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DISTRIBUTION AND POPULATION STRUCTURE OF DEEP-WATER CRAB *CHARYBDIS SMITHII* (DECAPODA: PORTUNIDAE) IN THE ARABIAN SEA AND BAY OF BENGAL

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ABSTRACT

The distribution and population characteristics of the potentially commercial deep-water crab *Charybdis smithii* were studied. The crabs were sampled during the research cruises of Fishery Oceanographic Research Vessel (FORV) Sagar sampada performed in the Arabian Sea and Bay of Bengal in 1985–1989. Samples were obtained from both pelagic and benthic zones. In the pleagic zone, the species was found almost throughout the study area with the maximum concentration in the offshore and inshore waters of the southwest coast of India. The highest densities of the benthic population were also found along the southwest coast of India (off Alleppey, 1740 kg h^{-1}). In the benthic zone, the crab was recorded in the depth zone ranging between 60 and 356 m with a maximum average catch at 201–300 m in the Arabian Sea (23.1 kg h^{-1}) and <150 m in the Bay of Bengal. A high percentage of pelagic hauls with *C. smithii* were from the oceanic province. In the Arabian Sea the pelagic crabs were found in almost all months, whereas benthic crabs were obtained only between July and January. The carapace width (CW) of crabs ranged from 11 to 72 mm CW and 11 to 69 mm CW for males and females, respectively. The crabs ≤31 mm CW were not found in the benthic catches. Juveniles ≤20 mm CW were only found in the pelagic zone with a high concentration in the oceanic province. Sex ratio of juvenile population was 1:1 but in most of the advanced size groups, a preponderance of males over females was noticed. Ovigerous females were found in the benthic zone and were totally absent in the pelagic samples.

The deep-water crab *Charybdis smithii* is an endemic species to Indian Ocean where it occurs in dense aggregation on the surface of deep-oceanic region at considerable distance from the shore (Della Croce and Holthuis, 1965; Stephenson, 1967; Losse, 1969; Zamorov et al., 1991a). Mass concentration of this species has also been reported in the benthic zone of lower continental shelf and upper slope of Indian coasts (Silas, 1969; Mohamed and Suseelan, 1973; Sulochanan et al., 1991). The importance of this species as a potential resource for future exploitation (Silas, 1969; Sulochanan et al., 1991) as well as its role in the trophic structure of scombroid fishes and pelagic sharks (Losse, 1969; Zamorov et al., 1991b) has been documented. However, knowledge regarding its life habits, ecology and population characteristics are still far from being well understood. Aspects of reproductive biology and feeding habits of this species have been reported by Balasubramanian and Suseelan (1998a,b). Little else is known of its biology. In this paper, we report spatial and seasonal distribution, size composition and sex ratio.

Materials and Methods

Samples were obtained from 75 research cruises of the fishery oceanographic research vessel (FORV) Sagar Sampada performed in 1985–1989 in the Arabian Sea and Bay of Bengal (05°00′N–23°30′N and 65°00′E–77°30′E in the Arabian Sea, 05°00′N–21°30′N and 77°30′E–95°30′E in the Bay of Bengal). Three types of nets namely Isaacs-Kidd midwater trawl (Isaacs and Kidd, 1953), pelagic trawl and bottom trawl (Panicker, 1990) were used during these surveys. The Isaacs-Kidd midwater trawl (IKMT) had 2.5 m total length and 4 m vertical opening with a mesh size of 1.5 mm (stretched) at the cod-end. A total of 429 IKMT hauls taken between February 1985 and July 1986 were examined for the present study, of which 259 were taken from the Arabian Sea (west coast) and 170 were from the Bay of Bengal (east coast) (Fig.1). The net sampled planktonic/micronektonic organisms of the deep scattering layers (dsl) which occupied the upper strata of the ocean up to a maximum depth of 600 m from the surface (Suseelan and Nair, 1990). The net was operated for 30 min during each haul horizontally along the dsl at a towing speed of 3 kt. The data were adjusted to correspond 1 h tows.

The pelagic trawl had a total length of 100 m, head rope length of 46.4 m and foot rope length of 26 m with a uniform mesh size of 40 mm (stretched) at the cod-end. The net operates up to a maximum depth of 400 m from the surface and generally 45–90 min tows were made at a tow speed of 3.5 to 4.5 kt. The data were adjusted to correspond to 1 h tows. A total of 334 pelagic trawling operations carried out during February 1985 to September 1989 were examined, of which 166 were from the Arabian Sea and 168 were from the Bay of Bengal (Fig. 1).

The bottom trawling operations were carried out by high speed demersal trawls (Panicker, 1990). The nets were basically two seam or four seam type of 44.5–46.5 m total length, 23.3–28.0 m head rope length and 26 m ft rope length with a mesh size of 40 mm (stretched) at the cod-end. The net was operated at a trawling speed 3.5–4.5 kt. The data were adjusted to correspond to 1 h tows. The bottom trawling operations were conducted between 30 and 777 m depth on the continental shelf and upper continental slope. Out of 445 hauls examined 243 hauls were from the Arabian Sea and 202 from the Bay of Bengal (Fig. 2).

