

THE OCCURRENCE OF THE DIATOM *PSEUDOHIMANTHIDIUM PACIFICUM* EPIZOOIC ON A COPEPOD FOUND IN THE COASTAL WATERS OF KARACHI

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An epizooic diatom, *Pseudohimanthidium pacificum*, is reported from the coastal waters of Pakistan. The distribution of the host copepod *Corycaeus clausii* and the diatom has been studied. The copepod harbours this epizooite on its tail region only. Male copepods carry more diatoms than females. The probable role of copulatory and non-copulatory clasping in the transfer of diatoms from one copepod to other is also discussed.

INTRODUCTION

A large number of epizoites are known to occur on marine copepods [19]. These epizoites are both animals and plants and include diatoms also. Copepods of the genus *Corycaeus* have been reported to harbour diatoms, especially those belonging to the genera *Amphora*, *Cymbella*, *Cocconeis*, *Synedra* and *Pseudohimanthidium* [2, 7, 8, 9, 13, 15, 16]. Sewell [19] has studied the epibionts of copepods from the Arabian sea, but diatoms were not included in that study. Simonsen [17] reported *Pseudohimanthidium pacificum* for the first time from the central Arabian Sea. The present paper deals with the distribution of the epizooic diatom *Pseudohimanthidium pacificum* in relation to the distribution of the copepod *Corycaeus* on the Karachi coast.

MATERIAL AND METHODS

Sampling was carried out in the coastal waters of Karachi (Fig. 1) between November and December 1976 at nine stations on board a fishing trawler hired for this purpose. At each station a zooplankton net of 200 μ m mesh, with an attached flowmeter, was towed horizontally for 10 minutes. Samples obtained were preserved in 4% formalin neutralized with hexamethylene tetraamine. In order to study live copepods some zooplankton samples were diluted with sea water and brought to the laboratory in thermoflasks. The samples were sorted and kept in finger bowls for examination under a Leitz stereomicroscope. Different culture media such as those used by Provasoli [12], and

'f' medium used by Guillard and Rhyther [5] were tried in order to culture the epizooic diatoms.

For detailed examination the diatoms were cleaned by the methods described by Hasle and Fryxell [6] and Swift [20]. Frustules of cleaned diatom were mounted in Hyrax and examined under a Leitz Dialux microscope.

RESULTS AND DISCUSSION

Morphological examination of the copepod *C. clausii*, which is commonly found along the Karachi coast, revealed the presence of epizooic diatoms, an account of which follows.

Taxonomy. The epizooic diatom under study is of the genus *Pseudohimanthidium*. The genus *Hormophora* erected by Jurilj [8] and the genus *Sameioneis* erected by Russell and Norris [13] were merged with the genus *Pseudohimanthidium* by Simonsen [17].

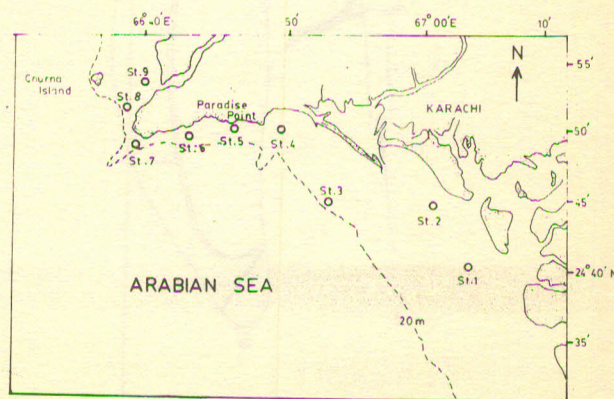


Fig. 1. Map of Karachi coast showing the location of Plankton sampling stations.

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Pseudohimanthidium pacificum Hustedt and Krasske
(Figs. 2-4).



Fig. 2. Tail region of the copepod showing stalked epizooic diatom.



Fig. 3. (a) Epizooic diatom *Pseudohimanthidium pacificum* (cleaned frustule) (b) Tail region of copepod *Corycaeus clausii* showing epizooic diatoms. (c.t. = copepod tail; p. Pseudoraphe; P. p. = *Pseudohimanthidium pacificum*. p.r. = pore row; s = stalk).

