



Temporal Variation of Mole Crab Species *Emerita asiatica* in Relation to Water Quality Along Gopalpur Coast, East coast of India

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ABSTRACT

Coastal sandy beaches are considered to be an integral part of the coastal ecosystems in marine environment. Sandy beach is an extremely dynamic environment where sand and water are always in motion. There are several fauna and flora occurring in this zone. The mole crab, *Emerita asiatica* is one of them from this sandy beach of Gopalpur coast. Gopalpur is a small fisherman village and also an important tourist spot of Odisha. The monthly data was collected over two years from January 2011 to December 2012 to assess the water quality. In this chapter we have discussed on the water quality standard of the major tourist beach with special reference to mole crab community. Various physico-chemical parameters like air temperature, water temperature, pH, turbidity, dissolved oxygen, salinity, and nutrients were studied along with the population study of mole crab species.

1. Introduction

Gopalpur-on-sea is located on latitude 19.27° N and longitude 84.92° E of Southern Odisha which lies on a four km stretch of coastal belt of Bay of Bengal with no mangrove or tropical forests. Among major commercial fisheries in the Indian seas, the Gopalpur coast plays an important role which contribute about one third of the total marine fish production in our country. There are about 102 fishes caught from the Gopalpur coast. The main commercially importance fishes are sardine, anchovies, pomfrets, mackerels, clupeids, perches, cat fish and penaeid shrimp. The peak season of catches is during October to December. The minimum catches gradually decreases from October-December to April-June. Due to rich fishery resources of Gopalpur coast there are many fishermen community, who generally depend on fishing for their livelihood. Normally six villages are established nearby Gopalpur beach. These marine fishermen group are called 'Nolia' in local language. These villages are Gopalpur, Sana Arjyapalli, Bada Arjyapalli, Haripur, New Boxipalli and Puruna Bandha. The fishermen use the crafts which are the small mechanized vessels, wooden trawlers, wooden gill netters, beach landing crafts, for fishing.

Besides all, the commercial fishery there is an animal, a very small crab which is not that much economic importance but plays a vital role in Gopalpur coastal ecosystem. *Emerita asiatica* belongs to family: Hippidae, phylum: Arthropoda, which is also known as mole crab, sand crab, sand fleas, or sea cockroach. These animals burrow in sand in the swash zone of the intertidal beach. Mole crabs are filter feeders with barrel shaped body. It has a rough exoskeleton and can hold its appendages close to the body, allowing it to roll in tidal current and wave.

Sand crab usually found on the beach in a large number from spring to fall. In winter wind carries the sand to offshore into sand bar. When the sand is transported back on the shore in the spring the crab comes with it. The reproductive season varies from February to October. The egg hatches approximately in one month. The larvae under go to 8 to 11 stages. During this time it may drifted far offshore. The *Emerita* has short life span i.e. for 2 to 3 year and it can reproduce in the first year of its life. The larvae may live as plankton for more than 4 months. They carried to a long distance by the ocean current. The number of zoea stages varies from species to species of *Emerita*. The main predator of *Emerita* are fish, sea birds,

sometimes the fishermen use the sand crab as bait. The soft shelled mole crabs are used by the fisherman as food.

Different parameters also affect the life cycle of *Emerita asiatica*. The Dissolved Oxygen in sea water enhances the rate of reproductive activity. When observed high dissolved oxygen level in sea water, the females were more in intertidal zone [1]. Temperature also affects the reproductively of *Emerita asiatica*. High temperature of air and water also increase the number of females than male [2]. Like temperature and do the other physicochemical parameter also affect the reproductive behavior and population on beach.

