Distribution and Abundance of Cephalopod Paralarvae in the Bay of Bengal

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Abstract

The 34 survey stations were conducted to collect the cephalopod paralarvae in the Bay of Bengal aboard M.V. SEAFDEC during 6 November to 7 December 2007 using a pair of bongo nets. A total of 278 paralarvae of 13 families and 19 genera were collected from 29 of 34 stations. The most numerous families were the Ommastrephidae (41% of total catch) followed by families Enoploteuthidae (14%) and Onychoteuthidae (6%). The majority of individuals were *Nototodarus hawaiiensis* (49 individuals) and *Abraliopsis* sp. (24 individuals). The paralarvae catch during the survey are all oceanic species (suborder Oegopsida) except 2 families from suborder Incirrata (order Octopoda). The compositions of the cephalopod paralarvae from the results show that the abundant paralarval squid is the commercial and/or minor-commercial target species to fisheries (Ommastrephidae, Enoploteuthidae, Thysanoteuthidae, Octopodidae).

Key words: cephalopod paralarvae, Bay of Bengal, distribution, abundance

Introduction

The composition and distribution of the cephalopod early life stages or 'paralarvae' (Young and Harman, 1988) has been investigated in the Pacific coast of Japan (Okutani, 1968 and 1969; Yamamoto and Okutani, 1975; Saito and Kubodera, 1993), the Gulf of Guinea (Arkhipkin *et al.*, 1988), the Northwest Pacific (Okutani, 1966; Kubodera and Okutani, 1981; Kubodera and Jefferts, 1984a; Kubodera and Jefferts, 1984b; Kubodera, 1991), the Arabian Sea (Nesis, 1974; Piatkowski and Welsch, 1991; Piatkowski *et al.*, 1993), and California current (Okutani and Mcgowan, 1969). Although, the Bay of Bengal is one of the largest marine ecosystem, the investigation of paralarvae distribution in the area is still sparse. The knowledge of the early life stages cephalopod distribution and abundance patterns is useful to determining the spawning area and period (Bower *et al.*, 1999). It can also help in understanding cephalopod population dynamics and in developing stock-recruitment models for commercial important species (Vecchione, 1987). The joint research survey by the fishery sector of BIMSTEC to observe and collect scientific data concerned with fishery and oceanographic aspects in 2007 provided a valuable opportunity to analyze the data from the bongo net collection. The present study is objective to provide the information on the composition and distribution of young stages of cephalopod in an extensive region of the Bay of Bengal.

Materials and methods

The sampling of cephalopod paralarvae at 34 survey stations were conducted in three areas off Bangladesh waters (area A; between latitude 16°N-19°N, longitude 88°E-91°E),

India and Sri Lanka waters (area B; between latitude 09°N-14°N, longitude 82°E-85°E), and Myanmar waters (area C; latitude 10°N-12°N, longitude 95°E-97°E) (Fig. 1).

The standard sampling procedure was conducted aboard M.V. SEAFDEC during 6 November to 7 December 2007. All oblique tows made during the day of about 30 minute duration were taken at each station with a pair of bongo nets 45 cm mouth diameter with 330 micron mesh zooplankton net equipped with a calibrates flowmeter at the mouth to measured volume of water filtered. The tow were made from about 150 m depth (mean depth=142 m, S.D.=18.9 m) to the surface at a speed of approximately 2 to 3 knots.

The samples were fixed in 5% formalin seawater solution and bring back to laboratory for sorting and transfer to 50% isopropyl alcohol for permanent preservation.

Cephalopod paralarvae were identified to the lowest possible taxa with the aid of published figures and descriptions of Okutani and Mcgowan (1969); Sweeney *et al.* (1992); Wakabayashi (1993) and Jivaluk (2001).

Dorsal mantle length (mm ML) of all undamaged paralarvaes was measured to the nearest 0.1 mm with an ocular micrometer connected to a stereomicroscope.

