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NUMERICAL ABUNDANCE AND SPECIES DIVERSITY OF SURFACE ZOOPLANKTON IN THE COASTAL WATERS OF UNITED ARAB EMIRATES ON THE ARABIAN GULF A PRELIMINARY STUDY

By

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ABSTRACT

Surface zooplankton of the coastal waters of the United Arab Emirates was studied bimonthly during the period September 1997 to July 1998. Species diversity, numerical abundance and seasonal dynamics were analyzed , at six sites, in the coastal waters of five Emirates including Abu Dhabi, Dubai, Sharjah, Umm Al Quwain and Ras Al Khaimah. A total of 70 taxa and species were identified. At all sites, copepods were predominant in the standing crop with an average of 1945 ind. m^{-3} and formed ~ 65.5%, numerically, of the total zooplankton community. The meroplanktonic larvae occupied the second rank and constituted ~19.7 % of the total zooplankton. Seasonally, the main peak of zooplankton abundance was recorded in winter (January) with an average of 3510 ind. m^{-3}, while September was characterized by the lowest density (1906 ind. m^{-3}). Relatively higher diversity values were recorded at Ras Al-Khaimah and a progressive decline in diversity was observed southward.

INTRODUCTION :

The Gulf's marine environment is becoming increasingly important in fulfilling social, economic, development and strategic objectives of the region. The Gulf plays a particularly vital role in providing most of the population with freshwater from desalination plants. Moreover, the Gulf provides fisheries and artisanal fisheries as a multi-million dollar industry. However, the discovery of oil in the Gulf during the 1930s and 1940s was principally responsible for the immense economic wealth and geopolitical importance of the region and led to massive increase in shipping today. To protect the Gulf biota, an evaluation of the intact ecosystem has to be made before the onset of a disturbance. Therefore, through a project aiming to study the species biodiversity of different biota in the United Arab Emirates coastal water, the structure and diversity of planktonic organisms have been investigated.

