

GENUS *PERIDINIUM* EHRENBERG, FROM INSHORE WATERS OF KARACHI

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Abstract

The present paper deals with a study of eleven species of *Peridinium* from inshore waters of Karachi. All the species are first reports from Pakistan's coastal area. *Peridinium truncatum* is recorded from the Indian Ocean for the first time. The species diversity of *Peridinium* was very high from October to December, 1970, which is the post-monsoon period in the N. Arabian Sea. Most species indicated the coastal nature of the area under study. The temperature and salinity ranges within which all the species were found growing in nature are given.

Introduction:

The genus *Peridinium* Ehrenberg of the class Dinophyceae of Division *Thallophyta* (Fritsch, 1956) occupies a very important position as phytoplankter in marine environment. It is used as food by important marine organisms as *Tintinnids*, *Salps*, etc. (Wood, 1954). Several species of *Peridinium* are very good indicators of water masses of different types (Wood, 1954) and are therefore, helpful tools in describing the hydrography of a given area. The taxonomy of *Peridinium* is based mainly on the external morphology of individuals like the presence or absence of spine, shape of the body, size, structure of epitheca etc. The present paper describes the species of *Peridinium* collected from Manora Channel and Korangi Creek during the period between April, 1970 and March, 1971 excluding the months of June and July which are months of intense south west monsoon season. For abbreviations used in the text reference may be made to the previous paper (Hassan & Saifullah, 1971) in which work done in Indo-Pak sub-continent and other tropical and subtropical areas, the area of study and methodology have been described.

Genus *PERIDINIUM* Ehrenberg

Key to species of the genus *Peridinium*

- 1. Antapical spines or horns absent. 2, intercalaries.
 Cell biconical, epitheca equal to hypotheca.
 Sulcus curving strongly to left.....*P. abei*
- Antapicals not hollow, cell depressed.
 Girdle right handed, often with 2 antapical
 spines, meta, quadra, penta or hexa.....2

- Antapicals not hollow. Cells ovoid with 'affixed' apical horn, Girdle right handed—2 antapical spines Para, hexa..... *P. hirobis*
- Antapicals hollow, often deeply indented base. Epitheca conical, may taper into insignificant apical horn. Meta, hexa or quadra one group para.....3
- Antapicals hollow. Cell quadrangular or pentagonal in ventral view, no apical horn. Girdle left handed or circular, Ortho, hexa.....4
- Antapicals hollow. Epitheca with concave side tapering into apical horn. Girdle left handed, oblique. Ortho, Quadra, may be ponta or hexa.....5
- 2(1) — Cell lenticular. 2, antapical unwinged spines..... *P. ovatum*
- Cell pear shaped. 2 antapical spines with moderate wings.....*P. steinii*
- 3(1) — Cell longer than broad. Girdle slightly left handed.....*P. truncatum*
- Cell shorter than broad. Girdle nearly circular.....*P. curtipes*
- 4(1) — Cell broadly pentagonal, with solid, small antapical spines.....*P. pentagonum*
- Cell rhombic with conical antapical.....*P. conicum*
- 5(1) — Cell equidimensional or slightly longer than broad.....6
- Cell much longer than broad.....*P. oceanicum*
- 6(5) — Long axis very oblique, Cell flattened obliquely dorso-ventrally.....*P. depressum*
- Long axis moderately oblique, cell rounded, rhombic.....*P. oblongum*