The number of cephalopod paralarvae per tow was standardized to number of paralarvae per 1,000 m^3 (individuals/1,000 m^3).

Small paralarvae of families Ommastrephidae and Onychoteuthidae could be distinctive identified only at family level. The identification was not possible either genus or species level because a growth series connecting paralarvae to known adults were not available.

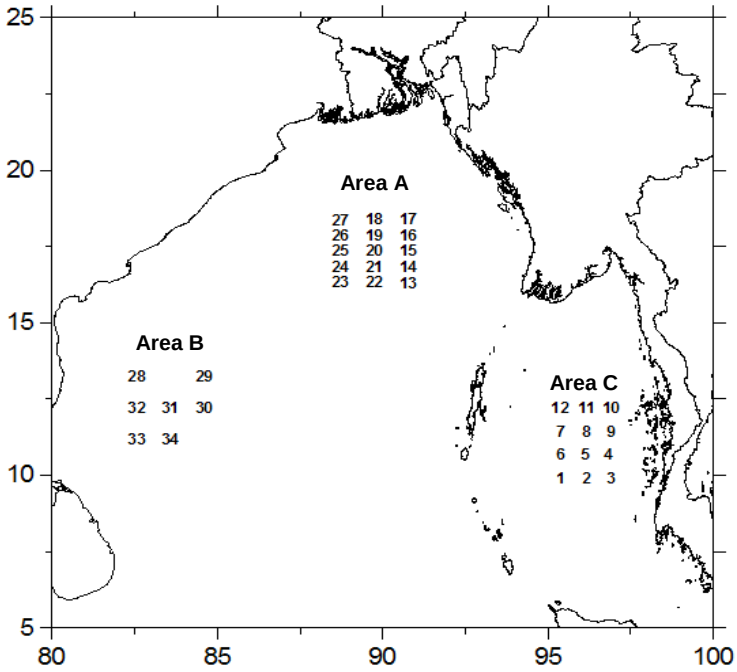

Figure 1 Map of sampling stations of the cephalopod paralarvae in the Bay of Bengal.

Results

Captured Composition

A total of 278 paralarvae of 13 families and 19 genera was collected from 29 of 34 stations (Table 1). The most numerous families were the Ommastrephidae (41% of total

catch) followed by families Enoploteuthidae (14%) and Onychoteuthidae (6%). The majority of individuals were *Nototodarus hawaiiensis* (49 individuals) and *Abraliopsis* sp. (24 individuals).

Only a small number of 24 squids from 9 genera of other families (Ancistrocheiridae, Brachioteuthidae, Chiroteuthidae, Chtenopterygidae, Cranchiidae, Histioteuthidae, Octopoteuthidae, and Thysanoteuthidae) and 6 octopods (order Octopoda; suborder Incirrata) of 2 genera from family Bolitaenidae and Octopodidae were captured (Table 1).

Distribution and Abundance

Order Teuthida (Suborder Oegopsida)

Family Ommastrephidae was the most widely distributed, occurring at 26 stations (Fig. 2). *Nototodarus hawaiiensis* was the most numerous species collected, comprising 43% of the ommastrephid catch, occurring at 13 stations of the survey area A and B (Fig. 3). *Sthenoteuthis oualaniensis* was occurred in survey area A, B and C, collected at 9 stations (Fig. 4).

Family Enoploteuthidae was collected at 18 stations and also occurred in every survey areas (Fig. 5) but less abundance than family Ommastrephidae. *Abraliopsis* sp. was the highest number collected at 11 stations, composed 25% of enoploteuthid catch and more abundance in area B (Fig. 6). *Abralia* sp. and *Enoploteuthis* sp. collected at 4 and 3 stations, occurring in the survey area B and C, but *Enoploteuthis* sp. was less abundance than those of *Abralia* sp. (Figs. 7 and 8).