Many research works on *Emerita analoga* and *Emerita asiatica* have been studied. The notable once are: Gunamalai [3], he has studied on the Vertebrate steroids and the control of female reproduction in two decapods crustaceans, *Emerita asiatica* and *Macrobrachium rosenbergii* in Madras coast, India. Sivakumar [1] has studied on Population density of *Emerita asiatica* in Relation to Oxygen Demand in the Kovalam Beach, East Coast, Kanchipuram District of Tamil Nadu, India. Yogamoorthi and Srikala [4] have studied on Evaluation of methanol extract of mole crab *Emerita asiatica* for its pathological properties using mouse assay from Pondicherry coast, India. Barnes and Wenner [5] have studied Seasonal variation in the sand crab *Emerita analoga* (decapoda, hippidae) in the Santa barbara area of California. Baskaran [6] have studied on the population density of *Emerita asiatica* in relation to carbonates and bicarbonates in the Kovalam Beach, East Coast, Kanchipuram District of Tamil Nadu, India. Sivakumar [2] have studied on the effect of temperature on the population of *Emerita asiatica* in the Kovalam beach, East coast, Tamil Nadu, India. Subramoniam [7] has reported on protandric hermaphroditism in a mole crab, *Emerita asiatica* in Marina beach, Madras coast, India. Ravindranath [8] have studied Effects of hydrogen ion concentration on the morphology of the hemocytes of the Mole crab *Emerita asiatica* in Madras beach, India. No work has been reported on the species of *Emerita asiatica* from Gopalpur coast of Odisha although this species is not economically important but it plays a vital role in the beach ecosystem. Hence, it is an attempt to study the population variation of mole crab in relation to water quality parameter of Gopalpur coast, East Coast of India.

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2. Experimental Methods

2.1 Sampling Location

Gopalpur is a village and beach-resort on the south Odisha coast of India which is 17 kilometer from Berhampur town and 30 kilometers from Rushikulya estuary. The study area is situated on the beach adjacent to Gopalpur village (Fig. 1). Gopalpur coast is an important marine resource of Odisha and also an important tourist spot. The seasonal climatic condition and oceanographic variations generally influence the fisheries. While determined by two monsoon periods, the powerful monsoon is south west, which effect from April to September with heavy rain fall and strong winds. The north east monsoon is fair weather season from October to March. Gopalpur is a small fisherman village lies on a four kilometers stretch of barren coast line with no mangrove or tropical forests. It is popular for beautiful sandy beach which is one of the best beaches of Odisha. The temperature ranges from 33 °C during summer to 17 °C during winter [9]. The region receives rainfall in both advance and retreat of southwest monsoon. Gopalpur has witnessed the notable and strong tropical storms in history including super cyclone of 1999 and cyclone Phailin of 2013, the latter hitting coast directly.



Fig. 1 Google image of Gopalpur coast showing latitude and longitude of study area

2.2 Sampling Periodicity and Sample Collection

The present study was aimed to assess the variation of water quality parameters in relation to mole crab species, *Emerita asiatica* along Gopalpur Coast, East coast of India. The hydrological and biological parameters were collected once on each month during the period of January, 2011 to December, 2012. In every field trips 3 numbers of samples was taken on every parameters and their average was calculated for more accuracy. A total of 24 surveys were carried out for the collection of samples during the day time on the sandy beach in and below the surf line. The mole crabs (sand crab) normally find the swash zone of coastal line where planktons are available. Normally no special gear or net were used to catch the mole crabs. The crabs were caught by hand with the help of container. The sample consists of *Emerita asiatica* of different size group (Figs. 2 and 3) from both sexes and the mole crabs were brought to laboratory with list disturbance in polythene bag with wet sand. Three types of crabs were collected such as male, female and ovigerous female for studying effects of physic- chemical parameter. Population study of mole crab was made randomly taking 10 meter × 10 meter plot are selected at the observation side. The starting two point of plot were parallel to the beach, where the wave actions end. The width of plot was 10 meter and marked. The same method was repeated for 10 plots. The average was calculated per plot from which the population of mole crab/day of beach was calculated. This process was repeated for each month for two years. The mole crabs were identified by using standard literatures such as Fernando & Fernando [10] and Barnes [11] etc. The analytical procedure for physico-chemical parameters were done in the Department of Marine Sciences, Berhampur University, Odisha by adopting APHA manual [12].