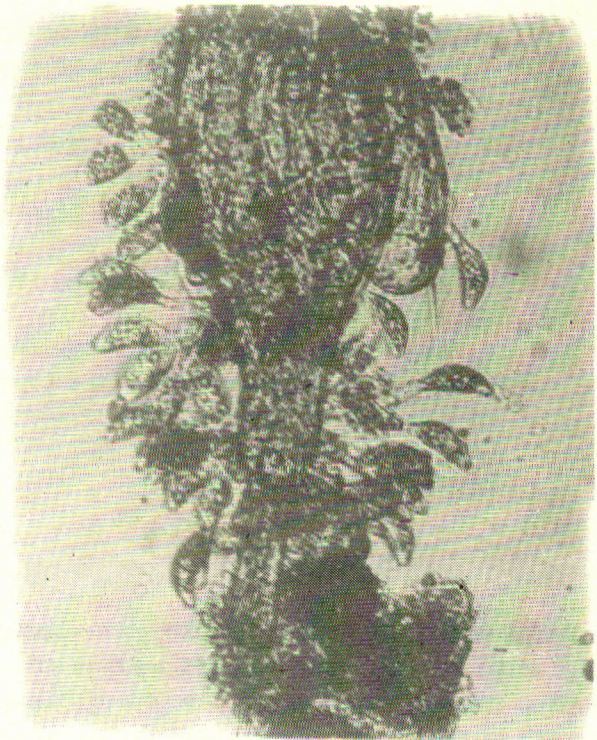


Fig. 4. *Pseudohimanthidium pacificum* showing the chromatophore and stalk.

Pseudohimanthidium pacificum Hustedt and Krasske; In Krasske, Arch. Hydrobiol., **38**: 272, Pl. 5, Fig. 8. 1941.

Syn: *Pseudohimanthidium pacificum* var. *minor* Voigt; Vie Milieu, **9**: 54, Fig. 1. 1958.

Pseudohimanthidium adriaticum Voigt; Vie Milieu, **9**: 54, Fig. 2-10. 1958.

Hormohpora zavodnikia Jurilj; Acta Bot. Croat., **16**: 99, Pl. 3. 1957.

Hormophora rogallii Jurilj; Acta Bot. Croat., **16**: 96, Pl. 2. 1957.

Semeioneis carinaes Russell and Norris; Pac. Sci., **25**: 358, Fig. 1. 1971.

Valve cymbelliform with smoothly arched dorsal margin and very slightly concave to straight ventral margin, 30-38 μm long, 12-14 μm broad, ends subcapitate. At each end of the valve a dorsally arcuate series of 4 to 8 pores running from the ventral edge of the valve towards the apex; the two series on each valve of unequal length. Pseudoraphe (Fig. 3b) narrow, running from the dorsal pore of the series at one end of the valve to the ventral pore of the

series at the other end; at each end of the frustule the pseudoraphe of one valve terminating at the dorsal pore, the pseudoraphe of the other valve at the ventral pore. Valves finally punctate, the minute puncta 25th of a micron arranged in rows perpendicular to the pseudoraphe. Many ellipsoidal to rounded chromatophores with pyrenoids irregularly arranged in the cell. Cells attached to the animal body by means of a branched hyaline flexible stalk.

Remarks. The description of the species recorded from Karachi closely applies to *Pseudohimanthidium pacificum* variety *minor* which Simonsen [16] has merged with *P. pacificum*. This species is widely distributed in the Indian, Pacific and Atlantic Oceans [3, 17]. It has been reported from the central Arabian Sea and the Persian Gulf [17]. This is the first record from the coastal waters of Pakistan.

The copepod genus *Corycaeus* is found in all seas [13]. Different species of this genus were reported from the Arabian Sea as well [18]. No systematic or ecological work has been done on this important group of copepods from the Karachi region. However the sampling carried out at Karachi between 1974 and 1976 shows the presence of *Corycaeus* throughout the year. Few specimens of *Corycaeus clausii*, which is the commonest species of *Corycaeus* in the Pakistan water were found to harbour epizooic diatoms in November and December. In order to study the distribution of the epizooic diatoms along the Karachi coast, zooplankton samples were obtained from different localities along this coast.

