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# Impact of sedimentation on the hydrobiology in relation to shrimp culture of two tidal ecosystems in Sundarbans of West Bengal

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**Abstract:** Studies on the changes of hydrobiology due to deposition of sediments in reservoir of two brackishwater tidal ecosystems *viz.*, Jagannath canal of north Sundarbans and Mooriganga river of south Sundarbans of West Bengal were conducted to evaluate the suitability of water of these two ecosystems for shrimp culture. On the second day of sedimentation in the reservoir, quality of water improved considerably. Dissolved oxygen increased and chemical oxygen demand and nutrient level decreased in the reservoir in both the areas. Transparency of water increased by 4.65 folds in north Sundarbans and 2.94 folds in south Sundarbans area. As a consequence, an average of 112 and 85% increase in gross primary production was occurred in the above two areas, respectively. Phytoplankton formed a bloom on the 8-10th day of sedimentation in north Sundarbans only. It is recommended that settled water of Mooriganga River is more suitable than that of Jagannath canal for shrimp culture and these waters can be preferably used for aquaculture on 4-6th day of sedimentation in the reservoir.

**Resumen**: Se llevaron a cabo estudios de los cambios en la hidrobiología debidos a la deposición de sedimentos en las represas de dos ecosistemas de mareas de aguas salobres, el canal Jagannath del norte de Sundarbans y el río Mooriganga del sur de Sundarbans, Bengala Occidental, con el fin de evaluar si el agua de estos ecosistemas es adecuada para el cultivo del camarón. Al segundo día de sedimentación en la represa la calidad del agua mejoró considerablemente. El oxígeno disuelto incrementó y la demanda de oxígeno químico y los niveles de nutrientes decrecieron en la represa en ambas áreas. La transparencia del agua incrementó 4.65 veces en el norte de Sundarbans y 2.94 veces en el área sur de Sundarbans. En consecuencia, la producción primaria neta en las dos áreas tuvo incrementos promedio de 112 y 85%, respectivamente. El fitoplancton tuvo un crecimiento explosivo entre los días 8 y 10 de la sedimentación sólo en la parte norte de Sundarbans. Se hace la recomendación de que el agua asentada del río Mooriganga es más adecuada que la del canal Jagannath para el cultivo de camarón, y que el uso de estas aguas para la acuacultura es preferible en los días 4-6 de sedimentación en la represa.

**Resumo**: Os estudos nas mudanças da hidrobiologia devido à deposição de sedimentos no reservatório de dois ecossistemas de águas salobras de maré, no canal de Jagannath no norte do Sundarbans, e do rio Mooriganga do sul do Sundarbans de Bengala ocidental foi efectuado para avaliar a adequação da água destes dois ecossistemas para a cultura de camarões. No segundo dia de sedimentação no reservatório, a qualidade da água melhorou consider avelmente. O oxigénio dissolvido aumentou e a demanda de oxigénio químico e o nível de

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nutrientes decresceu no reservatório nas duas estações. A transparência da água aumentou 4,65 vezes no norte do Sundarbans e 2,94 vezes na zona sul. Como consequência verificou-se um aumento de 112 e 85% na produção primária bruta, respectivamente nas duas estações referidas. O fitoplâncton formou uma camada no 8-10º dia de sedimentação somente na zona norte do Sundarbans. Recomenda-se que a água estável do rio Mooriganga é mais adequada do que a do canal Jagannath para a cultura do camarão e que estas águas podem ser preferentemente usadas para a aquicultura após o 4-6º dia de sedimentação no reservatório.

**Key words:** Hydrobiology, sedimentation, shrimp culture, tidal ecosystem.

## Introduction

For successful shrimp culture operation, good quality of source water is a prerequisite (Chanratchakool *et al.* 1994). The aquatic network of Sundarbans (West Bengal) comprises 1781 $m^2$ tidal rivers, creeks and canals which are brackish in nature. A number of shrimp culture farms of various sizes have been developed on the two banks of these tidal network. Almost all the waterbodies of this mangrove ecosystem are highly turbid with high load of suspended solids which may impair aquaculture production in several ways. To overcome this problem, sedimentation of water in a large reservoir has been suggested (Anon 1978; Chanratchakool *et al.* op. cit.). But the practice of sedimentation has been introduced in the coastal aquaculture system of West Bengal almost without any sound scientific study. The extent of changes in the hydrobiological characteristics in the sedimentation tank is very important for proper utilization of water and management of shrimp culture farms. Jagannath canal of north Sundarbans and Mooriganga river of south Sundarbans, the two important tidal waterbodies, are highly turbid and are used to feed shrimp culture farms. Studies were undertaken to evaluate the hydrobiological characteristics of these two ecosystems in lentic condition in the reservoir.

## Materials and methods

For the study, one reservoir each in north and south Sundarbans area was completely drained, cleaned and fed with high tide water up to 1.5 m depth. Both the reservoirs were attached with the semi-intensive shrimp culture farms. The size of the reservoirs were 0.7 and 1.2 ha in north and south, respectively. Exchange of water in the farms is generally carried out after each lunar cycle. Hence, draining, filling and hydrobiological studies were carried out for three consecutive lunar cycles in two seasons (February-March and June-July of 1997) and the mean with standard deviation is presented. Samples were collected from the surface at two days interval from the four corners of the reservoirs by a clean plastic bucket and pooled into one sample.

