

Influence of ciriped barnacles *Chelonibia patula* (Ranzani) on commercial crabs from Gulf of Mannar and Palk bay coastal waters

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Abstract: The attachment of the barnacle *Chelonibia patula* on the carapace of the three economically important crabs *Charybdis natator*, *Portunus pelagicus and Charybdis fruciata* from Gulf of Mannar and Palkbay coastal waters are reported. Here the barnacle attachment on *C. natator* is a first time observed in Indian waters. In general a maximum of 37% crabs were infested in Rameswaram, 22% in Pamban, 30% in Mandapam, 13% in Keelakarai and 10% in chinnaerwadi. A number of 100 crabs were scrutinized per sampling per site and three sampling were conducted per month. The *C. patula* attachment was found in June to August months. A record number of more than seventy seven barnacles were attached on single crab of *Charybdis natator* compare to this the number of barnacle varied from one to fifty four found on the swimming crab *P. pelagicus*, one to fifty five on *Charybdis fruciata*. Predominantly, most of the barnacles were attached to carapace of non-ovigerous female crabs. Significantly (*p*< 0.05) the infested crabs were showed reduction in weight compare to non infested crab and no significance between the number of barnacle attachment and the size of the carapace. The relationship between the epibionts and their hosts was clear evident for the parasitism endorse on other species in the area.

Key words: Chelonibia patula, Charybdis natator, Portunus pelagicus, Charybdis fruciata, Ectosymbiont

Introduction

The fouling organisms are one of the major threats for the world's marine fisheries; ubiquitously spread in all parts of the world ocean in attributes (Brady, 2001). The Barnacle is the major fouling organism, it attaches on diverse range of substratum. Preferably it requires a suitable substratum to recruit and flourish them to compete. Perhaps the barnacle mass recruit occur in natural to artificial substances like rocky shore, dead shells and mangroves and the artificial elements like concretes, piles, buoys, ships and all other floating materials in the sea, with hard and rough surface with the help of glue (slime layer) secreted by fouling microbes (Decho, 2000). The ciriped barnacle's *C. patula* is found commonly in all the Indian seas. Often it called as "Turtle barnacles". The shell of *C. patula* is conical white and thin and fragile and basal diameter between 25mm and 30mm, have massive shell. The carapace is loosely cemented with the host (Fernando, 1996).

In biofouling and epibiosis, C. *patula* was vastly reported as attached on living substrata, it has extensive geographic and host distribution in global marine waters (Badrudeen, 2000). The *C. patula* occurred in *P. pelagicus* have been reported within Moreten Bay by Phillips and Cannon (1978). In northern Gulf of Mexico, it is frequently found on spider crabs (Christie and Dalley, 1987). Most of the previous studies referenced *C. patula* on blue crabs, *Callinectess apidus* in Northern Carolina (Crisp, 1983; Marcus *et al.*, 1997) Florida (Gannon, 1990) and Colombia (Norse and Estevez, 1977). In the Southeast United States, it mostly infected the crabs *C. sapidus* and *L. polyphemus* (Pearse, 1952), *Callinectes amnicola* and *Portunus validus* in off Lagos Coast, Neigeria (Lawal Are, 2010). The prevalence of *C. patula* is usual in Indian crabs like *Charybdis fruciata, Portunus pelagicus, Portunus sanguinolentes* and it being the common ecto-symbiont for estuarine crab *Scylla serrata* (Phillips and Cannon, 1978). Badrudeen (2000) reported the rare occurrence of *C. patula* on moulted seasnakes *Hydrophius cyanocintus* collected from fish trawler in Rameswaram fishing jetty. Wagh and Bal (1974) confirmed that *C. patula* was found symbiotic with some other turtles, and gastropod specifically Busycon spp (Gittings *et al.*, 1986).

The aim of the present study probed the invasion of epibiosis of *C. patula* on three commercially important crabs, and its profusion in Southeast coast of India. The frequency of infestation varied significantly with the variables like age, sex, weight, carapace width and season, and investigated the impact of fouling on crab.

Materials and methods

Barnacle: The found attached barnacle belongs to the phylum: Arthropoda which comes under class: Crusteacea, subclass: Cirripedia and the order: Thoracica (Darwin, 1854) and it belongs to the family: Coronulidae, subfamily: Chelonibinae (Pilsbry, 1817) ant the genus: Chelonibia (Leach, 1870).

Specimen collection: The crab specimen were collected between March 2010 to March 2011 at Rameswaram, Pamban, Mandapam, Keelakarai and Chinna Erwadi, Gulf of Mannar and palkbay, Southeast coast of India (Fig. 1). The samples were gathered randomly from at least 15 fishing trawlers in each site, where fishes caught at the depth of 80 to 150 feet. The total 100 crabs were scrutinized per sampling per area and three sampling were conducted per area in a month, except April-15 to May-30, 2010. Hence fishing is banned during these periods by local government due to spawning of fishes.

