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POPULATION, ECOLOGY AND BIOLOGY OF *SCOPIMERA CRABRICAUDA* ALCOCK (DECAPODA: BRACHYURA, OCYPODIDAE) ON A QATAR SAND FLAT

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ABSTRACT

The inter-tidal sand flats of Al-Wakrah, Qatar were sampled monthly from October 2004 to September 2005 for the ocypodid crab *Scopimera crabricauda* Alcock. The study included a total of 454 individuals (326 males and 128 females). The mean abundance of this species was high during June-July and decrease from December to January. The CW measurements revealed that males are heavier than females. The ovigerous females comprised of 8.3% and 50% in the classes of >3.5 and the males were significantly outnumbered in most class-size. The *Scopimera crabricauda* showed two peaks of breeding March-April and September-October. The major breeding peaks were in April 53.9% and the lowest in September. The female *Scopimera crabricauda* attains sexual maturity at 3.8 mm in carapace width. The peak in number of juvenile crabs that recruitment of this species mainly takes place between October-November and April-June. The sex ratio in the smaller size classes shows no significant deviation from 1:1, but there was significant deviation in the higher classes.

1. INTRODUCTION

The ocypodid crab *Scopimera crabricauda* Alcock 1900, (Decapoda; Brachyura) is common along tropical and subtropical sand shores. In the Arabian Gulf *Scopimera crabricauda* is generally found abundantly on sheltered sandy beaches and sand flats. These species dig burrows in the sand and leaves characteristic radiating trails of pseudofeaces around them (Jones, 1983). Recently, Clayton and Al-Kindi (1998) studied the population structure and dynamics of *Scopimera crabricauda* in an estuarine habitat of Oman. However, there appears to be no previous work on its ecology and biology in Qatar. There have been considered ecology and biology on *Scopimera globosa* (Yamaguchi & Tanaka, 1974; Wada 1981a,b, 1983a, b, c, 1986; Suzuki 1983; Suzuki and Kikuchi 1984; Zimmer-Faust 1987; Henmi and Kaneto 1989).

2. MATERIALS AND METHODS

This study was conducted from October 2004-September 2005, to investigate the population ecology and biology of *Scopimera crabricauda* from sand flat at Al-Wakrah which situated on the east coast of Qatar (Fig.1). At the sampling site air and surface water temperatures were recorded at monthly intervals. Salinity and pH were determined using portable salinity and pH meters. Sediment samples of the top 5 cm from onshore were collected for analysis of surface sediment characteristics such as grain size, organic matter, and moisture content. These

samples were analyzed to determine the particle size using the sieve method Buchanan (1982). Organic carbon content of these sediments was determined measuring the loss of weight after 6h drying at 450° C.

Scopimera crabricauda were collected by digging burrows in the intertidal sand flats. The crabs were measured individually for maximum carapace width (CW) to the nearest 0.1 mm using an eyepiece micrometer under 60X magnification. The crab weights were recorded to the nearest mg. All individuals were sexed, and for females the presence or absence of eggs in each female sample were noted. Sex ratios were obtained for monthly sample.

The carapace width (CW)-weight relationship was calculated according to the method of least squares formula $W = aL^n$ or Log w = Loga + n Log CW. In all cases the abdomen of the females was lifted and examined to determine ovigerous females.

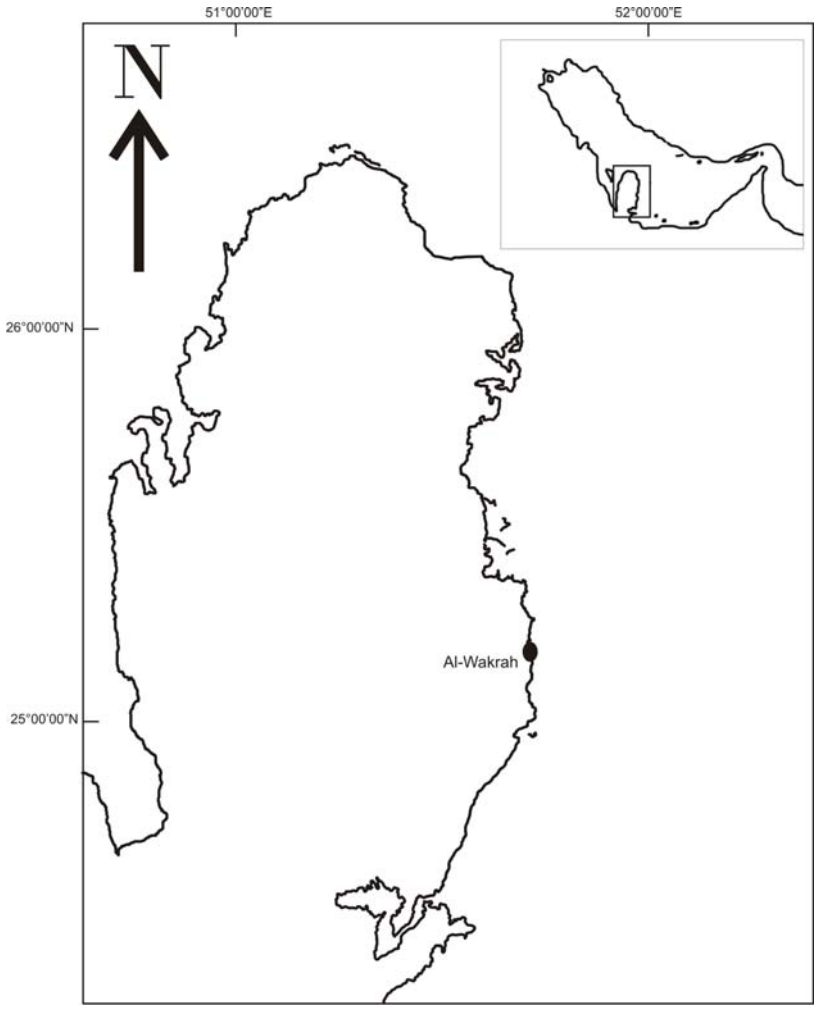

Fig. (1): Map of The State of Qatar showing the study site at Al-Wakrah.