Distribution of the host copepod. *Corycaeus clausii* comprised a very small fraction of the total biomass of the zooplankton during the present survey. Its density varied between 0 to 9/m³ (Fig. 5-7) Maximum numbers of *C. clausii* were observed at stations I and VII on 28.11.1976, while none were found at stations I, II, IV, V, VII on 14.11.76 and II and III on 28.11.76 Figs. 4-7 show the distribution of *C. clausii* along the Karachi coast during the study period. It can be seen that the maximum number of *C. clausii* was present at the end of November. This species was found at all stations on 20.12.76 but in small numbers. No correlation was observed between the abundance of *C. clausii* and temperature, salinity and oxygen concentration at station VIII on 14.11.76 (Fig. 8). At this station the male copepods were more abundant than the females and the ratio varied between 1:1.1 to 1:12.46 (Figs. 5-7 in favour of males.

Distribution of *Pseudohimanthidium pacificum*. *Corycaeus clausii* harbours a number of other epibionts besides *P. pacificum*, such as *Cocconeis scutellum*, *Amphora* sp., the ciliate *Vorticella* sp. and few monads. Though *P. pacificum* was dominated by all other epizoites, it was more

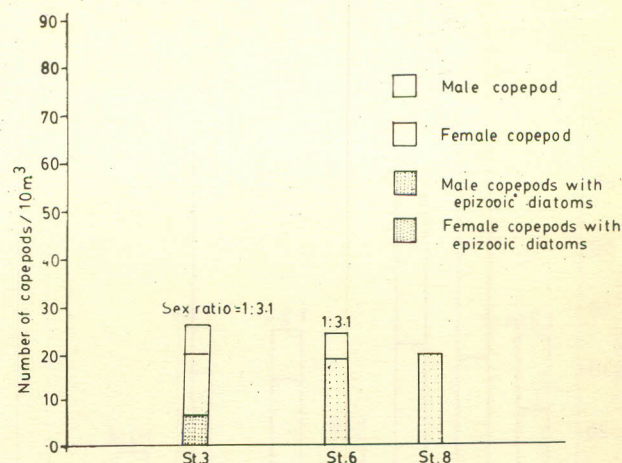


Fig. 5. Distribution of copepod *Corycaeus clausii* and epizooic diatom *Pseudohimanthidium pacificum* on different stations along the Karachi coast on 14.11.1976.

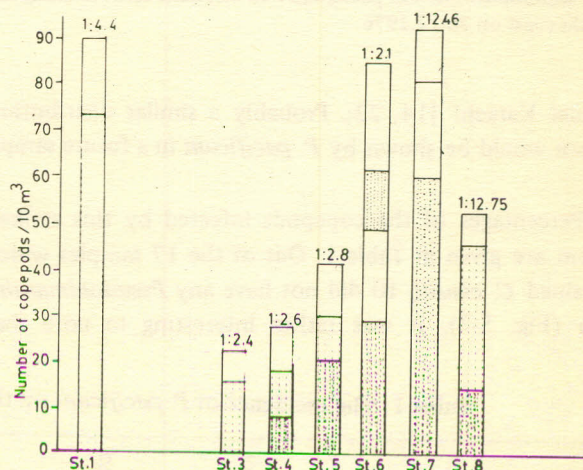


Fig. 6. Distribution of copepod *Corycaeus clausii* and epizooic diatom *Pseudohimanthidium pacificum* on different stations along the Karachi coast on 28.11.1976.

abundant in late November than during the rest of the study period. The epizooic diatoms were more abundant on stations VI, VII and VIII on 28.11.1978 than on others. Observations made on the samples collected from the intake channel of the Karachi Nuclear Power Plant (Paradise Point) Karachi showed that *C. clausii* carries *P. pacificum* in November and December only with the exception that in March 1977 only two out of the 48 specimens of *C. clausii*, were observed to carry *P. pacificum*. In another study species of planktonic diatoms have been found to show the maxima in November and a minor peak in March in Manora

