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Diversity, Distribution and Abundance of Zooplanktonic Larvae in Pakistani Waters

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Abstract: Zooplanktonic larvae are very important and at knowing the patterns of diversity, distribution and abundance on the coast of Pakistan offer a wide variety of zooplanktonic larvae. Thirty six species belonging to 7 major phyla, 3 minor phyla and 11 orders have been recorded conducted from September 2001 and December 2002. Two hundred and ninety three samples were collected from Sonmiani and Korangi Creek at sixteen stations in Pakistani waters. Oblique tows from 5 m above bottom to the surface were made for 10 min with 333 um mesh paired nets and for 1-3 min with a 110 μm mesh net. Temperature and salinity at the surface and near bottom were recorded at each station. The dominant zooplanktonic larvae groups reached their maximum abundance during summer June-August and also produced secondary peaks in fall October or winter December. A few species had numerical maxima in the spring (March and April). It is concluded from the results that the Pakistani waters Northern Arabian Sea sustains a high faunal range and a wide range of habital selection mainly depending upon their feeding habits and other behavior.

Key words: Zooplanktonic larvae, Pakistani waters, diversity, distribution and abundance

INTRODUCTION

Life in the sea has been broadly classified into three groups, viz. the plankton, the nekton and the benthos. Nearly all animals phyla contribute individuals to the meroplankton. The eggs and larvae of most macro invertebrates and fishes are planktonic and that are nektonic or benthic in their adult stage, in their mode of living and are collectively termed meroplankton. Their smaller body and greater surface area result in greater frictional resistance to sinking characteristically seasonal in occurrence depending upon the spawning habits of their parents.

Some common types of meroplanktons are found in collection class scyphozoans frequently washed up on sea shore with ephyra larvae, polychaete produce a trochophore larvae, setiger larvae, mollusks in gastropods with veliger larvae, sessile barnacles have free swimming nauplius stages usually six which are similar to the naupliur of copepods and other planktonic crustaceans. Crabs usually hatched as spiny zoea before settlement to a megalopa they resemble a miniature adult. Fifth eggs and fish larvae referred to as the ichthyoplankton.

Pakistan has geologically and ecologically diverse coastline dissected by harbours, estuaries, bays and creeks with diversity in animal forms exhibiting wide characteristics. Thus these areas are nutritionally rich, providing an ideal habitat breeding and nursery ground and reservoir for larvae and juvenile stages of a variety of marine animals which drift towards the coast to complete their life cycle, then going back to sea water and serving as a secondary trophic level in food web.

The present study is based on the diversity, distribution and abundance of the planktonic larvae collected from Sonmiani and Korangi Creek (Northern Arabian Sea).

Some of the earlier studies on the abundance of zooplanktons on the coast of Pakistan are those of Ahmed and Ayub (1999), Ahmed (1987), Ahmed and Hussain (2000), Ahmed and Rizvi (1980), Bano (1998), Ghory and Siddiqui (2002), Gurney (1937), Haq and Hassan (1973, 1975), Hardy (1956), Hashmi (1969, 1970a,b), Hassan (1980), Huda and Ahmed (1988), Khan and Khan (2001), Mustaquim and *et al.* (2001), Nayeem (1993), Newell and Newell (1963), Siddiqui and Tirmizi (1992, 1998), Siddiqui (1996), Tirmizi *et al.* (1991), Tirmizi and Kazmi (1984), Wickstead (1980).

Although considerable information has been published on the kinds of zooplankton which have been found in the Arabian Sea and the relative abundance of numerically dominant groups at certain times of the year, until now no data were available on seasonal changes in composition and biomass in relation to environmental parameters and on reproductive cycles of important elements of the food web, such as copepods. This report contains the results of a one year study of zooplankton in

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Pakistani waters. Cosidering the pivotal and crucially important position of faunal diversity in Pakistani waters. The present study was conducted to document the diversity and abundance of the area and to study their biological aspects.

