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Shell Utilization by the Hermit Crab, *Diogenes planimanus* (Anomura: Diogenidae) From Karachi Coast, Pakistan

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Abstract.- The purpose of present study was to investigate the shell utilization pattern of most abundant hermitcrab *Diogenes planimanus.* Hermit crabs were collected during June-August 2002. Out of 32 species of gastropod shells occupied the most frequent were *Nevrita didyma*, *Bullia tranquebarica, Babylonia spirata* and *Thais lacera.* Large size crabs (>5.0 mm sheild length, SL) were abundant at sublittoral zone, majority of which occupied three types of gastropod shells: *N. didyma, B. spirata* and *T. lacera* .Small size crabs (<5mm SL) were common in the intertidal zone occupying a wide variety of gastropod shells, most frequently occupied was *Bullia* spp. The largest size crab (l2.4 mm, SL) occupied *T. lacera* whereas the smallest ones were found in shells of *N. didyma, Bullia* spp. *Anachis fauroti* and *Natica alapapilionis.* Sex ratio was biased towards females (1:1.9) including majority of ovigerous females .The two sexes showed significant difference in shell occupancy, majority of males preferred light weight, low-spired *N. didyma* shells. Regression analyses between shell size and hermit crab size occupying *B. spirata, N. didyma* and *T. lacera* showed weak correlation and negatively allometric relationship between size of *D. planimanus* and shell size.

Key words: Gastropod shells, intertidal fauna, hermit crabs.

INTRODUCTION

Hermit crabs live in empty gastropod shells for protection against predators and physical stress. The connection between hermit crabs and shell affect almost all aspects of their biology (Hazlett, 1981) including their growth, survival and fecundity. Empty gastropod shells available for hermits are limiting resource to several populations (Kellogg, 1976), that may vary in size shape and condition. Shell selection is determined by shell availability and to a lesser extent by preferences with regard to shell weight and internal volume (Garcia and Mantelatto, 2001). Factors controlling the pattern of shell selection has been investigated by Hazlett (1981), Wilber (1990), Bertness (1980), Hahna (1998) and Botelho and Costa (2000).

Hermit crabs are common on sandy and rocky shores of Pakistan. Out of 800 species of hermit crabs distributed through out the world seventeen species have been reported by Tirmizi and Siddiqui (1981) from Pakistan coast. Apart from this taxonomic account there exist not a single study on abundance, distribution or shell utilization of local hermit crabs population. Keeping in view of the paucity of information present study was initiated. It deals with the shell utilization pattern of the most abundant species of sandy shore crab *Diogenes planimanus* (Henderson, 1893).

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MATERIALS AND METHODS

Samples of hermit crabs were collected from the sandy shores of Clifton and Sandspit during, June to August 2002. Collection was done from lower intertidal zone and from the catch of local fishermen obtained from sublittoral zone. In laboratory occupied shells were sorted, identified, measured (shell length and aperture width upto 0.l mm precision) with vernier calipers and weighed after removing the crab. Most common gastropod / hermit crabs of sublittoral zone were measured (cephalothoracic shield length, SL and aperture width, AW), - and weighed. To find relationships between crab sizes and shell size variables data were plotted and coefficients and linear regressions were calculated using Minitab program, 11.12.

RESULTS

A total of 1250 hermit crabs were examined, out of which 1223 were *Diogenes planimanus.*

Table I.- Number and size range of gastropod shells occupied by hermit crab, *Diogenes*.

No.	Gastropod shells	Size range (mm)	Sandspit	Clifton	Total
1.	*Anachis fauroti*	11-15	5	-	5
2.	*Babylonia spirata*	19-50	42	240	282
3.	*Bufonaria echinata*	35-39	4	14	18
4.	*Bullia tranquebarica*	1 4-32	119	115	234
5.	*Bullia mauritiana*	15-23	2	-	2
6	*Bullia melanoides*	14-37	2	1	3
7.	*Bursa spinosa*	42-45	2	2	4
8.	*B. granularis*	38	-	1	1
9.	*Cantharus erythrostomus*	46-49	3	2	5
10.	*Cantharus undosus*	16	1	-	1
11.	*Cerithida cingulata*	1 7-20	15	-	15
12.	*Latirus bonniae*	11-14	1	2	3
13.	*Morula granulata*	24	1	-	1
14.	*Nassarius distortus*	12	1	-	1
15.	*Nassarius hirtus*	13	1	-	1
16.	*N.albescens*	12	-	2	2
17.	*Natica alapapilionis*	8.8-16	1	1	2
18.	*Nevrita didyma*	6.3-31.5	106	197	303
19.	*N.peselphanti*	1 0-26	-	23	23
20.	*Oliva gibbosa*	16	1	-	1
21.	*Polinices mammilla*	28-44	16	34	50
22.	*Ptychobela opisthchetos*	16-24	-	3	3
23.	*Thais carinifera*	24-30	52	54	106
24.	*Thais lacera*	17.6-50	11	105	116
25.	*Thais rudolphi*	36-46	1	8	9
26.	*Thais rugosa*	38	1	1	2
27.	*Thais tissoti*	1 4-18	4	4	8
28.	*Tibia curta*	114-120	2	2	4
29.	*Tonna luteostoma*	31.2	1	-	1
30.	*Turricula amicta*	20-22	2	-	2
31.	*Turricula javana*	21 -58	2	9	11
32.	*Turritula bandorensis*	1 5-1 8	4	-	4
	Total		**403**	**820**	**1223**