Family Onychoteuthidae was less abundance than family Ommastrephidae and Enoploteuthidae, occurring at 8 stations in survey areas A, B and C (Fig. 9). *Onychoteuthis* sp. was collected at 3 stations of survey area A and B and composed 25% of onychoteuthid catch (Fig. 10). Onychoteuthid species A were collected only in survey area C, composed 75% of onychoteuthid catch (Fig. 11).

Family Chtenopterygidae contained 9 individuals of *Chtenopteryx* sp. (3% of total catch) were collected at 5 stations of area B and C (Fig. 12).

Family Chiroteuthidae was collected at 5 stations from area A, B and C (2% of total catch). *Chiroteuthis* sp. occurred in three areas but *Asperoteuthis* sp. was found a single specimen in area B (Fig. 13).

Family Brachioteuthidae was collected 3 individuals of *Brachioteuthis* sp. at 2 stations of area B and C (Fig. 14).

Family Thysanoteuthidae was collected only 2 individuals of *Thysanoteuthis rhombus* at 2 stations of area A and C (Fig. 15).

Single specimen of 4 genera (*Ancistrocheirus lesueuri*, *Liocranchia* sp., *Histioteuthis* sp., *Octopoteuthis* sp.) from 4 families (Ancistrocheiridae, Cranchiidae, Histioteuthidae, Octopoteuthidae) were found in area B and C (Table 1).

Order Octopoda (Suborder Incirrata)

Octopus sp. (family Octopodidae) was collected at 2 stations (3 individuals) of area C and 1 station (1 individual) of area A. Only 2 individuals of *Japettella* sp. (family Bolitaenidae) was collected at the same station (station 23) in area A (Fig. 16).

Table 1 Number of species and individuals of cephalopod paralarvae collected by zooplankton net during the BIMSTEC survey and mantle length range (mm) of samples.

	Area C												Area A														Area B							Total	ML range (mm)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34		
Order Octopoda																																				
Family Bolitaenidae																																				
Japettella sp.?																							2												**2**	**2.3 - 8.5**
Family Octopodidae																																				
Octopus sp.			2					1																			1								**4**	**1.7 - 3.9**
Order Teuthidae																																				
Family Ancistrocheiridae																																				
Ancistrocheirus lesueuri									1																										**1**	
Family Brachioteuthidae																																				
Brachioteuthis sp.	2																														1				**3**	**3.5 - 4.2**
Family Chiroteuthidae																																				
Asperoteuthis sp.																															1				**1**	
Chiroteuthis sp.	1													1					1													2			**5**	**3.9 - 6.9**
Family Chtenopterygidae																																				
Chtenopteryx sp.			1																											2	1	4	1		**9**	**0.9 - 4.5**
Family Cranchiidae																																				
Liocranchia sp.	1																																		**1**	
Family Enoploteuthidae																																				
Abralia sp.	3					2			2	3																					1				**11**	**1.8 - 7.2**
Abraliopsis sp.	3	1						1								1			2		1			1					7	1	4			2	**24**	**1.4 - 5.6**
Enoploteuthis sp.										1																				1			1			**3**	**2.2 - 5.1**
Family Histioteuthidae																																				
Histioteuthis sp.									1																										**1**	
Family Octopoteuthidae																																				
Octopoteuthis sp.				1																															**1**	
Family Ommastrephidae																																				
Sthenoteuthis oualaniensis	1	2									1							1	3		2	7											1	2	**20**	**2.0 - 5.1**
Nototodarus hawaiiensis?																2	4		2		9	7	8	3	7					1	1	3	1	1	**49**	**0.8 - 2.6**
Ommastrephid species	1	2	1	3		3		7	2		3	3			2	1	3					3				2			7	2				1	**46**	**0.4 - 2.1**
Family Onychoteuthidae																																				
Onychoteuthis sp.																					1		1											2	**4**	**2.4 - 7.4**
Onychoteuthid species A	3	6		1				1	1																										**12**	**1.7 - 2.9**
Family Thysanoteuthidae																																				
Thysanoteuthis rhombus?			1																				1												**2**	
Unidentified	12	6	1	12		1		6	11	5	5	2		1							1					1			4	3	7	1			**79**	**0.5 - 10.8**
Total cephalopods	**27**	**17**	**6**	**17**	**0**	**6**	**0**	**16**	**18**	**9**	**9**	**5**	**0**	**2**	**2**	**4**	**7**	**1**	**8**	**0**	**14**	**17**	**12**	**4**	**7**	**3**	**1**	**0**	**18**	**10**	**16**	**10**	**4**	**8**		

