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Impact of sand organic carbon and climatic changes on the population density and morphometric characters of *Emerita asiatica* in the East Coast of Southern India

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A population density of *Emerita asiatica* in relation to sand organic carbon in the Nemmeli beach, East coast, Kanchipuram District of Tamil Nadu was studied. Specimens were collected once in a fortnight from April 2017 to March 2018 by hand picking method in the intertidal region of Nemmeli beach. The total sand organic carbon level was recorded once in a fortnight. The population presented a smaller incidence of males in relation to females (48.66:51.34); however, in May 2017 an inverse pattern occurred (73:27). Ovigerous females were present in all samples with greater frequencies in October and November 2017 whereas, the highest juveniles were present in May and September 2017. The variation noted in a population of *Emerita asiatica* showed there is a relationship to sand organic carbon fluctuations; it can be determined that the sand organic carbon fluctuations have an influence on the population density of this species in Nemmeli beach. Hence, the rather stable sand organic carbon throughout the year and moderate changes in the sand may well be conducive to population biology of *Emerita asiatica*.

Keywords: *Emerita asiatica*, Population density, Sand organic carbon, Sex-ratio

The sandy shore environment is not a trouble-free place for organisms to exist. In contrasting the rock-strewn intertidal ecology, there is no hard substance on which to attach. Animals have to deal with crashing waves, altering tides, a beach that transforms seasonally, and oceanic and earthly predators. The flora and fauna which lives in this ecosystem are hidden in the sand. They all have adaptations that help them stay alive in the sandy beach environment. It is in this environmental unit that the sand crab can be found[1].

The newly recorded mole crab, *Emerita emeritus* from Chilka Lake acts as an important trophic link between producers and predators. Because, it feeds on planktonic materials, benthic algae and on the other hand it is grazed by shorebirds and predator fishes, shellfishes[2].

In spite of being the most extensive of coastal system worldwide, comprising three- quarters of the world is occupied by the shoreline ecosystem[3]. Although their low efficiency, sandy beaches harbor various marine fauna, which depends mostly on organic substance and debris brought in by waves. Platyhelminthes, harpacticoid copepods, nematodes, and oligochaetes overlook the meiofaunal grouping[4], while polychaetes, bivalve mollusks and crustaceans constitute the common macroinfaunal taxa[5]. Sandy coastal lines are along with the smallest amount productive as compared to further coastal ecosystems such as rocky shore, sub-tidal sediments and salt marshes[6]. In view of that uncovered sandy shores are one of the most comprehensive intertidal systems worldwide, in terms of both distribution and diversity, a good understanding of the reaction of organisms to perturbations, natural or manmade is crucial for suitable system management[7].

The zonal distribution of *Emerita emeritus* was reported that the smaller animals were found close to the soaring water altitude while the larger animals occurred next to the low water level. This pattern of distribution appeared to be caused by the differences in the nature of the substratum. At the low water level, the substratum is composed of coarse grain sand and at the high water level by the fine grain sand and has concluded that the distribution pattern of a species on a sandy beach could be influenced by various factors such as the nature of the substratum, period of exposure, availability of food, *etc*[8].

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From the foregoing accounts and also on the literature survey there are scanty reports on the population density of the sand crab *Emerita asiatica* with relation to sand organic carbon and also there are no reports for the past one decade on their population density in relation to severe climatic changes of the present day hence the present investigation has been undertaken to study the population density of *Emerita asiatica* in the Nemmeli beach.

Materials and Methods

The present study was conducted in Nemmeli beach 13º 06' N, 80º 24' E, located on the East Coast of Kanchipuram District, Tamil Nadu 42 kms away from Chennai. In order to determine the population density of *Emerita asiatica*, the sea shore was surveyed during the period of April 2017 to March 2018. Fieldwork was conducted once in a fortnight. A total of 24 surveys were carried out. Collections were made during the day-time on the sandy beaches in and below the surf line. Sand crabs were caught by hand. More than a hundred crabs were collected and brought to the laboratory with least disturbance in polythene bags containing wet sand. In the laboratory, males were identified by the presence of genital papillae at the base of the coxae of the fifth thoracic leg. Females were identified by the presence of three pair off pleopods, and they look like small threads on the underneath of the crab when the telson is raised[9,10].