Thirty two species of gastropod shells were occupied by *D. planimanus;* twentyone species were recorded at Clifton, and twenty eight at Sandspit (Table I). Shells most frequently occupied were *Nevrita didyma, Babylonia spirata, B. tranquebarica, Thais lacera, T. carinifera* and *Polinices mammilla*.The largest shell was *B. spirata* (58.7 mm) and the smallest was *N. didyma* (6.3 mm.) Out of eighteen rare shells (<5) seven were small sized and found at intertidal zone. The largest hermit crab was found in a shell of *T. lacera* and the smallest one was found living in the shell of *N. alapapilionis* (shell length, 8.3mm). Hermit crab size of sublittoral population (Mean±SD shield length) was 5.28±1.45 mm for 162 males; 7.73±1.81 mm for 186 non-ovigerous females; and 8.03±1.96 mm for 124 ovigerous females, respectively. The most preferred shells of large hermit crabs was *N. didyma,* followed by *B. spirata* and *T. lacera* whereas at the intertidal zone most commonly occupied shells were *Bullia tranquebarica* and *N. didyma,* the latter species appeared to be commonly chosen by a very wide range of size, from the smallest to very large size crabs on both sites and habitats.

The sex ratio during the study period was

biased towards females (1:1.9), males were 36%, nonovigerous females 40% and ovigerous females 26%, bearing large egg masses with their pleopods. Size of the smallest ovigerous female was 1.90 mm

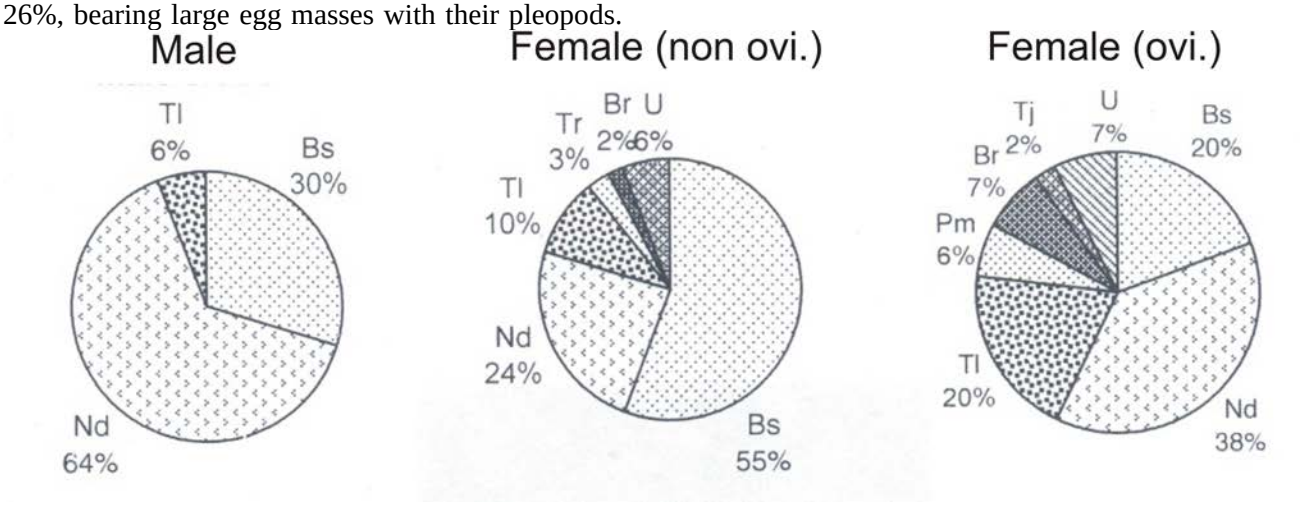

Fig. 1. Shell preference by male, non ovigerous and ovigerous females.

