Effect of some physico-chemical water quality parameters of sea grass habitat on the abundance of shrimp juveniles in the Negombo Estuary

B.R.C. Mendis[1]*and U.A.D.P. Gunawardena[2]

[1]National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka.
[2]Department of Forestry and Environmental Science, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.

Abstract

The present study was conducted to evaluate the effect of selected physico chemical water quality parameters of sea grass habitat on the abundance of shrimp juveniles in the Negombo Estuary. The objective of the study was to examine the relationship between the shrimp larvae and environmental factors in sea grass habitats. Sea grass habitats provide habitats and act as nursery grounds for economically and ecologically important shrimp species. The sea grass habitats located in the Negombo Estuary mainly Kadolkele, Pitipana, Aluthkuruwa, Thalahena, Sethapaduwa, Liyanagemulla, Katunayake, and Kurana were selected for this study. The shrimp population depends on the environmental parameters of the sea grass habitats. During monthly field visits data were collected on salinity, ammoniacal-nitrogen, nitrate-nitrogen, nitrite-nitrogen, phosphate-phosphorous and number of shrimp larvae, for a period of one year.

The result showed that the abundance of shrimp larvae in the Negombo Estuary was negatively correlated with nitrite-nitrogen content in the water and is positively correlated with nitrate-nitrogen content in the water. The seasonality in the shrimp larval catch and water quality parameters were observed with peak period from May/June to October/November, which apparently coincided with the Southwest Monsoon and the onset of Northeast Monsoon of the island respectively.

Keywords: Sea grass habitats, Water quality, Shrimp larvae

*Corresponding author- Email: chani004@yahoo.com

Introduction

The Negombo Estuary is one of the most productive semi-enclosed shallow brackish water estuaries in Sri Lanka (Pillai, 1965). It is situated in the Gampaha district on the Western coast about 20 km North of Colombo at 7^0 7' N and 79^0 50' E. It is 12 km in length and 3.75 km at its widest point. It is a mixing ground not only for sea water coming in through the tidal inlet and fresh water entering through the river delta, but also for dissolved inorganic and organic constituents and particulate matter, sediment and biomass. Therefore, its physical nature, chemical composition and biological diversity are always determined by the diurnal and seasonal changes and the catchments induced freshwater inflow (Silva, 1996). The main fresh water input comes from rivers; Dandugam Oya and Ja-ela canal but the estuary is characterized by a brackish water flora, sea grass and some mangrove forests in the Northern, Eastern and Western regions. These zones are very important ecologically as well as economically.

Sea grass beds cover 22% of the lagoon area and are highly productive, providing habitats for a variety of brackish water organisms including many economically important species of shrimp resources (Jayasuriya, 1991). These sea grass habitats are very sensitive to salinity and nutrients of the water body. These grasses are highly productive and provide habitat for a variety of aquatic organisms including many commercially important shrimp species of *Penaeus indicus* and *Metapenaeus dobsoni.* Estuaries are very dynamic environments, where salinity effects habitat complexity and species distribution. Shrimps have a complex life cycle that includes an estuarine phase, when post larvae enter the mouth of estuaries, disperse into the inner reaches, settle and become juveniles, grow for several months and subsequently migrate into the sea as sub adults. The salinity and nutrient gradients in estuaries depend in the relative balance of the following factors such as run-off from the land, rainfall, evaporation from the estuary itself and tidal influence and distance from the coast line (Tookwinas *et al.*, 1985).

Materials and Methods

The study area

Eight sampling locations were chosen within the estuary, North shore of estuary in Pitipana and Kadolkelle, Western part of Aluthkuruwa, Thalahena and Sethapaduwa and Eastern part ofLiyanagemulla, Katunayeke and Kurana area (Fig.1) and they represented

different environmental conditions in the Negombo Estuary. The in-situ data collection was done for some parameters due to fluctuation of environmental conditions which effect on results. The water depth where the measurements were carried out was less than one meter at all sites. The collection of existing data pertaining to seasonal changes effect on physico-chemical parameters of water body in the Negombo Estuary were carried out at the beginning of the monsoon periods. Water samples and number of shrimp larvae catch were collected monthly during the period from July 2007 to July 2008.