MATERIALS AND METHODS

Between September, 2001 and December, 2002, a total of 293 plankton samples were collected from Pakistani waters. The samples were taken at 16 stations selected (Table 1)

Plankton was collected using paired μm mesh nets attached to 61 cm diameter frames and a 110 μm mesh net 0.5 m in diameter at the mouth. A flow meter was attached with the aperture of each net to measure the amount of water filtered. At each station a 10 min oblique tow the paired nets was made from a depth approximately 5 m above the bottom to the surface and the smaller net was towed obliquely for 1-3 min the plankton catches from each type of net were divided into two equal parts, one part was fixed in 10% formalin buffered with sodium borate, for taxonomic analysis. The other part was filtered, using a Fisher vacuum pump per weighed Whatmen No. 5 filter paper. The plankton and filter paper were wrapped in aluminium foil and frozen. The frozen samples were dried for 2 days at 60°C, then brought to room temperature and weighed on an analytical balance to obtain dry weight in grams.

Surface and bottom temperatures and salinities were recorded at each plankton sampling station using a standard thermometer, salinometer.

Zooplankton analyses (excluding Protozoa) consisted of counting all pelagic invertebrates and lower chordates. Numerically dominant forms were identified to the lowest taxon possible, usually species in groups.

Larval forms were classified to the lowest major taxon, usually class, order or family, e.g., copepod nauplii, cirripede nauplii, crabs, stomatopod larvae, gastropod veligers, echinopluteus larvae and holothurian, doliolaria larvae the organisms were counted.

RESULTS AND DISCUSSION

Hydrography

The data on temperature and salinity showed;

1. Minor differences between surface and bottom readings;
2. Minor differences among temperatures and salinities at all stations during each sampling and significant seasonal differences. Because the differences between recording at surface and bottom are negligible for present considerations, only surface records are discussed. The atmospheric temperature ranged from 22.83 to 31°C whereas the water temperature ranged from 22 to 29.67°C being generally 1-3 degree lower. In summer May to October higher temperatures ranging from 30 to 31°C were recorded. As the winter approached December to March the surface temperature gradually fell to as low as 22-25.9°C (Table 1).

The surface salinities did not show a wide range of fluctuations higher salinities of 41‰ were observed in the month of December and lower salinities of 34 ‰ were noted during August and October. In the month of April, May, August, October, February and March they remained as 35.7 to 38.7‰ (Table 1).

Temperatures and salinities were relatively uniform during each sampling period. Minor differences in temperature at some stations during sampling can

Table 1: A-B Distribution of planktonic larvae (Korangi Creek and Sonmiani)

Station No.	Date	Salinity	Temperature Atmospheric	Water temperature	Dissolved oxygen contents (mL L^{-1})
1	Sept, 2001	34.3	30.50	28.0	2.7
2	Oct, 2001	34.2	28.00	31.0	4.2
3	Nov, 2001	36.0	26.00	26.0	2.9
4	Dec, 2001	41.0	18.50	22.3	2.8
5	Jan, 2002	40.0	22.83	22.5	1.5
6	Feb, 2002	38.7	24.00	24.5	2.0
7	Mar, 2002	38.7	25.00	25.0	2.8
8	Apr, 2002	38.0	28.10	26.5	1.2
9	May, 2002	37.6	29.50	30.0	0.6
10	June, 2002	37.5	31.50	29.6	0.3
11	July, 2002	38.0	30.00	30.5	0.5
12	Aug, 2002	35.7	30.50	29.0	2.0
13	Sept, 2002	34.0	30.50	28.0	2.7
14	Oct, 2002	34.2	28.00	31.0	4.2
15	Nov, 2002	36.0	26.00	26.0	2.9
16	Dec, 2002	41.0	18.50	22.3	2.8

Table 2: Mean plankton biomass (g^{-3}) collected with 110 um mesh net and 333 um net in

Months	333 um net	110 um net
Sept, 2001	0.08	
Oct	0.04	0.14
Nov	0.09	0.25
Dec	0.25	0.38
Jan, 2002		
Feb	0.15	0.45
Mar	0.03	0.30
Apr		
May	0.30	0.40
June	0.14	0.35
July		
Aug	0.15	0.39

