Cephalopod para-larvae in the northwest Arabian Sea- abundance and distribution in relation to monsoonal variability

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Abstract

The pelagic cephalopod para-larvae were part of the zooplankton samples that were collected during the five NASEER (North Arabian Sea Environment and Ecosystem Research) cruises, carried out between 1992 and 1994. Two cruises were during the northeast monsoon, two in the pre-southwest and one during the southwest monsoon period. The eighteen biological sampling stations (except Station 4) were beyond the 200 m depth contour, covering the area near the Pakistan shelf, the deeper Arabian sea, over the Murray Ridge and upto Oman (3 cruises).

The preliminary results showed that the three families, Enoploteuthidae, Caranchiidae and the Ommastrephidae were the most dominant in the area. The highest number of positive hauls were reported during the northeast monsoon period (cruises N1 and N5). Although the cephalopod para-larvae numbers were very low at some stations to estimate the abundance per m3, the highest number (118), mean 62.86 (±26.36) per 10 m3 were reported during N5 (northeast monsoon). The Ommastrephid (Sthenoteuthis oualenisis) was the most common of all the species during all the five cruises, with the highest percentage (~93%) during N5 (northeast monsoon). The general size ranged between mantle length (ML) 10.74 mm to < 1.0 mm. The overall abundance and distribution variability during the study period has also been discussed.

Introduction

The Arabian sea is located at the extreme northwest of the Indian Ocean, and experiences two monsoon regimes. The southwest (summer) monsoon begins from June and extends upto September and northeast (winter) monsoon begins from November and ends around February, during this period there is a seasonal reversal of atmospheric and oceanic circulation (7,8).

The present study was part of the North Arabian Sea Environment and Ecosystem Research (NASEER) that covered an area of the Arabian sea off the Pakistan coast and some part off Oman. The temperature and salinity from the water surface recorded during the NASEER showed spatial and temporal variations (Figure 2). Preliminary information on the zooplankton from the NASEER has been published (1, 2), more studies continue.

The para-larvae of squid were indeed an interesting component of the zooplankton samples from the NASEER. This study demonstrates the preliminary information on the distribution patterns and abundance of squid para-larvae in the upper surface layer of Arabian sea during the different times of the year.

Material and Methods

The zooplankton samples were from the northwest Arabian sea. The samples were taken at different monsoon periods (Table 1). All these stations were located beyond the 200 m depth contour. There were eighteen biological stations, out of which five were 24-hour stations (Figure 1). The zooplankton samples were collected by 10 minute horizontal tows taken from the surface water layer (0-5 meters) using a Bongo net. Details of biomass estimations, and preliminary information of dominant taxanomic groups are discussed earlier (1 a & b, 2).
The numeric abundance (N 10m-3) were estimated (1), and since cephalopod para-larvae abundance was very low, the entire sample was sorted to obtain all the cephalopod para-larvae that were present in each sample, and reported as numbers per haul (N haul-1), and these were used in the distribution plots (Figure 3 & 4). Preliminary identifications (P1, D1-3) were possible from literature available (3. 4, 5). Size estimates were made using an Olympus microscope and micrometer.

Data Analysis

One-way ANOVA
All groups (pooled)
· Abundance (N haul-1) during different monsoon periods
· Sorted for day-night variation (pooled)
family: Ommastrephidae para-larvae
· Abundance (N haul-1) during different monsoon periods
· Size variation from different monsoon periods

Distribution Coefficient (CD)

All groups (pooled)

CD= S2/Y , where S = variance and Y= mean (3, 6)

Distribution plots- SURFER 7
All groups pooled (N haul-1) (Figure 3)
family Ommastrephidae (N haul-1) (Figure 4)

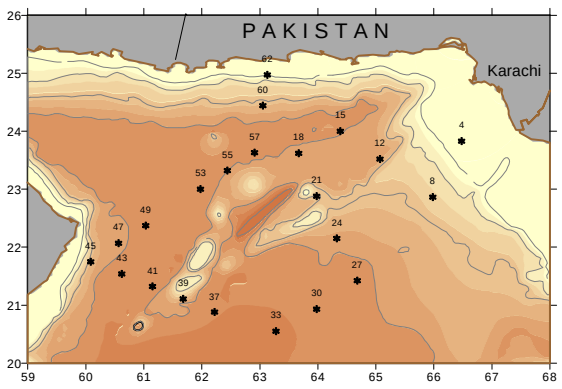


Figure 1. Cruise track of NASEER.

