SOIL COMPLEX IN RELATION TO AQUATIC PLANT COMMUNITIES

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(Communicated by R. Misra, F.N.I.)

(*Received June 19, 1964*)

Three permanent ponds near about Allahabad have been studied in order to distinguish different plant communities as a preliminary step for a clearer understanding of the edaphic factors that control the distribution of aquatic plants. Different plant communities are recognized from periphery to the centre of pond and the succession of plant communities has been noted. With a view to correlating chemical nature of the substratum with the distribution of aquatic communities, mud samples were analysed from different localities of the ponds, for *p*H, carbonates, total exchangeable bases, exchangeable hydrogen, calcium, potassium and magnesium. The soil analytical data are correlated with plant communities. It is concluded that plant communities which occupy a higher level in the ladder of succession grow in soils with a better supply of exchangeable bases.

INTRODUCTION

Much work has been done on the British lakes about the distribution of aquatic plants in relation to the nature of substratum. Pearsall (1920, 1929) and Misra (1938) have found the distribution of aquatic plants to be related to the nature of the lake bottom mud. This view is rather opposed to the belief that the substratum is only for mechanical support of the plants and that the nourishment is derived from the surrounding water.

In India, Misra (1946) has investigated the aquatic vegetation of temporary and permanent ponds round about Banaras with regard to the successional pattern of the vegetation. Practically no work has been done with a view to correlating aquatic communities with pond bottom mud. The present study is a beginning for more detailed investigations in this direction.

METHODS

Three permanent ponds near Allahabad were chosen for this investigation. The vegetation was studied by line transect, and quadrat methods in order to recognize different plant communities. Mud samples were collected from different localities from the margin to the centre of the pond and were transported to the laboratory inside glass stoppered jars for analysis. Soils were analysed for *p*H, carbonate content, total exchangeable bases, exchangeable

hydrogen, exchangeable calcium, potassium and magnesium. *p*H of the soil was determined in a 1 : 5 soil solution using Beckman's electronic *p*H meter; carbonate content was determined by Hutchinson and MacLennan's method as outlined by Piper (1944). Exchangeable hydrogen was estimated following the method outlined by Russel (1958). Total exchangeable bases and individual cations were determined by leaching the soil with ammonium acetate and following the method of analysis outlined by Piper (1944).

Density of the species is expressed as a percentage of the total number of plants in the quadrat.

Vegetation

The following plant communities were recognized from the centre to the periphery of the pond. The density of each species is given within brackets.

1. Depth of water more than one m
   - *Najas-Hydrilla* associes
     - *Najas minor* (52·5%)
     - *Hydrilla verticillata* (32·0%)
     - *Paspalum vaginatum* (15·5%)

2. Depth of water from 40 cm to one m
   - *Ottelia-Utricularia* associes
     - *Ottelia alismoides* (48·4%)
     - *Utricularia stellaris* (21·8%)
     - *Hydrilla verticillata* (11·2%)
     - *Limnanthemum indicum* (9·8%)
     - *Azolla pinnata* (3·8%)
     - *Scirpus maritimus* (5·0%)

3. Water up to a depth of 40 cm
   - *Eleocharis-Limnanthemum-Ipomoea* associes
     - *Eleocharis fistulosa* (25·5%)
     - *Ipomoea reptans* (22·7%)
     - *Limnanthemum indicum* (18·2%)
     - *Hydrilla verticulata* (10·2%)
     - *Najas minor* (5·2%)
     - *Azolla pinnata* (5·8%)
     - *Cyperus exaltatus* (2·6%)
     - *Scirpus maritimus* (1·3%)
     - *Paspalum vaginatum* (2·2%)
     - *Marsilea* sp. (1·8%)
     - *Ottelia alismoides* (1·6%)
     - *Nymphaea pubescence* (2·8%)

4. Very moist to water-logged soils

Asteracantha-Scirpus-Eleocharis associes

Asteracantha longifolia (39·2%)
Scirpus maritimus (28·8%)
Eleocharis fistulosa (10·5%)
Ischaemum rugosum (9·0%)
Cynodon dactylon (1·8%)
Staurogyne glutinosa (5·2%)
Ipomoea reptans (2·4%)
Alternanthera sessilis (2·0%)
Ammania senegalensis (1·1%)

5. Moist meadows

Cynodon associes

Cynodon dactylon (60·2%)
Evolvulus alsinoides (20·7%)
Caesulia axillaris (7·8%)
Paspalum scrobiculatum (6·9%)
Cyperus rotundus (3·2%)
Ammania senegalensis (2·1%)

6. Meadow association

Cynodon-Bothriochloa 'association'