3. RESULTS

3.1 Physical parameters

Monthly air temperatures, surface water temperatures, and salinity recorded at the area of study are shown in Figure (2). The maximum air temperature was recorded in June (40°C) while the minimum one in January (23.1°C). The hottest period occurred between June and August (37.5-40°C), while the coolest period was found to be between December and February (23.1-25.6°C).

Salinity at the sampling site survey fluctuated between 41-45‰ from April to August. The highest value of 45‰ was recorded in August 2005.

The results of grain size analysis, organic matter, soil pH and moisture content are presented in Table (1).

Sediment in the upper intertidal zone was made up of 92.70% sand and 7.30% mud with a mean sand particle size of 0.21 mm. The mid-intertidal sediment had a mean particle size of 0.17 mm consisting of 86.26% sand and 13.73% mud. The mid-intertidal substrate contained more water (20.37%) and organic matter (2.54%) than that found on the upper shore (Table 1).

Table (1): Sediment characteristics of the substrates at the collection site of the crabs (*Scopimera crabicauda*) at Al-Wakrah.

Character	Upper inter-tidal	Mid inter-tidal
Sand %	92.70±1.68	86.26±3.54
Mud % (silt & clay)	7.30±3.0	13.74±3.54
Organic matter %	1.94±0.3	2.54±0.22
Mean grain size (mm)	0.21±0.2	0.17±0.02
Moisture content (g)	13.75±2.34	20.37±0.27
Soil pH	7.70±0.08	7.52±0.15

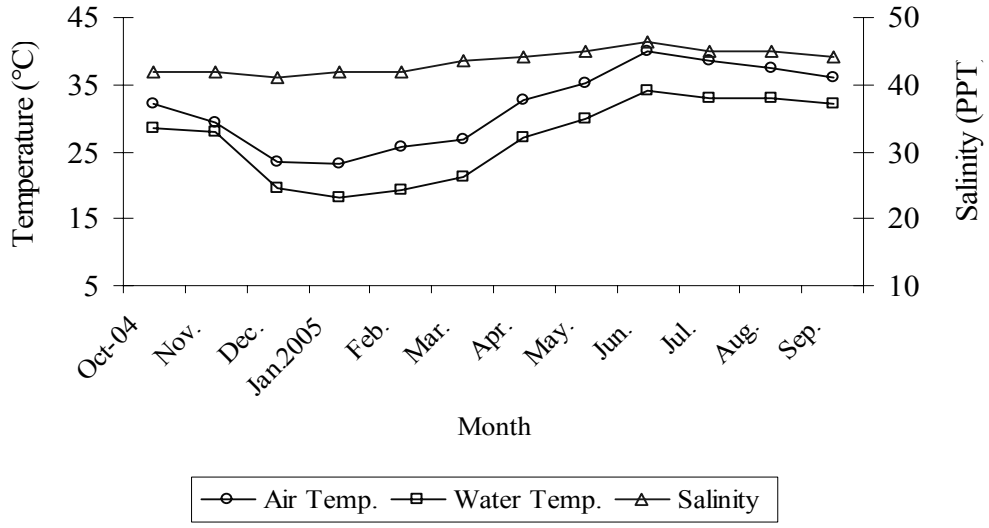

Fig. (2): Air and surface sea water temperatures (°C) and Salinity (ppt) At Al-Wakrah, October 2004 to September 2005.

3.2 Population abundance

The mean abundance of *Scopimera crabricauda* observed during the period from October 2004 to August 2005 is shown in Figure (3). On the upper intertidal *Scopimera crabricauda* was observed with highest values of 30-34 individuals/0.5 m^2 during June-July 2005, while the numbers decreased during December and January to 18 and 17 individuals/0.5 m^2 respectively. Variations in abundance in the mid intertidal were approximately similar but with lower numbers of individuals during winter.