A sample of sea shore sand collected from the Nemmeli beach was cleaned free from particles of hard shell. The sample was dried in sunlight. The sample was ground using a mortar and pestle. The sample was dried and ground again and was made to pass through a 0.5 mm screen. The analytical procedure for total sand organic carbon was estimated during the study period[11] and the significance level was calculated $P< 0.001$ for insignificant data, and also the data were confirmed statistically by using Statistical Package for the Social Sciences (SPSS, version 17) windows students' software.

Results and Discussion

The current investigation revealed some significant facts. During the study period the highest total sand organic carbon content (2.33 ± 0.226 mg/gm) was noticed in April 2017. Whereas the lowest was (1.16 ± 0.115 mg/gm) obtained in the month of December 2017 (Fig. 1 and Table. 1). During the study period totally 2886 crabs were collected: 1162 males (40.26%); 1238 females (42.89%); Among 1238 females 939 were ovigerous (75.84%) and 486 juveniles (16.83%). The highest abundance of males was recorded during April and May 2017. The maximum number of females were recorded during October and November 2017. It indicates that the level of total sand organic carbon content sustaining to increase the female population. Throughout the survey ovigerous females were collected, however, the greatest abundances were registered during October and November 2017. The highest percentage of juveniles was recorded during May and September 2017 represented graphically and tabulated (Fig. 2 and Table 2).

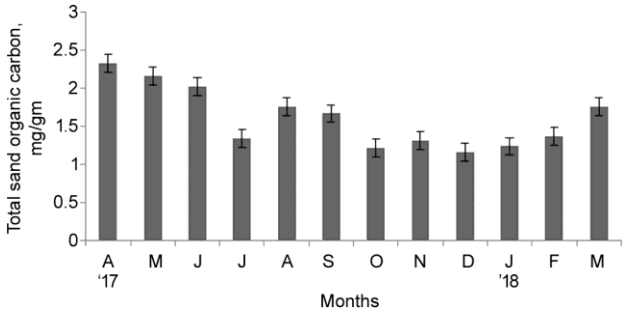

Fig. 1 — Level of Total Sand organic carbon in mg/gm of the study area from April 2017 to March 2018

Table 1 — Level of total sand organic carbon in (mg/g) of the study area from April 2017 to March 2018

Months	Total sand organic carbon
April'17	2.33±0.22
May'17	2.16±0.27
June'17	2.02±0.31
July'17	1.34±0.68
August'17	1.76±0.62
September'17	1.67±0.16
October'17	1.22±0.46
November'17	1.32±0.56
December'17	1.16±0.15
January'18	1.24±0.35
February'18	1.37±0.64
March'18	1.76±0.77

Values are expressed as mean ± SEM of 10 samples.

Among arthropods, attention has been focused primarily on a variety of shore crabs. Crustaceans although mainly aquatic are adapted to semi-terrestrial and land habitats; but they moreover move around to water for proliferation or clutch the spawn in a brood pouch borne on their bodies. Terrestrialization in crustaceans has been accompanied by a certain modification in physiology and performance of reproduction as well as premature development[12]. In crustacean, forms reproduction is either sporadic or rhythmic as seen in many populations of invertebrates[13].

Table 2 — Summarized population data of sand crabs in Nemmeli beach from April 2017 to March 2018

Months	Males	Females	Ovigerous	Juveniles
April'17	127±1.48	*73±1.03	*54±0.44	*34±0.68
May'17	145±1.08	*55±0.81	*38±1.87	*47±0.46
June'17	121±0.22	*79±1.30	*57±1.03	*39±0.60
July'17	106±1.25	*94±0.51	*67±1.30	*34±0.62
August'17	82±0.92	*118±0.91	*93±0.28	*45±0.56
September'17	76±1.41	*124±1.45	*104±0.47	*46±0.75
October'17	64±1.54	*136±1.68	*115±0.81	*38±0.46
November'17	59±1.77	*141±0.60	*122±0.46	*42±0.75
December'17	71±0.56	*129±1.26	*98±0.84	*44±0.44
January'18	78±0.81	*122±0.68	*96±0.51	*36±0.21
February'18	109±0.77	*91±0.92	*54±0.44	*42±0.53
March'18	124±1.45	*76±1.55	*41±0.72	*39±0.68
Total	1162	1238	939	486

Values are expressed as mean ± SEM of bimonthly collections *P< 0.001 **Insignificant.