Fig. 2 Mole crab dorsal view and 3. Mole crab ventral view

3. Results and Discussion

3.1 Physico-Chemical Parameters

The present study is mainly focused on the seasonal variation of water quality and population of the mole crab species along the Gopalpur coast. Sea water temperature varied from 26.20 °C to 32.50 °C, pH 8.16 to 8.34, salinity 28.34 PSU to 32.53 PSU, dissolved oxygen 6.68 mg/L to 7.88 mg/L, nitrite 0.539 mg/L to 0.119 mg/L, nitrate 1.025 mg/L to 5.525 mg/L, phosphate 0.380 mg/L to 2.023 mg/L and turbidity 24.50 mg/L to 83.10 mg/L during the period of observation. The highest water temperature was being 32.20 °C during the month of May 2011.

The water temperature was the highest being 32.20 °C during the month of May 2011 and the lowest temperature was observed to be 26.20 °C during December 2011. The pH of sea water was maximum during the month of March 2012 being 8.34 and the minimum sea water pH was observed to be 8.16 during the month of October 2011. The amount of turbidity of sea water was highest being 83.10 mg/L during the month of October and the lowest value of turbidity was observed in the month of January 2011 being 24.50 mg/L. The salinity of sea water was highest i.e. 32.53 PSU during the month of May 2012. The salinity value of sea water was lowest being 28.34 PSU during the month of November 2011. The dissolved oxygen value was highest being 7.88 mg/L during the month of December 2012 and the lowest dissolved oxygen value was observed to be 6.68 mg/L during the month of July 2011. During the period of observation it was observed that the nitrite value of sea water was ranged from 0.539 to 0.119 mg/L. The lowest value of nitrite was found to be 0.119 mg/L in the month of December 2011 as compared to 2012 i.e. 0.123 mg/L and the highest value of nitrite was observed to be 0.539 mg/L on the month of April 2011 as compared to 2012. The present study showed the nitrate value ranged from 1.025 mg/L to 5.525 mg/L. Higher value of nitrate was in a range of 5.525 mg/L in the month of April 2012 as compared to the previous year and the lowest nitrate value was observed to be 1.103 mg/L during the month of December 2012. The highest phosphate value was observed to be 2.023 mg/L during the month of November 2012 and the lowest phosphate value was observed to be 0.380 mg/L in the month of June 2011.

3.2 Biological Factor

It was observed that less number of male *Emerita asiatica* was found as compared to the female and ovigerous female from the month of August to the month of December during 2011 and 2012. Similarly the male mole crab *Emerita asiatica* found more in number as compared to the female and ovigerous female from the month of February to June 2011 whereas during the 2012 the male mole crab *Emerita asiatica* found more in number as compared to the female and ovigerous female from the month of April to July, 2012.

3.3 Statistical Approach

The statistical approach was done among the mole crab species and environmental variables using SPSS software (17.0) and the results were interpreted in the text (Tables 1-4). The correlation coefficient showed that temperature, salinity, nitrite and nitrate was positive correlated with the population of male mole crab while turbidity showed a negative correlation with male population. On the other hand it was found that there was negative co-relation were made between salinity, nitrite, nitrate with female and ovigerous female population of *Emerita asiatica* while turbidity showed a positive correlation with female population. The other environmental variables were not shown such correlation with the mole crab species.

The physical and chemical properties of the coastal water and sediment of Gopalpur exert considerable influence on the organisms including benthic resource present along the coastal region. Among all the hydrological parameters temperature was consider as the most important critical environmental parameter influencing metabolism, growth, reproduction, distribution, and survival of organisms [13]. Temperature has a positive relationship with the spawning activity of most of the benthic organisms. Spawning activity increases with increase in the water temperature [14]. The sea water temperature varied from 26.20 °C to 32.50 °C during the period of observation. The study revealed that lowest sea water temperature was 26.36 °C on December 2012 which was higher as compared to the month of December 2011 i.e. 26.20 °C. From the statistical analysis the correlation between physico-chemical parameters and biological parameters it was observed that during the year of 2011, the air temperature was strongly correlated with water temperature, salinity and nitrate and it was strongly negative correlated with dissolved oxygen and phosphate. Whereas there is no such strong correlation were made with pH, turbidity and nitrite.