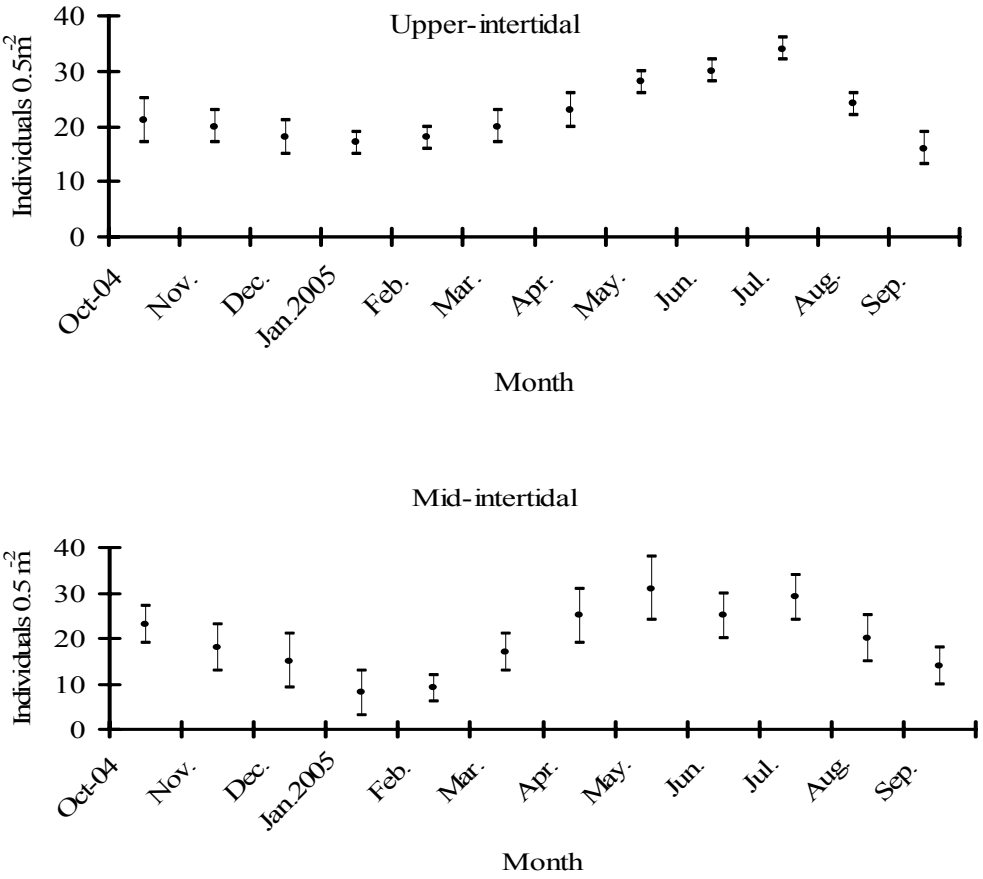

Fig. (3): Over all mean abundance of *Scopimera crabricauda* on the upper and mid-intertidal zone (Oct. 2004 to Sep. 2005). Vertical bars indicate standard errors.

3.3 Population dynamics

The frequency distribution of carapace width (from the total samples collected) of *Scopimera crabricauda* (Fig.4) showed that the males and females were unequal (326 males with size range 3.0 to 9.5 mm, 128 females with size range 2.5 to 8.0 mm). Both distributions were unimodal, and skewed slightly to the right in males (mode 5-5.5 mm and 6.0-6.5 mm, Fig. 4a) and the left in females (mode 5.0-5.5 mm, Fig. 4b). In terms of weight, males ranged from 0.0184g to 0.525 g, whereas females were from 0.025g to 0.428 g.

Table 2 shows that the mean CW for males ranged from a minimum of 4.25 ± 0.10 mm during September 2005, to a maximum of 6.69 ± 0.26 mm during April 2005. The mean values for females for the same period were generally higher ranging from 5.35 ± 0.20 mm to 7.55 ± 0.22 mm during April 2005. In terms of wet weight, the minimum and maximum means for males and females were found to range from 0.13 ± 0.02 to 0.27 ± 0.03 gm; and 0.06± 0.01 gm to 0.12 ± 0.03 gm, respectively during the above mentioned periods. Only 18.8 % of the females were ovigerous (Fig. 4b), and these were present in size classes >3 mm, comprising between 8.3% and 50% of the females in the classes >3.5 mm (Fig. 4b and Fig. 5). Males significantly outnumbered females in most class-sizes (Tab. 3 and Fig. 5).

The frequency distribution of carapace width of males and females during each of the 12 sampling periods is presented on Figure (6). There are a varying number of modes, few of which can be followed through successive sampling periods. The population tended to be concentrated in the mid range size class in October 2004 and in the mid to large range size classes from July and August 2005.

Table (2): Monthly changes in mean carapace width – weight for males and females *Scopimera crabricauda* collected from Al-Wakrah coastal area (October 2004 to September 2005).

Month	Male			Female		
	No. of Crab	CW (mm) ± SE	Wet Wt (gm) ± SE	No. of Crab	CW (mm)± SE	Wet Wt (gm) ± SE
October 2004	33	5.18±0.13	0.14±0.03	9	5.21±0.24	0.09±0.02
November	30	5.13±0.16	0.13±0.01	12	6.34±0.28	0.13±0.02
December	20	5.05±0.14	0.12±0.01	12	5.41±0.14	0.11±0.01
January 2005	24	5.40±0.21	0.21±0.02	9	6.54±0.35	0.09±0.01
February	33	5.48±0.12	0.17±0.01	12	6.02±0.25	0.12±0.01
March	16	5.55±0.16	0.22±0.03	10	6.28±0.29	0.13±0.01
April	22	6.69±0.26	0.27±0.03	13	7.55±0.22	0.12±0.03
May	34	6.65±0.16	0.25±0.02	5	7.18±0.26	0.08±0.01
June	25	6.08±0.22	0.24±0.03	7	7.44±0.32	0.06±0.01
July	56	6.56±0.13	0.25±0.01	6	7.43±0.16	0.13±0.02
August	40	6.07±0.18	0.22±0.01	11	6.99±0.20	0.09±0.01
September	29	4.25±0.10	0.13±0.02	22	5.35±0.20	0.06±0.01