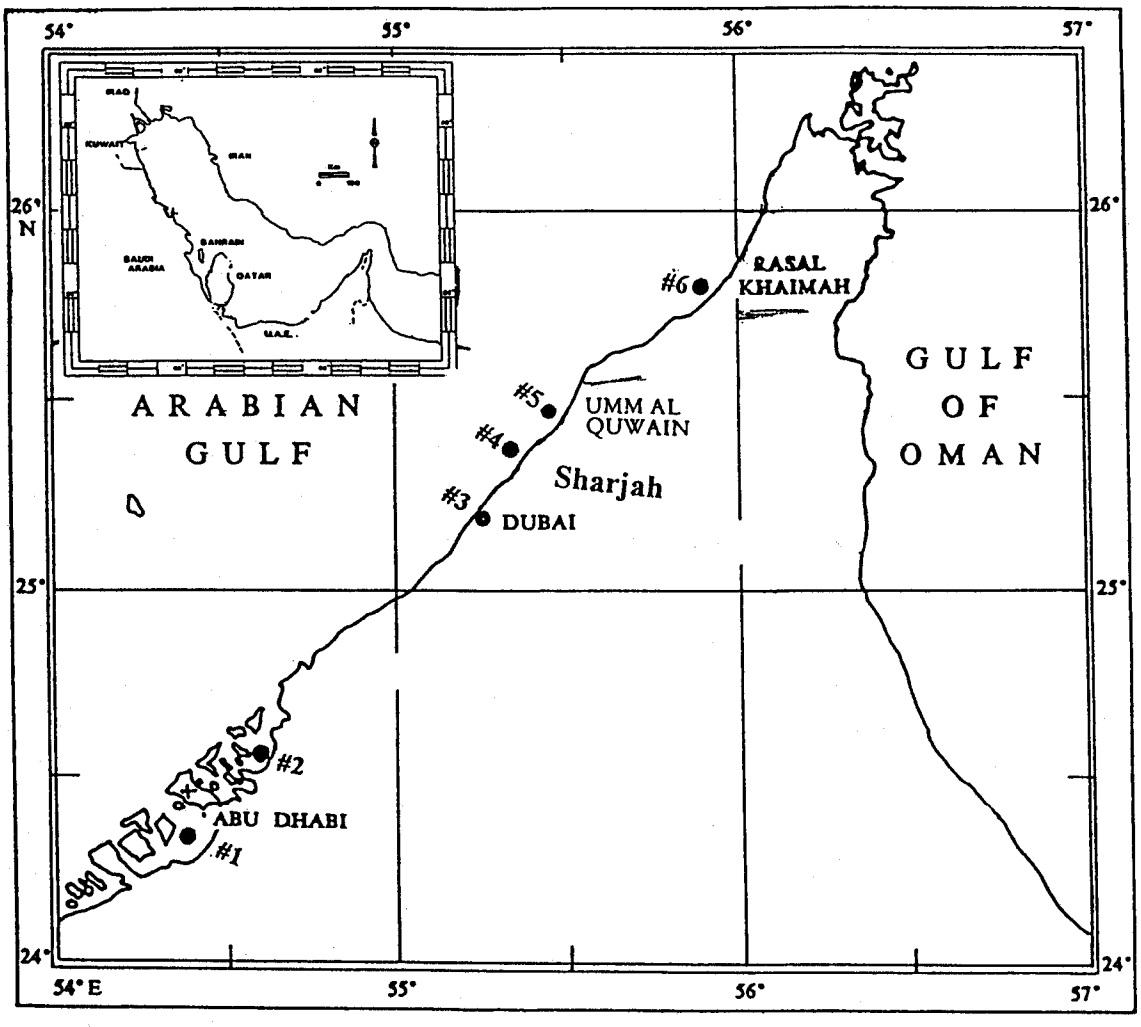
Despite the importance of zooplankton in many marine food chains of the Gulf, few systematic and seasonal studies have been conducted in the Arabian Gulf (Yamazi, 1974; a,b Gibson *et al.*, 1980; Michel *et al.*, 1986; Hussein, 1992 and Dorgham and Hussein 1997). Moreover, the lack of information concerning marine zooplankton in the United Arab Emirates coastal water is very regrettable. In the present work, the abundance characteristics of the distribution and species diversity of surface zooplankton in the coastal waters of Abu Dhabi, Dubai, Sharjah, Umm Al-Quwain and Ras Al-Khaima of United Arab Emirates on the Arabian Gulf were examined seasonally for a complete year.

MATERIALS AND METHODS

Area of study

The strait of Hormuz separates the Arabian Gulf from the Arabian Sea that forms the northwestern part of the Indian Ocean. The Gulf is shallow with an average depth of about 35 m and a maximum depth of about 100 m. Weather has an important effect on the seawater of the Gulf. Continuous sunlight, particularly in the summer months, warms the water surface (28 °C mean annual temperature), causing evaporation levels to increase. Rainfall is scarce (average 120 mm / year). The water is hypersaline (39-44 ‰)

Six sites were chosen for this study. Sites #1 and #2 represent Abu Dhabi site where the latter is affected by the mangrove trees of Al-Sammaliah Island. Site #3 is within Dubai creek water, where organic pollution might be expected to have its own impact on the plankton species composition and numerical abundance. Sites #4; #5 and #6 are within Sharjah, Umm Al-Quwain and Ras Al-Khaima water respectively



(Fig. 1)

Sampling and laboratory techniques

Bimonthly sampling of surface zooplankton was performed, during the period from September 1997 to July 1998, using plankton net of 55 µm mesh size. The net has an opening diametre of 50 cm and 1 m length. The net was towed horizontally just beneath the surface for 4 minutes (speed of boat 1.5 knots). A flow-meter was fitted onto the opening of the net to calculate the filtration rate. Sampling was conducted during day light hours between 18:00 and 20:00 h. In the field zooplankton were fixed in formalin, 5% final concentration, just after collection.

