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INFLUENCE OF PHYSICO-CHEMICAL PARAMETERS ON POPULATION STRUCTURE AND LENGTH-WEIGHT RELATIONSHIP OF *Artemia franciscana*

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KEYWORDS

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ABSTRACT

The *Artemia franciscana* populations were found throughout the year in Tuticorin saltpan ecosystem. In order to provide better growth and understanding of brine shrimp *A. franciscana*, the different ecological and biological parameters were taken out during 4 different seasons from January to December 2014. This study determines the impact of algae on growth and physicochemical parameters on population structure and length-weight of *Artemia* in different seasons of man-made saltpan habitat and algae fed *Artemia* culture pond at Tuticorin. Maximum population density of brine shrimp was observed in the monsoon season nauplii 54.91% & 52.77%, juvenile 20.52% & 20.03%, pre-adult 15.31 & 14.48%, male 4.91 & 7.53%, female 4.33 & 5.15% were observed in Station 1 & 2 respectively and decline was observed in summer season. The length was observed to the maximum of 8729.44 (µm) & 9696.00 (µm), and the minimum of 7909.77 (µm) & 8367.11(µm) in Station 1 & Station 2 respectively; maximum weight ranged from 0.007g & 0.009g in Station 1 & Station 2 respectively. The sex- ratio showed that males pre-dominated than females during the entire season in both stations. Based on the present study the growth and abundance of *Artemia* population were high in station 2 because of the enrichment of the algae supplementation.

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1 Introduction

Artemia is an excellent food source, which could provide quality feed to fish and crustaceans and help in the growth of aquaculture industry (Sorgeloos, 1980). The brine shrimp *A. franciscana* was mostly reported from the hyper saline environments and distributed all over the world (Van Stappen, 2002) and extensively used in aquaculture. In order to meet the increasing demand of *Artemia* cysts and producing high quality biomass, solar salt pond management techniques has been indiscriminately introduced worldwide into a large number of salterns and salt lakes (Persoone & Sorgeloos, 1980; Geddes & Williams, 1987; Tackaert & Sorgeloos, 1991). The need of finfish and crustacean species has increasing now a days, it seem to have the potential of aquaculture market to world need, but live food availability is one of the major constraints for the culture development of these species. Studies on *Artemia* populations and morphometric characters are important to know about their adaptability, size and growth of the animal for pilot scale production. Various researchers those who have conducted the field studies have forgot to include the relationship between population and morphometric characters on *Artemia* culture (Lenz & Browne, 1991; Browne, 1992; Browne, 1993).

Algae play an important role in *Artemia* growth and development (Mason, 1963) however, *Artemia* could not filter larger algae, especially filamentous algae (e.g. *Ossillatoria*) because they become a trap which can prevent movement of *Artemia* and it reduces their survivability (Sorgeloos et al., 1986; Dhont & Lavens, 1996). It is a continuous filter feeder which selects suspended particles only on the basis of size

(Gelabert & De la Cruz, 1990); although its feeding behavior may be affected by several factors which influence its filtration, ingestion, or assimilation rates. In addition it varies with age because the feeding efficiency increases with the number of functional thoracopods (Lavens & Sorgeloos, 1991).

Artemia populations can sustain in temperature oscillation and it can able to live even at 6 to 35°C with different ionic salt composition. Similarly, *Artemia* populations also have adaptation towards the water pH and these can tolerate pH from neutral to highly alkaline (Van Stappen, 2002). Therefore, the differences in physicochemical properties of water such as temperature, pH, salinity and oxygen level play an important impacts on the fluctuation of *Artemia* populations by influencing their reproductive strategies through ovoviviparous versus cyst production (Camargo et al., 2004). The aim of present study was to evaluate the physicochemical properties, population and morphometric characters of *A. franciscana* in Tuticorin saltpan ecosystem and in the *Artemia* culture ponds.

2 Materials and Methods

2.1 Site description

Study was conducted at Tharuvaikulam (Latitude 8° 44' 40.07''N; Longitude 78° 07' 27.87''E) which is situated at 10 km north to Tuticorin city (Figure 1). Study area was divided into two locations viz. 1. Manmade saltern and 2 *Artemia* culture pond. Selected areas have higher salt production as compared to other stations and also have very high *Artemia* density.

Figure 1 Geographical location of the study area.

2.2 Sample collection and hydrobiological parameters

Water and *Artemia* samples were collected for the period of 1 year from January to December 2014. The physicochemical and biological parameters of the collected samples were analyzed. Among these, salinity, temperature and pH were observed by standard methodological instruments (Hand Refractometer – ATAGO, Digital Thermometer and pH meter – Handy lab1). *Artemia* samples were collected by 150 μ m mesh size of nylon net and preserved in 5% formaldehyde for biometric analysis. The biological parameters like population density of *A. franciscana* were analyzed by using standard methods described by Amart (1979) and Vanhaecke & Sorgeloos (1980).