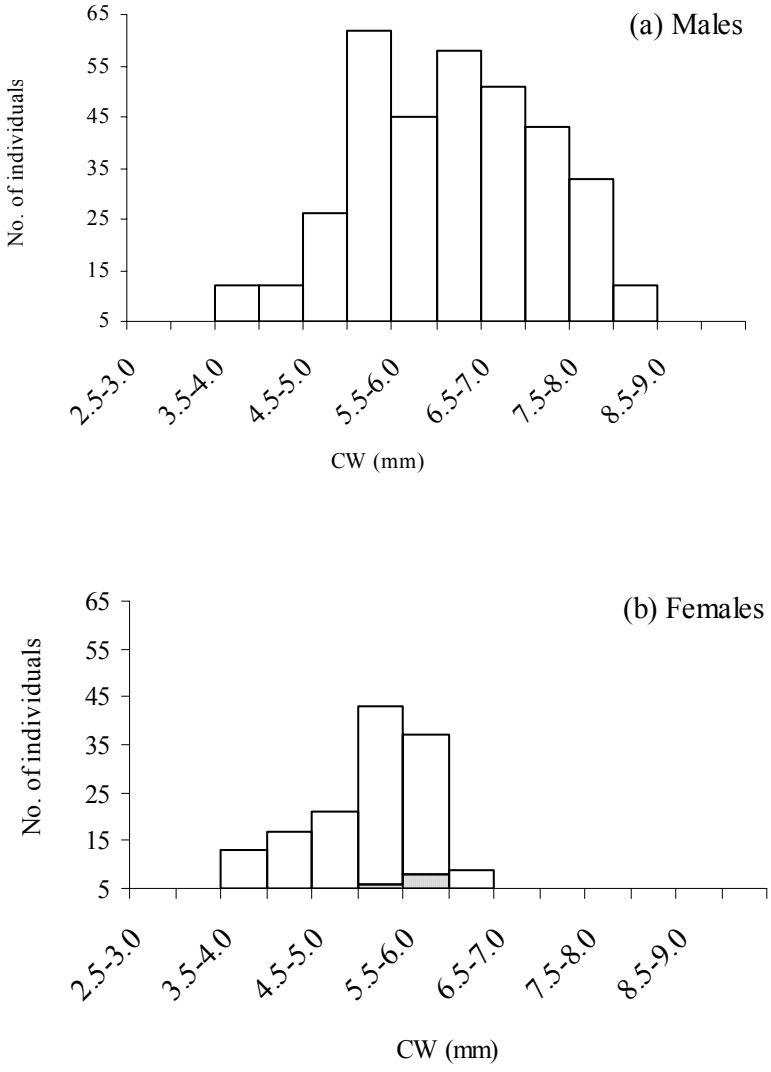

Fig. (4): ***Scopimera crabricauda*** **carapace width frequency distributions of total (a) males and (b) females (black spot = ovigerous females).**

Table (3): Carapace width – weight for males and females of *Scopimera Crabricauda* collected from Al-Wakrah coastal (October 2004 to September 2005).

Size-class	Male No.	Mean CW (mm)	Mean Wt (gm)	Female No.	Mean CW (mm)	Mean Wt (gm)	Ov.Female
2.5-3.0				1	3.0	0.0278	
3.0-3.5	1	3.4	0.0184	3	3.23±0.07	0.03±0.02	
3.5-4.0	12	3.7 ± 0.15	0.05±0.01	12	3.81±0.13	0.04±0.01	1
4.0-4.5	14	4.23 ± 0.13	0.06±0.02	15	4.24±0.15	0.05±0.02	2
4.5-5.0	26	4.69 ± 0.14	0.09±0.03	17	4.72±0.13	0.09±0.02	4
5.0-5.5	62	5.22 ± 0.13	0.13±0.11	37	5.23±0.13	0.10±0.02	6
5.5-6.0	45	5.66± 0.15	0.15±0.03	29	5.67±0.14	0.12±0.04	8
6.0-6.5	58	6.23±0.14	0.19±0.04	7	6.19±0.13	0.14±0.02	2
6.5-7.0	51	6.72±0.14	0.23±0.05	4	6.65±0.17	0.19±0.04	
7.0-7.5	43	7.22±0.14	0.29±0.06	2	7.20±0.28	0.26±0.05	1
7.5-8.0	33	7.67±0.14	0.34±0.05	1	7.5	0.428	
8.0-8.5	12	8.13±0.10	0.38±0.06				
8.5-9.0	4	8.58±0.10	0.49±0.04				
9.0-9.5	1	9.1	0.4895				

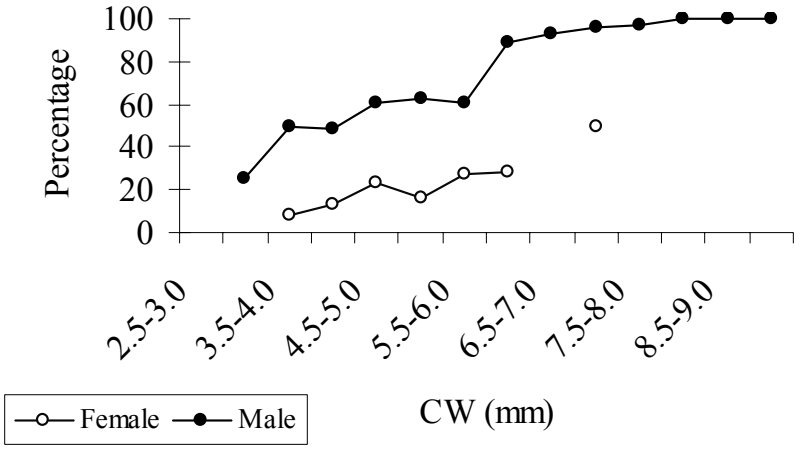

Fig. (5): *Scopimera crabricauda*, males and females as a percentage of total no. of individuals in each CW Class.