In the laboratory, plankton species were identified and taxon abundance (number per cubic meter) was estimated. The following publications and taxonomic references were used for identification: Jorgensen, 1933; Wimpenny, 1966; Dussart, 1967 and 1969 and Newell and Newell, 1967.

Measurements of diversity

Margalef's index (Margalef, 1968; Clifford and Stephenson, 1975) to measure species richness and Heip's index (Heip, 1974) to measure evenness or equitability were used. Cluster analysis was also performed to put similar stations into classes according to their planktonic characteristics using the Sorensen Similarity Index for quantitative data as modified by Bray and Curtis (1957). The complete linkage clustering method (the farthest neighbor) was used to draw a dendrogram (DeGhet, 1978).

RESULTS

A total of 70 taxa and species of zooplankton were recorded during the present study in the coastal waters of United Arab Emirates on the Arabian Gulf (Table 1).

Copepods and nauplii appeared as the most abundant group. Their average standing crop (all seasons and sites) was 1400 ind. m^{-3} and occupied 65.5 % of the total zooplankton community. Actually, copepods were represented by 34 species (Table I). Five of them, i.e. *Corycaeus ovalis* Claus, *Labidocera wollastoni* Lubbock, *Paracalanus parvus* Claus, *Pontella karachiensis* Rehman and *Pontellopsis macronyx* A. Scott, were considered new geographical records.

The meroplanktonic larvae occupied the second rank and constituted 19.7 % of the total zooplankton with an average of 508 ind. m^{-3}. Tunicata, Chaetognatha, then Cladocera, came next with an average of 7.5, 3.5 and 2.7 % respectively. The other components, which comprised the Tntinnida, Foraminifera, Radiolaria, Siphonophora, Ctenophora, Ostracoda and other taxa, were rarely encountered and they contributed collectively 1.1 % of the total zooplankton.

Sites and seasonal distribution

The magnitude of the standing crop of zooplankton attained its highest density at site #3, which sustained an average annual number of 4206 ind. m^{-3}. On the other hand, a marked decline in zooplankton densities from southern sites towards northern ones was noticed (Figure 2). The average annual number of individuals at site #4 decreased to 2386 ind.m^{-3}, then to 1742 and 1493 ind. m^{-3} at sites #6 and #5 respectively.

Regarding the seasonal variations, the main peak of zooplankton abundance was recorded in winter (average 3510 ind. m^{-3}), whereas September and May harbored the lowest densities (1906 and 1918 ind. m^{-3}, respectively).

Species diversity

The zooplankton community in the Arabian Gulf along UAE coasts is characterized by low species diversity. During the present study zooplankton species diversity decreased from north at site #6 to south at site #3 (Table II).

An inverse relationship was observed between equitability and the magnitude of standing crop of zooplankton, as indicated at site #3, which harbored the highest density, but it exhibited lowest evenness value.

Regarding the similarity of species diversity between the different sites, the cluster analyses indicated a relatively high degree of homogeneity in the zooplankton composition between the northern sites (Figure 4). Such similarity was less clear between southern sites (#1 and #2).

DISCUSSION

During the present study, Copepoda, meroplanktonic larvae, Tunicata, Chaetognatha, Cladocera, besides other taxa including Tintinnida, Foraminifera, Radiolaria, Siphonophora, Ctenophora and Ostracoda were the basic components of zooplankton community at the surface water of United Arab Emirates. Copepoda dominated the zooplankton community and occupied 65.5 % of the total zooplankton. Yamazi, 1974; Gibson *et al.,* 1980 and Michel *et al.,* 1981 & 1986,a,b, Micheal and Abd El-Rahman, 1993 and El-Serehy *et al.,* in press found copepods to dominate the zooplankton community.