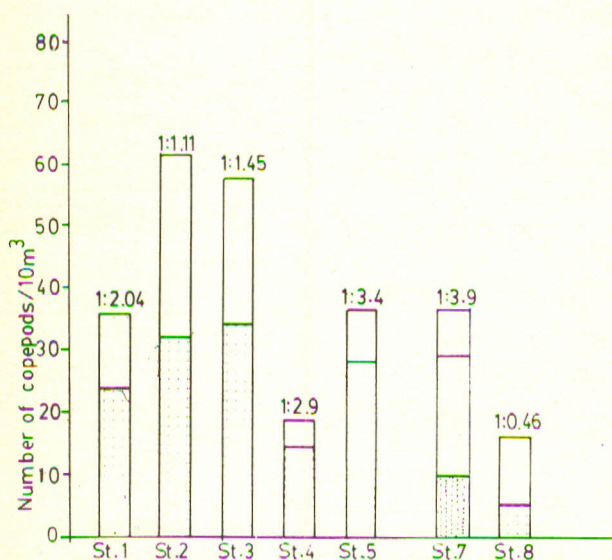


Fig. 7. Distribution of coepod *Corycaeus clausii* and epizooic diatom *Pseudohimanthidium pacificum* on different stations along the Karachi coast on 20.12.1976.

channel Karachi [14, 22; Probably a similar distribution pattern would be shown by *P. pacificum* in a future sampling.

Percentages of the coepods infected by this stalked diatom are given in Table 1. Out of the 17 samples which contained *C. clausii*, 10 did not have any *Pseudohimanthidium* (Fig. 5-7). It was rather interesting to note that

female *C. clausii* were not observed to harbour *P. pacificum* except that for the females (37%) at station VII which had epizooic diatoms on their bodies. At this station female coepods carried fewer *P. pacificum* than the males. On the average, female coepods carried fewer *P. pacificum* than the males bodies. An average of 4 specimens of *P. pacificum* were present on female coepods on 28.11.78, while males on the same station carried an average of 26 diatoms. Similar observations were recorded by Frucht [2] from the Adriatic Sea and by Russell and Norris [13]. Very little difference has been shown in the distribution of *P. pacificum* (as *Sameioneis carinaes*) on male and female *C. affinis* (0.4% more diatoms per male coepod).

Distribution of P. pacificum on the coepod body. In the present study *P. pacificum* was observed only on the tail and caudal furca of *C. clausii*. Klevenhusen [9] had earlier observed epizooic diatoms on the tail region of *C. speciosus*, *C. gracilis*, *C. latus* and *C. flaccus* from the South Atlantic. Jurilj [8] reported *P. pacificum* on the thoracic appendages and cephalothorax of *Corycaeus* spp. from the Adriatic sea, while Giesbrecht [4] observed the epizooic diatoms on the thoracic appendage and tail of *C. elongatus* of the Adriatic sea. Russell and Norris [13] observed this epizooic diatom on the whole body of *Corycaeus affinis* with a concentration on the carapace and 1st thoracic leg of the female and the second antennae of the male. They attributed the concentration of this pennate diatom on the body of the host to the copulatory and non-copulatory clasping of the male coepod and to prostrate migration.

Table 1. The incidence of *P. pacificum* on the coepod *C. clausii* found along the Karachi coast.

Date	St. No.	% Male coepod infected	% Female coepod infected	Number of <i>P. pacificum</i>				Total number diatoms per coepod
				Thoracic appenage	Genital segment	Anal seg.	Caudal ramus	
14.11.1976	III	21.67	—	5	—	—	—	5
28.11.1976	V	46	—	—	—	7	2	9
"	VI	68	—	4	10	4	3	21
"	VII	58.6	—	5	10	8	3	26
"	VII	—	34.7	—	—	3	1	4
"	VIII	74.6	—	—	2	4	3	9
"	IX	32	—	—	—	1	1	2
20.12.1976	VII	31	—	—	6	2	1	9
Total:				14	28	29	14	85