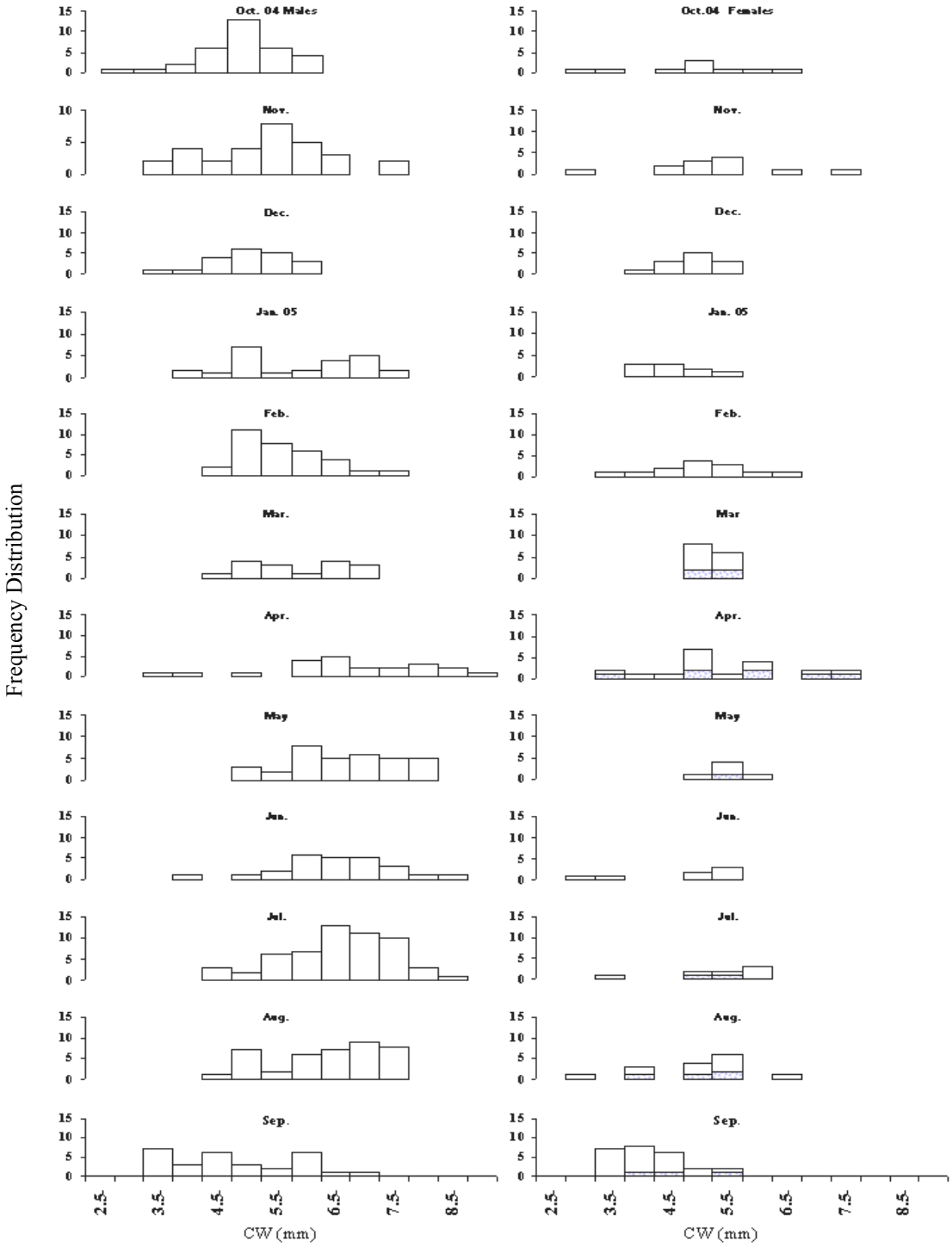

Fig. (6): ***Scopemera crabicauda*** **carapace width (CW) frequency distribution (no. of individuals) based on monthly samples (black spots = ovigerous females).**

3.4 Carapace width-weight relationship

The logarithmic relationship between carapace width and body weight for males, females and the total samples (males and females) for the species were found to be as follows:

Male:

$\log W = 2.8433\ CW - 2.9889$ ($r^2 = 0.8717$)

Female:

$\text{Log } W = 2.6392\ CW - 2.9094$ ($r^2 = 0.7469$)

Combined sexes (Male - Female):

$\text{Log } W = CW -$ ($r^2 = 0.8651$)

The relationship between carapace width and weight is shown in Figure (7). Males were found to be heavier than females throughout the year except in winter when the maximum weight was in favour of the females (Fig.7). The parabolic formula for carapace width-weight relationship, obtained for both sexes in all seasons showed that the rate of increase in weight as the crabs are growing in favour of males in all 3 seasons, while it was in favour of the females during the winter season. For a given width, e.g. 9 mm, the males' weight in autumn was 0.52g which increased slightly to 0.58 g during winter (11.5%), but then slightly declined to 0.52 during spring (6.0%), and increases again to 0.58 during summer (11.5%). For females, the weight fluctuated from one season to another, for a given width, e.g. 9 mm; the females' weight in autumn was 0.42 g, slightly increasing to 0.61 g during winter (45.24%), and later decline to 0.41g during spring (-32.79%) and continued to decline to 0.29g during summer (-29.27%) (Table 4).

Comparison of weight losses with the mean temperatures of cold and warm seasons showed a variation correlated to the size of crabs (Tab. 5). Males with 4 mm CW did not decrease in body weight, whereas those at 8 mm CW lost 2.44% of their body weight during summer. In contrast, the weight of females between 4 mm and 8 mm CW showed a loss of –16.67% and 48.84%, respectively, of body weights during summer.

Table (4): Seasonal non-linear regression values for the carapace width-weigh relationships for males and females of *Scopimera crabricauda*, (October 2004 September 2005).

Season	Equation for male	Wt.g for crab with Cw 6mm	Wt.g for crab with Cw 9mm	Equation for female	Wt.g for crab with Cw 6mm	Wt.g for crab with Cw 9mm
Autumn	$W=0.001CW^{2.8003}$	0.17	0.52	$W=0.001CW^{2.8503}$	0.15	0.42
Winter	$W=0.001CW^{3.0621}$	0.17	0.58	$W=0.001CW^{2.9696}$	0.18	0.61
Spring	$W=0.001CW^{2.8430}$	0.16	0.52	$W=0.001CW^{2.7349}$	0.13	0.41
Summer	$W=0.001CW^{3.0581}$	0.17	0.58	$W=0.001CW^{2.2225}$	0.12	0.29

Table (5): Seasonal changes in mean weight for males and females of *Scopimera crabricauda* collected from Al-Wakrah coastal area during winter and summer 2005.