Copepods were represented by 34 species, five of them (4 calanoids and 1 cyclopoids) can be considered as new geographical records for the Arabian Gulf. Yamazi (1974) reported 30 species of copepods throughout the Gulf; whereas Michel *et al.,* (1986 a) recognized 49 species in the Gulf area south of Kuwait. While, more than ~ 300 species as calanoids are known from the Arabian Sea and the Gulf of Aden (Delalo, 1966; Almeida Prado-Por, 1983).

The magnitude of the standing crop of zooplankton attained its highest density at site #3, which sustained an average annual number of 4206 ind. m^{-3}. This sharp increase in the population density of zooplankton, may be due to that site #3 lies at Dubai creek which has occasional unusually high nutrients levels with sharp fluctuations and wide spatial and temporal variations (Abu-Hilal *et al.,* 1994), suggesting an anthropogenic source of pollution, creating these conditions, near the sampling sit. These sources include several wastewater outlets and recreational facilities. Moreover, the zooplankton density at site # 2 was also relatively high (3645 ind. m^{-3}). This is probably due to increased nutrients and detritus from mangrove trees, which dominate this region of UAE coasts viz: Al-Sammaliah Island.

However, the highest population density of UAE zooplankton is comparatively very low when compared with other similar areas. Michel *et al.,* (1986,a,b,) counted 43000 ind. m^{-3} of zooplankton in Kuwaiti waters. The low zooplankton density in UAE waters might be due to low nutrient level compared to the more fertile Kuwaiti waters, which benefit from fresh water and nutrients input via the Shatt-El-Arab estuary.

Regarding the seasonal variations, the main peak of zooplankton abundance was recorded in winter (average 3510 ind. m^{-3}), whereas September harbored the lowest density (1906 ind. m^{-3}). The high abundance of January was due to increased numbers of planktonic larvae (Fig. 3), including copepod, polychaete, cirriped, mollusk, echinoderm and fish

larvae. Moreover, it is worth mentioning that, as summer approaches, the plankton density in the Arabian Gulf water at UAE decreases as the surface habitat becomes more hostile due to increasing temperature.

As shown in Table (II), specially, the zooplankton community in the northern Emirates (Umm Al-Quwain and Ras Al-Khima) is characterized by high zooplankton species diversity, compared to that of southern ones (Abu Dhabi and Dubai). The high proportion of meroplanktonic larvae of the diverse benthic organisms at Umm Al-Quwain and Ras may explain this peak in diversity. Moreover, diversity is reported to be higher in shallow waters than in deep seas, where the habitat becomes more hostile to plankton life as depth increases (Omori and Ikeda, 1984; Weikert, 1987). The water depth during the present study does not exceed 9 m either at northern or southern Emirates, indicating that the possible reason for low diversity of the latter maybe its water instability or pollution.

The inverse relationship which has been observed between equitability and the magnitude of the standing crop of zooplankton in UAE waters is attributed to the increase in density of only one group, the Copepoda, which comprised ~70 % of the whole population, as shown in Figure (2). Moreover, the less similarity between the southern sites (#1 and #2), may be due to the higher densities of zooplankters at these sites.

In conclusion, the UAE water is regarded as being among the oligotrophic marine habitats when considering the magnitude of standing crop of zooplankton. The diversity is relatively high at the northern Emirates compared to the southern ones, where the latter have been disturbed by pollution. However, United Arab Emirates waters have low zooplankton diversity when compared with other similar coastal areas.

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Table 1 : List of Zooplanktonic taxa and species collected from September 1997 to July 1998, in the coastal water of the UAE on the Arabian Gulf.

Tintinnida
1. *Codonella aspera* Kof. and Camp.
2. *Codonellopsis longa* Kof. and Camp.
3. *Favella brevis* Cleve
4. *Favella campanula* (Schmidt)

Foraminifera
5. *Globigerina inflate* (d'Orb.)
6. *Tretomphalus bulloides* (d'Orb.)