Details of cruise tracks, position of stations, depth, time, duration of trawling and other operational details were obtained from skipper’s logbook. Live samples obtained on board and formalin preserved samples deposited in the Crustacean Fisheries Division of Central Marine Fisheries Research Institute, Cochin (India) were used for biological studies. A total of 2199 specimens were sexed and carapace width (CW) measured to the nearest mm (CW was measured between the sixth antero lateral teeth). Presence of eggs or egg remnants or their absence on pleopod were noted. The crabs of size ≤20 mm CW were considered as juveniles. The sex ratio (as percentage of males) in samples were calculated size wise and tested by (Chi-square (χ^2) test (Snedecor and Cochran, 1967). As the surveys made by FORV Sagar Sampada were exploratory in nature, regular time series data could not be obtained from any particular region.

Results

Spatial Distribution and Abundance in the Pelagic Zone.—One hundred and nine of the 429 IKMT hauls (Fig. 1) provided a total of 3249 crabs. Individual catches ranged from 1 to 862 crabs 30 min^{-1} and the crab formed 0.3% of total IKMT catches (in terms of number). Eighty eight of the 259 IKMT operations made in the Arabian Sea hauled 2897 crabs for an average of 11 crabs per tow. This species was recorded throughout the west coast of India between the latitudes 05^{0}00′ and 21^{0}30′N but dense abundance were recorded off Veraval, areas between Bombay and Marmagoa, Mangalore and Quilon and off Cape Comorin (Fig. 1). In the Bay of Bengal, 21 IKMT hauls had 352 crabs for an average of two crabs per tow. Dense abundance was recorded off Madras, central as well as southern Bay of Bengal.

Seventy-two hauls of the 334 pelagic trawl catches (Fig. 1) yielded a total of 66,888 crabs (range: 2–54,306 crabs h^{-1}). Forty-eight hauls in the Arabian Sea had 65,185 crabs with an average of 393 crabs per tow. The crabs were trawled from almost throughout the pelagic zone in this sea, but dense abundance was found on the south west coast of India (Fig. 1). All the six pelagic trawl catches with >500 crabs h^{-1} were located between the latitudes 07^{0}00' and 09^{0}30′N. An unusual heavy catch of 54,306 crabs h^{-1} was recorded

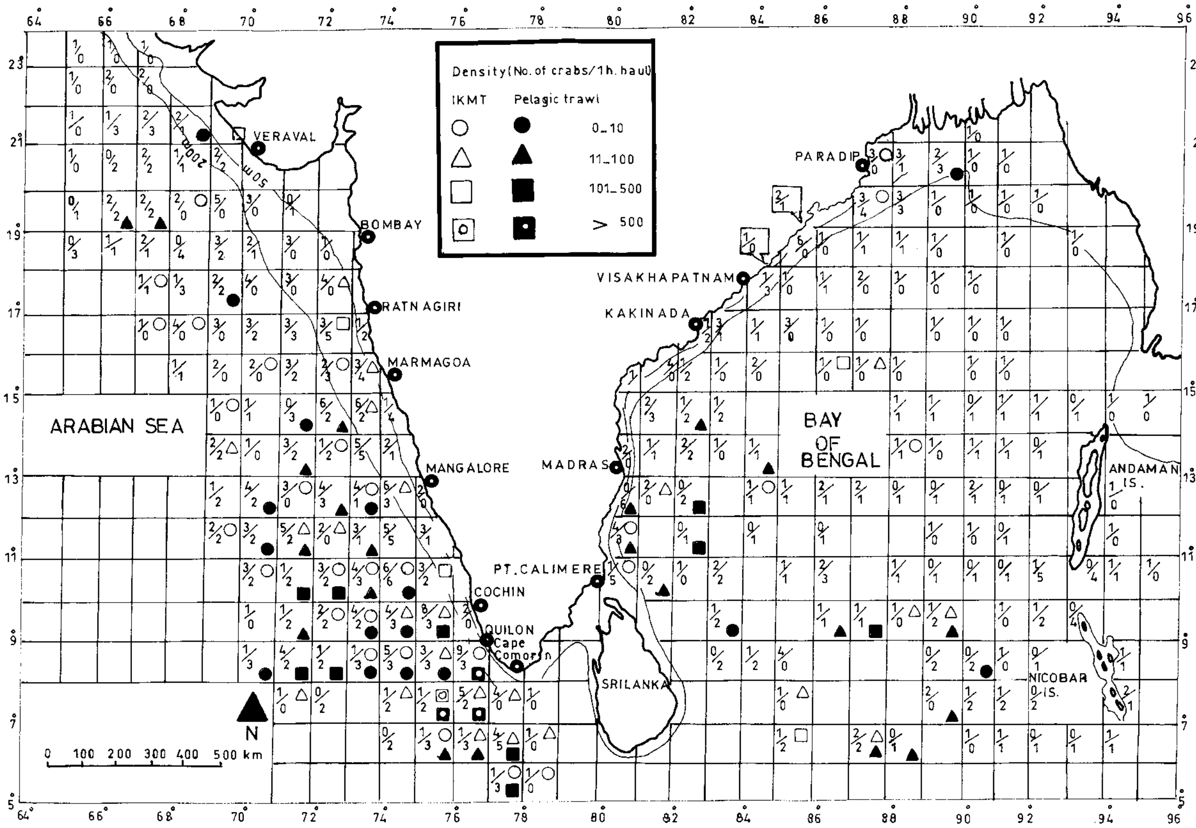

Figure 1. Distribution and abundance of *Charybdis smithii* in the pelagic zone based on Isaacs-Kidd midwater trawl and pelagic trawl operations made during the surveys of Fishery Oceanographic Research Vessel SAGAR SAMPADA. The number given above the bar denotes the IKMT hauls and number below the bar represents pelagic trawl hauls made in each one degree square.