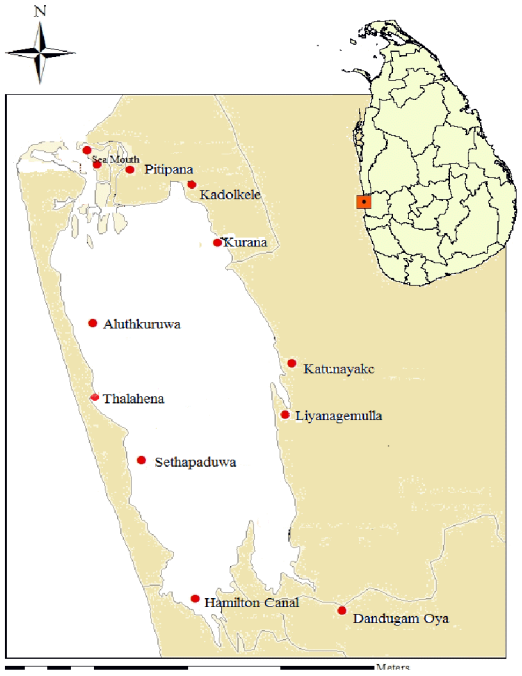

Fig. 1.Sampling Locations

Data collection

Shrimp larvae catch

Shrimp larvae catch was estimated using a one square meter quadrate which is subdivided into 25 squares of equal size nets and number of shrimp larvae in each square was counted. The larvae abundance was given in no./m^2.

Water quality

Salinity and nutrient measurements

Some important physico-chemical parameters such as temperature, salinity and nutrient measurement were monitored using a Mercury Thermometer (0-100^{0}C), Digital Refractometer (0-100 ppt). Nutrients such as ammoniacal-nitrogen, nitrate-nitrogen, nitrite-nitrogen and phosphate-phosphorus were analyzed using the UV Visible Spectrophotometer (APHA, 1998). All collected samples were stored at 4^{0}C during the transportation until refrigeration was done.

Data analysis

The collected data was analyzed statistically using Minitab version 14. The statistical method includes regression analysis.

Results and Discussion

The recorded sea grass species in this area were *Halodule pinifolia,Halophila minor*, *Potamogeton pectinatus* and *Rappia maritima*. The shrimp larvaeabundance was high from September to November, January and April to June (Fig. 2). The larval abundance in Negombo Estuary reached its maximum during Second Inter-monsoon (October and November) and Southwest Monsoon (May and June).

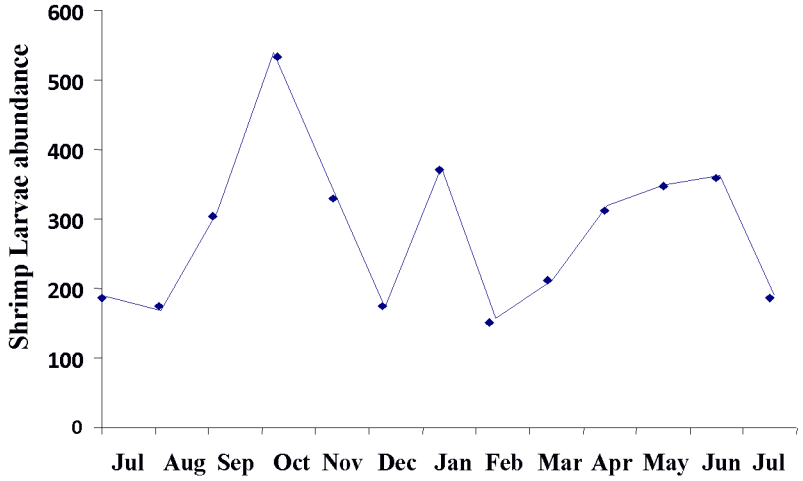

Fig. 2. Monthly variations of shrimp larvae catch

Water quality parameters

Temperature

Temperature is a critical water quality parameter since it directly influences the amount of dissolved oxygen that is available to aquatic organisms. Mean monthly surface water temperature ranged from 27 - 30 ^{0}C and the estuary water temperature was highest in September (Fig.3). The mean temperature variation in all locations were within the range of 27 - 32 ^{0}C.