Cynodon dactylon (51·2%)
Bothriochloa pertusa (19·2%)
Dicanthium annulatum (15·0%)
Euphorbia hirta (5·8%)
E. thymifolia (4·1%)
Evolvulus alsinoides (2·7%)
Justicia diffusa (1·1%)
Rungia repens (1·6%)

The hydrosere may be arranged as follows:

Cynodon-Bothriochloa 'association' (disclimax)
↑
Cynodon associes
↑
Asteracantha-Scirpus-Eleocharis associes
↑
Eleocharis-Limnanthemum-Ipomoea associes
↑
Ottelia-Utricularia associes
↑
Najas-Hydrilla associes

The *Cynodon-Bothriochloa* 'association' is a disclimax because the grassland formation in this country is due to constant biotic influences (Misra 1946).

Edaphic Factors

The following vegetational types are found in the three ponds A, B and C from where mud samples were collected:

No.	Habitat	Vegetation
A_1	margin of pond	*Cynodon-Asteracantha-Cyperus*
A_2	water depth 8 cm	*Cyperus-Eleocharis*
A_3	water depth 20 cm	*Ipomoea-Limnanthemum*
A_4	water depth 40 cm	*Scirpus-Eleocharis*
A_5	water depth 75 cm	*Utricularia-Ottelia*
B_1	margin of pond	*Scirpus-Ipomoea*
B_2	water depth 15 cm	*Limnanthemum-Azolla*
B_3	water depth 25 cm	*Najas-Scirpus*
B_4	water depth 30 cm	*Najas-Paspalum*
B_5	water depth 75 cm and more	*Najas-Paspalum*
C_1	water depth 38 cm	*Azolla-Scirpus*
C_2	water depth 40 cm	*Najas-Vallisneria*

The mud analysis data from the above-mentioned localities are set in Table I.

Discussion

Along the margin of the pond the mud is slightly to fairly alkaline having a range of 7·2–8·0. Mud samples from submerged areas are neutral or slightly acidic in reaction (*p*H 5·8–7·0). Carbonates show a range from 0·37 to 13·05 per cent. In general, pond bottom mud contains good amount of exchangeable bases. Total exchangeable bases vary from 18·87 to 51·1 m.e. per cent. Exchangeable bases are more towards the margin and shallower parts of the pond and lesser in deeper regions. Exchangeable calcium in mud varies from 8·3 to 31·63 m.e. per cent and the soils are mostly rich in available calcium. Calcium is more towards the margin and shallower parts and are lesser in deeper regions. The potassium content varies from 1·05 to 8·26 m.e. per cent and exchangeable magnesium content shows a range from 1·99 to 9·48 m.e. per cent.

It is remarkable that the total exchangeable bases and exchangeable calcium in mud samples are more towards the margin than in deeper parts. In other words, aquatic plant communities (*Cynodon* associes, *Asteracantha-Scirpus-Eleocharis* associes and *Eleocharis-Limnanthemum-Ipomoea* associes) which occupy a higher level in the ladder of succession grow in soils with a better supply of exchangeable bases than those which occupy lower levels (*Najas-Hydrilla* associes and *Ottelia-Utricularia* associes).

TABLE I

Mud analysis data

	Pond A					Pond B					Pond C	
	A_1	A_2	A_3	A_4	A_5	B_1	B_2	B_3	B_4	B_5	C_1	C_2
*p*H	8·0	6·5	6·7	7·3	7·0	7·2	7·0	6·9	5·8	6·8	6·0	6·2
Carbonate content (%) ..	2·39	1·02	3·63	2·03	4·05	2·14	0·51	13·1	0·34	0·37	0·25	1·23
Total exchangeable bases (m.e. %) ..	38·5	32·2	36·5	28·4	24·4	45·6	40·2	35·3	41·1	32·6	18·9	22·1
Exchangeable hydrogen (m.e. %) ..	9·6	0·6	1·4	0·7	Nil	0·3	8·0	0·9	9·0	8·8	13·9	10·8
Exchangeable calcium (m.e. %) ..	26·8	23·7	31·6	16·6	17·3	28·8	25·3	27·0	30·5	25·9	14·9	8·3
Exchangeable potassium (m.e. %) ..	3·23	2·86	0·93	1·15	3·68	2·38	3·72	5·20	3·58	2·60	1·05	8·26
Exchangeable magnesium (m.e. %) ..	4·23	4·08	1·99	8·19	2·62	9·48	8·38	2·30	6·46	2·26	2·92	3·46

Acknowledgements

The author is greatly indebted to Professor R. Misra, Head of the Department of Botany, Banaras Hindu University, and Dr. G. S. Puri, lately Director, Central Botanical Laboratory, Allahabad, for their valuable suggestions and laboratory facilities during the course of this work.

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