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STUDIES ON SEDIMENT OF KHARALAND (SALINE) PONDS OF RATNAGIRI WITH REFERENCE TO PRAWN CULTURE

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ABSTRACT

The coastal saline ponds have great potential for prawn culture. In order to understand the sediment characteristics of coastal saline ponds, the study was conducted in six Kharland ponds at Ratnagiri during September 1999 to August 2001. The pond soil is composed of sand (40.15-70.15%), silt (18.27-49.7%) and clay (6.39-20.43%). pH varied from 2.33 to 8.38, specific conductivity from 0.39 to 16.74 mS, total dissolved solids from 0.19 to 8.37%, available nitrogen from 1.12 to 26.6 mg/100 g soil and organic carbon from 0.0 to 2.85%. From this study, it is concluded that the sediment characteristics of these Kharaland ponds are suitable for the culture of prawns, *Macrobrachium rosenbergii* and *Penaeus monodon* separately or along with cultivable species of fishes.

INTRODUCTION

About 3.1 million hectares coastal saline soil has been reported in India (Yadav et al. 1983). Although this area is largely under agricultural cultivation, yet considerable part of this exhibits congenial ecological conditions for culture of fishes, shrimps and prawns. In Maharashtra, Thane, Raigad, Ratnagiri and Sindhudurg districts are along the coastal line and the area is estimated to be 65,465 hectares. The saline soil occurs in coastal areas of these districts due to the periodical inundation of cultivable land by creek seawater during high tides.

Salinity is a common feature of Kharland ponds. The salt contents were reduced considerably with the rainy season while they were increased a lot again during dry season (Mehta 1991). Pond soil plays an important role in influencing the water quality, biota and organic productivity. Soil also acts as a 'store house of nutrients' for the overlying water and helps in mineralization of organic matter, and absorption and release of nutrients into water. In addition, it also provides food and shelter to the bottom biota, which have significant influence on the productivity of bottom dwelling forms. This study, therefore, has been taken up in order to understand the sediment characteristics of Kharland ponds for the standardization of culture technology and also to assess their prawn culture potential.

MATERIAL AND METHODS

The present study was conducted in the six Kharland ponds, located within the campus of College of Fisheries, Ratnagiri (Maharashtra) India and situated between 16°59' 10" N latitude and 73°16' 25" E longitude. Each pond is a small, rectangular in shape with an area of 0.045 hectare (30 m × 15 m) and 1.5 m deep.

The sediment samples were collected at monthly intervals from all the four corners of the ponds during September 1999 to August 2001. The sediment samples were brought to the laboratory in plastic bags, dried under in direct sunlight and a single composite sample was made for each pond. Standard methods were used to analyze the sediment texture, pH, available nitrogen, organic carbon,

conductivity and total dissolved solids of samples following Jhingran et al. (1969) and FAO (1984). The results were statistically analyzed using analysis of variance and coefficient of correlation (Zar 1974).

RESULTS

The range of variation and mean values along with standard deviation of sediment characteristics of Kharland ponds have been given in Tables 1 and 2. The average percentage of sand, silt and clay in various Kharland ponds is shown in Fig. 1. During the period of study, the sand particles in the sediment of pond ranged from 40.15 to 70.15%, silt from 18.27 to 49.7% and clay from 6.39 to 20.43%. It was also observed that the pH of Kharland ponds was ranging from 5. 00 to 8.38, specific conductivity from 0.39 to 16.74 mS, total dissolved solids from 0.19 to 8.37 ppt, available nitrogen from 1.12-26.6 mg/100 g soil and organic carbon from 0.0 to 2.85% in the ponds studied during 1999-2001.

The values of coefficient of correlation among different sediment characteristics of Kharland ponds have been presented in Table 3. It was found that sand has shown a moderately negative correlation with silt. Similarly, silt also has shown a negative correlation with clay. Sediment pH has a slight positive correlation with specific conductivity, total dissolved solids and available nitrogen but it is negatively correlated with organic carbon. It was also observed that specific conductivity exhibits a very high positive correlation with total dissolved solids. However, it has shown a negligible positive correlation with organic carbon and negative correlation with available nitrogen. Total dissolved solids have shown a negative correlation with available nitrogen and a feeble positive correlation with organic carbon. Available nitrogen has, however, exhibited a negligible positive correlation with organic carbon.

