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Chemical and Textural Characteristics of Sediments from Different Depths in a Sub-tropical Pond

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Proportion of clay and silt increased and those of sand and gravel decreased along transects from shallow to deep water. Concentrations of nitrogen and organic matter and cation exchange capacities of sediments increased with water depth while concentrations of phosphorus and hydrogen ion (*p*H) decreased with depth.

Introduction

A comprehensive idea of the bottom sediment is a pre-requisite to the management of aquatic bodies. Various management procedure and natural processes alter bottom sediment (Hepher 1965, Jonas et al. 1970) and cause spatial variation in sediment characteristics of a pond.

Parameters which have been studied most in characterizing the sediments are: (i) sedimentation (Pennington 1974, Kirchner 1975); (ii) exchange mechanisms at the mud-water interface (Mortimer 1941, Heyes et al. 1958, Kamp-Nielsen 1973); (iii) nutrient chemistry (Frink 1969; Serruya 1971, Wildung et al. 1974); (iv) organic matter (Bordovisky 1965, Kemp 1971, Hargrave 1973); and (v) particle size (Mortland 1954, Hargrave 1972, Johnson 1974, Banin et al. 1974). The objectives of the present study was to determine the gradients in chemical tural properties of sediment occurring along and textransects from shallow to deep water in a pond at Kanpur in Northern India.

Methods

Description of the pond: The pond selected for the study is located in the Kanpur metropolitan city within the campus of C. S. Azad University of Agriculture and Technology at 26° 26' N latitude and 80° 22' E longitude at an altitude of 124 m above the mean sea level. The pond is nearly rectangular in shape with a surface area of 3 ha. Exact age of the pond is not known but since last two years this has been used as stocking pond for the fish and has received applications of inorganic fertilizer (super-phosphate). Run-off filling the pond is from watersheds covered by grasses, trees and various shrubs.

Sampling procedure: An Ekman dredge was used to collect sediment at intervals of 0.25 m water depth along two different transects from shallow to deep water. In order to prevent the loss of soil while it passed through the water column, sediment was obtained by pushing a polythene tube, 2.5 cm in diameter, into an Ekman grab sample. Four replicate samples were collected at each depth by scooping the top 3 cm sediment. Samples were spread in thin layer on plastic sheets and allowed to air-dry. One-half of each sample was ground to size 60 mesh, sieved to remove leaf litter and particulate organic material and used for chemical analysis while the remainder of each sample was used for textural analysis.

Textural analysis: The hydrometer method (Piper 1950) was used to fractionate dry sediments into gravel sand, silt and clay. Sand was separated from gravel by sieving dried sediment sample through a screen with 2 mm openings. All colloidal materials in samples was considered clay.

Chemical analysis: Total nitrogen was determined by micro-Kjeldahl method (Misra 1968) while phosphorus content was estimated following Jakson (1958). *P*H was determined electrometrically using 10 g freshly collected sediment mixed with 20 ml distilled water. Organic matter was determined by the Walkley Black method (Jackson 1958). Exchangeable cations, were extracted with 0.05N HCl plus 0.25N H_2SO_4 and determined by titrating the excess of acid with 0.05N NaOH using methyl red as indicator. Exchangeable acidity was estimated from the *p*H change of a buffer solution following addition of 20 g dry sediment and cation exchange capacity was calculated as the sum of exchangeable cations and exchangeable acidity.

Results

Gravel decreased with water depth and was absent in samples below 2m (figure 1). Sand comprised 60% or more of particles in sediments from depths of 1 m or less. The send fraction decreased with respect to depth in samples taken from depth of more than 1 m and usually made up less than 30% of the particles in samples from depths of 3 m or more As sand and gravel decreased along the depth gradient, silt and clay particles increased in almost equal proportion.