Table 1. Cruise numbers and monsoon periods of the North Arabian Sea Environment and Ecosystem Research (NASEER)

Cruise Number	Monsoon period
NASEER 1 – N1	January 1992 Northeast
NASEER 2 – N2	August 1992 Southwest
NASEER 3 – N3	March 1993 pre-southwest
NASEER 4 – N4	May 1994 pre-southwest
NASEER 5 – N5	December 1994 Northeast

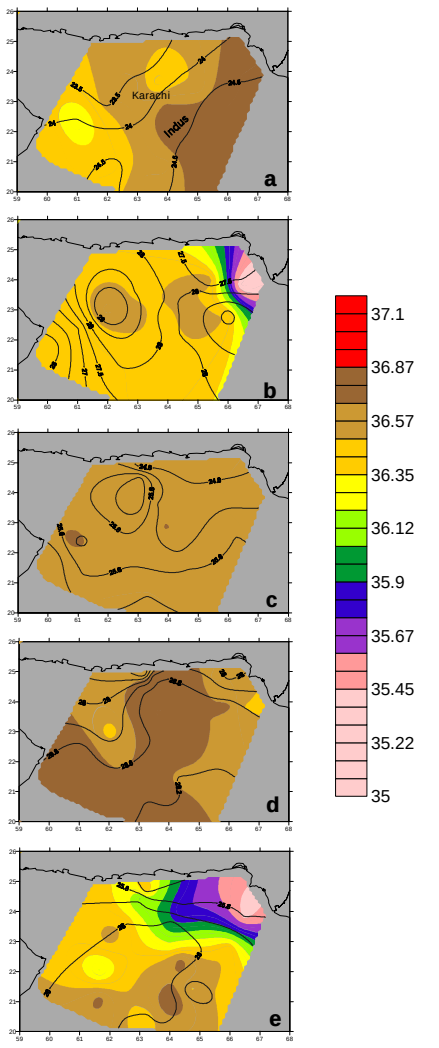


Figure 2. Temperature and salinity at the surface layer during NASEER, a= N1, b=N2, c= N3, d=N4, e=N5 (Table 1).

Results

Table 2 Number of hauls showing presence (+)-absence (-) of squid para-larvae

Cruise Number	N1	N 2	N3	N4	N5
+ hauls	11	4	10	8	14
- hauls	10	12	7	9	4

Table 3. Numbers per haul of squid para-larvae (in parenthesis - numbers per 10 m3) * = too few to estimate

Cruise Number	Total	Mean	Standard deviation (±)	Maximum	Minimum
N1	87 (189)	4.81(62.86)	3.36 (27.22)	12(94)	1 (47)
N2	17(*)	2.89	2.14	7	1
N3	109(204)	9.11(51.08)	17.22 (7.86)	63(63)	1(47)
N4	56(330)	4.67(55.01)	8.29 (19.25)	31(94)	1(47)
N5	249(566)	13.12(62.86)	40.24 (26.36)	179(118)	1(47)

Table 4. Number of day and night hauls, += hauls with squid para-larvae - = hauls with no squid para-larvae

Cruise Number	Number of day hauls		Number of night hauls	
	+	-	+	-
N1	6	9	10	5
N2	3	13	3	8
N3	3	12	9	5
N4	6	7	6	5
N5	2	6	10	2

⇓ Difference in Day-Night presence at surface

No difference at 0.05 level in the numbers of squid para-larvae between day and night samples at any of the monsoon periods except during N5

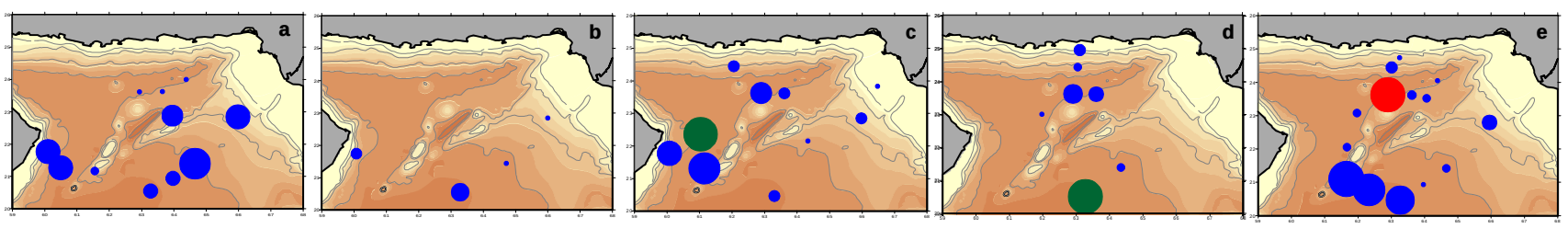
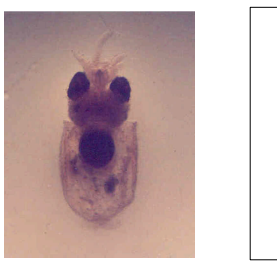


Figure 3. Abundance (N haul-1) and distribution of all groups of cephalopod para-larvae during NASEER, a=N1, b=N2, c=N3, d=N4, e=N5. (note: the highest (N haul-1) reported at 24 hour stations).