Hydrozoa

Trachymedusae
7. *Liriope tetraphylla* (Chamisso & Eysenhardt)

Siphonophora
8. *Chelophyes contorta* (Lens & Van Riem.)
9. *Diphyes chamissonis* Huxley
10. *Sulculeolaria turgida* (Gegenbaur)

Chaetognatha
11. *Krohnitta* sp.
12. *Sagitta enflata* Grassi
13. *S. ferox* Doncaster
14. *S. robusta* Doncaster

Annelida
15. *Polychaete larvae*

Cladocera
16. *Evadne tergestina* Claus
17. *Penilia avirostris* Dana

Ostracoda
18. *Conchoecia* sp.

Copepoda

Clanoida
19. *Acartia erythraea* Giesbrecht
20. *Acrocalanus gibber* Giesbrecht
21. *Calanopia elliptica* (Dana)
22. *Candacia bradyi* A. Scott
23. *Canthocalanus pauper* Giesbrecht
24. *Centropages furcatus* (Dana)
25. *C. orsinii* Giesbrecht
26. *C. yamadai* Mori
27. *Eucalanus subcrassus* Giesbrecht
28. *Euchaeta marina* (Prestandrea)
29. *Labidocerca acuta* Dana
30. *L. kroyeri* (Brady)
31. *L. minuta* Giesbrecht
32. *L. pavo* Giesbrecht
33. *L. wollastoni* (Lubbock) (N.G.R.)*
34. *Paracalanus aculeatus* Giesbrecht
35. *P. crassirostris* Dahl
36. *P. parvus* (Claus) (N.G.R.)*
37. *Pontella karachiensis* Rehman (N.G.R.)*
38. *Pontellopsis herdmani* Thompson and Scott
39. *P. macronyx* A. Scott (N.G.R.)*
40. *Temara discaudata* Giesbrecht
41. *T. turbinata* (Dana)
42. *Tortanus forcipatus* (Thomson & A. Scott.)

Cyclopoida
43. *Copilia mirabilis* Dana
44. *Corycaeus ovalis* Claus (N.G.R.)*
45. *Oithona nana* Giesbrecht
46. *O. plumifera* Baird
47. *Oithona* sp.
48. *Oncaea media* Giesbrecht
49. *Sapphirina nigromaculata* Claus

Harpacticoida
50 *Euterpina acutifrons* (Dana)
51. *Macrosetella gracilis* (Dana)
52. *Microsetella rosea* (Dana)

Amphipoda
53. *Hyperia* sp.
54. *Gammarus* sp.

Cirripedia
55. Cirripede larvae

Decapoda
56. Decapod larvae

Nematoda
57. Nematode larvae and adults

Mollusca
58. *Atlanta* sp.
59. Bivalve larvae
60. *Cavolinia longirostris* (Lesueur)
61. *Cressis acicula* Rang
62. Gastropod Larvae

Echinodermata
63. Echinoderm larvae

Urochrodata (Tunicata)

Thaliacea
64. *Doliolum denticulatum* Quoy and Gaim•
65. *D. gegenbauri* Herdman
66. *Thalia democratica* Forskal

Appendicularia
67. *Oikopleura dioica* Fol.
68. *O. longicauda* Vogt

Ascidiaceae
69. Ascidian larvae

Vertebrata
70. Fish eggs and larvae

* N.G.R. : New Geographic Record.

Table II. Average values of diversity indices of zooplankton in UAE waters at different sites.

Diversity index	Site					
	#1	#2	#3	#4	#5	#6
No. of species	40	45	37	46	53	59
Equitability	0.45	0.41	0.36	0.41	0.52	0.48
Richness	2.7	2.8	2.7	2.9	3.5	4.1