2.3 Population composition

Abundance of *Artemia* population was determined in 1 liter of collected water from each station. Abundance was determined by directly counting *Artemia* specimens by using a magnifying glass. In most of the cases, entire one liter sample was used to calculate abundance while in some samples where as *Artemia* population is too high; samples were divided in subsamples and used for estimation of population density. At each census, *Artemia* individuals were lightly narcotized with chloroform-saturated water and then sorted into four demographic classes. To determine the population composition, the nauplii (larvae without thoracopods), juveniles (larvae with thoracopods but not sexually differentiated), pre-adults (specimens sexually differentiated and not having reached the reproduction stage) and adults were numbered. Adults *Artemia* length were measured individually in a ventral position from the tip of the head to the base of the furca.

2.4 Length and weight

Average length was measured for 30 adults of *Artemia* and mean values were used for comparison. In all specimens, the total length (between top of head to base of caudal furca) was measured using optical microscope equipped with a calibrated micrometer eye piece.

3 Results

3.1. Physico-chemical parameters

The physico-chemical parameters of the collected water samples were measured for each station, these samples were divided into 4 seasons including post-monsoon, summer, pre-monsoon and monsoon. Highest temperature for station 1 (Manmade saltern) was reported 38.16 $^{\circ}$ C during the summer seasons while the lowest 33.5 $^{\circ}$ C was recorded in monsoon season. Results of study revealed that temperature of water samples varied with the sampling location (Figure 2). Average water temperature for this station was around 35.5 $^{\circ}$ C for the entire year. Similar trends was reported for the water temperature of station 2 (*Artemia* culture pond) and was also

showing maximum temperature (37.6 $^{\circ}$ C) during summer and minimum (33.3 $^{\circ}$ C) in monsoon season. The average water temperature for this station was also around 35.4 $^{\circ}$ C for the entire year.

Figure 2 Variations of water temperature recorded in station 1 and 2.

Further, in case of salinity, highest salinity 117.33, 104.00 ppt was reported during the summer while the lowest salinity 55.00, 57.33 ppt was reported in monsoon season for the station 1 and 2 respectively. Salinity of the two study areas varied with little difference which depend on the various season (post monsoon, summer, Pre monsoon and monsoon) (Figure 4). Like other parameters, in case of pH, maximum pH (8.30, 8.40) was reported during summer while the minimum pH (7.73, 7.93) was reported in the monsoon season from the station 1 and 2 respectively (Figure 3).

Figure 3 Variations of pH recorded in station 1 and 2.

3.2 Population variation

Wide variations was reported in the population abundance of *Artemia* at 2 stations (Figures 5 & 6). Total mean value of *Artemia* population significantly varied between seasons to seasons. However, some decline was observed in summer season. The number of individuals collected at monthly interval has varied and the lowest population was observed during summer season in both stations.

Figure 4 Variations of salinity recorded in station 1 and 2.

In both the stations, total population of nauplii consisted of 51.28% and 49.51%, juvenile composition was 22.43% and 24.5% and the *Artemia* pre-adult stage was 14.74%, & 13.72% respectively. While determining the sex ratio of the species male comprised 5.76%, 6.86% while this percentage was reported 5.76%, 5.39 % per liter of water in case of female for station 1 and 2 respectively. Maximum population density was reported in the monsoon season and this percentage was 54.91% & 52.77% for nauplii, 20.52 % & 20.03% for juvenile, 15.31% & 14.48% for pre-adult, 4.91% & 7.53% for male and 4.33% & 5.15 for female in one liter of water for the station 1 and 2 respectively.

The sex- ratio was predominated with male *Artemia* population and always slightly higher than female population. During the experimental observation nauplii composition was high in all the four seasons for both the studied stations. For the population composition, nauplii made up a very high fraction of the samples in all the four seasons (more than 50%).

Furthermore, the *Artemia* concentration was predominated in station 2 as compared to the station 1 for all the seasons, it may be due to the availability of the micro algae. The algae density was maintained in the separate algal ponds and supplied to the *Artemia* culture ponds in station 2. The highest algal density was appeared in the post-monsoon season. Overall average algal density was observed 173425.66/ml in post monsoon, 150841.00/ml in summer, 168388.66/ml in pre-monsoon and 162500 cells/ml in monsoon season.

The strong relationship found between distributed algal species with the water salinity. Therefore the abundant planktonic diversity was observed even at different salinity regimen, under seasonal influence. Compared to all other planktonic species *Dunaliella salina* was more predominant in hypersaline ponds while other planktons including *Oscillatoria*, *Pleurosigma*, *Navicula* and *Nitzschia* were common in all. *Dunaliella salina* was the only species consistently recorded in high number from all stations.

