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Research Paper

A STUDY ON THE BURROWING PATTERN OF MOLE CRABS ALONG KOVALAM, SOUTH EAST COAST OF INDIA

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Abstract

Intertidal zone, being a very productive zone, hosts a variety of organisms that adapt to the ever fluctuating physico-chemical parameters. Sandy beaches are subjected to harsh environmental challenges that warrants structural and behavioral adaptations by the organisms inhabiting these ecosystems. The effective adaptations to these changing ecological attributes impacts on the richness and abundance of the species in a population. Mole crab, one such intertidal fauna, is adapted to such harsh fluctuations. Being burrowing in habit, their distribution on the sandy shores depend largely on various factors like the sand grain size, direction of the waves, the intensity of the waves, the slope factor and the size of the animal. Two mole crabs, *Albuneacarabus*and *Emerita analoga,* of the Kovalam coast, Tamilnaduwere investigated to study their burrowing pattern to understand the effects of the limiting factors on their distribution.

Key words: Mole crab, Burrowing pattern, wave action, swash zone.

INTRODUCTION

Sandy beaches are subjected to constant wave actions and often challenges the habitat of the intertidal organisms. Macrofauna species which inhabit exposed sandy beaches generally exhibit behavioral and morphological adaptations which allow them to withstand the harsh physical conditions (1).One such intertidal organism is the mole crab which has the ability to burrow into the sand.The abiotic and biotic factors, including sand grain size and parasite infection has a direct effect on the burrowing speed of these sandy crabs (2). The mole crabs have adapted to survive in a beach ecosystem. The ability to burrow rapidly in disturbed sediments of different grain sizes and to orient in surging swash is central to the success of individual species. The structure of intertidal macrofauna communities of exposed sandy beaches is believed to be controlled largely by physical processes such as wave and sediment dynamics (3). The slope of the beach and the wave action influences not only what type of organisms can inhabit that environment, but also their behavior in that environment.

MOLE CRAB

Mole crabs or "sand crabs" are decapod crustaceans belonging to the familyHippidae. These small animals burrow backwards into the sand and face the sea in the wash zone and use their antennae for filter feeding. Sand crabs are not distributed uniformly across a beach. Females are found lower in the intertidal zone than males. *Emerita analoga* and *Albuneacarabus* are two common mole crabs in the beaches of Chennai. On the beach, a mole crab spends most of its time buried below the sand in the swash region of the beach, with no trace of eyes or antenna showing (4). To investigate the effect of beach morphodynamics on the biology of *Emerita analoga* and*Albuneacarabus*, we compared the abundance, size, structure, burrowing abilities and swash behavior of the two common sand crabs. We hypothesized that the burrowing abilities and swash behavior of the hippoid crab could vary with size.The investigation was done in the swash zone of a fine reflective beach in Kovalam, situated 30 km south of Chennai.

Emerita analoga

Albuneacarabus

MATERIAL AND METHODS

The site of study, Kovalam (12°48'08.5"N 80°14'57.0"E), is a typical reflective beach with narrow swash zones. It is 1500m in length with a maximum width of 98m. Waves are of 1-3 ft in size. The beach is east facing provided with prevailing long shore currents in the SW direction in relation to wind direction. The site of study is a typical reflective beach with narrow swash zones with 1-2 ft size waves. Width of the swash zone was found to be 4-10m along with time intervals between average swash ranging from 4-8 seconds and a slope of 3°-5°. A range of sizes of the hippoid crabs (*Emerita analoga*and *Albuneacarabus*), from the intertidal zone of Kovalam Beach, were collected between November and March 2014- 2015, and classified as megalops(non-adults) and adults. Weekly samplings were carried out 1 to 2 hours before the afternoon low tide as mole crabs are present in abundance in the swash region at that time. Six transects were selected along the beach in areas with maximum aggregation of the crab covering an area of 122m. The crabs were mainly picked by hand at the time of backwash.

The burrowing time of 135 crabs with carapace length ranging from 5mm to 56 mm were taken out of their natural habitat and timed in a small glass cuboidal tank (5 x 5 x 18 cm) filled with 7cm deep sand and 8 cm of standing seawater on the surface. Individual crabs were dropped into the glass tank and were timed with a stopwatch from the initiation of burrowing (abdomen in contact with sediment, penetration of the substrate by fourth pereopods) to the disappearance of the carapace under the sediment surface or the end of digging behavior (respiratory tube formed, antennae still). Crabs were removed from the sand immediately after burrowing. Carapace length was measured with the help of a vernier caliper, wet mass was found with the help of an electronic weighing scale, burrowing depth measured after the crab stopped burrowing in the container, position of crab after it burrowed, the sex of each crab and the reproductive state of the female crabs(ovigerous and non-ovigerous) were recorded.

Burrowing rate index (BRI) was calculated for each crab (Brown and Trueman,1994).

BRI = Wet mass (g) /Burrowing time (s) X 100

RESULTS

The sizes (CL) of individuals used in burrowing trials formed a continuous size distribution with some overlap in size between the two species: *Albuneacarabus*ranged from 21.3 to 55.5 mm CL, and *Emerita analoga*from 5.0 to 56.1 mm CL. The average carapace length of *E. analoga* was found to be 41.1 mm and *A. carabus* was 26.8 mm

The behavior of each crab from the release point to the burrowing position are:

(1) Swimming in the water column,
(2) Sliding in contact with the substrate,
(3) Tumbling across the substrate, and
(4) Orienting, pivoting to a head down current position in contact with the sediments.