Salinity

The mean monthly salinity values for each sampling site are given in Fig. 3. The salinity was high during the First Inter-monsoon (February to April) and it led to a condition where the estuary get high brackish water with the onset of the Southwest Monsoon (May and June). During the intermediate rainy season, pronounced salinity gradient was developed in the estuary. (e.g.January, July and December) with a range of 20 to 30 ppt

at the mouth 5-10 ppt at the Southern part of the estuary. The salinity level of the water at the Eastern part of the estuary was fairly low (around 15-29 ppt). The salinity level in the Northwestern part of the estuary was considerably high (22-30 ppt).The salinity gradient was well established during August and September. Relatively higher salinities were reported in March (32 ppt). The acceptable range of salinity values reported for shrimp growth and production is 10-32 ppt (CEA, 2001), (Table 2).

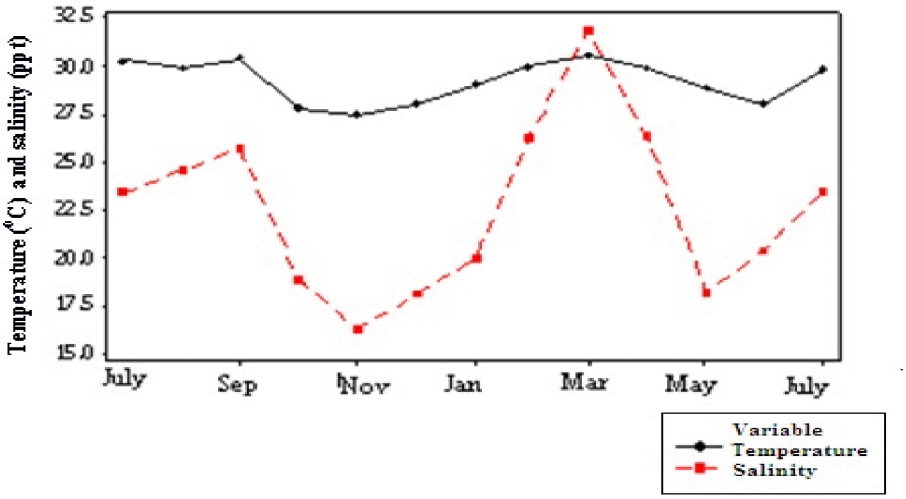

Fig. 3. Variation of monthly mean temperature and salinity

Nutrients

Nitrate-nitrogen

Nitrate is a primary nutrient in a brackish water estuarine environment, particularly where average salinity varies between brackish to hypersaline. In such estuaries, diatoms are the dominant planktonic organisms. Nitrate-nitrogen in the Negombo Estuary reached maximum during October-November and May-June (Fig.4) during the monsoon season. The proposed acceptable range of nitrate-nitrogen for shrimp larvae is less than 01 mg/L (Table 1), recommended by the Central Environmental Authority (CEA) in Sri Lanka, 2001.

Phosphate phosphorous

Phosphate-phosphorous is considered to be one of the important primary nutrients in estuary. The acceptable range of Phosphate-phosphorous for shrimp larvae is less than 01 mg/L (Table 1), recommended by CEA, 2001.

Ammoniacal nitrogen

Ammonia is an important nutrient of phytoplankton of the estuarine environment. It is also end product of protein catabolism excreted by aquatic animals. Ammonia in water consists of a unionized (NH_3) and ionized from (NH_4^+). Unionized ammonia can be toxic to fish. Monthly variations of ammoniacal nitrogen in the Negombo Estuary reached a maximum during August and April, just before the monsoon season and the lowest level in December and March (Fig. 4). The acceptable range of ammoniacal nitrogen for shrimp larvae is less than 01 mg/L (Table 1), recommended by CEA, 2001.