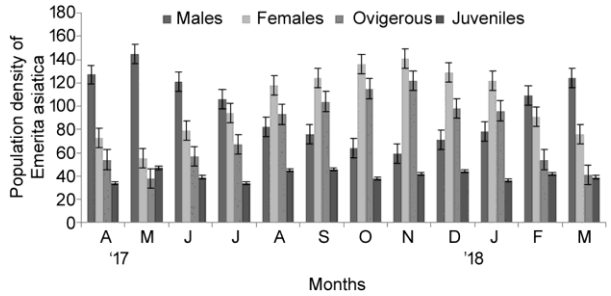

Fig. 2 — Population density of *Emerita asiatica* in the study area from April 2017 to March 2018

Sand organic carbon (SOC) is the carbon coupled through soil organic matter. Soil organic content is the organic fraction of the soil that is made up of decaying plant and animal resources as well as microbial organisms, however, does not consist of fresh and un-decomposed plant materials, such as straw and trash, lying on the soil surface. Sand organic carbon can moreover be present in inorganic forms, *e.g.* carbonates or lime in certain soils in the drier region. The organic substance is derived by plants by the way of photosynthesis, with water[14-16] and atmospheric carbon dioxide as raw materials. The plants and the animals as a part of the food chain ultimately die and come back to the sand where they are decayed and recycled. Mineral deposits are released into the sand and carbon dioxide reverse to the environment. There is a constant yield of organic carbon materials in the sand, and sand organic carbon is not a consistent matter but somewhat a composite blend of organic compounds at various phases of decomposition. Sand organic carbon is significant for all three feature of soil fertility, namely physical, chemical and biological fertility[17].

In general, the reproductive activity in many crustaceans with respect to temperature, salinity, rainfall dependant breeding activity of crustaceans was well documented[18]. In the present investigation heavy sand organic carbon 2.33±0.22, 2.16±0.27 and 2.02±0.31 is recorded in the months of April, May, and June 2017 respectively. During these periods a maximum number of male crabs are encountered because of the increase in sand organic carbon. When the organic carbon is low, the percentage of females are more, in contrast, when the organic carbon is high, the percentage of males are more. Likewise, the organic carbon variation in the sea is under the influence of monsoon rain from September to December and hence small sized females are more in these periods.

It has been reported that in the monsoon rains and salinity of the media influence the reproduction pattern in three crustaceans, *Uca annulipes, Portunus pelagicus*, and *Metanpenaeus affinis*[19]. The influence of rainfall on the reproductive activity in the fresh water crab, *Barytelphusa cunicularis* has been reported[20]. The importance of sea temperature for an improved reproductive pattern in marine invertebrates has been reported[21]. It has been described that in two species of *Scylla* of Pulicat Lake, the reproductive pattern is entirely based on the influence of temperature and salinity[22].

A number of authors have approved that many brachyurans confirm an increase in their size towards higher latitudes[23-25]. This is since in higher latitudes, abiotic (*e.g.* temperature, salinity, photoperiod and rainfall), and biotic (*e.g.* nutrient concentration and food availability,) are usually stable, support gonad development and larval release.

The egg production rate of the individual female of the crustaceans is a function due to temperature, body size and age, stage of the ovulation cycle and food

conditions[26]. Among various factors, temperature, food availability and reproductive condition of the female are considered to be the most important influencing factors in egg production[27]. The growth rate of *Acartia tonsa*, was reported to be lesser at 15°C when compared with 25°C[28]. Recently, two species from the Konkan coastal region of Maharashtra were studied for comparative analysis using different morphometric ratio as well as phylogenetic analysis with Cytochrome C Oxidase subunit I (COI) gene of Portunid crabs, *Portunus reticulatus* and *Portunus pelagicus* from the west coast of India[29].