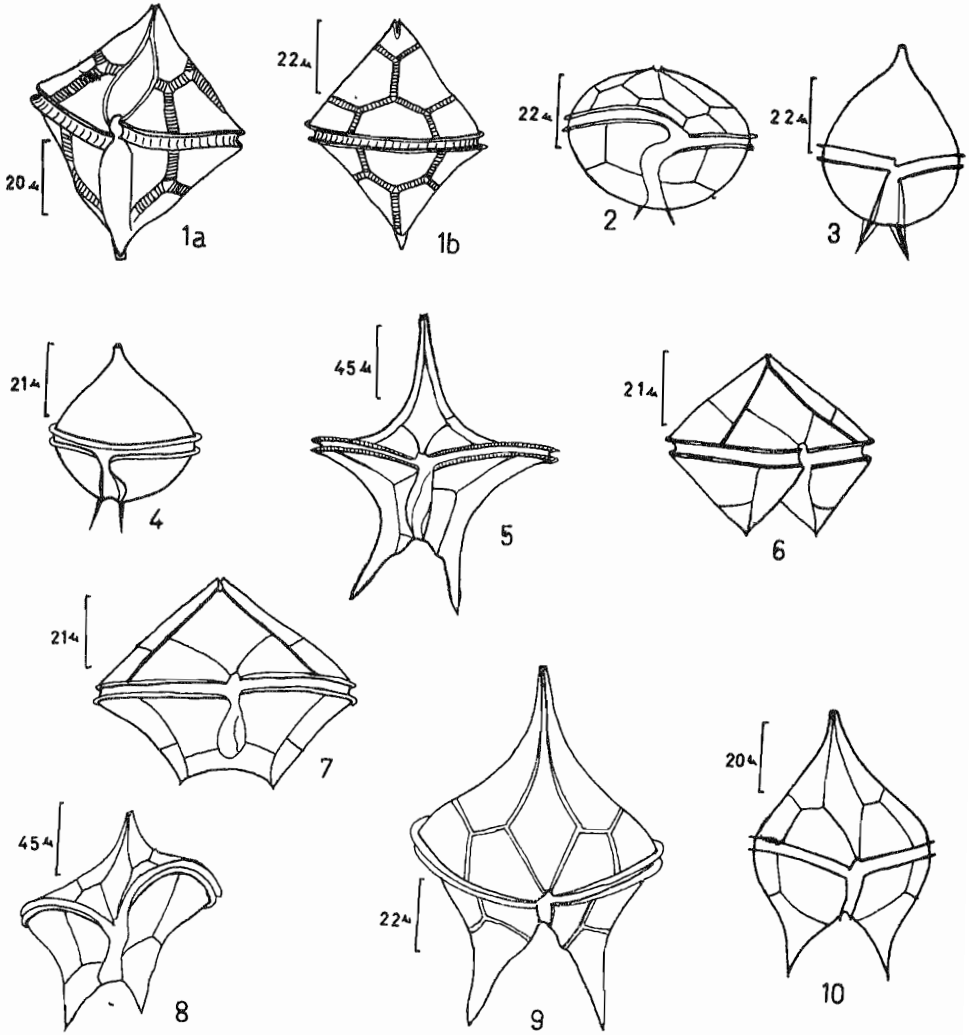


Fig. 1—10. Species of *Peridinium* from inshore waters of Karachi coast.

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|-------------------------|-----------------|
| 1a. <i>P. abei</i> | (ventral view). |
| 1b. <i>P. abei</i> | (dorsal view). |
| 2. <i>P. ovatum</i> | (ventral view). |
| 3. <i>P. steinii</i> | (ventral view). |
| 4. <i>P. hirobis</i> | (ventral view). |
| 5. <i>P. truncatum</i> | (ventral view). |
| 6. <i>P. conicum</i> | (ventral view). |
| 7. <i>P. pentagonum</i> | (ventral view). |
| 8. <i>P. depressum</i> | (ventral view). |
| 9. <i>P. oceanicum</i> | (ventral view). |
| 10. <i>P. oblongum</i> | (ventral view). |

Peridinium abei Paulsen
(Fig. 1a, b)

Abe, 1936, p. 667, Fig. 52-61.

Wood, 1954, p. 229, Fig. 91.

Wood, 1968, p. 97, Fig. 283.

Body biconical, longer than broad. Epitheca conical equal to hypotheca. Hypotheca also conical with single spine on right side. Girdle left-handed, indented with narrow lists. Sulcus deep, curving to left, ending on left margin of hypotheca. Theca porulate, intercalary striae broad. Tabulation: Ortho, 2 intercalaries.

Dimensions: $l=65-90$ micron
 $d=56-76$ micron

Local Distribution: Manora Channel Stations I, II, III, Korangi Creek Station I.

General Distribution: Mutsu Bay (Abè, 1936); Port Hacking, New Guinea, Swan River (Wood, 1954); North Eastern Gulf of Mexico (Balech, 1967); Straits of Florida (Wood, 1968).

P. ovatum (Pouchet) Schutt
(Fig. 2)

Paulsen, 1908, P. 44, Fig. 54.

Grontved & Seidenfaden, 1938, P. 192.

Wood, 1954, P. 236, Fig. 11a-d.