Table 1 Seasonal variation of physico-chemical parameter and population of mole crab (*Emerita asiatica*) from Gopalpur coast during 2011

MONTH	AT	WT	pH	Salinity	DO	Nitrite	Nitrate	PO ₄	Turbidity	Male No.	Female No.	O. F. No.
January	28.30	27.23	8.23	29.36	7.59	0.183	1.650	1.362	24.50	11	14	15
February	29.20	28.20	8.19	30.52	7.53	0.196	2.120	1.258	25.20	13	10	11
March	29.80	28.30	8.32	31.29	7.49	0.425	3.010	1.143	27.80	15	12	10
April	33.90	31.50	8.26	32.23	7.19	0.539	4.240	1.033	28.90	18	10	12
May	34.40	32.20	8.25	32.39	7.24	0.335	2.710	0.457	30.50	19	10	10
June	35.70	32.50	8.22	31.49	7.36	0.133	3.110	0.380	44.60	15	12	11
July	32.40	31.50	8.17	30.69	6.68	0.232	4.650	0.672	31.40	13	13	13
August	31.30	29.60	8.24	29.78	6.92	0.198	4.210	0.978	38.30	10	12	13
September	31.20	30.70	8.22	29.56	7.32	0.189	2.291	0.530	69.10	9	13	14
October	28.80	28.10	8.16	28.50	7.37	0.125	2.380	0.934	83.10	8	17	18
November	27.50	26.20	8.21	28.34	7.46	0.173	3.120	1.205	30.50	7	19	19
December	26.60	26.20	8.29	28.79	7.67	0.119	2.240	1.215	65.50	10	15	13

Table 2 Seasonal variation of physico-chemical parameter and population of mole crab (*Emerita asiatica*) from Gopalpur coast during 2012

MONTH	AT	WT	pH	Salinity	DO	Nitrite	Nitrate	PO ₄	Turbidity	Male	Female	Ovigerous Female
January	28.49	27.16	8.25	29.76	7.42	0.193	2.51	1.502	25.1	10	12	13
February	29.76	28.12	8.23	30.32	7.33	0.187	2.793	1.425	26.3	12	9	10
March	31.83	29.36	8.34	31.43	7.14	0.31	3.125	2.012	29.7	10	11	10
April	33.9	31.41	8.28	31.73	7.63	0.423	5.525	1.539	29.5	17	11	13
May	34.66	32.15	8.22	32.53	7.39	0.349	2.592	1.026	31.8	16	10	11
June	34.81	31.73	8.26	31.29	7.33	0.186	3.112	0.712	33.7	16	11	12
July	32.72	30.79	8.19	30.76	7.39	0.23	4.995	0.817	32.11	14	12	14
August	31.93	29.21	8.2	29.28	7.64	0.185	4.978	0.66	43.6	9	11	12
September	30.39	29.11	8.25	29.42	7.29	0.176	2.122	1.11	68.2	9	14	15
October	28.8	27.88	8.19	28.75	7.36	0.132	2.375	1.45	82.9	8	18	19
November	27.7	26.42	8.28	28.88	7.53	0.21	1.025	2.023	31.1	8	17	18
December	27.82	26.36	8.26	28.99	7.88	0.123	1.103	1.899	42.2	9	16	12

Abbreviation: AT: Air Temperature, WT: Water Temperature DO: Dissolved Oxygen PO₄: Phosphate, Male: Male mole crab Number, Female: Female mole crab Number Ovigerous Female : Ovigerous Female mole crab Number

Table 3 Correlation co-efficient of different physico-chemical parameter with population of mole crab (*Emerita asiatica*) during 2011