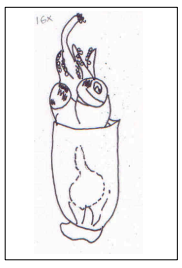
⇒ distribution - "highly patchy" in all the five monsoon periods

Overall squid para-larvae abundance (N haul-1)

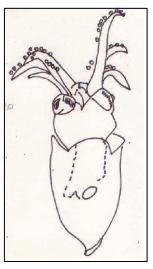
⇒ No statistically significant difference at 0.05 level at the surface layer, between different monsoon periods of the NASEER.



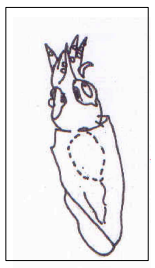
P1- family Ommastrephidae



D1- Camera lucida drawing (ML- 4.3 mm)



D2- Camera lucida drawing family Enoploteuthidae (ML - 2.375 mm)



D3- Camera lucida drawing family Caranchiidae (ML- 8.69 mm)

Table 5. Percentage (%) of family Ommastrephidae and others in the samples

Cruise Number	Ommastrephidae	Others
N1	69.99	30.01
N2	35.29	64.71
N3	33.02	66.98
N4	78.57	21.43
N5	93.17	6.83

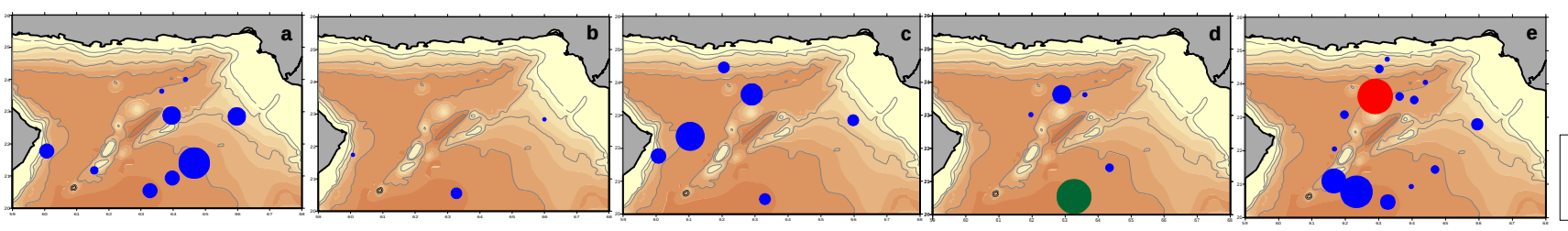


Figure 4. Abundance (N haul-1) and distribution of family Ommastrephidae para-larvae during NASEER, a=N1, b=N2, c=N3, d=N4, e=N5. (note: the highest (N haul-1) reported at 24 hour stations).

Abundance- Ommastrephidae (N haul-1)

⇒ No statistically significant difference between the monsoon periods, at 0.05 level

Table 6. Mantle size (ML- mm) of overall squid para-larvae during NASEER

Cruise Number	Mean Mantle size (mm)	Standard deviation (±)	Maximum size	Minimum size
N1	2.310	0.788	4.60	0.680
N2	2.965	1.077	5.00	1.60
N3	2.250	1.223	5.20	0.864
N4	1.636	0.470	2.80	0.954
N5	2.818	1.686	10.74	0.810

⇒ Size distribution

Statistically significant difference at 0.05 level, between family Ommastrephidae para-larvae and other families, during the pre-SW cruises (N3 and N4).
There was statistically significant difference (P£0.05) in the mantle size of family Ommastrephidae para-larvae from different monsoon periods during the NASEER.

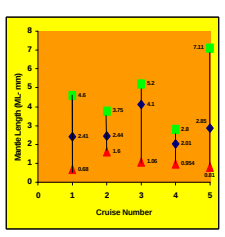


Figure 5. Size estimates of family Ommastrephidae during NASEER.

Conclusions

- The overall abundance of the cephalopod para-larvae at the surface layer remain more or less same during all the monsoon periods.
- There is generally no difference from day and night in the overall abundance at the surface waters.
- The overall distribution is highly patchy in all the monsoon periods.
- The family Ommastrephidae were the generally most dominant cephalopod in the area, their abundance was more or less same in all monsoon periods, their distribution was highly patchy.
- The size varied from seasons, the smallest observed during the northeast monsoon (N1 & N5), indicating perhaps main spawning time.
- More and confirmed results to come.

Main references

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