(SL) occupying shell of *N. alapapilionis.* The two sexes showed slight difference in shell occupancy. Males occupied three species of shells, majority of males occupied shells of *N. didyma* (64%) and *B. spirata* (30%). Females were found in thirteen species of shells however, there was not much difference between variety of shells occupied by ovigerous and non ovigerous females, 78% of ovigerous females occupied the three of the most common shell,; of *N. didyma, B. spirata* and *T. lacera* (Fig. 1).

Lengths and weights of commonly occupied gastropod shells of *N. didyma, T. lacera* and *B. spirata* were correlated with crab size (Fig. 2). The strongest relationship was found for *N. didyma.* Regression analysis showed negative allometric relationship between crab size (SL) and shell size (length and weight) and aperture width (AW) , indicating faster rate of growth of crabs as compared to the size of available shells except *B. spirata* which showed isometry between crab size (SL) and shell length.

DISCUSSION

Diogenes planimanus was found occupying 32 shell species during (June to August) the monsoon season, this is in consistent with the observation made by Emmerson and Alexander (1985) on a congener species *Diogenes brevirostris*, from South Africa. Two other hermit crabs of family Diogenidae, utilized lesser number of gastropod shell species, *Clibanarius virescens* utilized 23 shells (Reddy and Biseswar, 1993) and *C. erythropus* utilized 19 shells of gastropod at Sao Miguel Azores archipelago (Botelho and Costa, 2000). All the three species were similar in occupying a wider variety of shell species in the smaller size range (2-3 mm shield length) than observed for larger crabs.

The availability of particular gastropod shells influences the shell utilization by hermit crabs in the natural habitat as they tend to be opportunistic with regard to the shells they inhabit (Botelho and Costa, 2000). *Diogenes brevirostris* used three species of *Bullia* shells very commonly at the coast of South Africa (Emmerson and Alexander, 1986). Similarly *Bullia* shells were used abundantly by small size recruits of *Diogenes planimanus*. *Clianarius virescens* preferred high spired shells, whilst *C. laevimanus* showed preference for shells with low spires. *C. laevimanus* possesses large cheliped, so it was restricted in the choice of shells in the natural habitat and it had to select shells with large

apertures (Reddy and Biseswar, 1993). Large size crabs, particularly males, preferred short spired globular shaped shells of *Nevrita didyma* and *Babylonia spirata.* The short-spire shells were linked with refugial strategy for burrowing (Barnes, 1997). Selection of tall-spired heavy *Thais lacera*