The diameter of the stalk (4.1-4.8 μm) of *P. pacificum* corresponds to the distance between the raphae of each valve (4.7-5.0 μm) at the end of cell. Similar observation have been made by Russell and Norris [13] on *P. pacificum* from Washington. They have attributed the formation of the stalk to mucilage secretion through the raphae. In order to determine the chemical composition of the stalk different stains were used in the present study. These stains were the same as used by Nemoto and Ishikawa [11] for determining the composition of the aggregates in seawater. It appears that the stalk may be composed of a polysacchride since it stains with acid fuchsin and α naphthol. Fee and Drum [1] have noticed stalks of polysacchride nature in diatoms found as epizoids on parasitic copepods of fishes from Des Moines River, Iowa. The secretion of mucilage and its probable role in the distribution of diatoms on the copepod *C. clausii* may be the same as described by Russell and Norris [13].

Observations made on living copepod *C. clausii* indicated that males clasp other males or females of the same species and swim actively in the water. During the clasping transfer of *Pseudohimanthidium* from one copepod to another might occur. The same behavior was noticed in *C. affinis* by Russell and Norris [13], who dealt in detail with the clasping of the copepod and its role in transfer of the epizoidic diatom. Table I shows the distribution of *Pseudohimanthidium* on the body of *Corycaeus* from different stations along the Karachi coast. The occurrence of the epizoidic diatom on the tail of *C. clausii* differs from the distribution on *C. affinis* reported by Russell and Norris [13], and is attributable to the behaviour and sex ratio of copepods in the plankton.

During clasping (either between two males or between a female and a male) the tails of copepods come in contact, and in this process the transfer of diatoms from one tail to another may occur. Due to the presence of more males in the sample (Fig. 4), male to male clasping is more likely to occur than of male to female. Another reason may be that in order to get rid of the clasping copepod the grasped male liberates itself by jerking the tail, increasing in the process the frequency of contacts between tails. This increase in the number of contacts might play a major role in the transfer of diatoms from one copepod to another. Females did not display such a behavior as they do not resist clasping so reducing the chances of contact between tails. Male *C. clausii* were sometimes observed to grasp other males and hold them with their second antennae placed around their carapaces. The same non-copulatory mating was observed by Russell and Norris [13] in *Corycaeus affinis*. This sort of clasping does not play any role in the transfer of *P. pacifi-*

cum from one *C. clausii* to another. The reason for such a non-copulatory clasping is unknown.

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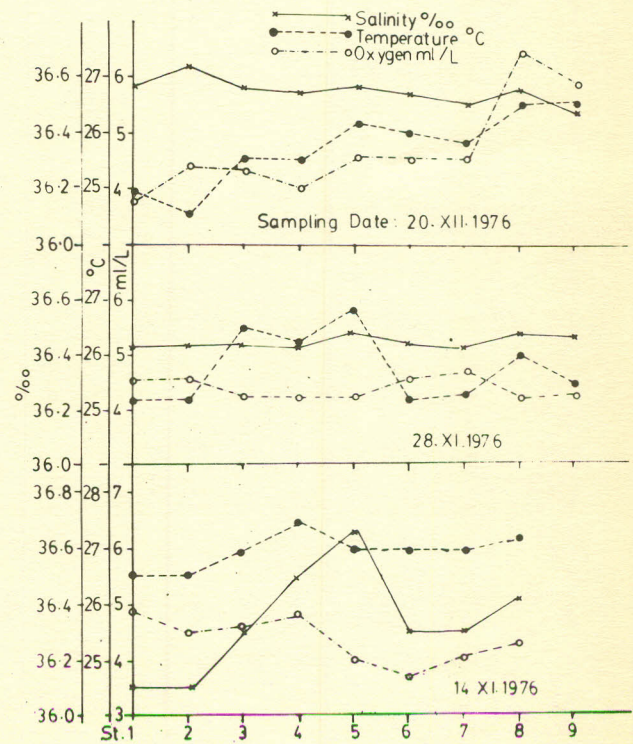


Fig. 8. Distribution of seawater temperature, salinity and dissolved oxygen on different stations along the Karachi coast.

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