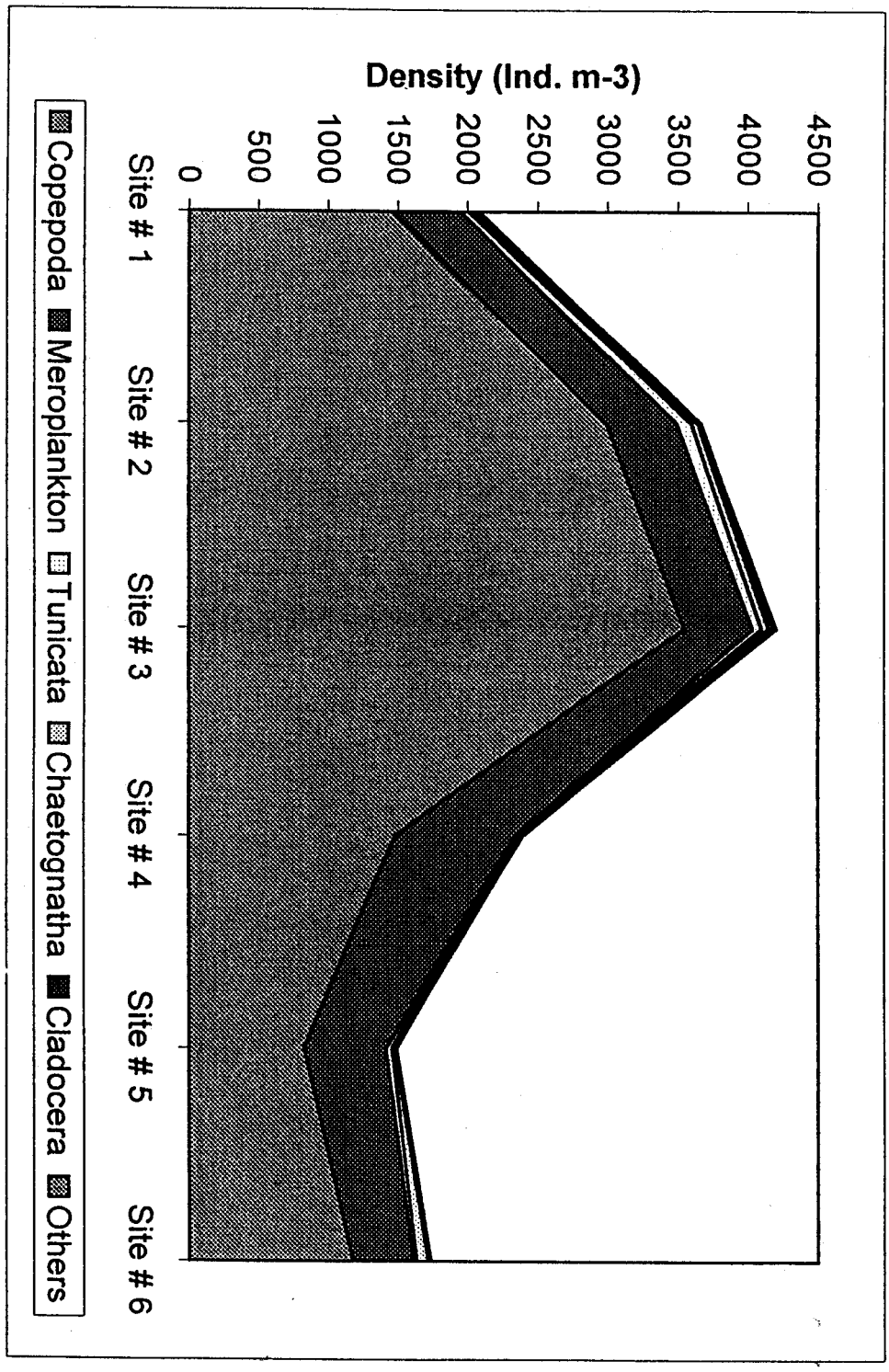

Fig. 2: Site variations of total zooplankton at UAE waters (September 1997-July 1998)

