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Reproductive Strategy in Hermit Crabs of Vellar Estuary

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Clibanarius longitarsus was found to breed over an extended period of the year from March through October with 2 distinct peaks. Breeding in *C. padavensis* was between March and September with a single peak. Even though *C. olivaceus* and *Diogenes avarus* were found to breed throughout the year, reproductive activity during monsoon months was restricted. Two breeding periods were observed in *Coenobita cavipes* with quiescent periods in between. Reduced salinity with sparse distribution of planktonic food for the larvae during monsoon seemed to restrict breeding in estuarine hermit crabs, and higher saline conditions with plenty of planktonic food for the larvae appeared to be favourable for breeding activity in them. But *C. cavipes* was found to breed in the months of reduced salinity. Different peak periods of breeding among these, whose larval stages are released into the same environment, appeared to be timed so as to maximize the survival rate of larvae and to prevent high mortality of larvae due to competition between them for food and shells.

Studies on breeding in tropical marine invertebrates strongly point to the fact that it is salinity and not temperature which influences breeding in them[1-3], thus invalidating the notion by Semper[4] and Orton[5] that in tropics where seasonal temperature extremes are least pronounced, reproduction occurs throughout the year. It is apparent from these studies that the planktonic larvae of these organisms will have a better chance of survival if released at a time of favourable environmental conditions. Higher saline conditions with plenty of planktonic food for the larvae were found to be favourable for their breeding. While a lot of work has been done on other animal groups, there is paucity of information on the reproductive strategy in tropical marine hermit crabs[1]. In the present study reproductive cycle in 4 species of estuarine hermit crabs, viz. *Clibanarius longitarsus*, *C. padavensis*, *C. olivaceus* and *Diogenes avarus* occurring in Vellar estuary (lat. 11°29'N and long. 79°46'E) and 1 species of land hermit crab *Coenobita cavipes* which occurs in large numbers on the banks of the estuary and hatch off the larvae in the estuary has been investigated.

Materials and Methods

Giese[6], while reviewing the methodology employed for studying the annual reproductive cycles of marine invertebrates, pointed out the futility of following any one method to determine the annual cycle and suggested combining effectively 2 or more methods. This has been followed in the present study. The reproductive condition of the population of each species in different months is expressed in terms of percentage of berried females found among the total number of females observed and this was plotted against time to indicate the breeding period. In lean months some hermit crabs were sacrificed and the reproductive condition of the gonad was noted. This method was found to be ideal for hermit crabs and has an advantage in that, a large number of crabs could be observed without being killed.

In hermit crabs the period of incubation of eggs after oviposition was found to last for 15 to 20 days. So, fortnightly collections were made regularly during low tide. As *C. cavipes* is nocturnal it was collected only during night. The animals were brought to the laboratory and the shells alone were carefully cracked with the help of a mechanical vice. After observation the animals were provided alternate shells and were let off in the same area from where they were collected. In lean season, 10 females were sacrificed every month to note the reproductive condition of the ovary.

Results

Clibanarius longitarsus—The annual reproductive cycle of this crab was studied for 19 months (July 1975 to Jan. 1977). The reproductive cycle of this animal was also studied by the gonad index method, following the formula given by Farmanfarmaian *et al.*[7] for 1 yr (Dec. 1975 to Nov. 1976).

$$\text{Gonad index} = \frac{\text{Wt of the gonad}}{\text{Wt of the animal}} \times 100$$

Breeding in this animal (Fig. 1) extended from March to October with 2 distinct peak periods, one in postmonsoon (February-April) and the other in premonsoon (July-September). Breeding activity during premonsoon appeared to be very intense compared to the postmonsoon. From Nov. 1975 to