The samples were separated according to their sex, Male and female crabs were further classified into mature and immature groups. In female, ovigerous and non-ovigerous were differentiated. The crab carapace width was measured from the tip of the left dorsal spine to the tip of the right dorsal spine using meter scale. The weight of the infested and non infested crabs also recorded on the board itself using weighing balance.

The number of *C. patula* found on the exoskeleton of infested crabs had been counted and the size of the barnacles also measured. Moreover the fishing time, area, fishing ground, depth and the nature of the fishing ground were also enquired and included as additional data to correlate the results. The statistical data in this study were analyzed by Two way ANOVA using computer software Sigma stat 3.0.

Results

The present report was observed all along the coastlines of Rameswaram, Pamban, Mandapam, Keelakarai and Chinna Erwadi from Gulf of Mannar and Palk Bay Coast (Fig. 1). *C. patula* found attached on the carapace of crabs P. *pelagicus*, *C. natator* and *C. fruciata* collected in the Gulf of Mannar and Palk Bay coastal waters (Figs. 2, 3 and 4). The presence of *C. patula* on the carapace of *C. natator* is the first ever observation in Indian waters.

Here the barnacle mostly founded on the external surfaces of the crabs. A documentation of more than seventy seven barnacles were attached on the carapace and merus of a single crab *C. natator* (Fig. 2) compared to this, the number of barnacle varied from one to fifty four found on dorsal side of the crab *P. pelagicus*, one to fifty five on carapace of *C. fruciata*. Compare to dorsal side, the ventral side of the crab having maximum four number of tiny *C. patula*.

During the study periods (from March 2010 to March 2011), the observing of infested crab was recorded in April 2010 and from June to October 2010 the crab with *C. patula*. In June 2010 was found the maximum infestation was observed in all study sites, and the percentage occurrence was 57% of *C. natator*, 42% of *P. pelagicus* and 29% of *C. fruciata* which gradually decreased in the following months (Fig. 5). After that the barnacle attachment is not observed between October 2010 and March 2011. Hence these data was not considered for statistical analysis.

In Palkbay Coast the Rameswaram exhibit the high infestation in all months for all three species, over all 37% crabs were infested in Rameswaram, 22% in Pamban, 30% in Mandapam, 13% in Keelakarai and 10% in Chinna Erwadi (Fig. 6). Especially in June 2010 the data was compared in all areas, In Rameswaram, 85% in *C. natator*, 68% in *P. pelagicus* and 44% in C. *fruciata* was infested only this area infested crabs was found up to October (Fig. 7). In Mandapam 78% of *C. natator*, 56% of *P. pelagicus*, 46% of *C. fruciata* was recorded (Fig. 8).

In the Gulf of Mannar coast, Pamban was highly affected, in June 2010, 42% of *C. natator*, 49% of *P. pelagicus* and 39% of *C.*

fruciata infested were perceived. Match up to other sites *P. pelagicus* was greatly affected in Pamban for all months (Fig. 9) Keelakarai and Chinna Erwadi both are not recorded much infestation, but in Keelakarai the *C. natator* was highly infested 56% in June month. Specifically these two areas, 100% non infested crab were noticed in September and October 2010 (Fig. 10, 11). Primarily from all locations the Rameswaram was exemplifies the increase percentage of infestation of all species in all the month and followed by the Mandapam, Pamban, Keelakarai and Chinna Erwadi (Fig. 12).

The statistical analysis (Two way ANOVA test) indicates that the infestation of crabs is significantly different in all months for all areas. Compared to other species the C. natator is highly significant infested in all months (p value 0.0002, F = 4, df = 10.48) and all areas (p value 0.002, f = 4, df = 6.55) and the C. patula distribution on P. pelagicus for all months (p value 0.0005, f = 4, df = 10.01) and all areas (p value 0.005, f = 4, df = 7.54) and C. fruciata (p value 0.0003, f = 4, df = 9.63) and all areas (p value 0.004, f = 4, df = 5.65) are also significantly differ . In both sexed the mature crabs are highly infested, particularly mature female crabs are seriously infested compare to mature male crabs in all species (Table -1). The average width of barnacles on crab in relation to the width of the crab's carapace was examined. The crabs had an equal chance of being fouled by barnacles of varying width (Table - 2). The average width of barnacles on crab was independent of the carapace width of the crabs, with small crabs having the same size range of barnacles on them as large crabs.

