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Short Communication

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Burrowing habits in juveniles of marine prawn *Metapenaeus dobsoni* (Crustacea : Decapoda)

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Juveniles of *M.dobsoni* revealed an intrinsic circadian rhythm, burrowing to rest quietly in day and moving actively at night, and the schedule of changing over the phase is sunrise and sunset. The intensity of light is the prime factor stimulating burrowing habit that the juveniles would burrow on subjected to light in night and emerge to move actively under reduced light in day. Several factors, such as, cloudiness, temperature, salinity and availability of food interrupt burrowing. The critical temperature limits are 18-32°C and below 10°C is fatal. The juveniles measuring <25 mm size have no response to light and do not burrow as larger ones.

The organisms inhabiting the coastal tidal zone are constantly exposed to the cyclic environmental changes of the day and night, that make it imperative that the animals do adapt certain intrinsic habits to cope with the dynamic conditions. One of the proven in-built habits among the penaeid prawns is the burrowing behaviour.[1-3] Culture fishery of prawns has been the fast developing field for its lucrative yield. The juvenile phase of the penaeid species is reared in culture pond, where it would need the living conditions more suitable to the natural habits for increasing productions. It necessitates more and more studies on natural habits in different species under varied conditions. *Metapenaeus dobsoni* (Crustacea : Decapoda) is a typical penaeid species and its juveniles inhabit the estuaries and backwaters in large abundance along the southern region of India. The present study is on burrowing habits of juveniles of the species in response to certain environmental and biotic factors.

Juveniles of *Metapenaeus dobsoni* (15-50 mm length) netted from Adyar estuary and reared in the laboratory were used in varied experiments. Normal medium of rearing was the diluted seawater to the salinity level of 15-18 ppt. The medium was aerated throughout and animals were not fed, except for feeding experiments. One experimental tank, which was kept inside a thatched shed enclosed with bamboo meshes and another tank in the adjacent verandah with one side open to the glaring sunlight at an acute angle, received slightly different intensity of light. The tanks were filled with about 200 liters of medium giving the water column of about 20 cm and a substratum of 6-8 cm deep beach sand. A batch of 25 juveniles (15-50 mm TL) was introduced into the tanks and the animals sighted over the sand surface during the day and night were counted and their size recorded at time intervals during the next two days of introduction. The experiment was repeated after a week on a different set of juveniles and the average values of the four days of observations were considered. The tank kept inside the shed was also used without substratum for observations on behaviour of the juveniles under daylight situations and in relation to feeding response.

In a glass trough with about 20 cm deep of water medium and 4-5 cm deep sand substratum, 10 juveniles (25-50 cm TL) were introduced and swirling with hand a fast water current was created. The changes in positions of the animals in relation to the current were then noted.

Burrowing habit—Juveniles of *M.dobsoni* burrowed under the sand substratum on exposure to light, but the young ones <25 mm TL had no response to light and not burrowed as larger ones. Juveniles introduced into a glass tank having one half with sand substrate and another half without substrate preferred in daylight to burrow in sand substrate 19 out of 20 times than resting upon the hard bottom. In total absence of substrate, the juveniles were resting quietly, preferably over the black border of the tank bottom, under bright light. When the water current was created in a trough, the freely moving animals in it burrowed quickly and faced the direction of the current.

Diurnal rhythm—The juveniles (25-50 mm TL) revealed a circadian rhythm of burrowing habit. They were actively moving around at night and burrowing under the substrate or resting quietly over the hard bottom during the day. These natural diurnal habits were reversed, when the animals were subjected to darkness in day and artificial illumination at night. The transit time of normal day-night cyclic habits coincided with the sunset and sunrise (Table 1) under natural conditions. The minor variation in intensity of light between the experimental tanks kept in verandah and inside the shed influenced on the number of juveniles having emerged or burrowed (Table 1) during the day and also with reference to the time around sunset and sunrise. For total emergence on a clear day, the animals inside the shed required 5 minutes after the sunset, as against 26 minutes in verandah. Also, the juveniles started emerging from 90 minutes before the scheduled sunset inside the shed, as against 5 minutes in verandah. Similarly, the juveniles burrowed earlier in verandah than in the shed before the sunrise. Over 50% of the animals could emerge inside the shed, as against the maximum of 15% in verandah, under reduced daylight during cloudy or rainy condition. However, 100% emergence occurred only after sunset on any day in both tanks.