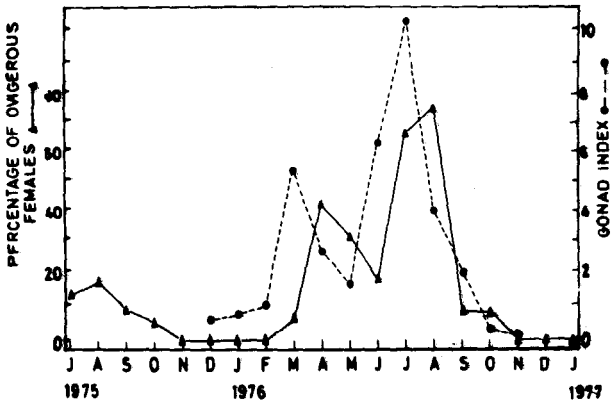


Fig. 1—Annual reproductive cycle of *C. longitarsus*

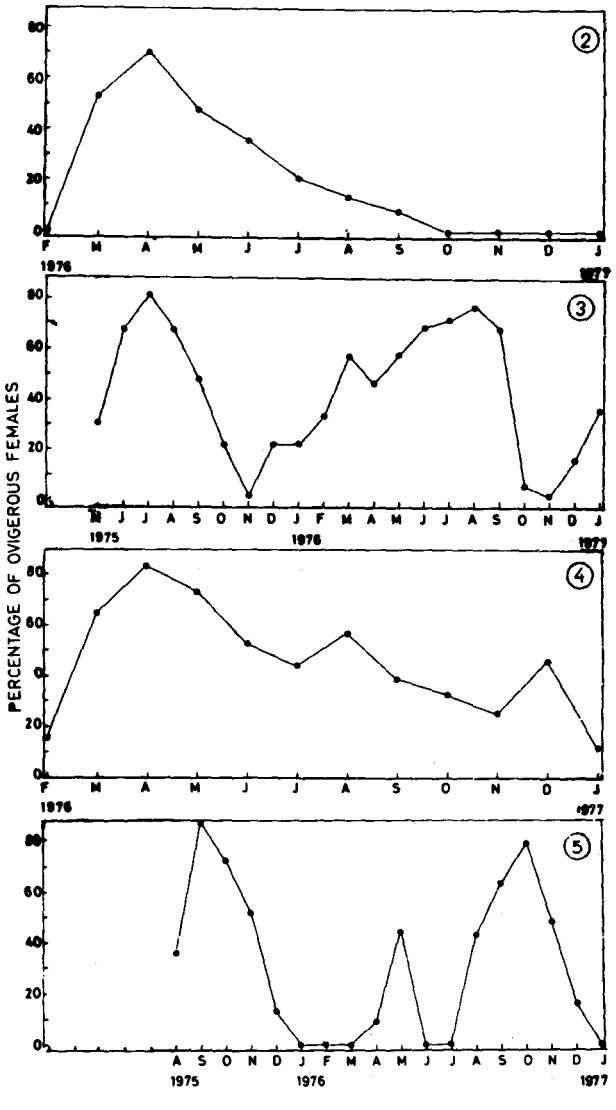
Feb. 1976, not even a single ovigerous female could be collected and this period appeared to be the quiescent period for this crab.

The gonad index also showed 2 peaks, one in March 1976 and another in July 1976. During Dec. 1975 and Jan. 1976, the index was lowest and during this period not even a single female among 10 sacrificed each month showed ovarian development. After Feb. 1976, the ovarian development started (3 out of 10 showed ovarian development). From March 1976 to Sept. 1976 ovarian development could be followed in most of the animals. Again in Oct. and Nov. 1976 ovarian development was very poor. The incidence of ovigerous females was thus found to coincide very well with the findings on the gonadial index. The gonad index showed a peak in March followed by the occurrence of berried females in April; similarly the 2nd peak in gonad index was in July, followed by berried females in August. Thus by plotting the percentage of ovigerous females against time, the annual reproductive cycle could be studied in this crab. When there were no berried females, few crabs were sacrificed to check on their ovarian development because of the possibility of ovarian development taking place in all the months of the year though breeding, oviposition and larval spawning do not seem to take place during this period. So in others, specimens were sacrificed only during lean months.

C. padavensis—Annual reproductive cycle of this species was studied from Feb. 1976 to Jan. 1977. The breeding season in this crab (Fig. 2) was the shortest among the 4 estuarine hermit crabs studied, extending from March to September, with a single distinct peak in April when 70% of the females were found to be berried. From October to February not even a single ovigerous female could be collected though normal ovarian development could be noted in the animals sacrificed during all these months.

C. olivaceus—The annual reproductive cycle of this species was studied for 21 months (May 1975 to Jan. 1977). This species was found to breed throughout the year (Fig. 3). Two distinct peak periods are evident one in postmonsoon and the other in premonsoon. The peak in premonsoon was more pronounced than the peak in postmonsoon. Even though ovarian development was noticed in almost all the specimens examined during monsoon (October-December) the incidence of berried females was low at this time.

Diogenes avarus—Reproductive cycle in this crab, studied from Feb. 1976 to Jan. 1977, showed that just as *C. olivaceus*, this species is also a continuous breeder but with 3 distinct peaks (Fig. 4). The 1st peak occurred in April, the 2nd in August and the 3rd at the end of monsoon in December. Among the 3 peaks, the 1st was more pronounced and the 3rd least pronounced. Even though ovarian development was noticed in all the crabs during monsoon months the incidence of ovigerous females was in general low during these months.