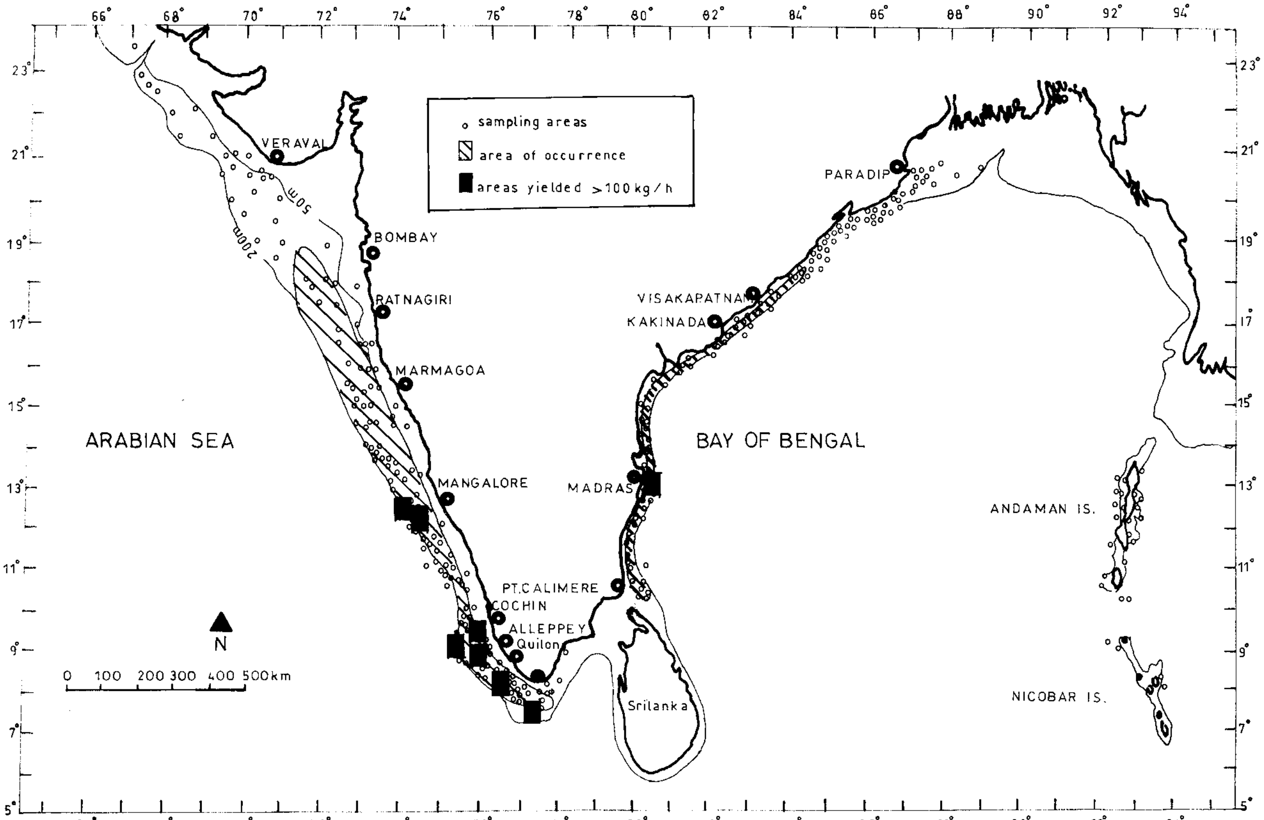

Figure 2. Distribution and abundance of *Charybdis smithii* based on bottom trawl operations made during the survey of Fishery Oceanographic Research Vessel SAGAR SAMPADA.

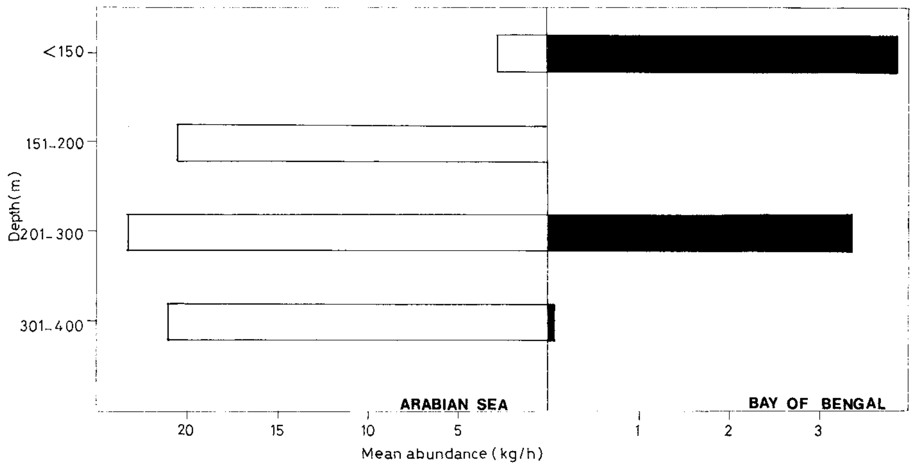

Figure 3. Bathymetric distribution and mean abundance based on bottom trawl catches taken from the Arabian Sea and the Bay of Bengal.

from the offshore water off Quilon. Twenty four hauls in the Bay of Bengal yielded for 1703 crabs with an average of 10 crabs per tow. In this sea the maximum abundance was recorded in the oceanic waters between Point Calimere and Madras as well as in the southern central region of Bay of Bengal (Fig. 1).