The impact of barnacle attachment on the weight of the crab was examined, based on classifying the carapace width in to three groups' viz., $50\pm5mm$, $100\pm5mm$ and $140\pm5mm$. In all the three groups, the infested crabs were significantly (p<0.05) reduced in weight compare to non infested crab (Fig. 13 to 15). Relationship between carapace width and the number of barnacle attachments was not displayed significance for all species. For instance the more number of barnacles attached on small size of carapace and the more size of crabs were attached with less number of barnacles and it impose that it is not a size dependent (Fig. 16 to 18).

Discussion

The attachment of barnacles on crab species have been recorded in Indian waters. In this study the presence of the ciriped barnacle status was verified and base line data was created for Indian waters. The result noticed, the existence and diversity of *C.patula* was expanded on crab species and it affect the growth and regular activities of the crabs.

Over street (1978), barnacle and other large bodied crustaceans offer nothing more than a hard substratum for settlement and competition. The crab carapace is a biologically active surface made of chitin, calcium and microbial films. The carapace is an ideal habitat for several sessile organisms they may be particularly true over mud and sand substrata. But the symbiotic association on different organism is may perhaps based on the availability of host on the suitable environment, health condition of host, and the pollution of the particular area or it may indicate the host migration.



Fig. 1: Map of the Study area in Gulf of Mannar and Palkbay



Fig. 2: Attachment of Chelonibia patula on Charybdis natator



Fig. 3: Attachment of *Chelonibia patula* on *Portunus pelagicus*



Fig. 4: Attachment of Chelonibia patula on Charybdis fruciata



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Fig. 9: percentage of infested crab in Pamban



Fig. 10: percentage of infested crab in Keelakarai

















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Crab species

Fig. 15: Comparison of infested and non infested crab weight and Carapace width 140 ± 5 mm

The Rameswaram and the Madapam study sites have more profusion of crab infestation compare to other areas, because these sites were having huge number (500 to 915) of trawlers comparatively. Moreover both the areas texture of the seafloor is muddy in nature as reasons for more sedimentation. It has the impact of river runoffs in the monsoon season. The river runoff draws and dumps rich amount of nutrients every year. Due to these reasons and some more additional factors like food and shelter were attributed the crabs to reside and proliferate in these seafloors naturally. Additionally most of the boats are fishing very near to Srilankan ocean boundaries these also one of the reasons for caught more amount (Kg) of crabs than the other sites, because in Srilanka, trawlers were less in number and somewhere not present (Suryanarayan, 2005).

The barnacle larvae are discriminating settlers, when the substrates are in demand, many barnacle species settle on their own species, the barnacle C. patula illustrate evidence of this gregarious manner of larval settlement (Marcus, 1997). Gregarious settling could be a response to certain crabs being more attractive or having greater exposure to barnacle larvae (Gannon, 1990). But in this study no gregarious settlement were seen. In connect with Tania (2010) most of the barnacle larvae were settled on the dorsal side of the crabs, since it is exposed to more light and has a more attractive microbial layer. In case of ventral surface attachment of barnacles was less because it may experience more abrasion and siltation when the crabs walk along the seafloor. The risk of abrading epizoans during copulation is a greater problem for male crabs, since female crabs copulate only immediately after molting, when they would be soft and likely devoid of epizoans (Williams, 1965). The present study was parallel to this report, after the month of June, in August the productivity and caught of crab was very less in quantity and ovigerous females landing occurs in low guantity in all locations and it prevails till October. The recovery of crab proliferation starts again from November.



Fig. 16: Relation between Carapace width(mm) and attachment of barnacles on *C. natator*



Fig. 17: Relation between Carapace width(mm) and attachment of barnacles on *P. pelagicus*



Fig. 17: Relation between Carapace width (mm) and attachment of barnacles on *C. fruciata*

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The present study reveals that there was no relationship flanked by crab surface area and average number of barnacles for each crab. This is concurrence through Lawal Are (2010) evidences an even distribution of *C. patula* on all sizes of *Callinectes amnicola* and *Portunus validus*. The various sizes of barnacles attachment on crab is not size dependent, is based on self determining or choice of availability.

The relationship of barnacle and crab is more likely depend on Salinity than the depth. The salinity and temperature affect the presence of barnacles on crab. Most of the infested crabs are available on June to September 2010. Particularly in June, high frequency of infestation was noticed (57% of C. natator, 29% of C. fruciata and 42% of P. pelagicus). In because the April to June is post monsoon (summer) consequently low rainfall is recorded and mixing of river runoff in Marine environment is low thus increases the salinity. Moreover, April and May has been the spawning time for both the sites. It is owing to the trawlers were not allowed for fishing, so the trawlers disturbance is less on marine water and organism especially larvae settlement, this is the right time for flourish and attachment of barnacles on crab. More number of barnacles is attached on the carapace of crabs, Maximum number seventy organisms of C. patula were attached along with the C. natator, twenty eight organisms were attached with P. pelagicus and thirty was attached on the C. fruciata.