	AT	WT	pH	Salinity	DO	Nitrite	Nitrate	PO ₄	Turbidity	Male	Female	Ovigerous Female
AT	1											
WT	0.974**	1										
pH	-0.034	-0.117	1									
Salinity	0.824**	0.777**	0.308	1								
DO	-0.547	-0.625*	0.345	-0.307	1							
Nitrite	0.406	0.365	0.497	0.722**	-0.196	1						
Nitrate	0.501	0.492	-0.037	0.379	-0.846**	0.424	1					
PO ₄	-0.795**	-0.848**	0.21	-0.453	0.481	0.025	-0.265	1				
Turbidity	-0.215	-0.116	-0.213	-0.512	0.145	-0.498	-0.292	-0.244	1			
Male	0.727**	0.670*	0.371	0.972**	-0.184	0.724**	0.276	-0.344	-0.512	1		
Female	-0.653*	-0.654*	-0.278	-0.857**	0.251	-0.558	-0.21	0.294	0.431	-0.819**	1	
Ovigerous Female	-0.562	-0.544	-0.499	-0.831**	0.11	-0.476	-0.152	0.301	0.393	-0.816**	0.902**	1

Table 4 Correlation co-efficient of different physico-chemical parameter with population of mole crab (*Emerita asiatica*) during 2012

	AT	WT	pH	Salinity	DO	Nitrite	Nitrate	PO ₄	Turbidity	Male	Female	Ovigerous Female
AT	1											
WT	0.985**	1										
pH	-0.024	-0.095	1									
Salinity	0.852**	0.846**	0.240	1								
DO	-0.256	-0.307	-0.144	-0.347	1							
Nitrite	0.642*	0.642*	0.372	0.811**	-0.127	1						
Nitrate	0.659*	0.641*	-0.220	0.450	-0.017	0.508	1					
PO ₄	-0.616*	-0.630*	0.658*	-0.233	0.125	0.067	-0.528	1				
Turbidity	-0.268	-0.183	-0.388	-0.530	-0.061	-0.472	-0.215	-0.115	1			
Male	0.850**	0.859**	-0.009	0.872**	-0.087	0.672*	0.538	-0.420	-0.476	1		
Female	-0.675*	-0.624*	-0.069	-0.744**	0.294	-0.515	-0.568	0.425	0.633*	-0.650*	1	
Ovigerous Female	-0.451	-0.361	-0.275	-0.604*	0.066	-0.330	-0.274	0.142	0.623*	-0.438	0.842**	1

**Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Abbreviation: AT: Air Temperature, WT: Water Temperature DO: Dissolved Oxygen PO₄: Phosphate, Male: Male mole crab Number, Female: Female mole crab Number Ovigerous Female : Ovigerous Female mole crab Number.

Temperature fluctuation in the coastal region show marked temporal and spatial variation of species groups. Some organisms have a negative relationship with temperature, their reproduction, abundance decreases with increase of temperature gradient. From the biological point of view, the present study revealed that *Emerita asiatica* showed strongly positive correlated with air temperature whereas in case of female and ovigerous female it was strongly negative correlated. From the above observation it was concluded that when air temperature rises, the male population got increased which was divergence with female and ovigerous female population. So the present result is in agreement with the result of

Sivakumar [2]. They have studied the effect of temperature on the population of *Emerita asiatica* from the Kovalam beach, East Coast of India. This may be due to similar environmental condition in both the Gopalpur and Kovalam beach of India.

The pH of a water body is generally responsible for the growth, distribution and osmo-regulation of benthic organisms. The pH of Gopalpur coast varied from 8.16 to 8.34 during the study period. The present study showed that the pH of sea water was highest i.e. 8.34 as compared to the year of 2011. Similarly the lowest pH was observed to be 8.16 in the month of October, 2011 as compared to the year 2012. During

the present investigation, pH was not a limiting factor for the population curve. There was not such correlation was found between pH with other hydro biological factor. This may be due to current pattern and bathymetry of the location of Gopalpur.

The Salinity of sea water varied from 28.34 PSU to 32.53 PSU. During the two years of observation it was concluded that the highest salinity value of sea water was 32.53 PSU in the year 2012 as compared to the previous year. The statistical analysis showed a remarkable positive correlation with air temperature, water temperature, nitrite and with male population. The negative correlation was made with phosphate, turbidity along with female and ovigerous female population during the year of 2011. The similar pattern of correlation was seen during the year of 2012, among the physico-chemical and biological parameter. The salinity ranging from 28.34 PSU to 32.39 PSU is quite suitable for the availability of *Emerita asiatica* from Gopalpur coast. It was observed that salinity from 19.77 PSU to 35.00 PSU was ideal for abundance of *Penaeus indicus* seeds from Rushikulya estuary [15]. The hypo-saline condition may not be conducive for the availability of *Emerita asiatica*. But the hyper-saline condition is favorable for the abundance of *Emerita asiatica* from Gopalpur coast is in agreement with the result of Nayak [15].