Spatial Distribution and Abundance in the Benthic Zone.—Forty two of the 445 bottom trawl catches had *C. smithii* weighting 4976.67 kg. Individual catches ranged from 0.1 to 1740 kg (an average of 11.2 kg h^{-1}). The largest catch occurred off Alleppey (1740 kg h^{-1}). The crabs were found to be distributed at the bottom of the lower continental shelf and upper continental slope between Cape Comorin and Bombay on the west coast and between Point Calimere and Gopalpur on the east coast (Fig. 2). Thirty-seven trawls in the Arabian Sea netted 4,368.2 kg for an average of 18 kg per tow. Thirty three of these hauls made between 07°30′ and 14°00′N, accounted for about 99% of benthic catches. Dense concentration were recorded between Manglore and Ponnani (depth 101–200 m) as well as Cochin and Cape Comorin (depth 201–300 m). Five trawls in the Bay of Bengal accounted for 608.5 kg with an average of 3 kg per tow.

In the pelagic zone, *C. smithii* was found at the subsurface waters of neritic as well as oceanic province between ~40 m and ~4000 m respectively. A marked high proportion (83%) of this species caught by the IKMT was from the oceanic province, whereas 82% of this species trawled by pelagic trawl was from the neritic province. The high proportion of this species in the neritic catches of the pelagic trawl was owing to a single heavy catch (54,306 crabs h^{-1}, depth 83 m) the number of IKMT and pelagic hauls yielding *C. smithii* were higher in the oceanic province than in the neritic province.

In the benthic zone *C. smithii* was recorded in almost all the depth zone ranging from 60 to 356 m on the continental shelf and upper continental slope, however the depth of high concentration varied considerably in the Arabian Sea and Bay of Bengal (Fig. 3). The maximum average catch rate (23.1 kg h^{-1}) was recorded in the depth zone 201–300 m in the Arabian Sea, whereas in the Bay of Bengal the maximum average catch rate was recorded <150 m depth zone.

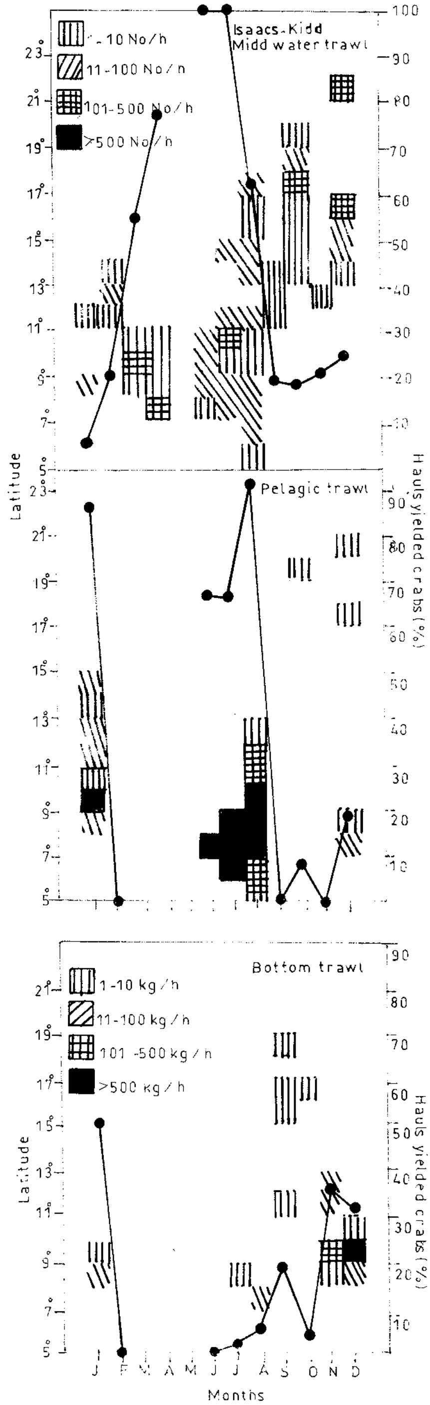

Figure 4. Monthwise distribution of *Charybdis smithii* in the Arabian Sea. Percentage of hauls yielded crabs are also represented.

