

## ECOLOGY OF THE COEXISTING COPEPOD SPECIES IN COCHIN BACKWATERS

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### ABSTRACT

Association between the common copepod species of Cochin backwaters were analysed. Grouping of the low saline and medium saline species generally stood separate from the high saline species. A high degree of correlation was found among most of the high saline species. The degree of ecological differentiation between them was not very clear. Probably the peculiarities of the estuarine system allowed them to survive as competitors, since it is conceivable that the competing species expand their overlapping niches, in space with time because of salinity incursion. The elimination is automatically brought about by monsoonal change before severity in competition occurs.

### INTRODUCTION

Ecological interactions between organisms occupying an environment has been a matter of considerable study from marine as well as terrestrial and limnetic regions. The results of these interactions could be positive or negative; they may accommodate each other and coexist or compete.

The Cochin backwaters consist of shallow, semi-enclosed extensive body of brackish water running parallel to the coastline located in the tropical zone. The system is saline during the dry months from December to April. But most of its areas remain practically freshwater during the rest of the year when the monsoonal waters inundate it. Salinity has been found to be the key factor controlling the distribution of zooplankton in the estuary and their abundance is comparatively very low during low saline period (Madhupratap, Rao and Iyer, 1977; Madhupratap, 1978). Salinity recover followed by succession of various high saline species is a gradual process starting from the mouth of the estuary by November-December and attains peak values by April with a gradient decreasing from mouth (34‰) to head (13‰).

Copepoda constitute a major group of the zooplankton of the estuary. Among them the coexistence of the species of the family Acartiidae from the Cochin backwaters has been studied earlier by Tranter and Abraham (1971) and the major families of Copepoda by Madhupratap, Haridas, Rao and Iyer (1975). The present paper is an attempt to identify the pattern of associations between species of copepods that more or less consistently occur in the estuary irrespective of generic or family differences.

### MATERIALS AND METHODS

The material included zooplankton from two series of samples: (1) Day and night samples taken from 2 stations - barmouth, Cochin and Aroor, about 14 km south

of barmouth in every month from November 1971 to October 1972; (2) Monthly day collections from 7 stations fixed in the backwaters (Haridas, Madhupratap and Rao, 1973) from Cochin to Alleppey (mouth to the head of the estuary) in 1972. All samples were collected in oblique hauls from bottom to surface lasting five minutes by a HT net (mesh size-300  $\mu$ ) with a flow meter attached.

The organisms in each sample were counted to species level and computed to counts per unit volume of water filtered using flow meter data. 16 calanoid copepods from the first series and 13 species from second series, common in the samples were selected for analysis. Correlation matrices for these species using log transformation of figures for numerical abundance were formed for two stations in the first series and over space and time in the second. Dendrograms were constructed from these by the methods of Mountford (1962) after choosing the first group on the basis of highest correlation coefficient.

#### RESULTS

The species selected for the study included a low saline (0 to 10‰) species, *Acartiella gravelyi*, species which preferred medium salinity (15 to 25‰) like *Acartia plumosa* and *Acartiella keralensis* and high saline species. *Pseudodiaptomus annandalei*, though tolerated a wide range of salinity (0 to 35‰), was more abundant in the stratified waters of the lower reaches during monsoonal period and did not occur towards the head of the estuary. The rest of the species showed considerable salinity tolerance (Madhupratap and Haridas, 1975) but occurred in abundance in the higher saline waters (20-34‰) of the premonsoon. The salinity values given for the various groups are their optimum ranges and they occurred in smaller numbers in other salinities also.

The modes of distribution of various species were reflected in the groupings represented in the dendrograms (Figs. 1-4). *Acartiella gravelyi*, the dominant monsoonal species always showed negative association with the high saline species. *Acartia plumosa* and *Acartiella keralensis*, two species preferring medium salinities, exhibited close association at barmouth and Aroor in the first series and over time in the second series. Over space (Fig. 3) *A. keralensis* showed significant correlation with *A. gravelyi*. This was because both species were more abundant at the middle and upper reaches of the estuary, but during different periods. *Acartia plumosa* also joined this group over space although the level of correlation was not significant. *Pseudodiaptomus annandalei* was grouped with these species at barmouth, Aroor and over time. Over space, this species joined with those high saline species such as *Acartia southwelli* and *Centropages alcocki* which also did not penetrate into the interior of the estuary. The groupings of the four species *Acartiella gravelyi*, *A. keralensis*, *Acartia plumosa* and *Pseudodiaptomus annandalei* generally stood separate from the other high saline species. Closer association of *Acartiella keralensis* and *Acartia plumosa* with high saline species over time was due to their predominant occurrence during saline period, but they occurred only towards the middle and upper reaches where salinity values were not as high as at the mouth.