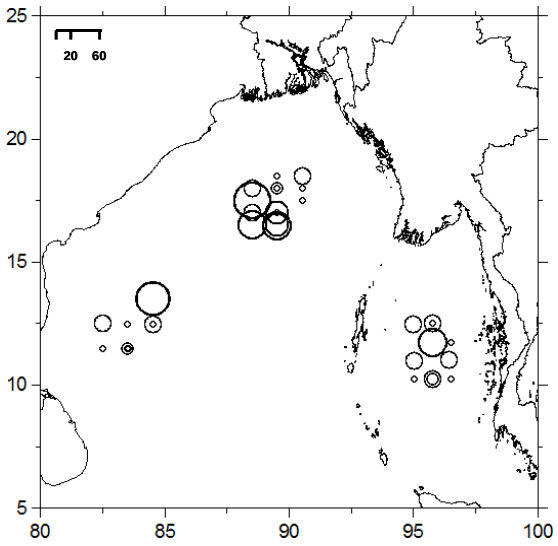

Figure 2 Distribution and abundance (ind./1,000m^3) of family Ommastrephidae.

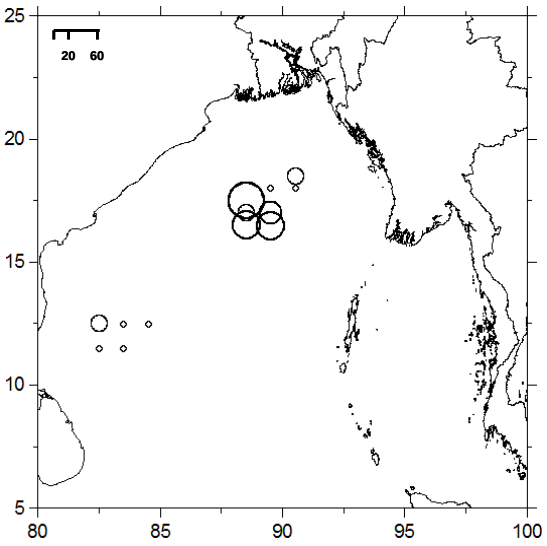

Figure 3 Distribution and abundance (ind./1,000m^3) of *Nototodarus hawaiiensis*.

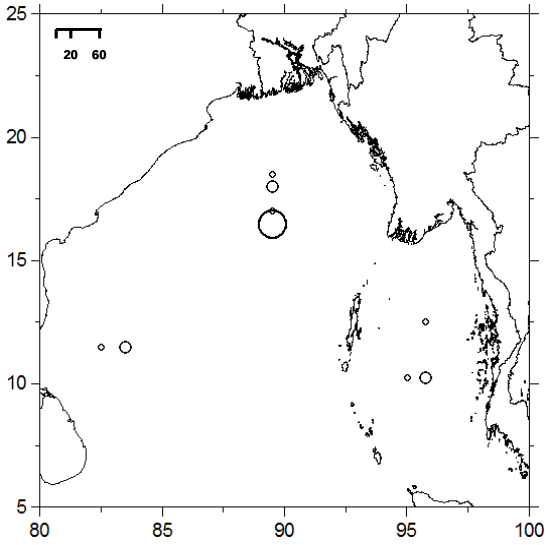

Figure 4 Distribution and abundance (ind./1,000m^3) of family *Sthenoteuthis oualaniensis*.