DISCUSSION

It is quite well known that the sediment influences nutrients greatly in a pond ecosystem. The biogeochemical cycling in the system helps replenishment and consequent removal of nutrients from the system. Such exchange of nutrients depends upon the characteristics of the sediments and the hydrographic features of ponds.

In sediment, the percentage of sand was relatively more as compared to silt and clay in all the ponds studied. This was due to the features of soil of Kharland ponds in Ratnagiri. Gandhi et al. (2000) have concluded that the morphological and sediment characteristics differ from one environment to the other and reflect on the local hydrodynamic conditions. In an estuarine environment, however, the variations in sediment texture are due to circulation pattern during different seasons (Reddy 1983). Gupta et al. (1999) studied the sediment texture of coastal saline soils of Gopalapuram, and Nellore in relation to prawn farming and recorded values of sand varying from 52.5 to 80 %, silt from 7.5 to 14 % and clay from 10 to 35 %. The deposition and erosion of silt and clay depend on the monsoon (Hylleberg et al. 1985). In the present study, it was observed that the changes in the soil composition of ponds were mainly monsoon and tide dependent. Regarding the variations in the contents of sand, silt and clay, Rajsegar et al. (2002) have also held responsible the influence of tides and monsoon floods in Vellar estuary.

The pH of sediment varies from 5.00 to 8.38 during the course of the present study. During the monsoon period, the sediment pH of all the ponds was acidic and after monsoon and pre-monsoon it became slightly alkaline. It was also observed that the sediment pH of all the ponds was more acidic

Table 1: Range of variation and mean values along with standard deviation of sediment characteristics of Kharland ponds.

S. No.	Parameters	P1	P2	P3	P4	P5	P6
1.	Sand (%)	56.76-67.7 (62.43±3.03)	58.14-70.15 (63.12±3.48)	55.14-70.15 (62.49±3.67)	40.7-52.67 (46.66±4.02)	55.49-65.2 (60.43±2.83)	58.8-69.26 (63.11±2.88)
2.	Silt (%)	20.55-31.46 (26.75±2.83)	18.27-30.29 (25.35±3.43)	18.4-35.47 (26.59±4.32)	35.1-48.7 (40.37±3.79)	24.29-34.46 (28.87±3.21)	18.4-30.4 (26.33±2.69)
3.	Clay (%)	7.53-14.98 (10.85±2.04)	7.97-15.22 (11.39±2.10)	6.39-15.22 (11.10±2.09)	7.69-20.43 (12.87±3.61)	7.53-15.22 (10.81±2.00)	7.18-14.57 (10.78±1.74)
4.	pH	5.2-7.79 (5.19±1.42)	5.0-7.45 (5.32±1.28)	5.16-7.41 (95.89±1.04)	5.5-8.38 (6.02±1.00)	5.21-7.3 (6.10±0.90)	5.10-7.72 (6.26±0.75)
5.	Specific conductivity (mS)	1.14-12.68 (6.33±3.72)	0.8-16.74 (6.71±4.48)	0.55-14.26 (6.63±4.72)	0.96-16.1 (7.38±5.15)	0.47-15.74 (6.39±5.28)	0.88-12.08 (6.06±4.29)
6.	Total dissolved solids (ppt)	0.57-6.05 (3.22±1.92)	0.73-8.37 (3.42±2.22)	0.27-7.14 (3.36±2.33)	0.48-8.06 (3.72±2.54)	0.27-8.01 (3.18±2.66)	0.19-6.06 (3.11±2.17)
7.	Available nitrogen (mg/100g soil)	2.52-22.12 (10.78±4.99)	1.12-19.88 (11.21±4.78)	2.8-19.32 (11.45±4.49)	1.12-21.84 (11.93±5.77)	4.2-26.6 (11.35±4.78)	2.8-19.6 (9.43±4.43)
8.	Organic carbon (%)	1.2-2.73 (1.80±0.51)	0.84-2.82 (1.55±0.55)	0.81-2.37 (1.54±0.43)	0.96-2.85 (1.74±0.55)	0.54-1.95 1.37±0.34)	0.06-2.04 (1.24±0.39)

Table 2: Range of variation and mean values along with standard deviation of sediment characteristics of Kharland ponds (all ponds taken together).