Feeding and burrowing habits—Availability of food disrupted burrowing among the juveniles. They emerged within a period of 1-30 minutes (Table 2) since the introduction of pieces of prawn meat into the tank. Smaller animals responded earlier to emerge and also stayed longer consuming the food for a maximum of 90 minutes. The reaction in response to food was quicker to be visible among the animals in the tank without substratum. Even to a few drops of the solutes of crushed prawn muscle, the animals resting on the hard bottom responded immediately moving the antennae and started wandering erratically in search of any food.

Temperature and burrowing habits—The normal burrowing behaviour among the juveniles was maintained only within the temperature limits of 18-32°C. The temperature of the water and the sand substratum in an experimental glass trough, which was placed over a warm cement surface exposing to direct sun light around noon, substantially increased with minor variations due to different conductivity of heat. The water temperature was first to increase, but gradually absorbing the heat from the cement surface, the temperature of the sand substrate at bottom also increased and exceeded that of water. The animals already present in the trough burrowed normally until the water temperature touched 32°C, beyond which abrupt changes in burrowing behaviour were noticed. As the water temperature exceeded 32°C, the animals burrowed deeper than normal depth and remained under the sand substrate until its temperature increased to 34°C. They emerged then from the substrate even though the water temperature was then still higher and swam restlessly for a short period before settling quietly over the thin and faint shadow of the vertical glass wall falling on the sand substratum. The temperatures of the water and substrate increased meanwhile to the maximum of 38°C and 39°C, respectively. Even on repeated disturbance to drive away from the shadow area, the juveniles returned every time to the same shadow area to rest as before.

Table 1—Diurnal variations of frequency and size-range of *M.dobsoni* deburrowed or free-moving on a clear day

Time (hrs)	In 'shed'		In 'verandah'	
	Deburrowed (%)	Size-range (mm)	Deburrowed (%)	Size-range (mm)
1300	nil	nil	nil	nil
1500	nil	nil	nil	nil
1630	5	25-30	nil	nil
1700	26	25-35	3	25-30
1730	33	25-40	6	25-35
1800	40	25-45	13	25-40
1830	89	25-45	15	25-40
(Sun-set at 1836 hrs.)				
1840	100	25-50	44	25-45
1900	100	25-50	100	25-50
2000	100	25-50	100	25-50
2200	100	25-50	100	25-50
2400	100	25-50	100	25-50
0030	100	25-50	100	25-50
0050	100	25-45	100	25-50
0060	82	25-40	94	25-45
0630	42	25-40	82	25-45
(Sun-rise at 0635 hrs.)				
0640	12	25-40	58	25-40
0700	3	25-35	10	25-35
0730	nil	nil	8	25-35
0830	nil	nil	nil	nil
1000	nil	nil	nil	nil

Table 2—Frequency of deburrowed juveniles at sequences of time intervals since placement of food, size-range and duration of consumption of food

Time-interval (minutes)	Deburrowed (%)	Size-range (mm)	Food consumption (minutes)
0	nil	Introduction of food	—
0-5	12	25-35	30-90
6-10	28	30-45	20-65
11-20	65	30-50	15-30
21-30	100	40-50	5-30

Response to temperature was also noted to be quick. When the animals conditioned at 28-30°C were released into the trough with higher temperature of water at 34°C and substrate at 37°C, they burrowed instantly sensing first the higher temperature of the water. However, they emerged immediately on feeling still higher temperature of the sand substratum and settled on the shadow area after restless swimming for a while as described.