Figs 2 to 5—Annual reproductive cycle of *C. padavensis* (2), *C. olivaceus* (3), *D. avarus* (4) and *C. cavipes* (5)

Coenobita cavipes—Annual reproductive cycle of this land hermit crab was studied for 18 months (Aug. 1975 to Jan. 1977). The reproductive cycle differed sharply from the other 4 species. Two breeding periods are distinct during summer and monsoon seasons with 2 quiescent periods in between, during postmonsoon and premonsoon (Fig. 5). The 1st breeding season extended only for a brief period (April and May) but the 2nd breeding season was an extended one (August-December). During nonbreeding months ovarian development could not be noticed in this species.

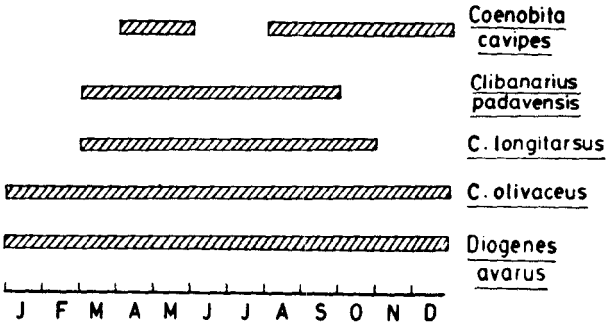


Fig. 6—Breeding patterns in hermit crabs

Discussion

The present study on the annual reproductive cycles in 4 estuarine and 1 land hermit crabs showed interesting results. Breeding was continuous (Fig. 6) in 2 species (*C. olivaceus* and *D. avarus*), extended in 2 species (*C. longitarsus* and *C. padavensis*) and discontinuous in 1 species (*C. cavipes*). Breeding periods in the estuarine hermit crabs were generally in the dry months of the year, but in the land hermit crab the breeding was confined to summer and monsoon months.

Pillay and Nair[2] and Ajmal Khan and Natarajan[3], who discussed the role of environmental factors on breeding in tropical marine invertebrates, correlated breeding with changes in salinity. Reduced salinity can affect ovarian development[3], embryonic development[8,9] and larval development[9-13] *in toto* or a particular aspect of it. In the present study, during monsoon no ovarian development was found in *C. longitarsus*, in *C. padavensis* even though there was ovarian development no oviposition took place, in *C. olivaceus* and *D. avarus* even though oviposition took place, the activity was in general low and in *C. cavipes*, berried animals were found only during these months. It will be worthwhile to investigate the role of salinity on these 3 aspects in the 4 estuarine hermit crabs and on the larval development of the land hermit crab *C. cavipes*, as ovarian development and embryonic development in this crab take place on land itself and it comes in contact with water only to hatch off the larvae.

Differences in breeding pattern among hermit crabs inhabiting the same environment or among hermit crabs which release the larvae in the same environment will serve to increase the survival rate of these larvae by preventing the planktotropic larvae coming into direct competition with each other for food[1,14,15]. Also hermit crabs depend on empty gastropod shells for their survival and sympatric species frequently overlap greatly in their use of shells. The degree of overlap is greater in young crabs of similar size[15]. Moreover the post larval stage-glaucothoe will not moult to juvenile instar unless it enters an empty gastropod shell[15,16]. In the absence of suitable empty gastropod shell they will have to perish and so there will be competition among them for shell occupation. However, it will be reduced if they use the shells sequentially, with different species using the same shells at different times of the year[15]. In Hawaiian waters the bimodal pattern of breeding in *Calicinus latens* and *C. laevimanus* was suggested as an adaptation to prevent the planktotrophic larvae of both species coming into direct competition with each other[1]. In Christmas Bay, *Clibanarius vittatus* was found to breed during the warmer months of the year, and *Pagurus longicarpus* and *P. pollicaris* during the winter when the salinity reached a minimum of $8^{o}/_{oo}$[14]. Fotheringham and Bagnall[15] suggested that these 3 pagurid crabs had developed seasonal breeding pattern which seem to aim at maximizing the potential survival of the larvae. The apparent disadvantage of winter breeding season in *P. longicarpus* and *P. pollicaris* may be offset by a reduction in the density of predators, competitors and by an increased availability of small shells due to winter mortality of young snails. In the present study, the 4 species of estuarine hermit crabs were found to breed during the dry months of the year when the ambient water salinity was high with lush plankton production. Probably to avoid direct competition with the larvae of the above four species for food and shells, *C. cavipes*, the land hermit crab, breeds during monsoon months. Experimental work done on the lines suggested above and on the shell selection behaviour of the glaucothoe larvae of all these 5 species of hermit crabs will facilitate better understanding of the reproductive strategy of these hermit crabs.

Acknowledgement

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