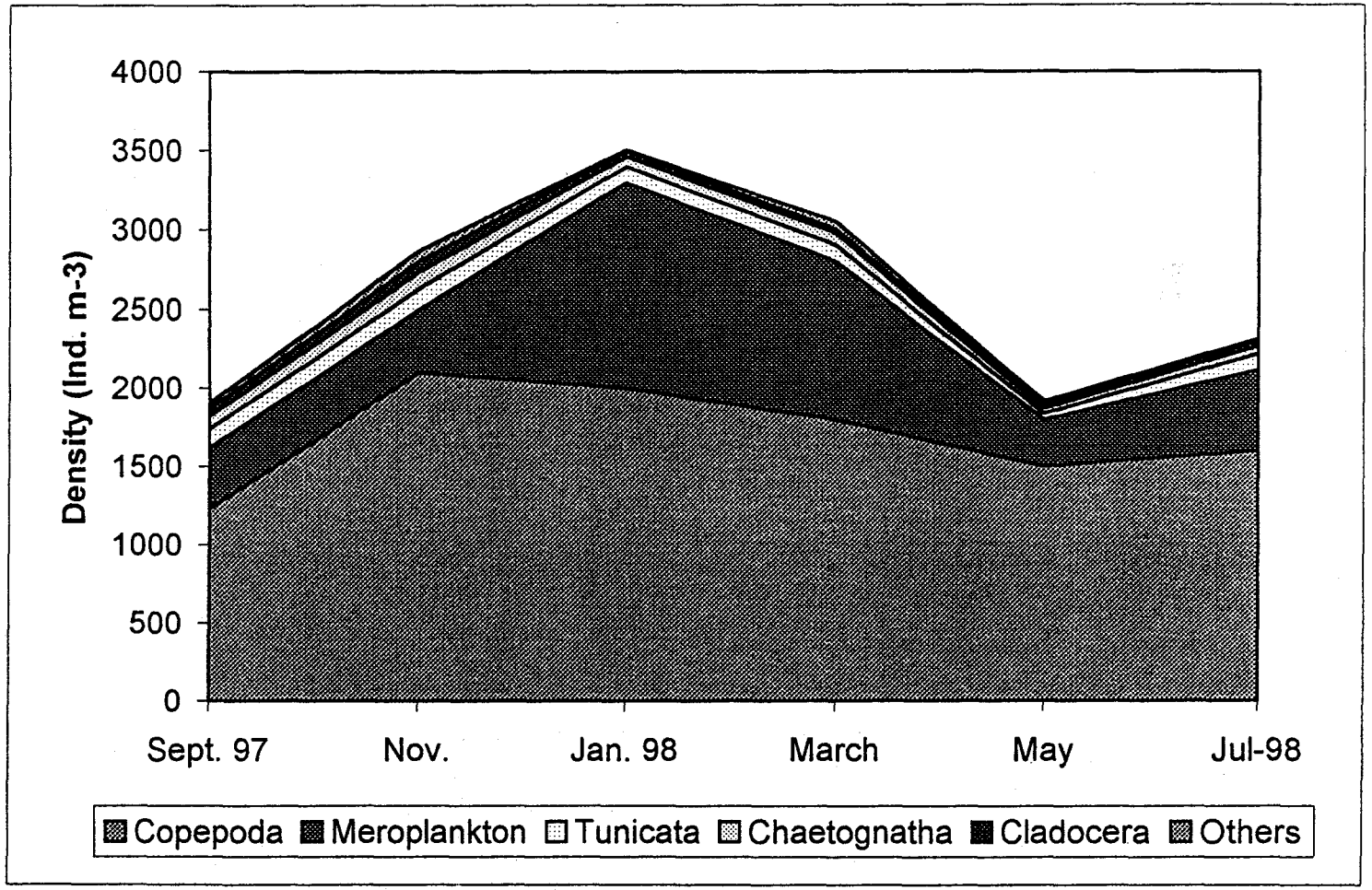

Fig. 3: Bimonthly variations of total zooplankton at UAE waters (September 1997-July 1998)