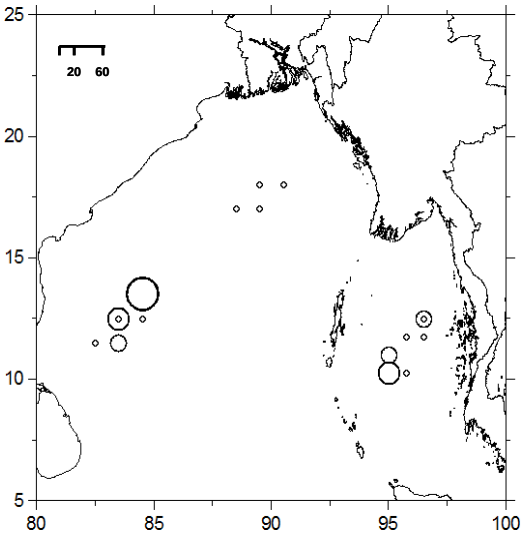

Figure 5 Distribution and abundance(ind./1,000m^3) of family Enoploteuthidae.

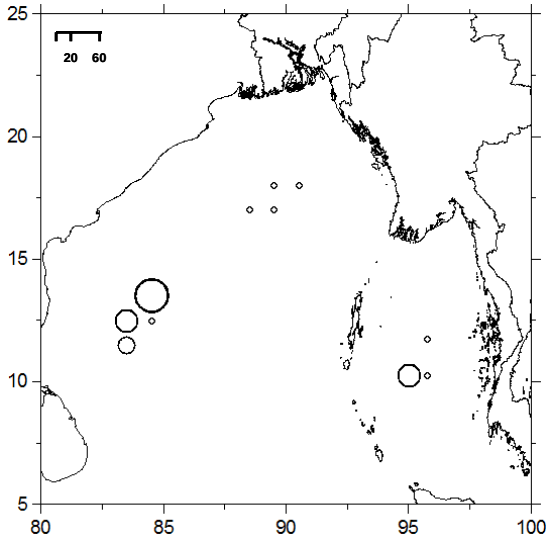

Figure 6 Distribution and abundance (ind./1,000m^3) of *Abraliopsis* sp.

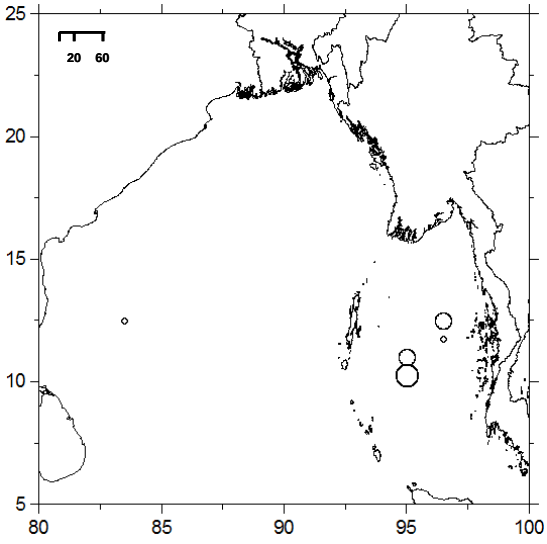

Figure 7 Distribution and abundance (ind./1,000m^3) of *Abralia* sp.

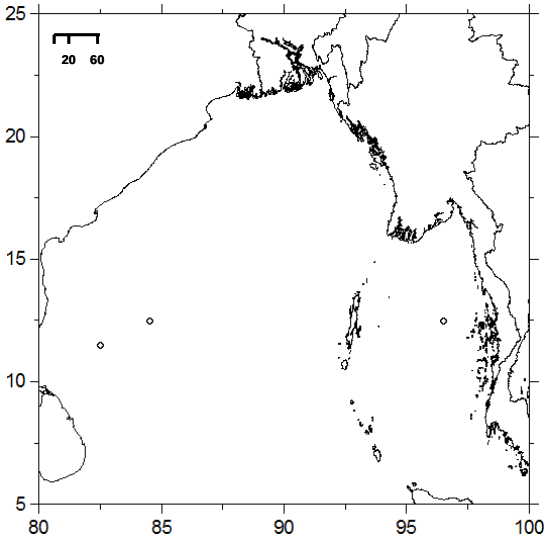

Figure 8 Distribution and abundance (ind./1,000m^3) of *Enoploteuthis* sp.