In the present study the female crabs are mostly fouled compare to male crabs, in female crabs, typically the nonovigerous had high prevalence of C. patula. Earlier findings regarding to occurrence of C. patula on crabs of differing sexual condition was parallel to the current result. Since the male crabs sustained to molt (Truitt, 1939; Van Engel, 1958; Tagatz, 1968b; Perry, 1975; Overstreet, 1979, 1983; Crisp, 1983) but females following their pubertal molt it reach the terminal anecdysis, exclusive of C. patula in particular on aged female crabs that have spawned more than two times (Perry and Stuck, 1979; Tatum, 1979; Crisp, 1983; Millikin and Williams, 1984). And Female crabs were might have exposed to settling larvae over a longer period, incase in our studies even in shorter period the barnacle larvae would have attach in the female crabs even the females were not significantly larger (and, therefore, not presumably older) than the males. And mostly the barnacle larvae prefer to settle the attractive females. C. patula was prefers normally between 25 to 40 ppt salinity. This was a suitable condition for the C. patula egg hatching (Lang, 1976) it's a main reason it binds to female who spend more time after mating to higher salinity water with their egg masses for hatching.

In both sex, the adult crabs are mostly affected, as immature crabs can flee owing to continuous molting. The nonovigerous mature females were fouled significantly more than ovigerous female. The other study of the prevalence of fouling of *C. patula* on crabs of differing sexual condition was by Shields (1992). That study, involving a different host species, found that nonovigerous females were not significantly fouled more than ovigerous females since when females were buried, they would be burden by the eggs and

Table- 1: Mean value of sexually infested crabs	
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Location	C.natator			P.pelagicus			C.fruciata		
	Male	Ovigerous Female	Non ovigerous Female	Male	Ovigerous Female	Non ovigerous Female	Male	Ovigerous Female	Non ovigerous Female
Rameshwaram	18	12	20	13	8	14	7	7	11
Pamban	7	5	10	8	5	12	7	4	7
Mandapam	15	9	16	10	8	11	9	2	12
Keelakarai	8	6	11	3	2	5	2	0	3
Chinnaerwadi	4	3	6	4	2	5	2	1	3

 Table- 2: Relationship between average size of barnacle and carapace width of crab

Crab species	Range of carapace	Weight of	% infested	Mean value	Size of barnacles (mm)	
	width (mm)	crab (gm)	crabs	barnacles attached		
Charybdis natator						
	50-70	65-75	10	19±7.83	1-17	
	71-110	100-140	70	48±11.28	1-17	
	111-140	150-180	20	31±14.49	1-15	
Portunus pelagicus						
	50-70	60-80	10	18±8.20	1-17	
	71-130	100-180	65	31±10.30	1-18	
	131-170	200-250	25	24±24.59	1-17	
Charybdis fruciata						
	50-70	60-90	11	11±6.87	1-17	
	71-130	110-200	60	29±11.05	1-17	
	131-170	210-265	29	22±12.25	1-19	

therefore less vigorous in their movement with correspondingly lower respiratory current affording the best opportunity for the barnacle attach but this study found that the mature non ovigerous was more fouled. The present study results were conflicted to these hypothesis and agreed to the Marcus (1997) report, it has nonovigerous mature females (75%) were fouled significantly more than ovigerous females (52%).

This preliminary investigation of this report found that this barnacle might have negative symbiotic relationship with these crabs for the reason that the barnacles weight attach on a single crab is elevated compare to crab weight, consequently the burden reduce the active movement of the crab, all of which make the crab more susceptible to predators and it may the reason to easily caught by fishing, and the infested immature crabs were not found with the normal weight and the size, it affect the further growth of the crab. Moreover this study reveals that the infestation of barnacle on crab induced by suitable (resides optimal condition for proliferation) or localized environmental conditions and host availability. For instance, in compare to other sites the Rameswaram found to be more number of infested crabs in which the amount of crab landing was high when compare to other areas. It's due to lower depth, high temperature and salinity which is suitable for the barnacle fouling. (Zullo, 1979; Pearse, 1947).

Finally the attachment of the barnacle decreases the commercial value of the crab due to decrease in weight which

reduces the fishermen revenue for catch per unit. Moreover these areas found landing of crabs from August to November was scarce in these months. This may be the resemblance of less copulation occurs in between infested female and male. Over all the ectosymbiotism of *C. patula* is affected the health, growth rate and economical value of the crabs, and the barnacle select the new host like *C. natator* may provides an opportunity to access pollution level increases in the marine environment and the various aspects of crab biology and other conditions. This data may help to know the current status of the *C.patula* and impact on marketable crabs in Indian waters and further this study is move towards the enzymatic and genetic level changes of the *C.patula* infested crabs.

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