S. No.	Parameters	Range of variation	Mean ± SD
1.	Sand (%)	40.15 – 70.15	59.71 ± 6.77
2.	Silt (%)	18.27 – 49.7	29.04 ± 6.19
3.	Clay (%)	6.39 – 20.43	11.31 ± 2.43
4.	pH	5.00 – 8.38	6.89 ± 1.14
5.	Specific conductivity (ms)	0.39 – 16.74	6.58 ± 4.57
6.	Total dissolved solids (ppt)	0.19 – 8.37	3.33 ± 2.29
7.	Available nitrogen (mg/100 gm soil)	1.12 – 26.6	11.02 ± 4.86
8.	Organic carbon (%)	0.0 – 2.85	1.54 ± 0.50

Table 3: Coefficient of correlation (r) between various sediment characteristics of Kharland ponds.

S. No.	Parameters	Coefficient of correlation
1.	Sand v/s silt	–0.744
2.	Sand v/s clay	–0.083
3.	Silt v/s clay	–0.476
4.	pH v/s total specific conductivity	0.241
5.	pH v/s total dissolved solids	0.248
6.	pH v/s available nitrogen	0.028
7.	pH v/s organic carbon	–0.113
8.	Specific conductivity v/s total dissolved solids	0.996
9.	Specific conductivity v/s available nitrogen	–0.070
10.	Specific conductivity v/s organic carbon	0.37
11.	Total dissolved solids v/s organic nitrogen	–0.077
12.	Total dissolved solids v/s organic carbon	0.362
13.	Available nitrogen v/s organic carbon	0.169

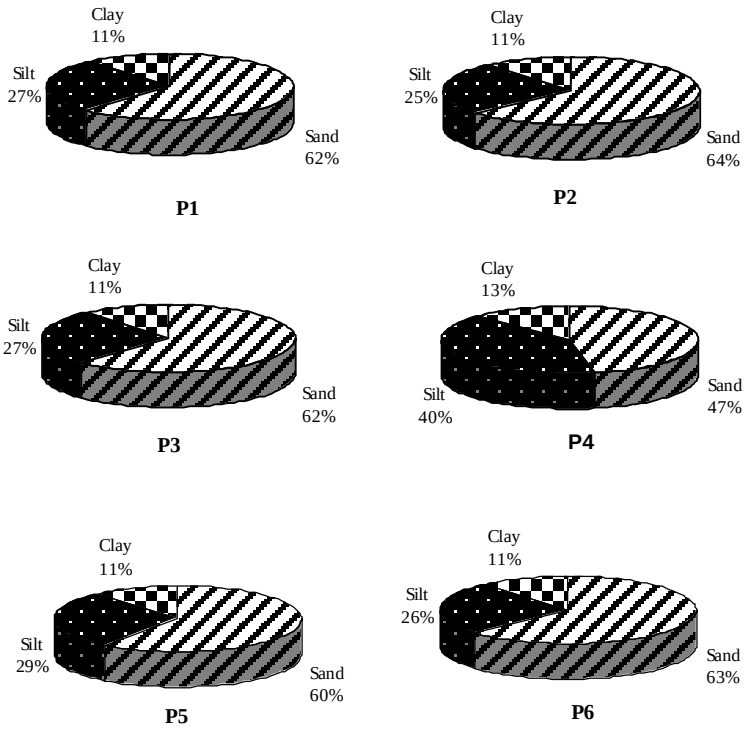

Fig. 1: Average percentage of sand, silt and clay in various ponds (P1 to P6).

during first year of the study as compared to that of second year. The sediment pH varied from 7 to 8.3 in the coastal saline soils of West Bengal (Chattopadhyay et al. 1988). In low productive rain-fed brackish water culture ponds, located along the periphery of Chilka lake, Orissa, Gupta et al. (1993) reported pH of soil ranging from 6.2 to 9.4. The pH values from 7.90 to 8.40 were observed in the soils of fish and prawn culture pond of West Bengal (Chattopadhya & Mandal 1968). Importance of neutral to slightly alkaline pH values of pond soils and water on fish production has already been emphasized. The values of pH of coastal saline soil in Gopalpuram ranged from moderately acidic (5.2) to alkaline (8.4). The low pH values may be due to the higher amount of iron and low amount of calcium carbonate in the coastal saline soil (Gupta et al. 1999). The results of present study corroborate the observations made by earlier workers.