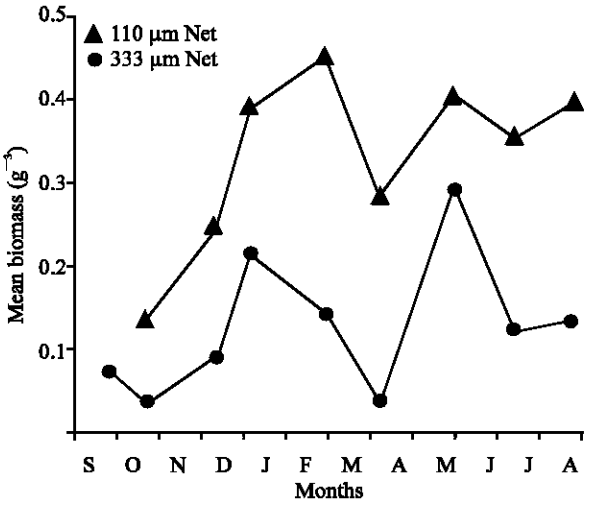

Fig. 1: Mean plankton biomass (g^{-3}) collected with 110 um mesh net and 333 um net in Pakistani waters

probably be attributed to sampling time since the lower temperatures were recorded at stations occupied during early morning while the higher readings were obtained at stations occupied near midday. Dissolved oxygen ranged from 5.10 to 6.47 mean 5.62+0.48 mL L^{-1}.

The major causes of mixing appear to be the sinking of hypersaline surface waters, tidal currents and turbulence resulting from frequent fishing activities and commercial ship traffic.

Biomass: Mean biomass measurements were greater for the smaller-net samples during every sampling period (Fig. 1 and Table 2) mainly because the smaller mesh retained the numerous minute copepods and larval forms. Plankton productivity was greatest in winter (January-early March) and summer (June, July, August). The lowest measurements from catches of both nets were recorded in October and April. Undoubtedly, fluctuations in phytoplankton population profoundly influenced the measurements of biomass. In addition to seasonal differences, there were distributional differences during each sampling. For example in December, 2001 the highest biomass of 1.904 g^{-3} was recorded from a sample taken with a small net at station 10, while the lowest biomass of 0.004 g^{-3} was recorded from a sample obtained with the 0.333 µm mesh net. The mean biomass of all samples collected at each station indicates that some areas were more productive than others, I. e. the northern stations 10, 11, 12, 13, 15, 16 (Fig. 1 and Table 2).

Zooplankton analyses: The data reported here are derived only from samples collected with the 110 µm mesh net. The paired net samples were excluded because of the greater capacity of the smaller net to retain zooplankton and also because it was towed for shorter periods, minimizing or eliminating the clogging problem caused by high productivity of phytoplankton. More than 26 genera and 36 species of zooplanktonic larvae belonging to 7 phyla were identified. Total numbers and percentages of the major groups and the dominant species are given in Table 3.

Coelenterata: The overall both collection from Sonmiani and Korangi creek, 85 coelenterate comprised less than 0.7% of the total zooplankton population. Their importance as predators has not been quantitatively assessed and can not be estimated by the methods used in this study for many reasons, e.g., the watery composition of the relatively massive living organisms and the great range in size, most being much larger than their prey (copepods, larvaceans, larval fish etc.) thus their role in the pelagic environment is not reflected by the relatively low numbers recorded during the study (Table 3).

Annelida: Among the polychaeta, Spinoid larvae were greatest in numbers 0.4% as compared to the Terebellid 0.1% and Pectinaria larvae 0.3%. Setiger larvae 0.03% occurred sporadically in very low numbers collected from Sonmiani. From Korangi creek Terebellid and Pectinaria both 0.2% are equal in numbers Spinoid larvae 0.5% and Setiger larvae less 0.01% abundant in numbers (Table 3).