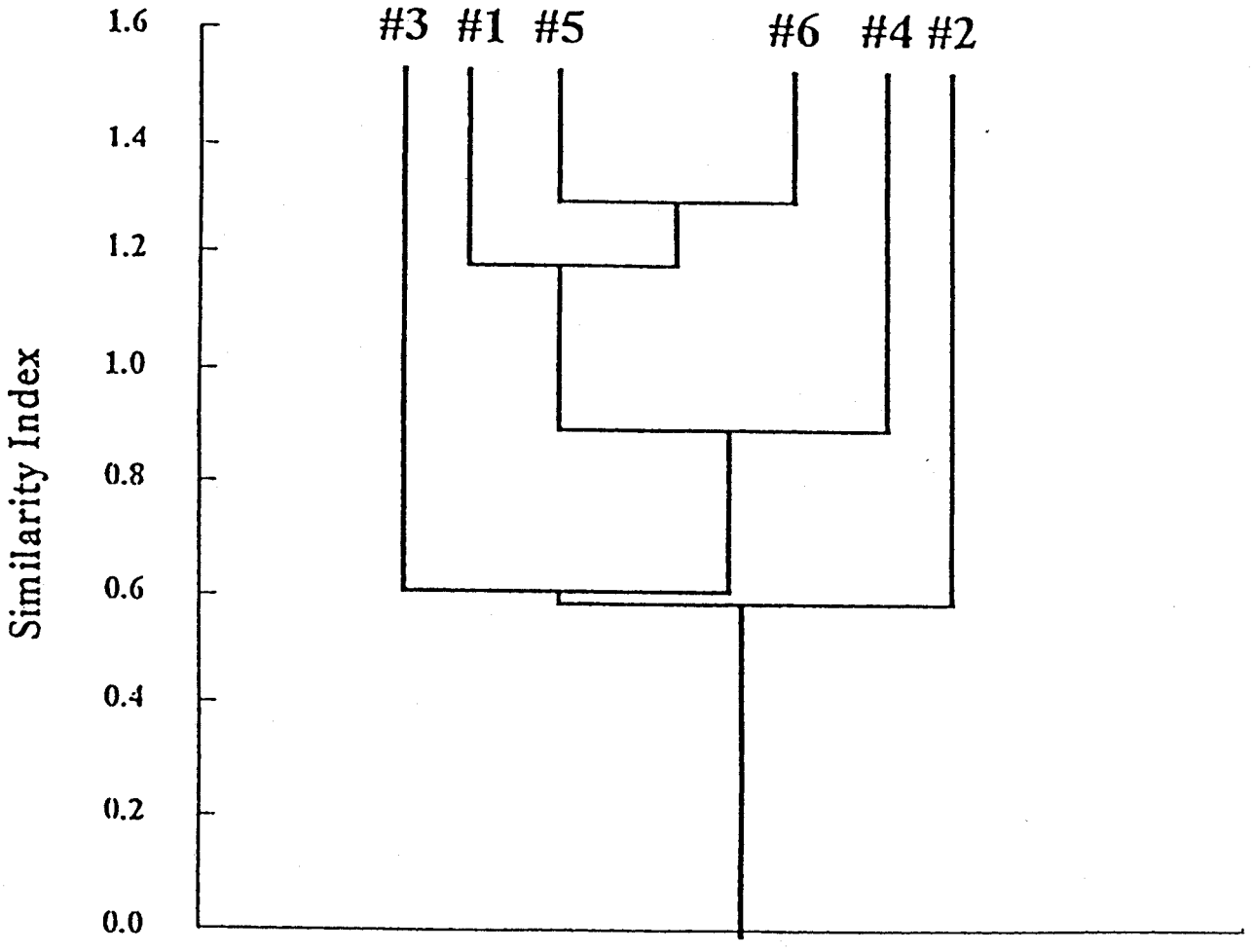

Fig. 4. A classification (dendrogram) showing site similarity of zooplankton composition in UAE Water on the Arabian Gulf, based on average seasonal Similarity Index.