Season	Mean temp. °C± SE	Male		Female	
		4 mm	8 mm	4 mm	8 mm
Winter	13.1± SE	0.05	0.41	0.06	0.43
Summer	34.2± SE	0.05	0.40	0.05	0.22

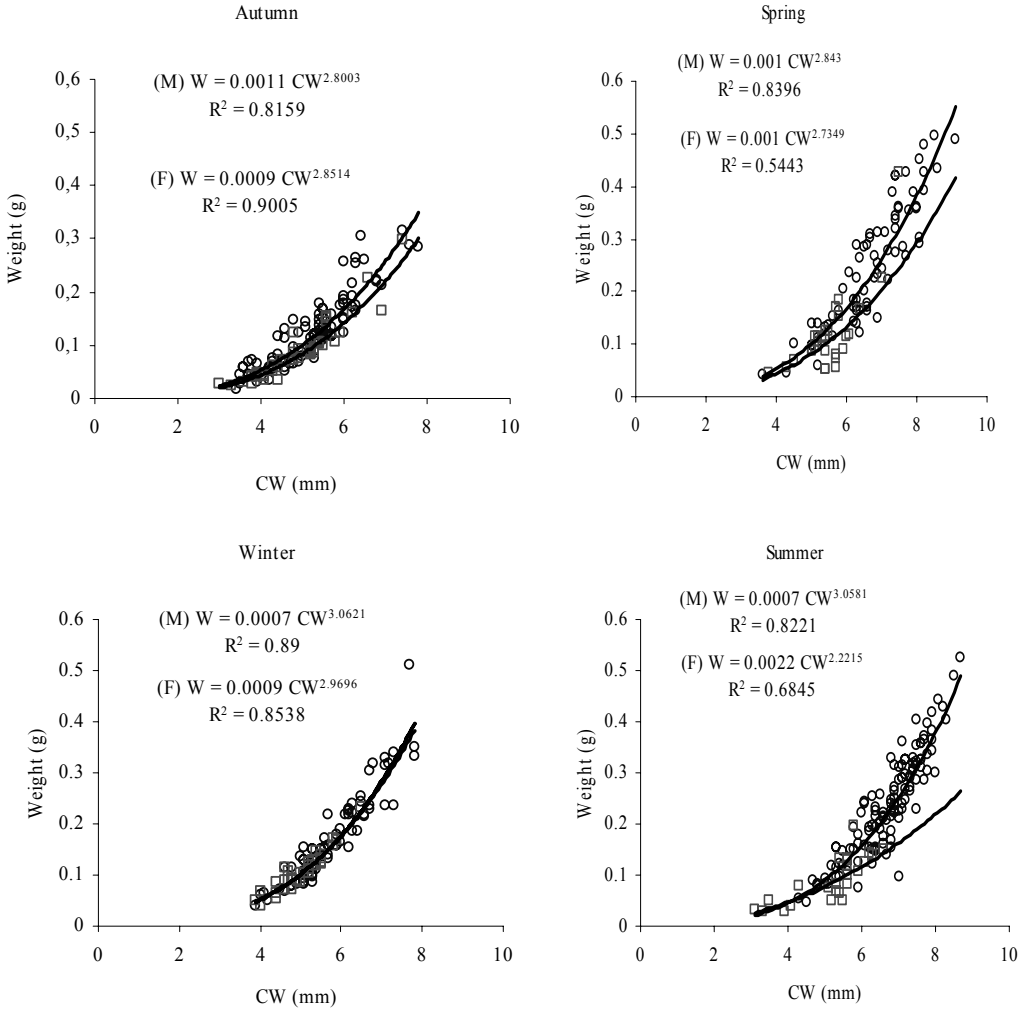

Fig. (7): Seasonal changes in carapace width - weight relationship for males and females of *Scopimera crabicauda* (Oct. 04 - Sep. 05). W = a * CW^b (circles = males and squares = females).

3.5 Carapace width-weight ratios

Weight-width ratios of all samples for the 12 month period males and females showed that for most size-classes the male mean weights were heavier than those obtained for the females. The differences in weight for both sexes were in the range of the size classes 3.5-4.0 mm, gradually increasing in the classes above 4.0 mm. The same pattern was found in mean width, with the exception of the size-classes of 3.5-4.0 mm, 4.0-4.5 mm and 4.5-5.0 mm, which were slightly higher in females (Tab. 6).

Table (6): Monthly variation of the a sex ratios of *Scopimera crabricauda*.
A: for different month

Month	No. of males	No. of females	Total	% of males	% of females	Chi-square	Significance
October 2004	33	9	42	78.6	21.4	13.71	S
November	30	12	42	71.4	28.6	7.71	S
December	20	12	32	62.5	37.5	2.00	NS
January 2005	24	9	33	72.7	27.3	6.82	S
Febraury	33	12	45	73.3	26.7	9.80	S
March	16	10	26	61.5	38.5	1.38	NS
April	22	13	35	62.9	37.1	2.31	NS
May	34	5	39	87.2	12.8	21.56	HS
June	25	7	32	78.1	21.9	10.13	S
July	56	6	62	90.3	9.7	40.32	HS
August	40	11	51	78.4	21.6	16.49	S
September	29	22	51	56.9	43.1	0.96	-

Test of heterogeneity: *df* (*df* = 1, P< 0.05)
Sum of 12 Chi-squares 11: 133.19
Pooled Chi-square: 111.75

B: Variation in class-size in males and females of width-size class *Scopimera crabricauda*.