The point where the crabs burrowed was noted and the sand above the crab was removed in order to observe the position it burrowed in.

Table 1. Burrowing time of *E. analoga*

Size distribution	No. of crabs	Burrowing time (s)	Wet mass (g)
27-30	6	0.9-20.1	2-5
30-33	3	0.5-15.1	3-6
33-36	4	1.1-16.0	2-7
36-39	9	1.0-11.2	3-7
39-42	12	0.8-14.2	4-8
42-45	24	0.6-12.4	5-8
45-48	32	1.5-10.3	5-10
48-51	7	1.4-13.1	5-11
51-54	6	1.2-5.2	6-10
54-57	5	1.1-3.6	8-12

The fastest burrowing time observed for *Emerita analoga* was 0.3 s and the slowest burrowing time observed in the laboratory was 20.1 s. In the case of *A. carabus,* fastest burrowing time recorded was 2.2 s while the slowest was 10.5s. Burrowing time did not vary with carapace length and mass in *E. analoga.* A similar trend was seen in *A. carabus*. The burrowing rate index (BRI) did not consistently remove the effect of size for use in interspecific comparisons of burrowing ability of crabs. For *Emerita analoga*and *Albuneacarabus*, BRI varied significantly with crab size.

Table 2. Burrowing time of *A. carabus*

Size distribution	No. of crabs	Burrowing time (s)	Wet mass (g)
27-30	2	0.9-20.1	2.5
30-33	3	0.5-15.1	3.5
33-36	4	1.1-16.0	3.6
36-39	1	1.0-11.2	5
39-42	4	0.8-14.2	5.4
42-45	2	0.6-12.4	4.5
45-48	3	1.5-10.3	7.5
48-51	2	1.4-13.1	8
51-54	1	1.2-5.2	8
54-57	0	0	0

Most crabs chose to burrow almost immediately while some crabs swam around before initiating burrowing. The net movement of all crabs released in the swash zone was generally seaward and to the NE with the longshore current. (Fig. 1)

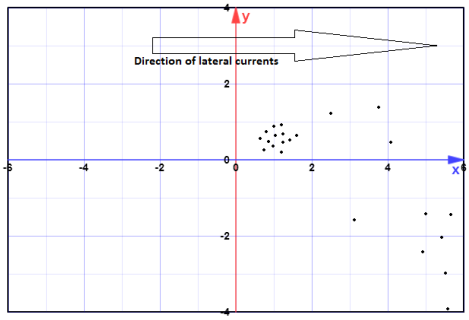

Fig. 1. Movement of the crabs of release for burrowing.

In general, *E. analoga*moved the shortest distance (m) from the release point prior to burrowing compared to *A. carabus*which moved the greatest distance from the release point before burrowing successfully. Burrowing times in field conditions were longer than in the laboratory for *A. carabus*. Burrowing times in the field showed little significance with carapace length for *both A. carabus*and *E. analoga*. The proportion of individuals that reached the substrate and burrowed successfully in times less than or equal to the average swash period (6.2 s) varied among the two species. The majority of *Emerita analoga*individuals reached the substrate and burrowed in times less than or equal to the swash period. A few individuals tumbled or drifted passively in the water. Most of the individuals burrowed faster than the average swash period in *A. carabus.* However, majority of the mole crabs were seen tumbling or drifting passively in the water before successfully initiating burrowing. Almost all crabs burrowed upto a depth of 2.5cm or less.

DISCUSSION

The two species of crabs investigated in this study were active and rapid burrowers in the glass tank and in the swash zone. Alternatively, larger individuals could be sufficiently strong to dig deep enough to avoid hydrodynamic conditions in the swash. *E. analoga* aggregations found on the swash zone mostly consisted of juveniles and a few adults. Adults live outside these aggregations (5).Among the specimens collected, it is noted that the number of females is drastically higher than the number of males (Out of the 108 crabs collected, 84 of them were females). Time taken to burrow completely into the sand, (i.e., disappearance of the carapace under the sediment surface or the end of digging behavior where respiratory tube is formed, and antennae is still) varied with carapace length. Some crabs with carapace length of 54mm buried in less than 2.1s while some crabs measuring 26mm burrowed in 14s in swash zones with average swash period as 6.2s. *Emerita analoga*'s larger telson and tail fan in comparison to *A. carabus*species contributes to its ability to burrow well in a variety of sand grain sizes as a substrate generalist (6).

The sand grain size perhaps, plays a major role in the burrowing abilities of the mole crabs. Samples taken at the site of study showed that mean grain size varied from 0.24mm up to a depth of 2 cm and increased up to 1.46mm for several inches. Sand crabs that were used in the field burrowed no more than 2.5cm in depth. The crab burrows under the soil and positions itself close to the surface in order to emerge with the next uprush of water.Field studies indicate that there are three components that appeared to be important for crabs inhabiting the swash zone: pre-burrowing time and behavior (e.g., orientation and movement before contact is made with the benthic substrate) and burrowing time. Swash climates are generally closely related to the morphodynamic state of the beach (7,8). In conclusion, we were able to see that mole crabs are capable of burrowing rapidly into the sand and that *E. analoga* burrows at a much faster rate compared to *A.carabus.*

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