively. Measurements of the pH, CO_2, PO_4, Cl, Organic C, K, Na, Ca, Mg and N content of soils which contained the three most common algae, are compared with those soils which did not contain these algae. The genus *Nitzschia* showed greater specificity as compared with *Pinnularia* and *Navicula* with regard to the soil physico-chemical properties.

Introduction

Algae are the important constituents of the soil microflora of both temperate and tropical regions. Soil-algal floristics and their contribution to the soil fertility, have been studied in greater detail from various parts of the world, during the past few decades (Shields & Durrel, 1964). Apart from Cyanophyceae and Chlorophyceae, the Bacillariophyceae (diatoms) from the next major components of soil algal flora.

Unlike the higher plants, algae are a more heterogeneous group with regard to their morphology, physiology and nutrition, and there appears to be a great variation in the elemental requirements of algae (O'Kelley, 1974). However, very few attempts have so far been made to study the distribution of soil algae, in particular the diatoms, in relation to the soil physico-chemical components. In view of this lacuna, we are attempting to find out the possible relationships between different algae with various factors controlling the soil environments. Present report is an outcome of such studies.

In our previous study (Bangale & Bharati, 1980), the algal flora of cultivated soils of Karnataka State was reported. The flora included 244 species of blue green algae, 80 species of the green algae and 53 species of diatoms. The Bacillariophyceae were represented by fourteen genera. In the present communication, the presence or absence of *Nitzschia*, *Navivula* and *Pinnularia* is associated with the soil physico-chemical properties, and the frequency of distribution of all diatom genera is given.

Material and Methods

A total of 144 soil samples were studied. They were collected from both dry-land and wet-land cultivated fields in six districts of Karnataka, covering lateritic, red and black soil types. Detailed methods of sample collection, enrichment culture technique and identification of algae have already been described (Bharati & Bangale, 1975; Bongale &

Bharati, 1980; Bangale, 1981a). Analysis methods were supported for various soil physico-chemical properties including hydrogen ion concentration, carbonates, available phosphates, total chlorides, organic carbon, exchangeable potassium, sodium, calcium, magnesium and total nitrogen (Bongale, 1981b). Soil samples were studied and grouped according to the presence or absence of *Nitzschia*, *Navicula* and *Pinnularia* and the soil properties. The data were statistically analysed following, 'One Criterion of Classification' (Croxton & Cowden, 1955).

Observations and Discussion

The number of species and the frequency of occurrence of 14 diatom genera are shown in Table 1. *Nitzschia*, *Navicula* and *Pinnularia* were represented by more species and occurred with greater frequency than the other eleven genera. The relationship between

Table 1—Relative abundance of diatom genera in 144 samples of cultivated soils from Karnataka State

Genera	Number of species	Frequency (%)
Nitzschia	13	49
Navicula	10	30
Pinnularia	10	17
Achnanthes	4	9
Stauroneis	1	11
Synedra	2	3
Eunotia	2	3
Cymbella	2	2
Surirella	2	1
Hantzschia	1	1
Neidium	1	1
Fragilaria	1	1
Cocconeis	1	1
Pleurosigma	1	1

the three most common diatom genera and the soil physico-chemical properties is shown in Table 2. Soil samples in which *Nitzschia* occurred had significantly higher values of pH, N, P, Cl and Ca than those samples in which *Nitzschia* was absent. *Navicula* was present in samples with significantly higher values of N, and lower values of pH as compared with samples that did not contain *Navicula*. Values of pH, CO_3 and K were significantly lower in soil samples containing *Pinnularia*. Differences in other soil properties were found not to be significant with respect to the presence or absence of these genera.

Navicula seems to be the most tolerant to variations in soil physico-chemical properties, since only pH and nitrogen content significantly affected its distribution, while the occurrence of *Nitzschia* seems to be most specific and *Pinnularia* comparatively less specific

Table 2—Occurrence of diatom genera in relation to soil properties in Karnataka soils (average % values)

	pH	CO_3	PO_4	Cl	Org.C	K	Na	N	Ca	Mg
Nitzschia :										
Present	7.7	0.43	0.003	0.032	0.65	0.028	0.022	0.126	0.015	0.0009
Absent	7.3	0.49	0.002	0.026	0.56	0.022	0.016	0.096	0.013	0.0004
F value	**	N.S.	**	*	N.S.	N.S.	N.S.	***	*	N.S.
Navicula :										
Present	7.3	0.39	0.003	0.035	0.62	0.027	0.016	0.013	0.013	0.0007
Absent	7.7	0.57	0.002	0.028	0.59	0.030	0.022	0.092	0.020	0.0010
F value	**	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*	N.S.	N.S.
Pinnularia										
Present	6.5	0.11	0.002	0.032	0.61	0.014	0.014	0.112	0.013	0.0013
Absent	7.8	0.54	0.003	0.030	0.60	0.028	0.021	0.094	0.014	0.0006
F value	***	***	N.S.	N.S.	N.S.	**	N.S.	N.S.	N.S.	N.S.

F : Statistical significance at 5% (*), 1 % (**) and 0.1% (***) levels;
N.S. : Non-significant

to the soil physico-chemical properties. It is noteworthy that in the absence of other reports on this aspect of study, it is difficult to make any further generalizations. The few reports which are available on the occurrence of diatoms from other soils, indicate that diatoms are found where appreciate amounts of phosphates (and nitrates) are available (Shields & Durrell, 1964). In the present study, phosphates in soils containing *Nitzschia* was significantly higher. However, this factor was not significant in affecting the occurrence of *Navucula* and *Pinnularia*. Total nitrogen content was significantly higher in soils containing *Navicula* and *Nitzschia* but not significantly higher in samples containing *Pinnularia*.

Lund (1945) made a thorough study of diatoms in British soils, but he expressed the difficulty in making even tentative assumptions as to the influence of chemical factors on the growth of soil diatoms. He concluded that in general, base-deficient soils, below pH 6.0, with less than 0.0015% available phosphates and no nitrate or calcium carbonate, had poor diatom floras. In the present study, *Nitzschia* and *Navicula* appeared to prefer higher pH; but *Pinnularia* was recorded from soils with pH below 7.0. *Pinnularia* also preferred soils with lower carbonate content. Similarly Lund (1945) reported *Pinnularia* spp. in soils with more acidic pH. Other reports do not permit general statements on the preference by diatoms for high or low pH (Metting, 1981). Lund (1945) observed clear correlation between potash content and diatom productivity in soils. However, in the present study, *Pinnularia* preferred significantly lower levels of potassium content of soils, while the presence or absence of *Navicula* and *Nitzschia* was not correlated with this factor.

Since very little is known about the relation of algal flora to various nutrients in soils, it can only be said that *Nitzschia, Navicula* and *Pinnularia* appeared to show great

variations in their soil physico-chemical requirements. Among these three algae, *Navicula* and *Pinnularia* seem to be more tolerant and *Nitzschia* more specific with regard to soil physico-chemical factors.

Present observations on the more frequent occurrence of *Nitzschia* and *Navicula* agree with those of Fritsch (1922: cf. Shields & Durrell, 1964, p.112) who studied cultivated soils from England. Lund (1945) found that species of *Navicula* and *Nitzschia* were more frequent in all types of soils. Thus *Nitzschia, Navicula* and *Pinnularia* can be considered to be the most common diatom soil-inhabitants.

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