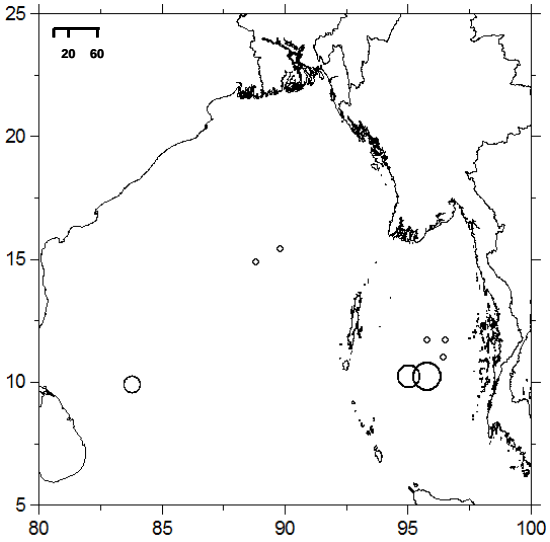

Figure 9 Distribution and abundance (ind./1,000m^3) of family Onychoteuthidae.

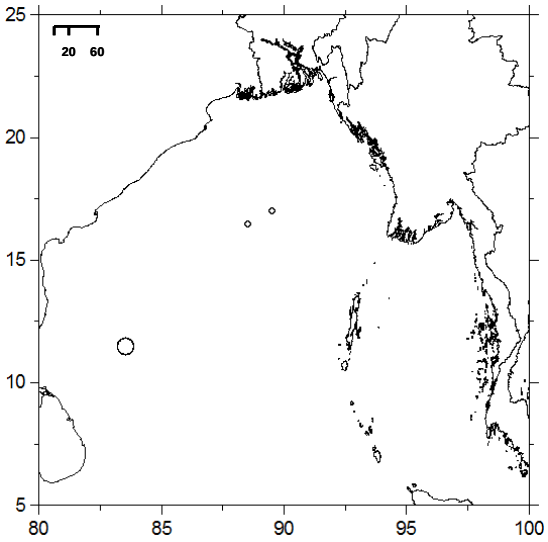

Figure 10 Distribution and abundance (ind./1,000m^3) of *Onychoteuthis* sp.

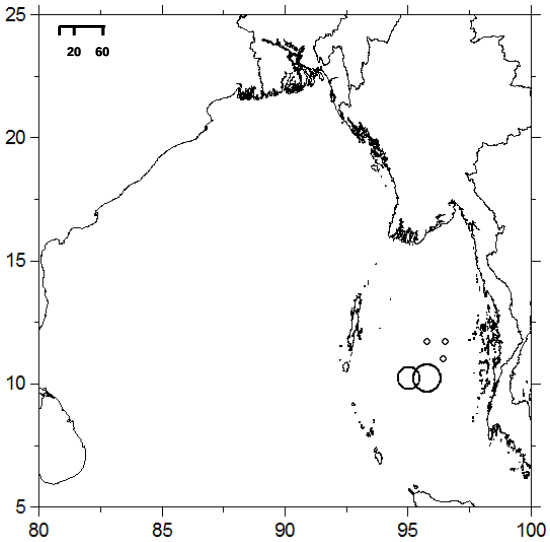

Figure 11 Distribution and abundance (ind./1,000m^3) of Onychoteuthid species A.