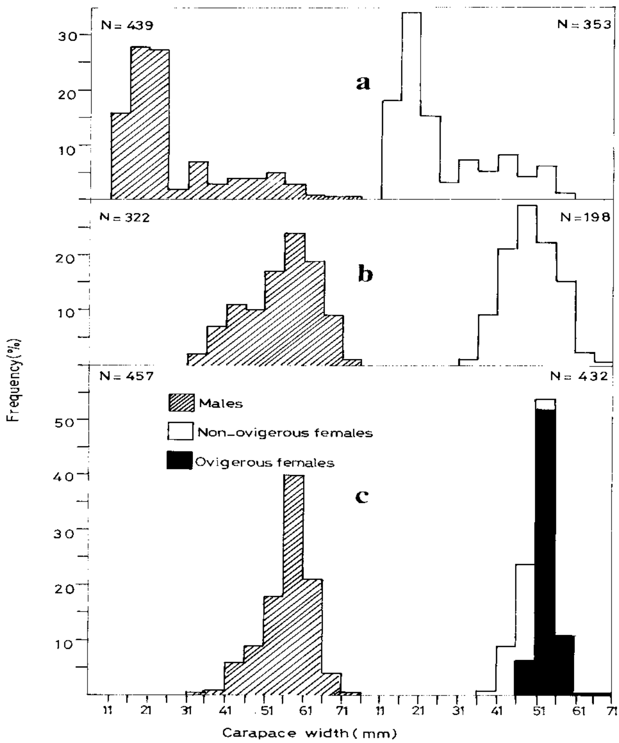

Figure 5. Overall size frequency distribution of *Charybdis smithii* as a function of sex in the samples taken by different gears a. Isaacs-Kidd midwater trawl, b. Pelagic trawl and c. bottom trawl.

Seasonal Distribution and Abundance.—In the pelagic zone of the Arabian Sea, the crabs occurred in all months except in May with maximum abundance in summer monsoon (June–September) (Fig. 4). No IKMT or pelagic trawling operations, however, were carried out in May. On the other hand, in the benthic zone, *C. smithii* was only found from July to January with highest abundance in winter monsoon (October–January). There was no clear trend in abundance or occurrence of the crab in the Bay of Bengal because of insufficient catch.

Size Composition.—Overall size frequency distribution of *C. smithii* obtained in IKMT, pelagic and bottom trawl catches indicates that males were slightly larger than females reaching a maximum size of 72 mm CW compared with 69 mm CW for females (fig. 5). In IKMT catches about 70% of crabs were juveniles (≤20 mm CW), whereas pelagic and bottom trawl catches were entirely constituted by subadults and adults. In IKMT catches advanced juveniles and adults of both sexes were generally scarce, however, crabs in size range 36–61 mm CW were more frequently found when catches were low. In pelagic trawl catches, nearly 60% was constituted by size group ranging 51–61 mm in male, and 85% by size group ranging 41–61 mm in females. About 80% of males in the bottom trawl catches were between 51 and 66 mm CW, whereas 70% of females were between 41 and 61 mm CW. Examination of carapace width statistics for each sex in different gears (Table 1) showed that mean sizes of males and females were greatest in bottom trawl catches. Males were significantly larger than females in both pelagic and bottom

Table 1. Results of t test (Ts) comparsion of mean size of male and female *Charybdis smithii* in the catches of Isaacs-Kidd midwater trawl (IKMT), pelagic trawl and bottom trawl. *indicates significance at 0.001.

Gear	Male			Female			Ts.
	Mean	Range	SD	Mean	Range	SD	
IKMT	26.40	11–72	13.50	26.10	11–58	12.80	0.32
Pelagic trawl	54.70	31–72	9.20	48.60	31–69	6.70	8.70*
Bottom trawl	57.10	31–72	6.50	51.60	36–69	4.20	15.30*

trawl catches, no significant difference, however was noted in the size of male and female in the IKMT catches. Mean carapace width of crabs in the bottom trawl catches was also significantly larger that of crabs in the pelagic trawl catches (males: $ts = 4.1$, $P < 0.01$; females: $ts = 5.8$, $P < 0.01$). In the benthic zone of the Arabian Sea, the mean sizes of both sexes were greatest in January (57.9 mm for males and 51.5 mm CW for females) whereas in July–August (summer monsoon) mean sizes of both sexes were smaller than January (Fig. 6).

Sex Ratio.—Pooled samples from the pelagic and benthic zone showed a ratio of 1.4 males to 1 female (792 m, 560 f) and 1.3 males to 1 female (248 m: 190f), respectively, and indicated a preponderance of males over females in both samples. However, the deviation from the expected ratio (1:1) was not significant. Table 2 shows the sex ratio of individual samples obtained from the trawling operations of IKMT, pelagic trawl and bottom trawl. Sex disparity was not statistically significant in any of the IKMT samples. In all the pelagic trawl samples males showed a preponderance over females and out of 11 samples, six samples showed that variation in sex ratio was statistically significant ($P < 0.01$). In all the bottom trawl samples examined, except one (in which females dominated) the males outnumbered females. Out of 9 samples, six showed that variation in sex ratio was statistically significant ($P < 0.01$). A single sample obtained from the Bay of Bengal showed an exclusive population constituted by males. Figure 7 shows the sex ratio as a function of size. In pelagic crabs, sex ratio did not differ significantly from 1:1 at the size ≤20 mm CW, however the size group >20 mm to 31 mm CW males dominated significantly ($P < 0.01$). The size group ≤31 mm to 56 mm CW did not differ significantly from the expected 1:1 ratio, then proportion of males increased steadily and at ≤71 to76 mm CW 100% of population was composed of males. In the benthic crabs size group ≥41 to 56 mm CW showed a significant deviation from the expected 1:1 ratio ($P < 0.01$), and where females dominated over males (Fig. 7). In remaining size group ≥56 mm CW males dominated over females significantly ($P < 0.01$).