With regard to the other common species which occurred in high saline water, viz., *Acrocalanus similis*, *Paracalanus crassirostris*, *Centropages alcocki*, *Pseudodiaptomus serricaudatus*, *P. jonesi*, *Labidocera pectinata*, *Acartia centrura*, *A. bowmaai*, *A.*

*spindicauda*, *A. bilobata*, *A. pacifica* and *A. southwelli*, it was observed that all of them showed significant correlation ( $p < 0.5$ ) with each other. Exceptions were *Paracalanus crassirostris* and *Acartia pacifica* at barmouth (Fig. 1), *Pseudodiaptomus serricaudatus* and the group *Centropages alcocki*-*Acartia spindicauda*-*A. pacifica* at Aroor (Fig. 2) and *Centropages alcocki* over space and time (Figs. 3, 4). But these species showed significant correlation with other species at some other station. The more common aberrations of *Centropages alcocki* were because it is a euryhaline marine species frequenting the backwaters and has its distribution restricted to the lower reaches. *Labidocera pectinata* though another euryhaline marine species, had a wider distribution occurring upto the head of the estuary along with salinity incursion.

Cassie (1963) while reviewing literature on correlation coefficients of plankton states that it is difficult to distinguish any consistent pattern in coefficients so far ascertained, since for the same pair of species, the coefficient may change in magnitude from day to day. Variations in groupings of species did exist in the present study at the two stations and over space and time, but the pattern remained the same in a broad sense. All the high saline species except *Paracalanus crassirostris* and *Pseudodiaptomus jonesi* were highly significantly correlated ( $p < .001$ ) with each other at one station or the other. This showed that their occurrences overlapped or that they coexisted.

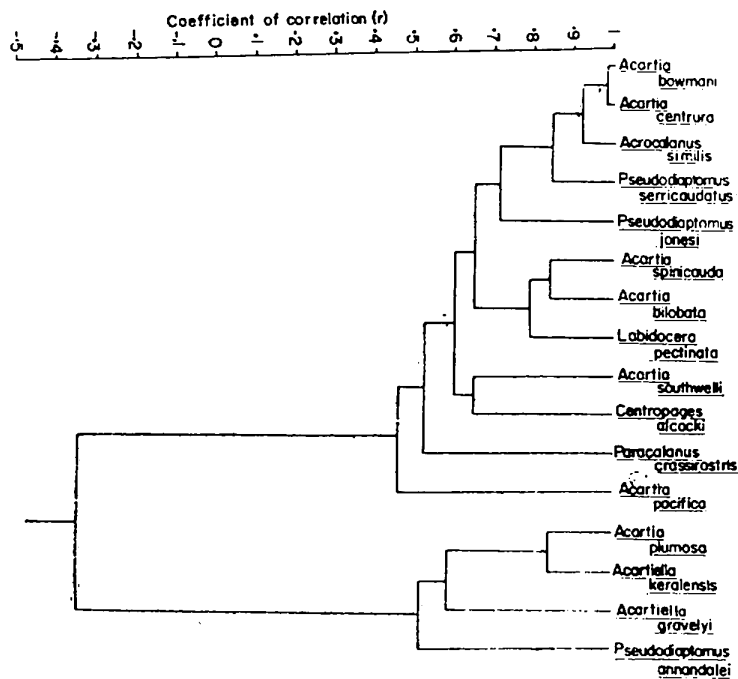


Fig. 1. Dendrogram from correlation coefficients (vertical scale) among common copepod species at barmouth, Cochin.