Dissolved oxygen (DO) is the measure of the amount of gaseous oxygen dissolved in an aqueous solution. It is one of the most important parameters in aquatic life as it is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions [16]. The oxygen dissolved in water is a very important parameter in water analysis as it serves as an indicator of the physical, chemical and biological activities of the water body. Two main sources of dissolved oxygen are diffusion of oxygen from the air and photosynthetic activity. Oxygen is considered to be the major limiting factor for survival and growth of the aquatic organisms [17]. In the present study the DO value varied from 6.68 mg/L to 7.88 mg/L. It was found that the highest dissolved oxygen value was 7.88 mg/L in the month of December 2012 as compared to the previous year. It was found that dissolved oxygen showed negative correlation with air temperature, water temperature and nitrate during the year of 2011 but there was no significant correlation was made with the other physico-chemical and biological parameters. Similarly, in the year of 2012, there was no correlation was made with any of the above parameters.

The nitrite value of sea water was ranged from 0.539 to 0.119 mg/L. Nitrite showed a positively correlation with salinity and male population while it was negatively correlated with female population. During the 2 years of observation, it was observed that the nitrate of seawater was not correlated with any of the physico-chemical and except Dissolved oxygen. Dissolved oxygen showed a negative correlation with the nitrate value. The nitrate value showed positive correlation with the male population and negative correlation with the female population of *Emerita asiatica*.

During the study period it was found that the phosphate value was ranged from 0.380 mg/L to 2.023 mg/L during the period of observation. It was found that the highest phosphate value was observed to be 2.023 mg/L in the month of November 2012 and the lowest value was observed to be 0.380 mg/L in the month of June 2011 as compared to their consecutive year. The present investigation showed that there was no such correlation observed between phosphate and other hydro-biological parameter except temperature. Temperature showed a negative correlation with phosphate. The study showed no such correlation between phosphate and the population of *Emerita asiatica*. The high phosphate values were seen at the mouth of Rushikulya estuary and the availability of post larvae of penaeid prawn may related to the high phosphate value was observed [15]. But the high phosphate value is unfavourable for abundance of *Emerita asiatica* from Gopalpur coast [15].

The amount of turbidity varied from 24.50 mg/L to 83.10 mg/L during the two years of observation. It was concluded that the highest and lowest value of turbidity was found in the year 2011 as compared to 2012. From the statistical analysis it was observed that the turbidity showed a negative correlation with salinity and male *Emerita asiatica* population and positive correlation with female *Emerita asiatica* population.

The present study showed there was a less number of male *Emerita asiatica* found as compared to the female and ovigerous female from the month of August to the month of December during 2011 and 2012. Similarly the male mole crab *Emerita asiatica* found more in number as compared to the female and ovigerous female from the month of February

to June 2011 whereas during the 2012 the male mole crab *Emerita asiatica* found more in number as compared to the female and ovigerous female from the month of April to July, 2012. The same trend was observed by Sivakumar [2] which states that during the summer season (March – May), more number of males were found as compared to other months.

4. Conclusion

During the present investigation and on the basis of statistical analysis it was concluded that the male mole crab *Emerita asiatica* showed a positive correlation with air temperature, water temperature, salinity and nitrite value while negative with turbidity, female and ovigerous female *Emerita asiatica* population. Whereas, the female mole crab *Emerita asiatica* showed a positive trend with the above physico-chemical and biological parameters. It showed a positive correlation with only ovigerous female mole crab while negative correlation with air temperature, water temperature, salinity, nitrite and male mole crab population. Similarly, the same correlation was happened with ovigerous female mole crab population as like female mole crab.

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