Occurrence of Ovigerous Females and Juveniles.—Ovigerous females ranging between 46 mm and 69 mm CW were found to occur only in the bottom trawl catches, and none of the females of this size group in the IKMT as well as pelagic trawl catches were found to be ovigerous (Figs. 5,6). Further, in the pelagic collections, the ovaries of all specimens were immature, whereas almost all crabs examined from the bottom were either ovigerous or ovaries with different stages of maturation (Balasubramanian and Suseelan, 1998a). In the Arabian Sea, ovigerous females were most abundant (~80%) in January (winter monsoon). However, very few ovigerous crabs were trawled in July and August (summer monsoon) (Fig. 6).

A total of 2657 juveniles were sampled during the present survey and all the juveniles were obtained from the pelagic zone by IKMT operations. A total of 2489 (94%) juve-

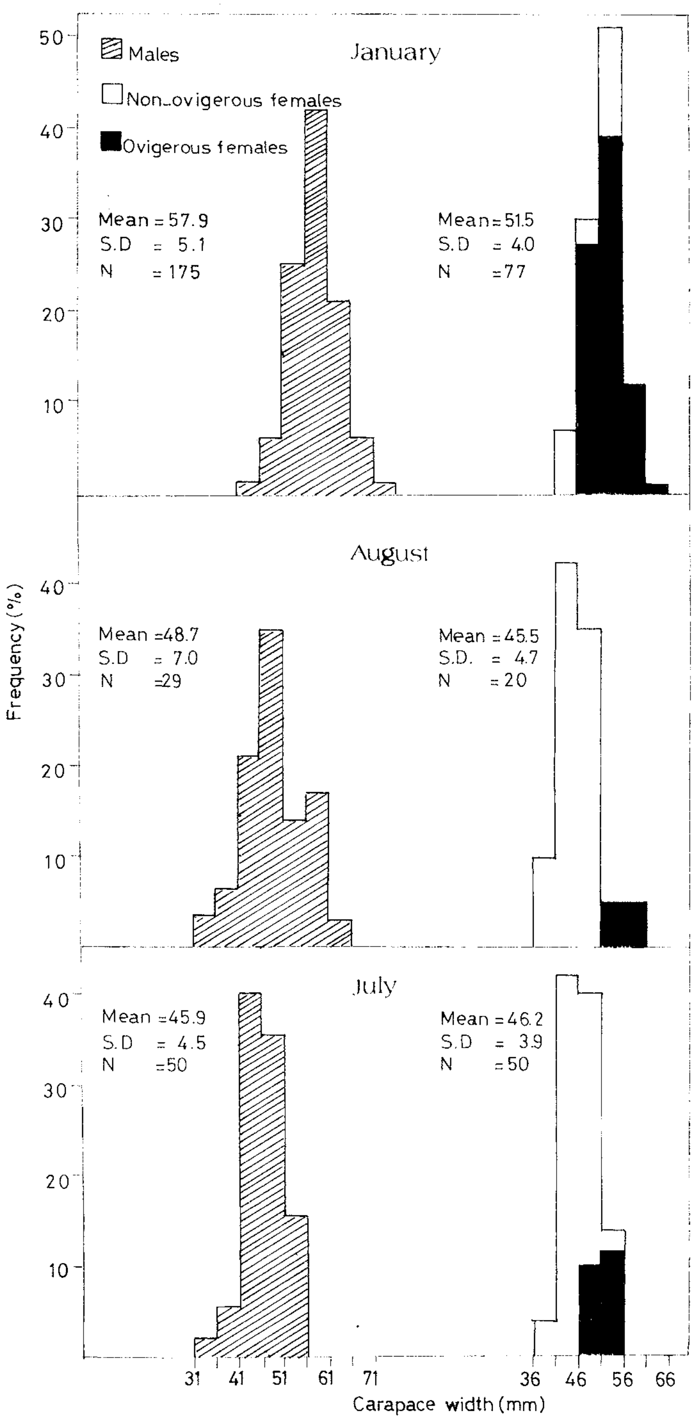

Figure 6. Size frequency distribution of *Charybdis smithii*, by months, taken by bottom trawl from the Arabian Sea.

Table 2. *Charybdis smithii* Distribution of sex ratios in different gears.