During the present investigation, the maximum total sand organic carbon was recorded during in April 2017 whereas, the lowest was recorded in the month of December 2017. When the sand organic carbon content was high, the percentage of males was more. In April 2017, 64% males, 36% females, 74% ovigerous females and 14% juveniles were recorded. A reverse pattern occurred during the month of December 2017, 36% males, 64% females, 76% ovigerous females and 18% juveniles were recorded. Among the females the percentage of ovigerous females was more. It is a well-known fact that the sand organic carbon variation in the Nemmeli beach is under the human emissions of carbon dioxide level in sea water. In this present investigation the low sand organic carbon in the study area during December 2017, the females were very large and they can tolerate an only a narrow range of sand organic carbon.

Conclusion

The present study on the sand organic carbon of the study area showed higher values in the months of April and December 2017. In this period more males, females and juveniles have been recorded thereby suggesting the enhanced rate of reproductive activity. It indicates the sand organic carbon has created an impact on the population density of this species. The variation noted in population density of *Emerita asiatica* showed there is a relationship between sand organic carbon fluctuations; it can be concluded that sand organic carbon fluctuations have an influence on the population of this species in Nemmeli beach. Hence, the rather stable sand organic carbon throughout the year and moderate changes in sea shore may well be conducive to population biology of *Emerita asiatica*.

References

1 Ríos-Elósegui D, Hendrickx ME, Abundance, relative growth and fecundity of Emerita rathbunae Schmitt, 1935 (Decapoda, Anomura, Hippidae) in the S.E. Gulf of California, Mexico. *Crustaceana*, 88 (2015) 127.

2 Debashish M, Subodha KK, Surya KM, Bita M, Muduli PR, Ajith KP & Susanta N, First record of a burrowing mole crab *Emerita emeritus* (Decapoda: Anomura: Hippidae) from Chilika Lake, East coast of India. *Indian J Geo Mar Sci*, 47 (2018) 109.

3 Hamid A & Wardiatno Y, Population dynamics of the blue swimming crab (Portunus pelagicus Linnaeus, 1758) in Lasongko Bay, Central Buton, Indonesia. *AACL Bioflux*, 8 (2015) 729.

4 Hamid A, Wardiatno Y, Batu DTFL & Riani E, Fecundity and gonad maturity stages of ovigerous female blue swimming crab (Portunus pelagicus) in Lasongko bay, Southeast Sulawesi, Indonesia. *Bawal*, 7 (2015) 43.

5 Hamid A, Wardiatno Y, Batu DTFL & Riani E, Changes in proximate and fatty acids of the eggs during embryo development in the blue swimming crab, Portunus pelagicus (Linnaeus 1758) at Lasongko bay, Southeast Sulawesi, Indonesia. *Indian J Sci Tech*, 8 (2015b) 501.

6 Mashar A, Wardiatno Y, Boer M, Butet NA, Farajallah A & Ardika PU, First record of Albunea symmysta (Crustacea: Decapoda: Albuneidae) from Sumatra and Java, Indonesia. *AACL Bioflux*, 8 (2015) 611.

7 Qonita Y, Wardiatno Y & Butet NA, Morphological variation in three populations of the pill ark cockle, Anadara pilula (Mollusca: Bivalve) of Java, Indonesia. *AACL Bioflux*, 8 (2015) 556.

8 Santoso J, Hanifa YN, Indariani S, Wardiatno Y & Mashar A, Nutritional values of the Indonesian mole crab, Emerita emeritus: are they affected by processing methods?. *AACL Bioflux*, 8 (2015) 587.

9 Wahidah, Bin S, Omar SA, Trijuno DD & Nugroho E, Morphometric variance of South Sulawesi's freshwater prawn Macrobrachium rosenbergii and Macrobrachiumidae. *Int J Sci Res*, 5 (2015) 1.

10 Zairion, Wardiatno Y, Boer M & Fahrudin A, Reproductive biology of the blue swimming crab Portunus pelagicus (Brachyura: Portunidae) in east Lampung waters, Indonesia: fecundity and reproductive potential. *Trop Life Sci Res*, 26 (2015) 67.

11 Zairion, Wardiatno Y & Fahrudin A, Sexual maturity, reproductive pattern and spawning female population of the blue swimming crab, Portunus pelagicus (Brachyura: Portunidae) in east Lampung coastal waters, Indonesia. *Indian J Sci Tech*, 8 (2015) 596.