3.3 Length & weight relationship of *Artemia*

The length, dry and wet weight measurements of *Artemia* population in two stations are presented (Figures 7, 8 & 9). Results of study revealed that both populations are significantly different in growth performance. Maximum *Artemia* length was observed during the monsoon season (8729.44 μm & 9696.00 μm) while it was reported minimum in summer season (7909.77 μm & 8367.11 μm) for station 1 & 2 respectively. Further, the maximum weight was recorded during monsoon 0.007g & 0.009g while the minimum weight was observed during summer season 0.005g & 0.007g for station 1 and 2 respectively but it was not significantly different.

Figure 5 Variations in different stages of *Artemia* during four different seasons at station 1.

Figure 6 Variations in different stages of *Artemia* during four different seasons at station 2.

4 Discussions

The physicochemical parameters were observed in both stations and the peak value of temperature was reported 38.16°C, Salinity 117.33 ppt and pH 8.40 noticed, results of present study are in conformity with the findings of Persoone & Sorgeloos, (1980). Similarly, Kulasekarapandian & Ravichandran (2003) has described that the physicochemical properties and population analysis of Chennai water and the similar results were noticed in the present study with slight variations in salinity. In the present study, *Artemia* population density was observed maximum during the monsoon season. The density of Nauplii was 54.91 to 52.77 % and the similar observations were made by Razia sultana et al. (2011). The physicochemical properties, population analysis and size variation observed in the present study was similar to Shaikha Al Dhaheri & Anitha Saji (2013). Radhika et al. (2011) studied the physicochemical and population analysis in Tuticorin environment and noticed the similar kind of results. In the

present study, the reported physicochemical parameters are within the normal range but Al Dhaheri (2004) reported *Artemia* can tolerate and survive up to 237 ppt of salinity.

The physicochemical and various hydrological characters of water play an important role in the determinant of development of biological community of salt pans (Davis, 2000). Van Stappen, (2002) reported that *Artemia* can survive in wide range of pH which varies from neutral to highly alkaline. Interestingly, the physicochemical parameters impacts on *Artemia* populations by influencing their reproductive strategies through ovoviviparism versus cyst production (Camargo et al., 2004) and morphological characters of adult specimens (Gilchrist, 1960; Hontoria & Amat, 1992; Litvinenko et al., 2007; Asem & Rastegar-Pouyani, 2008; Ben Naceur et al., 2011a). During the present study, high evaporation of water, high salinity, low oxygen and neutral pH are the characteristic features of the salt pans which were also observed (Gunde Cimerman et al., 2000).

Figure 7 Length of *Artemia* in Station 1 and 2 during four different seasons.

Figure 8 Wet weight of *Artemia* in Station 1 and 2 during four different seasons.

Figure 9 Dry weight of *Artemia* in Station 1 and 2 during four different seasons.

The abundance of micro plankton was observed and dominated by diatoms and dinoflagellates which accounted about 90% of the total abundance in the saltpan. However, the diversity and species richness remained poor in the salt pans (Rehman, 2006). The above study demonstrated that salt pans represent discrete ecosystem among the saline zones which has a unique life restricted to these system only. Despite the heavy constraints, temperature plays a regulatory factor in the development of plankton community of these systems (Ayadi et al., 2004). The similar trend was observed by Estrada et al. (2004) in species richness of micro autotrophic plankton community along the salinity gradient in salterns.

Present study clearly suggested that salinity influences the planktonic population in the saltern ecosystem. The poor *Artemia* population may occur because of high salinity, temperature and low food (phytoplankton) in the water. Similar

findings were observed by Kuruppu & Ekaratne (1995). The fluctuation of *Artemia* population observed in the salt pans is being due to the seasonal influences (Davis, 1980).

In the present study survivability also showed an interesting fact that it persisted in the extreme halophilic environment of 117.33 ppt. According to Abatzopoulos et al. (2003) high salinities induce a reduction in the fertility of the females which caused declined in the population density during the summer season and the population density was maintained in station 2 by the supply of green water and reducing salinity. The input of freshwater during the monsoon season is the main reason for allows the water salinity to bring down for population development. During the water inflow the physicochemical parameter including salinity and temperature was optimized which triggered the hatching of cysts and increase reproductive rate of *Artemia* population. The brine

shrimp *Artemia* showed a better growth performance and abundance in station 2. The maximum length of 9696.00 µm was recorded in station 2 when compared with station 1 (8729.44 µm). The amount of food particles in the diets could affect the energy availability for growth and survival to the *Artemia*.

Therefore the feeding of algae to brine shrimp is a prerequisite to support the aquaculture industry in order to improve nutritional quality, healthy growth and hatchery efficiency. Hence the study was concluded that among the four different seasons post-monsoon, pre-monsoon and monsoon seasons are suitable for the production of cysts and biomass from culture of brine shrimp and by supplying the green water.

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Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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