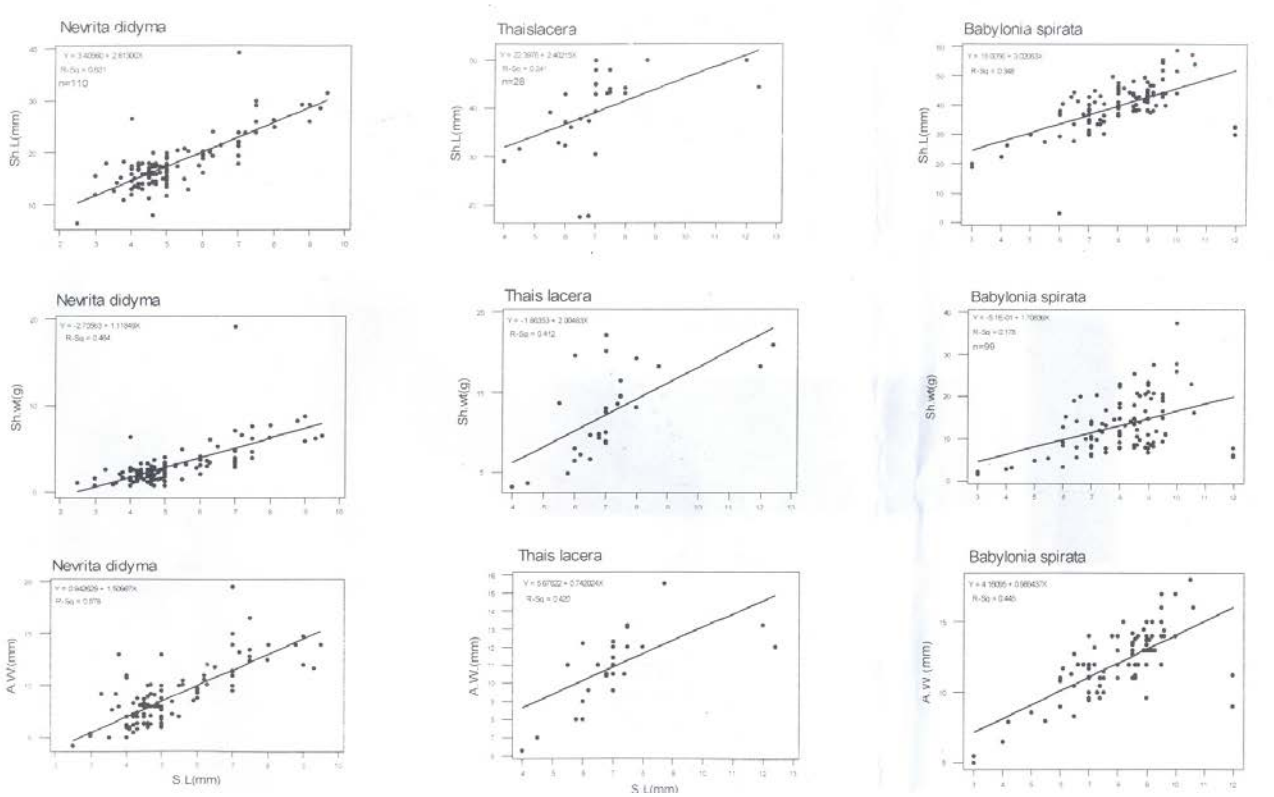

Fig. 2. Allometric relationship between size of *Diogenes planimanus* and shell length (Sh.L.), shell weight (Sh.wt.) and aperture width (AW) of shell of gastropod, *Nevrita didyma, Thais lacera* and *Babylonia spirata*.

shells with narrow aperture by 20% of ovigerous females can be explained with the strategy of protection of egg mass from predators.

Sex ratio was found female biased in many species of hermit crabs, such as *Calcinus tubularis* and *Diogenes pugilator* (Manjon-Cabeza and Garcia-Rasso, 1995, 1998), *Clibanarius virescens* (Imazu and Asakura, 1994) and *Diogenes brevirostris* (Carlos and Christopher, 2005). In our study sex ratio was in favour of females (l:1.9). This trend is in agreement with that of other crustacean populations, which in almost all cases have sex ratios differing from 1:1 (Wenner, 1972). An unequal ratio was attributed to differential mortality and growth rates between sexes and migrations. In most tropical and sub-tropical regions the breeding season occur during the summer months when food sources are abundant in the plankton. However, year round breeding and continuous recruitment was found in *Diogenes pugilator* (Manjon-Cabeza and Garcia Rasso, 1998), *Diogenes brevirostris* and *Dardanus inermis* (Carlos, 2005). *C. tubularis* showed a resting period during winter (Manjon-Cabeza and Garcia-Rasso, 1995) and *Diogenes avarus* during monsoon months (Khan and Natarajan, 1981).Thus occurrence of majority of females, including 39% of it in ovigerous stage indicate that *D. planimanus* had a peak of breeding activity during summer months. The size of smallest egg bearing female of *D. planimanus* was (1.9 mm SL) whereas, *C. tubularis* spawn at a comparatively smaller size *i.e.*, 0.7 mm SL ((Manjon-Cabeza and

Garcia-Rasso, 1995).

Ovigerous females occur more frequently in the shells of certain species (Fotheringham, 1976). Difference in shell occupancy between sexes of *Clibanarius erythropus* was explained by Gherardi (1991), advantage of some kind of shells for females were related to energy saving for reproductive process. Elwood *et al.* (1995) observed the number of eggs produced were larger among female *Pagurus bernhardus* occupying lighter shells. Bertness (1982) reported the preference of less spiraled shells by *Calcinus tibicen.*. Ovigerous females of *Calcinus tibicen* also tend to occupy heavy shells of *Stramonita haemastoma* (Mantelatto and Garcia, 1999). Sexual difference in shell utilization of *Clibanarius virescens* has also been reported (Imazu and Asakura, 1994). In the present study preference of less spiraled light weight shells of *N. didyma* by majority of *D. planimanus* females and males showed its abundance in the study area and its suitability for the hermit crabs. Occupation of heavy, high spire *Thais lacera* shells by large ovigerous females can be related to its capacity to provide better protection against predators.

Hermit crab, *Pagurus longicarpus,* changed its preference for shell species with size (Wilber, 1990). The same behaviour was found in *Clibanarius erythropus* (Botelho and Costa, 2000). In the present study small size *D. planimanus* occupied several types of gastropod shells, when they grew larger they had lesser choice from the available large shells of *N. didyma*, *T. lacera* or *B. spirata.*

Linear regression between crab size (shield length) and shell size (length and weight) and aperture width was not significant for most shell species, however a well fitted linear regression was obtained for *N. didyma* and *B. spirata*. Crab length showed stronger correlation with shell length of *N. didyma.* The relationship of hermit crab size with shell weight was weak, most probably due to the frequent encrustation and damage to the shells. Botelho and Costa (2000) had also noticed weak relationship between the size of *C. erythropus* and weight of occupied shells. Although a correlation between hermit crab weight and shell weight of *Pagurus granosimanus* and *P. samuelis* was reported by Hahna (1998).

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