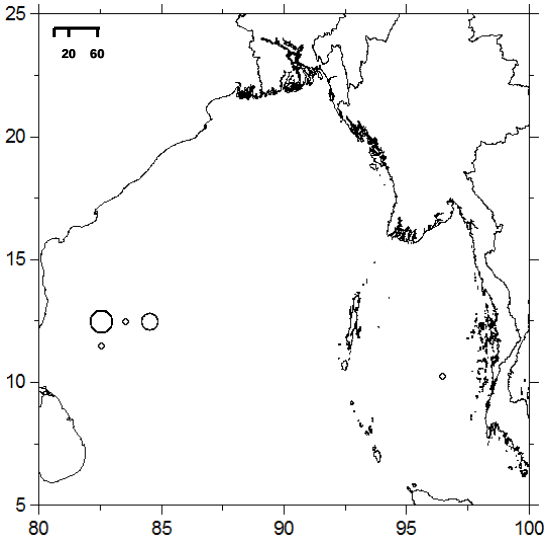

Figure 12 Distribution and abundance (ind./1,000m^3) of *Chtenopteryx* sp.

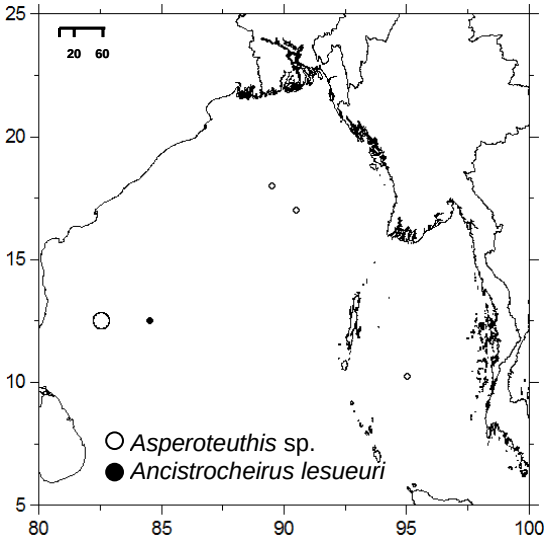

Figure 13 Distribution and abundance (ind./1,000m^3) of *Asperoteuthis* sp. and *Ancistrocheirus lesueuri.*

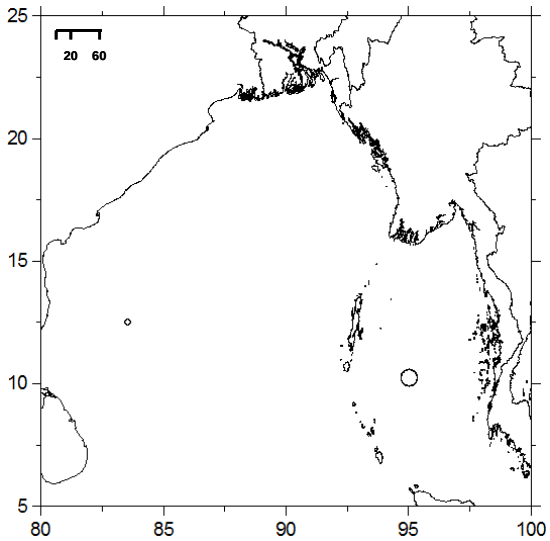

Figure 14 Distribution and abundance (ind./1,000m^3) of *Brachioteuthis* sp.

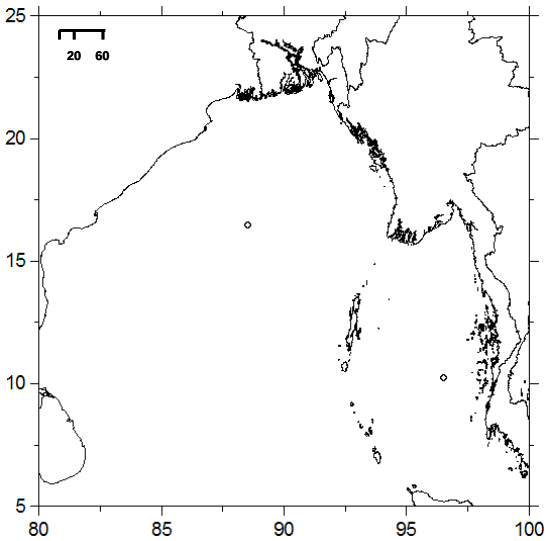

Figure 15 Distribution and abundance (ind./1,000m^3) of *Thysanoteuthis rhombus*.