The conductivity of sediment influences the ionic concentration of water in ponds. A high conductivity of sediment was observed during monsoon period in all the ponds under the present study. Chattopadhyay & Mandal (1986) reported the specific conductivity values ranging from 3.0 to 8.3 m mho/cm in West Bengal ponds. High specific conductivity values were due to the presence of large amount of water soluble cations and anions in saline soils (Subramanyan et al. 1976). Rajyalakshmi et al. (1988) observed that the specific conductivity ranging from 8.70 to 8.90 mmho/cm indicated high salt content. Chattopadhyay et al. (1988) recorded the specific conductivity of coastal saline soil varied between 2.6 and 9.3 mmho/cm. It is suggested that the increased specific conductivity is due to increased salt content of the saline soil and that is caused by inundation of coastal areas (George 1974, Gupta et al. 1999). This is true for Kharland ponds also.

The total dissolved solids in sediment ranged from 0.19 to 6.96 parts per thousand in the study. The values of total dissolved solids of sediments were low during the first year, which may be due to the leaching effect of the sediment as well as due to allochthonous input during the monsoon period.

Banerjee & Pakrasi (1986) observed a low concentration of available nitrogen (4.0 to 8.6 mg/100g soil) in the newly constructed brackish water impoundments in the lower Sundarbans area. Available nitrogen in soil fluctuated between 12.89 and 20.02 mg/100 g soil in Chilka lake fringe area ponds and indicated a poor productivity (Rajyalakshmi et al. 1988). Banerjee (1971) and Chattopadhyay & Mandal (1980b) observed that the rate of mineralization of organic nitrogen in pond soils decreases with increased salinity. High salinity might be one of the reasons for slow mineralization of available nitrogen. Available nitrogen in ponds along Chilka lake ranged from 11.37 to 23.83 mg/100g of soil (Gupta et al. 1993). Nasnolkar et al. (1996) reported the sediment nitrogen content varied from 2.81 to 32.71 mg/100 g soil in Mandovi estuary. The available nitrogen was varying from 0.91 to 20.1 mg/100g soil in the estuarine saline soils of Gopalpuram (Gupta et al. 1999). The available nitrogen is being influenced by monsoon as well as during pre-monsoon as there are high values and lower values during monsoon period were observed (Rajsegar et al. 2002). In Kharland ponds, the available nitrogen in sediment ranged from 1.12 to 26.6 mg/100 g and fluctuated widely in all the six ponds.

The organic carbon represents the status of organic matter in ponds. Chattopadhyay & Mandal (1986) studied organic carbon of brackish water pond soils of West Bengal and reported very low percentage of organic carbon ranging from 0.24 to 0.59%. Similar observations were also made in marshy soils of West Bengal with low organic matter (Gopalswamy & Roychoudhary 1970). In the present study, the organic carbon range was also very low, i.e., from 0.06 to 2.85% in various ponds. Chattopadhyay et al. (1988) reported organic carbon percentage between 0.3 and 1.3% in the coastal saline soil. Available nitrogen varied from 0.15 to 1.32% in the ponds situated near the Chilka lake fringe area (Gupta et al. 1993). Algaraswami (1991) reported organic carbon in sediments varying from 0.1 to 3 % of Mandovi estuary in Goa. Reddy (1983) observed organic carbon content ranging from 0.24 to 3.48% in the Nethravati-Gurupur estuary. The above investigations are in conformity with these results. Low organic carbon content was recorded in brackish water ponds (Rajyalakshmi et al. 1988). In our study also the percentage of organic carbon content decreased with increased depth as reported by Raji et al. (1996). Chattopadhyay & Mandal (1980a) also recorded low organic carbon in the soils of West Bengal. Tang & Chen (1967) have assigned that increase in organic carbon content of pond soil enhances the yield. Chakraborty et al. (1985) reported that pond soil with >1% organic carbon shows better prawn production. Rajsegar et al. (2002) concluded that the percentage of organic carbon was high during pre-monsoon and low during monsoon seasons. In view of the hydrobiological characteristics (Saksena et al. 2006), primary productivity status (Gaidhane et al. 2006) and characteristics of soil of Kharland ponds of Ratnagiri, it is concluded that these ponds are suitable for the culture of prawns, *Macrobrachium rosenbergii* and *Peneaeus monodon* alone or along with cultivable species of fishes.

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