	Issacs-Kidd midwater Trawl			Pelagic trawl			Bottom trawl		
	Position	Depth of operation (m)	Sex ratio (M:F)	Position	Depth of operation (m)	Sex ratio (M:F)	Position	Depth of operation (m)	Sex ratio (M:F)
1	07º30′N 75º30′E	2,765	1.2:1	06º03′N 75º04′E	2,391	1.2:1	07º30′N 77º30′E	88	1.4:1
2	07º31′N 76º47′E	1,670	1.3:1	08º00′N 71º00′E	4,158	3.2:1*	08º35′N 76º15′E	273	5.6:1*
3	09º29′N 74º15′E	3,815	1.2:1	08º00′N 72º10′E	3,094	1:1	09º04′N 75º41′E	260	19:1*
4	12º30′N 81º10′E	3,403	1.2:1	10º58′N 73º00′E	2,141	1.2:1	09º04′N 75º45′E	299	3:1*
5	16º00′N 72º40′E	504	1.1:1	10º51′N 74º46′E	2,141	1.7:1*	09º18′N 75º55′E	239	2.4:1*
6	06º55′N 86º00′E	3,815	1.2:1	11º00′N 72º00′E	1,870	1.3:1*	09º19′N 75º55′E	320	1:2.8*
7	07º00′N 85º00′E	385	1.2:1	10º30′N 81º30′E	1,050	2.2:1*	12º41′N 80º27′E	86	1.2:1
8	15º00′N 87º24′E	2,937	1.2:1	11º00′N 80º10′E	75	32:1*	13º23′N 80º21′E	60	1.2:1
9				12º00′N 80º40′E	2,643	2.2:1*	13º55′N 80º23′E	60	100:0*
10				12º36′N 82º31′E	3,423	1.4:1			
11				14º00′N 82º00′E	3,320	1.7:1*			

* Significant at 0.01% level

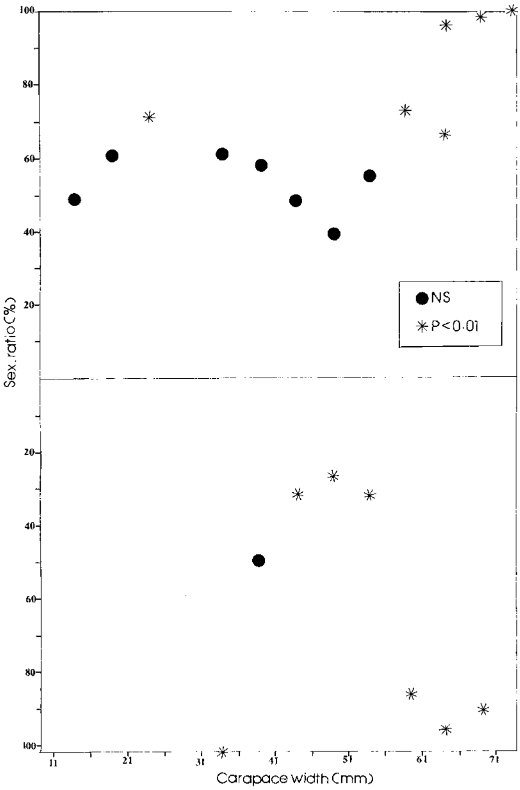

Figure 7. Sex ratio (as proportion of males) of *Charybdis smithii* in pelagic and benthic zones as function of size. Significant (P < 0.01) and non significant deviation (χ^2 test) from expected 1:1 sex ratio.

niles were obtained from the Arabian Sea. Juveniles were trawled from inshore waters (~40 m) as well as deep oceanic waters (~4000 m). Nevertheless, the highest abundance of juveniles was found at the oceanic waters. Juveniles were recorded in almost all months of the year except February, May and November (there was no IKMT operation in May).

Discussion

Size Composition.—A wide range of size of the crab varying between 11 and 72 mm CW was recorded during the present study. Juveniles (≤20 mm CW) were a regular component of IKMT catches and it was absent in the bottom trawl catches. This could not totally be explained by mesh selectivity of the bottom trawl, because crabs belonging to different genus/species measuring more or less the same size of juveniles of *C. smithii* were often trawled by this gear from the same fishing ground (Suseelan, unpubl. data). This precludes the possibility of the existence of juveniles of this species at bottom and suggests that the juveniles of *C. smithii* may not have a benthic life as in the case of most of the brachyuran crabs. This phenomenon which elsewhere in brachyura occurs only in certain pinnotheridae and deep-sea majid crab *Dorhynchus thomsoni*. (Hartnoll, 1971; Rice and Hartnoll, 1983).

During the present study comparatively larger size was recorded for males than females and this is in agreement with the general pattern of brachyuran crabs. Earlier workers also recorded a greater size for males than females for this species (Della Croce and Holthuis, 1965; Losse, 1969; Silas, 1969). The difference in size between males and females has also been observed in many brachyuran crabs (Katoh et al., 1956; Haefner, 1978; Wenner et al., 1987; Padayatty, 1990).

SEX RATIO.—Our results indicate that sex ratio for the total population, pelagic and benthic, was close to 50% but it varied markedly with the size of crabs except in juveniles where male-female ratio was close to 50%. Possible factors affecting changes in sex ratio include growth rate, longevity factors, sex reversal, differential mortality and differential migration (Wenner, 1972). In both pelagic and benthic samples, size group ≥56 mm CW showed a significantly higher proportion of males over females (Fig. 5). This could indicate male crabs likely to have a longer life than females. Further, mortality of females might be higher after spawning as in the case of deep-sea shrimp, *Pandalus borealis* (Allen, 1959) and *P. jordani* (Dahlstrom, 1970). Present results also show that 50% of pelagic and bottom trawl samples were predominated by males than females significantly (Table 2). Losse (1969) also recorded predominance of male *C. smithii* over females. One of the bottom trawl samples was exclusively constituted by males. Silas (1969) also noted exclusive mono-sexed catches and this prompted to suggest sexual seggregation for this crab at least during some season.