## DISCUSSION

Classical ecological theories usually imply that coexistence of species requires ecological differentiation between them. Hardin's (1960) competitive exclusion principle stating "complete competitors cannot coexist" is supported by Slobodkin's (1962) view "no two species can indefinitely continue to occupy the same ecological niche". Niches of *Acartiella graveyi*, *A. keralensis*, *Acartia plumosa* and *Pseudodiaptomus annandalei* in the Cochin backwaters are rather well defined and differentiated. The ecological differentiation in food requirements between the coexisting medium saline species *Acartiella keralensis* and *Acartia plumosa* has been shown based on the differences in their mandibular structure (Tranter and Abraham, 1971). But evaluation of ecological differences in other high saline species is difficult. Jeffries (1967) states "Subtle differences can collectively culminate to make one species perform better than its competitor in a particular situation. What is not yet clear is the degree of ecological difference required to permit coexistence, and we are not sure how this difference should be measured (Slobodkin, 1962). Measuring these differences in marine copepods is hard".

To measure the ecological differences, the niche component of each coexisting species will have to be identified. Apart from environmental factors, this would consist of food requirements, morphological variations, physiological functions, generation time, etc. of individual species. These are difficult to be estimated from

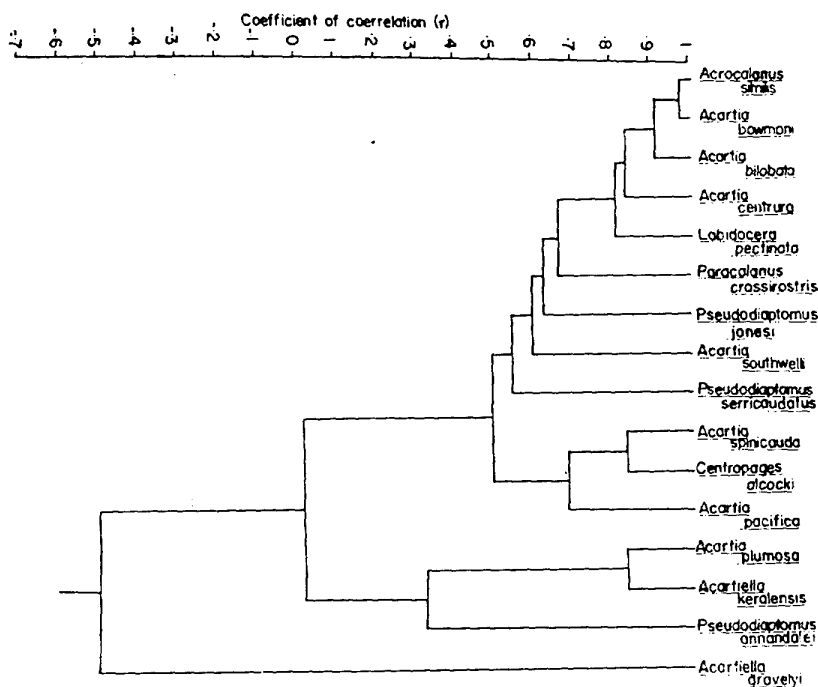


Fig. 2. Dendrogram for common copepod species at Aroor.

natural plankton communities especially of estuaries where "spatial organisation is again and again destroyed by turbulence" (Margalef, 1968). Tranter and Abraham (1971) had tried to establish ecological differentiation between closely coexisting high saline species of family Acartiidae in the estuary based on their mandibular structure. In their opinion "the differences which do exist are not sufficient to establish niche separation".

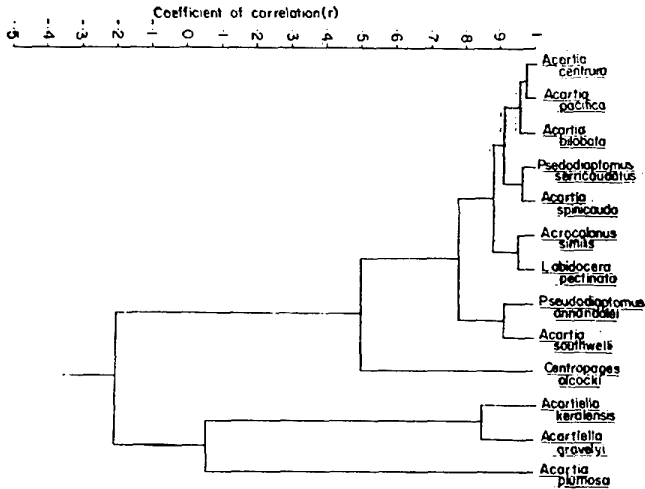


Fig. 3. Dendrogram for common copepod species over space (Cochin to Alleppey) in the year 1972.