Mollusca: Veliger larvae of benthic bivalves and gastropods 0.4, 0.5% from Sonmiani and 0.6% and 0.4% from Korangi creek, collected mainly at coastal stations, accounted for the majority of the planktonic mollusks Bivalve veligers were most abundant in October and January, while gastropod veligers maintained relatively high numbers through most of the year, with a peak in August (Table 3).

Table 3: Total numbers of Pakistani waters zooplanktonic larvae, based on numbers caught per m3 of water filtered by a 110 um mesh net at stations from October 2001 to December 2002 and the percentage each component comprised both within its category and in relation to all other components

Sonmiani	Taxa		Total	Percentage within group	Percentage overall
I	Coelenterata		31	99.9	
A.	Scyphozoa---*Ephyra* sp. 1	larvae of Aurelia	1200%	38.70%	0.3
	Ephyra sp. 2.	larvae of Aurelia	19	61.20%	0.6
II	Annelida		187	123.71	
A.	Polychaeta				
1	Terebellid larvae		45	24.06%	0.1
2	Pectinaria larvae		39	44.91%	0.3
3	Spinoid larvae		96	51.00%	0.4
4	VI-Setiger larvae		7	3.74%	0.03
III	Arthropoda-Crustacea		542	99.93%	
1	Cirripedia				
A.	Nauplii		249	45.90%	0.4
B	Euphausiid-larvae		18	3.32%	0.03
C	Caridean-larvae		6	1.10%	0.01
D	Copepode-larvae		21	3.87%	0.03
E	Porcellanid-larvae		120	22.14%	0.2
F	Zoea		128	23.60%	0.2
IV	Mollusca		9	99.99%	
A	Gastropoda		4	44.44%	0.4
B	Lamillibranch-larvae		5	55.55%	0.5
V	Urochordata		122	99.99%	
A	*Oikopleura* sp. 1 larvae		54	44.26%	0.4
B	*Oikopleura* sp. 2 larvae		68	55.73%	0.5
VI	Chordata		1		
	Mullet-larvae		1	0.15%	0.1
Total	892				
Korangi Creek					
I	Coelenterata		54	99.99	
A.	Scyphozoa---*Ephyra* sp. 1	larvae of Aurelia	32	59.25%	0.5
	Ephyra sp. 2.	larvae of Aurelia	22	40.74%	0.4
II	Annelida		182	100.38	
A.	Polychaeta				
1	Terebellid larvae		38	20.87%	0.2
2	Pectinaria larvae		39	21.42%	0.2
3	Spinoid larvae		103	57.00%	0.5
4	VI-Setiger larvae		2	1.09%	0.01
III	Arthropoda-Crustacea		3746	100.53%	
	Cirripedia				
A.	Nauplii		1499	40.01%	0.3
B	Caridean larvae		5	0.33%	0.003
C	Euphausiid-larvae		9	0.60%	0.005
D	Copepode-larvae		2011	53.68%	0.5
E	Porcellanid-larvae		92	2.45%	0.02
F	Zoea of Anomuran larvae		128	3.41%	0.03
	Squilla larvae		2	0.05%	0.0004
IV	Mollusca		30	100.00%	
A	Gastropoda		18	60.00%	0.6
B	Lamillibranch-larvae		12	40.00%	0.4
V	Echinodermata		19	99.97%	
A	Doliolaria larvae		4	21.05%	0.2
B	Bipinnaria larvae		2	10.52%	0.1
C	Brachiolaria larvae		6	31.57%	0.3
D	Echinopleuteus larvae		2	10.52%	0.1
E	Ophiopleuteus larvae		5	26.31%	0.2
VI	Urochordata		169	99.99%	
A	*Oikopleura* sp. 1 larvae		124	73.37%	0.7
B	*Oikopleura* sp. 2 larvae		45	26.62%	0.2
Total	4200				
	Invertebrate larvae		Not counted		
	Nemertea, Bryozoa, Branchiopoda				
Grand total			5092		

Arthropoda-Crustacea

Copepoda: Nauplii, copepodites were the most abundant and ubiquitous organisms in Pakistani waters, comprising Nauplii copepodites 0.03 and 0.5% from Sonmiani and Korangi creek of the total zooplankton. Copepodites of the three major free-living groups occurred in proportions similar to those recorded elsewhere in tropical and subtropical seas (Table 3).