Nitrite -nitrogen

Nitrite-nitrogenis an intermediate product in the nitrification of ammonia to nitrate. It is toxic to fish and therefore is important for aquatic organisms. Monthly variations of nitrite-nitrogen in the Negombo Estuary reached a maximum during March and minimum was found in June (Fig. 4).Nitrite-nitrogen levels as high as 25 - 100 mg/L are toxic to fish and range of less than 01 mg/L is favorable aquatic organism (Johnson *et al.*, 1985). The acceptable range of Nitrite -nitrogen for shrimp larvae is less than 01 mg/L, recommended by CEA, 2001.

Table 1. Water quality standards for brackish water shrimp

Parameters	**Tolerance Limits**
Temperature	<35 ^{0}C
Salinity	10-32 ppt
Nitrite -Nitrogen	<1.0 mg/L
Nitrate-Nitrogen	<1.0 mg/L
Phosphate-Phosphorous	<1.0 mg/L
Ammoniacal- Nitrogen	<1.0 mg/L

Source: Central Environmental Authority (2001)

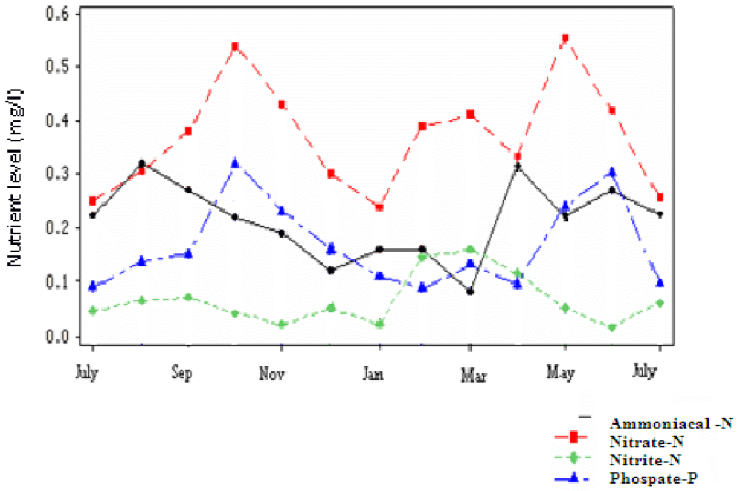

Fig. 4. Monthly variation of nutrients levels (mg/L) in sea grass habitat

Contribution of water quality parameters to shrimp productivity

Correlation coefficient

In order to investigate the relationship between water quality parameters of the sea grass habitats and shrimp larval abundance, the correlation coefficient were performed and results are given below.

The best fitting regression model state that,

Shrimp larvae catch = -59 + 6.9 Salinity (ppt) + 34 Ammoniacal - N (mg/L) + 638 Nitrate - N (mg/L) - 1550 Nitrite -N (mg/L) + 175 Phosphate - P (mg/L)

Table 4. Probability values of salinity and nutrient levels (p=0.05)

Water quality parameters	Coef	SE Coef
Salinity (ppt)	6.93	15.30
Ammoniacal -N (mg/L)	33.9	433.8
Nitrate-N (mg/L)	638.5	719.0
Nitrite-N (mg/L)	-1550	1919
Phosphate-P (mg/L)	175.5	974.2

S = 93.8394 R-Sq = 60.3% R-Sq (ad) = 31.9%

According to the results of shrimp larvae abundance for the sea grass habitats indicate that Nitrite-nitrogen contribute negatively, while nitrate-nitrogen, phosphate-phosphorous and ammoniacal-nitrogen, contribute positively to the larvae abundance.

The present study revealed that the water quality conditions were favourable for shrimp juveniles living in the sea grass habitats. A comparison of the data obtained here showed a significant correlation between water column nutrient concentrations and community production despite the fact that there were high levels of both dissolved inorganic nitrogen and soluble reactive phosphorous at all sites. A factor which could explain this difference in 2008 is the initially low concentration of nitrogen and phosphorous of dry season months of January to March, 2008 and July to September, 2007. Negombo town discharges large amount of sewage directly into the estuary (Silva, 1996). Water quality of the sea grass habitats for breeding and nursery ground could be considered within the acceptable limits recommended by the CEA Standard (2001). Kodolkele, Thalahena and Kurana had the high density of sea grass communities. The high abundance of shrimp larvae in sea grass habitats were found in these sites.

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