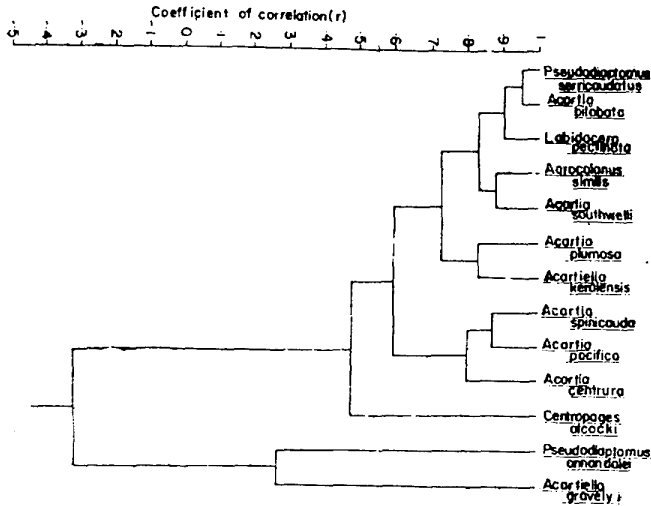


Fig. 4. Dendrogram for common copepod species over time (January to December, 1972) from Cochin to Alleppey.

Assuming that ecological differentiations exist between various high saline species, competition would then become intraspecific. This would also be harmful for the species unless spatial width of its niches expand. This could be conceived to happen in the estuary for the high saline species along with the increase in the extent of salinity penetration.

Species of the families Pseudodiaptomidae and Acartiidae are quite diverse in the backwaters. Species belonging to the latter are especially successful thriving in abundance in the estuary and many of them coexist. Jeffries (1967) states that congeneric associates help in the efficient utilisation of the biotope competing for common resources.

The absolute validity of the theory of competitive exclusion had been criticised by several authors (see, Hutchinson, 1961; Hulbert, 1977) since the equilibrium conditions envisaged under it where the better competitors exclude poorer competitors or where the final assemblage would consist of the population of only a single successful species is not usually attained in natural conditions. Recently, it has been demonstrated (Sale, 1977) in coral reef fish communities, where even within habitat diversity is very high, there is a large amount of overlap in requirements (space and food) among coexisting species. The concept of a guild (a guild is a group of species which uses the same environmental resources in similar ways, Root, 1967) or synergy may be applicable for the coexisting high saline species of the estuary.

On the other hand, competition can sustain when the number of competing species are limited and resources are plenty. Species diversity is low in the estuary and it would seem that equilibrium in niche division is not attained in the estuary. The number of common high saline copepod species occurring in the estuary is limited to about 12. Qasim (1970) and Madhupratap, Haridas and Rao (1977) have observed that primary food is in excess in the estuary as grazing by zooplankton is insufficient to utilize it completely. The idealised situation with niches defined and divided and each species with clear ecological differentiation need not occur under such circumstances. Also a certain amount of competition, whether interspecific or intraspecific, does occur in all natural communities.

Even if the common high saline species occurring in the estuary are competitors and their niches overlap, the incursion of salinity provides all of them with opportunity to expand the niches spatially. Bowman (1971) considers estuarine copepods as eurytopic species which must maintain a high degree of genetic variability and cannot be closely adapted to narrow ecological niches. In his opinion 'physiological efficiency must be sacrificed for adaptability'. The better adapted or the more tolerant species will be able to exploit the situation better and escape to the upper reaches of the backwaters first from the more severe competition at the lower reaches. Thus habitat selections (Mac Arthur, 1965) occur. But as salinity values increase further towards the head region, other species which were restricted to the lower reaches would also penetrate to this area. Competition at different rates occur at all stages in such situations. But the development of the situation of the ultimate survival of the better adapted and the elimination of the other(s) is automatically averted by the periodic monsoonal efflux which flushes all of them out before the severity of competition could lead to it. Thus, since these are recurring conditions from year to year, transmission of these informations as some inherent genetic

code or template through evolutionary period may even be permitting them to coexist as competitors.

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