Water quality parameters *viz.*, temperature, suspended particulate matter (SPM), transparency, salinity, pH, carbon dioxide, alkalinity, dissolved oxygen (DO), chemical oxygen demand (COD) and nutrients (nitrate, ammonia, phosphate and silicate) were determined following standard methods (APHA 1992; FWPCA 1969; Philbert 1977; Strickland & Parsons 1968). Extinction coefficient ($K_t$) was estimated from the formula, $K_t$ = 1.44/Secchi depth in meter (Holmes 1970). For the collection of phytoplankton, five liters of water were collected in a plastic bottle and fixed with Lugol's iodine. Counting of phytoplankton was done by the "Direct census method" (Jhingran *et al.* 1969). The rates of primary production of the surface water were estimated as per the standard "Light and dark bottle method" (Gaarder & Gran 1927). Total heterotrophic bacteria (THB) of water was enumerated by pour plate technique using dehydrated nutrient agar in brackishwater as the culture medium (APHA 1992).

## Results and discussion

The hydrobiological characteristics of the studied ecosystems both in lotic and lentic condition are given in Tables 1-4. On the second day of sedi-

sedimentation, the turbid tidal water became highly transparent in both reservoirs during both the seasons. But the rate of sedimentation was higher in north Sundarbans, where 87.36 and 90.13% of SPM settled down in February-March and June-July seasons, respectively as against 77.28 and 72.57%, respectively in south Sundarbans. As a consequence, Secchi-transparency of water increased by 3.64 and 5.95 folds and 2.88 and 3.00 in north and south reservoir, respectively. pH of water in the reservoirs increased probably due to partial withdrawal of free carbon dioxide. The undersaturated nature of dissolved oxygen (DO) of the source waters was observed to become improved substantially in the reservoir ecosystem. With the deposition of SPM, chemical oxygen demand (COD) also decreased significantly in the reservoirs of both the areas. Nitrate-nitrogen increased probably due to the oxidation of ammonium-nitrogen in the reservoirs. A little change in the concentration of phosphate-phosphorus and silicate-silicon was also noticed. The potentiality of primary productivity was latent and highly inhibited by the high extinction coefficient which was a function of high load of non-photosynthetic suspended particles in both Mooriganga river and Jagannath canal ecosystems (De *et al.* 1990; Saha *et al.* 2001). But after settling of suspended particles in the reservoir, the primary productivity increased to almost double in the second day of sedimentation, successing the system from the heterotrophic nature of the source water (P<R) to the autotrophic condition in the reservoirs (P>R) as proposed by Odum (1956). Due to an average decrease of 79.41 and 65.95% of extinction coefficient, an increase of 112.67% and 85.40% of GPP was observed in the reservoirs of south and north Sundarbans respectively. Decrease of about 70-72% total heterotrophic bacterial counts in north Sundarbans and 57-69% in south Sundarbans also indicated decrease in heterotrophic activity in the reservoirs.

In the subsequent days of sedimentation, though growth of phytoplankton increased with the parallel decrease in concentrations of different nutrients in both the reservoirs, changes in the hydrobiological characteristics occurred was different in the two reservoirs during both the seasons. In both Sundarbans, phytoplankton concentration reached to its peak (226.76 x $10^2$ No. $1^{-1}$) on the tenth day forming a bloom during February-March season (Table 1). Peak phytoplankton concentration (244.10 x $10^2$ No. $1^{-1}$) was observed earlier (eighth day) in the June-July period (Table 2), that may be due to the acceleration of primary productivity by the higher solar radiation accompanied by higher temperature. This observation is corroborated with the observation of Riley & Chester (1971). The levels of ammonium-nitrogen and phosphate-phosphorus decreased to minimum at the peak phytoplankton production period during both the seasons. Then, a sudden collapse of phytoplankton was observed decreasing productivity level and increasing COD level and heterotrophic population. Decomposition of dead phytoplanktons leads to lowering of DO concentration drastically (Boyd 1982) and was at a minimum of 3.19 mg $l^{-1}$ (Feb.-March) and 2.23 mg $l^{-1}$ (June-July). Sharp increase in ammonium-nitrogen concentration (15.68 and 18.36 µg-at $l^{-1}$) was also observed.

In south Sundarbans area also, phytoplankton peaked on 10th and 8th day in the February-March and June-July seasons, respectively (Table 3 & 4), but the growth rate was comparatively slow and formation of bloom and subsequent collapse were not observed. This may be attributed to the lower concentration of nutrients, particularly phosphate-phosphorus, which was almost exhausted (0.08-0.12 µg-at $l^{-1}$) on the tenth day during both seasons. Regeneration process of nutrients was also slower as compared to north Sundarbans, which was attributed due to lower THB counts.

Considering low nutrients and COD levels, it can be contended that the water of the Mooriganga river after settling in the reservoir will be more suitable for semi-intensive shrimp culture than that of Jagannath canal. The concentrations of the nutrients is not much important for the production of shrimp in semi-intensive system, as the shrimps are supplied with artificial feed in this system. However, little quantity of nutrients for photosynthetic activity is necessary for the production of oxygen in this system. Excess nutrients of source water in addition to the nutrients released due to mineralization of detritus remains may accelerate phytoplankton bloom, which would be deleterious for the shrimp. Direct use of water of both Jagannath canal and Mooriganga River would be beneficial for traditional shrimp culture or polyculture, where the cultured species are fully dependent on autotrophic production for their diet. The water of

Jagannath canal can be preferred for feeding shrimp culture ponds in semi-intensive/modified

extensive system on fourth day of sedimentation during both the seasons. The water of Mooriganga river can be considered on fourth and sixth day during February-March and June-July period, respectively.

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