12 Sivakumar J, Nappinai B, Jayanthi J & Ragunathan MG, Population density of *Emerita asiatica* in relation to oxygen demand in the kovalam beach, East Coast, Kanchipuram district of Tamil Nadu, India. *J Modern Technol*, 3 (2014) 30.

13 Petrovskaya NB, Forbes E, Petrovskii SV & Walters KFA, Towards the Development of a More Accurate Monitoring Procedure for Invertebrate Populations, in the Presence of an Unknown Spatial Pattern of Population Distribution in the Field. *Insects*, 9 (2018) 29.

14 Prajapat P, Singh D, Tripathi S, Patel K, Abbas H & Patel A, Effect of water stress on antioxidative enzymes and glycine betaine content in drought tolerant and drought susceptible cotton (*Gossypium hirsutum* L.) genotypes. *Indian J Biochem Biophys*, 55 (2018) 198.

15 Singh VP, Srivasatava JP & Bansal R, Biochemical responses as stress indicator to water logging in pigeon pea (*Cajanus cajan* L.). *Indian J Biochem Biophys*, 54 (2017) 300.

16 Bavita A, Rashpal K & Navtej SB, Why and how putrescine modulates thermotolerance in Wheat?. *Indian J Biochem Biophys*, 55 (2018) 404.
17 Baskaran S, Sreenivasan M, Jayaprakash S, Jayaprakash J & Ragunathan MG, Population density of *Emerita asiatica* in relation to carbonates and bicarbonates in the Kovalam beach, East Coast, Kanchipuram district of Tamil Nadu, India. *J Modern Technol*, 3 (2014) 47.
18 Sivakumar J, Nappinai B, Jayanthi J & Ragunathan MG, Effect of temperature on the population of *Emerita asiatica* in the Kovalam beach, East coast, Tamil Nadu, India. *Indian J Pharm Bio Res*, 2 (2014) 26.
19 Sharma SD, Nayak L, Samantaray S & Pati MP, Temporal Variation of Mole Crab Species *Emerita asiatica* in Relation to Water Quality Along Gopalpur Coast, East coast of India. *J Environ Sci Pollut Res*, 2 (2016) 117.
20 Gillam KB, Examining the combined effects of dissolved oxygen, temperature, and body size on the physiological responses of a model macrobenthic polychaete species, Capitella teleta. (The University of Southern Mississippi) (2016).
21 Perello MM, Kane DD, Golnick P, Hughes MC, Thomas MA & Conroy JD, Effects of Local Weather Variation on Water-column Stratification and Hypoxia in the Western, Sandusky, and Central Basins of Lake Erie. *Water*, 9 (2017) 279.
22 Rakocinski CF & Gillam B, Temperature-modulated expression of allometric respiration strategies supports a metabolic scaling rule. *Front Mar Sci*, 4 (2017) 261.
23 Biddanda B, Global significance of the changing freshwater carbon cycle. *Eos*, 98 (2017) 15.
24 Falina A, Sarafanov A, Ozsoy E & Turuncoglu UT, Observed basin-wide propagation of Mediterranean water in the Black Sea. *J Geophys Res Oceans*, 122 (2017) 3141.
25 Michalak AM, Study role of climate change in extreme threats to water quality. *Nature*, 535 (2017) 349.
26 Steinman AD, Cardinale BJ, Munns Jr.WR, Ogdahl ME & Washburn E, Ecosystem services in the Great Lakes. *J Great Lakes Res*, 43 (2017) 168.
27 Weinke AD & Biddanda BA, From bacteria to fish: ecological consequences of seasonal hypoxia in a Great Lakes estuary. *Ecosystems*, 21 (2017) 1.
28 Montagna M, Haug JT, Strada L, Haug C, Felber M, Tintori A, Central nervous system and muscular bundles preserved in a 240 million year old giant bristletail (Archaeognatha: Machilidae) *Sci Rep*, 7 (2017) 46016
29 Vivek RV, Rajendran N & Lakara WS, Morphometric and phylogenetic analysis of Portunid crabs, *Portunus reticulatus* (Herbst, 1799) and *Portunus pelagicus* (Linnaeus, 1758) from the west coast of India. *Indian J Geo Mar Sci*, 47 (2018) 2094.