Other crustaceans: The remaining crustaceans consisted of the decapod and larval stages of benthic Cirripedia, Stomatopoda. Cirripede larvae, found in lowest numbers throughout the year and most abundant in August. From Sonmiani Euphausiids 0.4%, Caridean 0.01%, Porcellanid 0.2%, Anomuran Zoea of Anomuran larvae 0.2%, whereas from Korangi creek Euphausiids 0.005%, Caridean 0.003%, Porcellanid 0.02%, Zoea of Anomurans larval forms 0.03%, Squilla larvae 0.0004% occurred in very low numbers. They were found in greatest abundance along the coast in June and also were collected throughout summer and fall (Table 3).

Echinodermata: During the month of January and February, echinoderm larvae are mainly represented by bipinnaria, brachiolaria auricularia and doliolaria. This phylum consisted larvae only from korangi creek, they were in greatest abundance 0.3% but from Sonmiani collection they were not found (Table 3).

Urochordata: This phylum was represented mainly by the larvacean only *Oikopleura* sp. 1 and sp. 2 which have come with tides. These comprised 0.7 and 0.5% of the total zooplankton populations fluctuated widely throughout the year, from low densities in October and December to peak abundance in June, they remained relatively abundant through August like the other major components of the zooplankton they were most numerous in summer (Table 3).

Chordata: Fish larvae also found in low numbers 0.1% only recorded from Sonmiani provided insufficient data for analyses (Table 3).

Invertebrate larvae: Additional kinds of invertebrate larvae were collected. They represent phyla of benthic animals: Nemertea, Bryozoa, Branchiopoda, their infrequent occurrence and low numbers provided in sufficient data for analysis.

DISCUSSION

In all the 2 samples which were taken from Sonmiani and Korangi creek Zooplanktonic larvae makes up a relatively large part is indicates production are essential and strong processes in the sea water of the Northern Arabian Sea water. Numbers of certain species are enormous; however systematic diversity is quite moderate. In other works, a sample biomass is generated by only a few species and genera.

The zooplanktonic larvae consists of these groups show two or three outstandingly abundant species and some which occur occasionally. Among the Crustaceans larvae densely distributed in the plankton. Comparison were also made between the present study and earlier ones on the number of individuals. Further more densely populate the photic zone;among these we find, all collecting trips revealed numberless jelly fishes; the young *Aurelia aurita,* ephyra larvae a pelagic medusa had a bell diameter of about 1 cm.

The copepods in our study showed usual dominance over other groups as was also found in the earlier report by Nayeem (1993). Copepods as their larvae, Cirripedes, the Nauplius stages, are quite abundant. Microscopical examination of the zooplankton exhibits a clear predominance of zoea and megalopa of Anomurans and Brachyurans. This is a common pattern in most marine plankton samples. Among the crustaceans the porcellanids present to a remarkable extent; by its enormous paired spines compound eye, Euphausiids larvae A further question refers to the distinction between holoplankton and meroplankton. While the holoplankton comprises all organisms that drift in the pelagic environment during all stages of their life cycle, the meroplankton includes larval stages of animals that spend their adult and mature phase in another environment e.g., the bottom or the intertidal zone. Zooplanktonic larvae described here the share of various stages of polychaetes. In all samples some Veliger larvae of Gastropods and Opisthobranchs were detected. Most of the larvae of Echinoderms also appear but not in abundant forms, bipinnaria, brachiolaria, ophiopluteus, auricularia, doliolaria are regular inhabitants of Pakistan waters lesser abundance taken near to the coast (Off Manora Channel). But Echinoderms larvae greater in abundance from the Korangi creek in present study. Ichthyoplankton of fishes a few Mullet also present. After all it can be said that meroplankton occasionally only. Some forms which are part of almost any plankton sample lack here completely. Chaetognath worms were also found, but no siphonophore larvae.

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