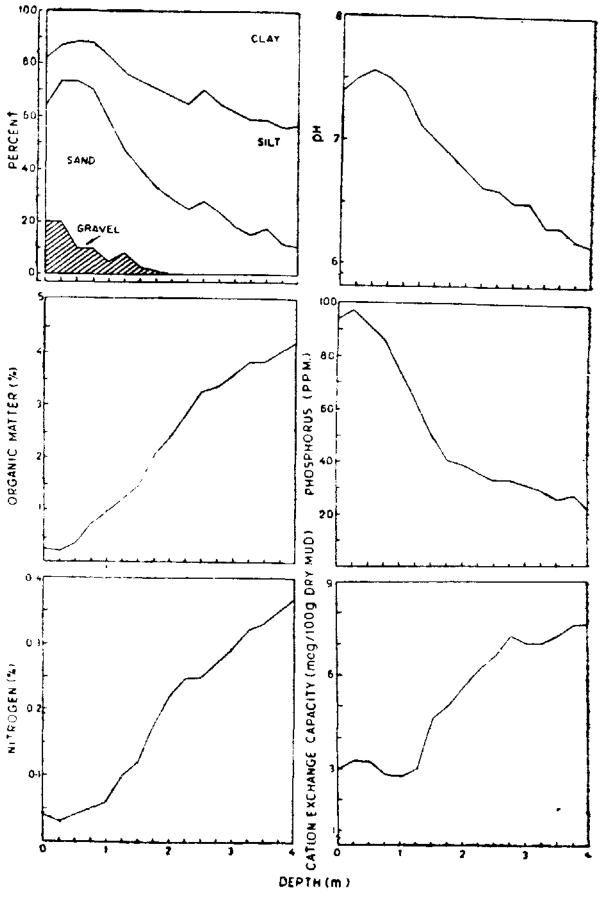

Figure 1 Relationships between water depth and textural and chemical properties of pond sediments

Data from chemical analysis reveal that concentrations of organic matter and nitrogen were higher in the sediments of deeper area as compared to that of shallow area. Organic matter concentrations in sediments increased from 0.25 to 1% near edges to 2 to 4% in deep water. Similarly nitrogen increased from 0.03 to 0.10% near edges to 0.20 to 0.36% in deep water. Sediments from shallow area have higher *p*H values (7.4 to 7.6) than those from deeper area (6.2 to 6.5). Concentration of phosphorus is higher near edges and increased with depth.

Discussion

Several factors were responsible for gradients in sediment texture with depth. Large particles (sand and gravel) entering thepond in run-off settled quickly in shallow water areas but finer particles (silt and clay) remained in suspension untill reaching the quieter deeper water. Wind-induced currents and wave action were sufficient to carry the fine material into deeper water without the drastic mixing occurring in open water bodies.

Increase in organic matter with respect to depth resulted from gravitational effects that caused downslope and accumulation in deeper water area of pond. Furthermore, sediments in deeper water are usually anaerobic because of oxygen depletion during summer stratification. Decomposition is less rapid and complete under anaerobic conditions, favouring greater accumulation of organic matter in anaerobic sediments. Higher concentrations of nitrogn in sediments of deep water were related to accumulation of organic matter. Superphosphate was applied around shallow edges of pond resulting in greater accumulation of phosphorus in sediments of shallow than of deep water. The greatest percentage of colloidal material, both clay and organic matter, in the deep water was responsible for greater cation exchange capacity (CEC). Increased *p*H of sediment from deep areas was probably due to higher concentration of organic matter. On the basis of textural and chemical characteristics of sediments beneath different depths of water the pond shows three clearly defined zones as presented in table 1.

Table 1 *Zonation of pond bottom according to textural and chemical characteristics*

Water depth	Sediment characterirtics
Zone 1 Shallow (0 to 1.5 m)	(i) Lowest concentrations of organic matter and smallest cation exchange capacity (ii) Highest *p*H and phosphorus values (iii) Texture-coarser
Zone 2 Intermediate (1.5 to 2.0 m)	(i) Transition zone with values for most parameters intermediate between those for shallow and deep water
Zone 3 Deep (2.0 m and below)	(i) Highest conscentrations of organic matter, nitrogen and greatest cation exchange capacities (ii) Lowest *p*H and phosphorus values (iii) Texture—finer

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