PELAGIC PHASE AND BREEDING POPULATION.—The results suggest that *C. smithii* has a distinct pelagic phase noticed in all life stages including juveniles, subadults and adults. Animals included in brachyura are typically permanent members of benthos as adults. Instances of pelagic occurrence have however been reported in certain species of grapsid and portunid crabs. The grapsid crab, *Varuna litterata* occurs in surface of inshore waters on drifting along the floating objects (Sakai, 1976). Among portunid crabs pelagic occurrence and swarming adult stages is reported in *Portunus sayi* (Hartnoll, 1971), *P. affinis* (Jerde, 1967), *P. hastatus* (Bouvier, 1940), *Polybius henslowi* (Allen, 1968) and *Euphylax dovii* (Jerde, 1967). Other crustaceans of similar habits are anomuran crabs, *Pleuroncodes planipes* and *Munida gregaria* (Boyd, 1967; Longhurst, 1967; Williams, 1980). All the above species except *Portunus sayi* have benthic phase in addition to the pelagic phase, however *P. sayi*, has been described as completely pelagic (Hartnoll, 1971).

The factors which govern the distribution, abundance and pelagic occurrence have not satisfactorily been explained in none of the animals showing this unusual behavior. In *P. planipes* Boyd (1967) reported that length frequency distribution of benthic animals overlaps with the pelagic stock and this prompted the suggestion that there could be an alternation of individuals between the two habitats. This cannot be the sole explanation of the dual habitat occupied by *C. smithii* where the size composition of benthic and pelagic individuals are different (Fig. 5). Besides pelagic crabs are entirely composed of non-ovigerous females, whereas ovigerous crabs are found only at the bottom. In stomatopod, *Oratosquilla investigatoris* Losse and Merrett (1971) observed surface swarming only once in 3 yrs of their survey and it has prompted the suggestion that the pelagic swarming could be the result of population explosion. But the present survey indicates that the pelagic occurrence is a regular phenomenon for *C. smithii*. Losse (1969) suggests that the pelagic swarming of *C. smithii* may be associated with active voracious feeding phase following spawning. Balasubramanian and Suseelan (1998b) have also been reported voracious feeding habit of pelagic crabs, however condition of vulva of pelagic females did not provide any evidence of mating (Balasubramanian, 1993). Females trawled from the pelagic zone were entirely constituted by non-ovigerous individuals in contrast to the high percentage (53–98%) of ovigerous females in the bottom trawl collections. Further, there is no evidence of gonadal maturation in the pelagic individuals, although 50% of females caught from the pelagic zone were above the estimated minimum size of maturity (Balsubramanian and Suseelan, 1998).

Della Croce and Holthuis (1965) and Losse (1969) have also reported the absence of ovigerous crabs of *C. smithii* in their surface swarm collections. In *Portunus affinis,* species of similar habit, Jerde (1967) noted the non-ovigerous females in pelagic zone and ovigerous females of this species are found only at the bottom. In view of this he concludes, "it is possible that the pelagic *P. affinis* found far at sea over deep-water are not part of the reproductive population. They may have developed from larvae that drifted out to sea and subsequently developed into young crabs, where conditions were favourable". Our results also confirm a pelagic non-breeeding population and a benthic breeding population.

The question to be resolved, therefore, is whether or not the oceanic individuals in the pelagic phase are lost to the parent stock on the continental shelf edge and slope or return to the coastal areas. Though the largest specimens were recorded in both pelagic and benthic samples, the means size of benthic individuals are significantly larger than pelagic individuals. This indicates at least a part of offshore pelagic individuals might eventually settle at the bottom of lower shelf and upper slope water.

Losse (1969) and Zamorov et al. (1991a) suggest that *C. smithii* leaves from the shelf waters during southwest monsoon shifts to northeast monsoon and crabs aggregates in the pelagic zone during the inter monsoon period (September–November). Our results, however showed that maximum abundance in the pelagic zone of the Arabian Sea occurred during the summer monsoon (June–August) period (Fig. 4). In the benthic zone of the Arabian Sea, the maximum concentration was found in the winter monsoon (October–January)

Abundance at Bottom.—The results of bottom trawling operations indicate a wide range of distribution for the species in the Arabian Sea and Bay of Bengal however, dense concentration occurs at southwest coast of India, and certain restricted pockets on the east coast. On the south west coast the areas of abundance of this resource restricted to Mangalore-Ponnani area at 101–200 m and in Cochin Cape Comorin at 201–300 m. These results agree with that reported by Silas (1969) and Sulochanan et al. (1991) for this species. The bottom condition was found to be as an important variable in different trawling grounds of southwest coast. The outer continental shelf, north of Cochin is reported to be fine mud and sand, whereas the same depth region of most of the southern areas are rocky. The upper continental slope south to Cochin is generally soft due to fine grey mud composed of foraminiferan shells (John and Kurian, 1959; Silas 1969). The abundance of crabs thus appears to have a close relationship with muddy substratum prevailing the outer continental shelf north of Cochin and upper continental slope south of Cochin. This observation is in agreement with that of Wenner et al. (1987) who noticed that the abundance of golden crab *Geryon* (= *Chaceon*) *fenneri* was closely related to substratum characterized by a mixture of slit-clay and foraminiferan shells.

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