Class-size	No. of males	No. of females	Total	% of males	% of females	Chi-square	Significance
2.5-3.0		1	1		100.0		-
3.0-3.5	1	3	4	25.0	75.0	1	NS
3.5-4.0	12	12	24	50.0	50.0	0.00	NS
4.0-4.5	14	15	29	48.28	51.72	0.03	NS
4.5-5.0	26	17	43	60.47	39.53	1.88	NS
5.0-5.5	62	37	99	62.63	37.37	6.31	S
5.5-6.0	45	29	74	60.81	39.19	3.46	NS
6.0-6.5	58	7	65	89.23	10.77	40.02	HS
6.5-7.0	51	4	55	92.73	7.27	40.16	HS
7.0-7.5	43	2	45	95.56	4.44	37.36	HS
7.5-8.0	33	1	34	97.06	2.93	30.12	HS
8.0-8.5	12		12	100.0			-
8.5-9.0	4		4	100.0			-
9.0-9.5	1		1	100.0			-

Test of heterogeneity: *df* (*df* = 1, P< 0.05)
Sum of 10 Chi-squares 9: 160.34
Pooled Chi-square: 111.75

3.6 Sex ratio

Studies on the sex ratio are based on all specimens with a CW range 2.5 to 9.5 mm. Percentage of each sex has been computed for every month. The observed ratios were tested against an expected 1:1 ratio by using χ^2. These are given in Table 6 which shows that the monthly sex-ratio insignificant (P = 5%) level during December, March, April and September and significant during the rest of the months and highly significant in May, July and August with a preponderance of male. The evaluation of probability of equal abundance of sexes in each class-size showed that up to 0.5 mm there was no significant departure from the expected 1:1 ratio. The males however were significantly more abundant in higher class-sizes. It was noted that in the 8.5 to 9.0 mm class-size the males were more abundant.

3.7 Reproductive season

The smallest female crab bearing eggs recorded was 3.8 mm and the largest was 7 mm in CW. The highest percentage of ovigerous females was in the size range between 7.0- 7.5 CW mm (Fig. 8). Ovigerous females occurred in the population from March to May and from July to September. The major peaks were in April (53.9%) and the lowest values in September 13.6% (Fig. 8). Ovigerous individuals of 4 mm CW were recorded in April 2005 and the same size formed 4.5% from October 2004 to December 2005 comprising between 5-6.7% of the total numbers.

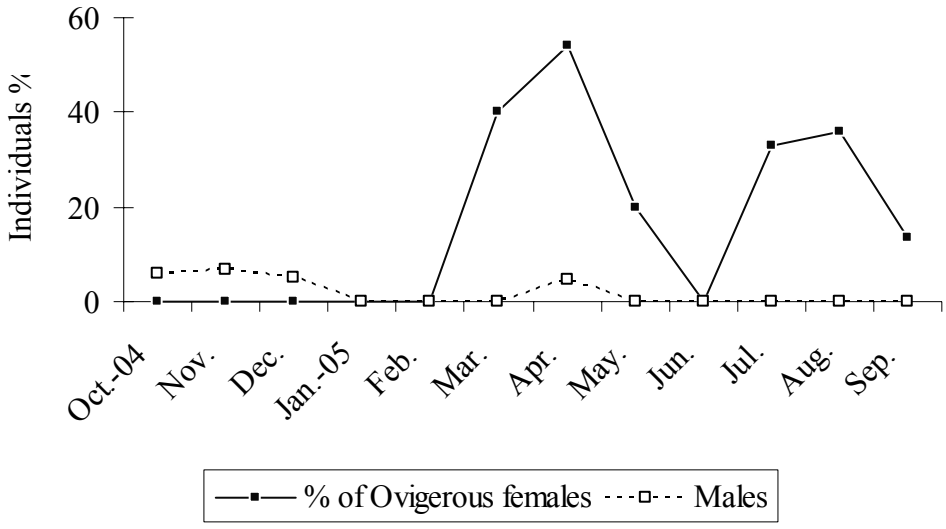

Fig. (8): *Scopimera crabricauda*, black spot: ovigerous females as percentage of mature females (3.5 mm CW); white spot: individuals 4 mm CW as percentage of total individuals, October 2004 to September 2005.

4. DISCUSSION

There are several important factors affectting distribution, position on the shore and populations size of *Scopimera crabricauda*. Ocypodidae mouthparts are highly specialized for extracting food in the form of organic material and micro-organisms from certain substrate particle sizes (Ono, 1965; Von Hagen 1970). Schembri (1982a) reported that texture of substratum is a main factor restricting the distribution of ocypodid crabs. Hartnoll (1973) stated that *Dotilla* and *Scopimera* prefer sandy shores where their specialized mouthparts enable them to sort the sand with high efficiency to extract the low proportion of organic material (Tweedie, 1950; Ono, 1965). Hence the substrate characteristics such as sediment grade, organic matter and moisture content are of primary importance in distribution of the ocypodid crabs (Ono, 1965; Firth, 1977b; Hartnoll, 1973; Wada, 1976, 1982 and Icely and Jones, 1978).

The sand flat of Al-Wakrah is mainly dominated by *Scopimera crabricauda*. They were also observed to dominate the high shore especially on more sheltered shores of this area. Equally *Scopimera proxima* was reported to dominate upper intertidal zone (Silas and Sankarankutty, 1967). On the other hand, the distribution of *Scopimera globosa* is reported for the mean tide level, and the population may be found in narrow (Harada and Kawanabe, 1955) intertidal bands. Clayton and Al-Kindi (1998) studied two Scopimerine sand crabs *Scopimera crabricauda* and *Dotilla sulcata* where they found that the former occurred between low high water neap and mean low water neap, and the later below this down to near mean low water springs. Sediment grain size is an important factor in determining position of the crab on the shore. Analysis of the substrates occupied by *Scopimera crabricauda* in the present study area indicated that *S. crabricauda* is restricted to medium grain sands where the silt fraction is very small. In general, *Scopimera* prefered well-drained, clean, medium to fine grain sands where the silt-clay fraction (<63µm) is very small (<2%) (Day and Morgans 1956; McNae and Kalk 1962; McIntyre 1968; Hartnoll 1973; Day 1974; Wada 1976, 1982; Titgen 1982; Clayton and Al-Kindi 1998).