The water temperature in the trough was gradually reduced by addition of ice-cold medium water on a clear day. The animals, which were already in burrow inside the trough, emerged when the temperature of the medium decreased below 18°C. They fell on their sides and drifted along with the current on further decrease below 15°C. Exposure to <10°C over 10 minutes was lethal for the young juveniles of about 25 mm size.

Salinity and burrowing habit—Salinity was not an effective controlling factor, as temperature was, on burrowing behavior of the juveniles. Animals did burrow in higher salinity of undiluted seawater (34-35 ppt) and very low salinity (< 5 ppt), though the deviation from normal habits increased against extremes of salinity. About 50% of the specimens emerged even on exposure to clear daylight within 15 minutes since the salinity was changed outside the range of 10-30 ppt, but burrowed again in less than an hour.

The intrinsic diurnal cycle, being active under darkness at night and resting quietly under the substratum in daylight, observed in the juveniles of *M.dobsoni* have also been reported for several other species of penaeids[1,4-6]. Burrowing habit in daylight has obviously evolved as an adaptation to hide from the predators and also to protect from the rising temperature. The change of phase of emergence and burrowing cycle of the day coincides respectively with the sunset and sunrise regardless of the prevailing intensity of light. The time lag between the total emergence of juveniles and sunset is 5-26 minutes under the present experimental conditions and it is noted to be 20-30 minutes for *Penaeus duorarum*[5] and *P.semisulcatus*[9] has been observed to emerge at 1900 hrs and burrow at 0600 hrs. Negative response to burrowing habits among the juveniles of < 25 mm size and quicker response among smaller animals to emerge could indicate the gradual acquisition of burrowing behavior as the animals grow in size. Fuss & Ogren[2] have similar observation that the young juveniles of *Penaeus duorarum* of < 55 mm size are not burrowing like the larger ones even though exposed to bright light. Higher sensitivity to light among larger juveniles is also evident from their late emergence after sunset when more of light would diminish. Garcia & Le Reste[7] have reported in this context that higher concentration of larger juveniles occurring at the deeper zones of the backwaters is because they are more sensitive to higher light penetration in shallow grounds and so move away to darker zones. Juveniles prefer to burrow under substratum than to rest upon the hard bottom and that implies suitable substrate rquired for normal burrowing activity. Aziz & Greenwood[1] have found preference of *Metapenaeus bennettae* to silt and fine sand among different kinds of substrates.

The juveniles maintain normal burrowing habits within the temperature range of 18-32°C and deviations outside 15-34°C lead to distress. Similarly the critical temperature limits for *P.duorarum* have been observed to be 14-34°C[4]. The critical temperature limit is also apparently the prime factor for varying magnitudes of abundance of *M.dobsoni* along the north-south axis of the country. The species is rare along the colder northern regions, while it occurs in very large abundance along the warmer southern regions of the country.

Even extreme ranges of salinity do not disrupt the burrowing activity of the juveniles. Such uninterrupted burrowing habits in a wide range of salinity have been necessarily developed to withstand extreme salinity fluctuations that the juveniles would be exposed due to constant tidal changes and freshwater flooding. Agreeing to the limited role of salinity, Gunter[6] has reported that higher salinity has no consequences on the juvenile distribution of penaeids and Zein-Eldin[11] have held that the salinity *per se* might not play the direct role on growth and survival of the juveniles of *P.setiferus* in estuarine environment. Burrowing and facing the water current appears an adaptation of resistance among juveniles from being drifted away in natural waters. Fuss & Ogren[4] have observed in further details that the prawns would increase the resistance against the current by decreasing the burrowing angle to the current axis.

The experiments thus indicate that an inherent circadian rhythm, burrowing to rest quietly in day and active at night, has been the normal way of juvenile life and several factors would interfere with these natural habits. Since any disruptions of normal behavior of the rearing animals in culture fishery are likely to impede growth performance and the yield, it is imperative to simulate the conditions to suit their natural habits in culture ponds.

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