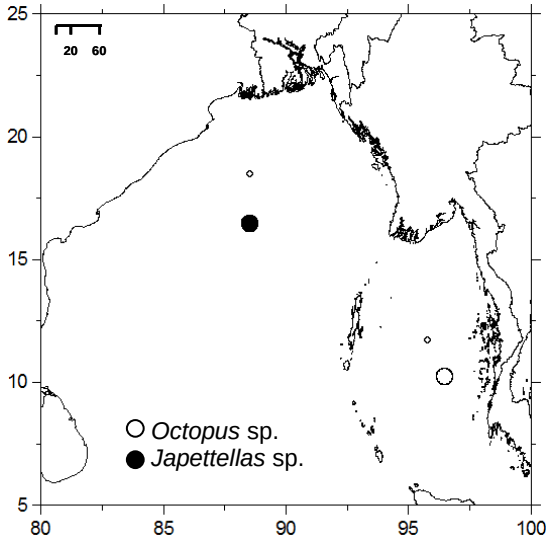

Figure 16 Distribution and abundance (ind./1,000m^3) of *Octopus* sp. and *Japettella* sp.

Discussion

The results of the present study showed that the paralarvae catch by zooplankton net during the survey are all oceanic species of various families of suborder Oegopsida (order Teuthida) except 2 families from suborder Incirrata (order Octopoda). The benthic adult octopods (*Octopus* sp.) were found occurred more than 200 km offshore of the Myanmar and Bangladesh waters. The results of the distribution found the assemblages of the pelagic adults in the continental slope and oceanic waters (*Abralia* sp., *Abraliopsis* sp., *Enoploteuthis* sp.), epi-mesopelagic adults (*Sthenoteuthis oualaniensis, Nototodarus hawaiiensis, Onychoteuthis* sp. *Thysanoteuthis rhombus*), mesopelagic adults (*Asperoteuthis* sp., *Chiroteuthis* sp., *Histioteuthis* sp.), and meso-bathypelagic adults (Chtenoteryx sp., *Liocranchia* sp., *Octopoteuthis* sp., *Brachioteuthis* sp.). A diverse community and the most numerous numbers of captured occurred in the survey area off Myanmar waters. Especially, the abundance of the small size of Ommastrephid species (<2 mm) suggesting the nearshore spawning in this area. Possibly the good feeding grounds influenced by surface water runoffs transporting nutrient-rich freshwater into the coastal areas (Sundström *et al*., 1987; Janecarn and Chullasorn, 1997; Limpsaichol *et al*., 1998) and/or upwelling conditions create by warm surface waters mixing the nutrient rich bottom (Dwivedi and Choubey, 1998). As the inshore-offshore spawning migrations is common in many cephalopod species (Nesis, 1993a; Mangold, 1987). Some *Enoploteuthis* species have also been reported to spawn only over the slopes or in nearshore oceanic regions (Nesis, 1993a and 1996). It is possible that spawning of ommastrephid squids may occur throughout the Bengal Bay. The composition from the results also show that the abundant paralarval squid is the commercial and/or minor-commercial target species to fisheries (Carpenter and Niem, 1998).

The results from the present study is useful for determining when and where adults spawn, particularly for species whose adults are difficult to catch (Bower *et al*., 1999). Further sampling survey in different monsoon season will help to provide a better understanding on life history of cephalopod species in these areas.

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