The thermal regime in Qatar is typical of arid regions with high temperatures and high evaporation. Variation in sea water temperatures in the study area followed that of the air temperatures in the different months. Measurements of surface sea water temperatures on the monthly basis showed that the surface water temperature attained its minimum values in winter and increased to a maximum value during summer. Due to the high rate of evaporation, shallowness of the seawater and the absence of terrestrial runoff the salinity also showed seasonal variations. It is apparent that the tidal flat fluctuations are most significant to the overall ecology of the area.

Uca sp were found to be affected by temperature and high humidity (Macnae 1968; Crane 1975), salinity (Ono 1965), and tidal wetting (Ono 1965; Crane 1975; Firth *et al*., 1976).

4.1 Carapace width-weight relationship

Since the value of 'b' for logarithmic relationships between carapace width-weight in the equation calculated for this species is close to 3, it can be concluded that the weight increased approximately as the cube of its width. This normal relationship implies that the environmental factors are adequate for this crab species (Al-Khayat 1996). *Scopimera crabricauda* showed little difference between the slope values as shown in Figure 7 and a single regression suffices to describe the species (Hartnoll, 1982).

The carapace width-weight measurements revealed that for the same carapace widths males (0.02 to 0.5 g) were heavier than

females (0.03 to 0.43 g). Seasonal changes in weight for the same carapace width for females occurred with maximum weights in winter, and lowest in summer for females (autumn for males). As winter water temperatures drop to 13°C and summer temperatures exceed 30°C with a high salinity (>40‰) this might be explained by water loss from crabs during summer period (Tagatz 1965). Al-Khayat (1996) reported that females of *Nasima dotilliformis* and *Serenela leachii* showed greatest seasonal weight during autumn, while *Eurycarcinus orientalis* and *Macrophthamus depressus* during summer. For the females of these species it is likely that accumulation of reproductive biomass in connection with spawning masks any environmentally related weight loss (Al-Khayat, 1996).

4.2 Ovigerous females

Ovigerous *Scopimera globosa* occur during the summer months (Yamaguchi and Tanaka 1974; Wada 1981a, Suzuki 1983; Henmi and Kaneto 1989). In Kuwait, Snowden *et al.,* (1991) stated that the ovigerous females of *Ilyoplax stevensi* appear to be present all the year round, but in greater proportions during September to March, while ovigerous *Tylodiplax indica* occurred between May and August. In south west India, the breeding of *Ilyoplax gangetica* is largely restricted to winter, possibly timed to coincide with post-monsoonal food abundances (Pillai and Nair 1971). In temperate regions, ovigerous *Macrophthalmus hirtipes* in New Zealand, are present all the year round except for the autumnal months of March and April (Simons and Jones 1981).

Clayton and Al-Kindi (1998) also suggested a similar autumnal cessation of breeding for both *Scopimera crabricauda* and *Dotilla sulcata*, but indicated two peaks of breeding for both species with those for the higher shore *S, crabricauda* occurring before those of *D. sulcata*. Similarly, in the present study *Scopimera crabricauda* showed two peaks of breeding March-April and September-October. The major peaks were in April 53.9% and the lowest in September.

4.3 Sexual maturity

Determination of size at sexual maturity is not only of scientific interest but also of particular value as it serves as an important tool in the studies of population dynamics and management of commercially exploited resources (Jacob *et al.,* 1990). In the present investigation it was revealed that the female *Scopimera crabricauda* attain sexual maturity at 3.8 mm in carapace width. In Oman, Clayton and Al-Kindi (1998) reported that the size of ovigerous *S. crabricauda* ranged between 3.1-5.43 mm CW with low numbers of eggs produced in comparison with those produced by the larger *S. globosa*, while *D. sulcata* attaining a larger size of 7.8 mm CW with high number of eggs. No information is available about size at sexual maturity for males of *Scopimera crabricauda*, but it is not unreasonable to assume that the size at first maturity, as in the case of females, may also occur in small size classes.

4.4 Spawning season

The peak in the number of juvenile crabs shows that recruitment of this species mainly takes place between October–November and April–June. Therefore the highest peak of breeding, which occurs in July-August leads to recruitment in October. From Figure (6) the smallest sizes enter population in October, hence ovigerous females were abundant on March-April but by June-August no large crabs were left. This means that they must have died. This suggests that the growth rate is high and life span is of approximately 10-11 months. This population is ovigerous in March-April and give recruits at the end of April. These grow rapidly in summer and breed in July-September. It can be suggested that the main reproduction in *Scopimera crabricauda* is biannual with recruitment from autumn spawning entering population in

late September-October growing up during winter. In contrast, *Scopimera globosa* probably live for two years and there were two distinct mode sizes of adults (Suzuki 1983; Henmi and Kaneto 1989), and females bred in their 2nd year (Wada 1981a). Results given on *Dotilla myctiroides* that females lived for 10 months and males for 13 months (Hails and Yaziz 1982). While for *Scopimera crabricauda* and *Dotilla sulcata* from Oman are consistent with the present study and both of these crabs live for about a year (Clayton and Al-Kindi, 1998).

4.5 Sex ratio

The sex ratio in the smaller size classes shows no significant deviation from 1:1, but in case of size class (5.0-5.5mm) there was significant deviation from the expected 1:1 ratio in favour of males. Similarly at the largest size classes (6mm to 8mm) there were significantly more males. Overall male *Scopimera crabricauda* were significantly more abundant than females with an overall mean M:F ratio of 2.8:1. Deviations from 1:1 are common amongst brachyurans although consistent 1:1 ratios for ocypodids have been reported by Simons and Jones (1981) and Snowden *et al.* (1991). In the present study it is possible that either non-ovigerous females remain at deeper levels staying alone in burrows outside the breeding season, or that males remain on the surface to exhibit territorial displays (Clayton 1988). Clearly further research into the behavior of *Scopimera crabricauda* is required to substatiate such speculation.

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