Brunel, 1962, P. 198, Pl. 61-62.

Wood, 1968, P. 106, Fig. 316.

Cell lenticulate. Epitheca domed, low, tapering into small apical horn. Hypotheca low, equal to epitheca rounded, not depressed, lists supported by spines. Sulcus reaching to the base, curved to left, lists conspicuous. Tabulation: meta, penta.

Dimensions: $l = 26 - 45$ micron
 $d = 33 - 56$ micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Station I.

General Distribution: Eastern Australia, New Guinea, Southern Coast of Victoria (Wood, 1954); Bay of Chaleurs (Brunel, 1962); Straits of Florida (Wood, 1968).

P. steinii Jorgensen
(Fig. 3)

Paulsen, 1908, P. 47, Fig. 58.

Lebour, 1925, P. 125, Plate XXV, Fig. 4a-4d.

Wood, 1954, P. 204, Fig. 20.

Wood, 1968, P. 109, Fig. 229.

Cell pear shaped, symmetrical. Epitheca rounded, larger than hypotheca, sides tapering into long apical horn. Hypotheca rounded, with two winged antapical spines. Girdle right-handed, not excavated, lists supported by fine spines. Sulcus broader at the base, with conspicuous lists, left continuous with antapical spine. Tabulation: meta, penta.

Dimensions: $l = 35 - 60$ micron
 $d = 30 - 40$ micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Stations I, II.
General Distribution: Plymouth (Lebour, 1925); Tasmanian Sea. Eden to Solomon Is. Storm Bay, Port Phillip (Wood, 1954), Gulf of California (Klement, 1964); Santaren Channel, Straits of Florida, Benguela Current, Brazil (north-coast), Caribbean Sea (Wood, 1968).

P. hirobis Abè
(Fig. 4)

Wood, 1954, P. 243, Fig. 126.

Wood, 1968, P. 103, Fig. 306.

Cell rounded, Epitheca semicircular, ending into small, tapering apical horn, equal to hypotheca. Hypotheca also semi-circular with two wingless antapical spines. Girdle right-handed, not depressed, lists wide. Sulcus wide, excavated with lists, right continuous with antapical spine. Tabulation: para, hexa.

Dimensions: $l = 46$ micron
 $d = 44$ micron

Local Distribution: Manora Channel Stations I, II, III.

General Distribution: Port Hacking (Wood, 1954); Straits of Florida, Caribbean Sea (Wood, 1968).

P. curtipes Jorgensen

Lebour, 1925, P. 128, text. Fig. 39.

Cell broad Epitheca conical low with concave sides equal to hypotheca. Hypotheca concave, side low, end into two antapical horns. Girdle circular, lists prominent, supported by spines. Sulcus narrow, lists conspicuous and extend beyond base. Theca reticulate. Striae broad.

Dimensions: l — 78 — 85 micron
d — 64 — 86 micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Stations I, II.
General Distribution: Plymouth (Lebour, 1925).

P. truncatum Graham
(Fig. 5)

Graham, 1942, P. 30, Fig. 39-41.

Mid body compressed antero-posteriorly in girdle region. Epitheca low, with concave sides, tapering into long tubular apical horn. Hypotheca rapidly tapering into two antapical long horns. Girdle slightly left-handed, excavated with narrow lists, supported by spines. Sulcus long rotated with well developed lists. Theca reticulate. Tabulation: meta, quadra.

Dimensions: l = 187 micron
d = 150 micron
a = 135 micron
L = R — 56 micron

Local Distribution: Manora Channel Stations I, II, III, Korangi Creek Stations I, II.
General Distribution: Pacific Ocean between 16° S to 34° N (Graham, 1942).

P. conicum (Gran) Ostenfeld & Schmidt
(Fig. 6)

Psulsen, 1908, P. 59, Fig. 74a-d.

Lebour, 1925, P. 111, Pl. XIX, Fig. 1a-1d.

Wood, 1954, P. 250, Fig. 146a.

Brunel, 1962, P. 189, Pl. 56-57.

Klement, 1964, P. 351, Pl. I, Fig. 6.

Wood, 1968, P. 99, Fig. 292.

Body symmetrical, dorso-ventrally flattened. Epitheca conical equal to hypotheca. Hypotheca with tapering sides, two hollow antapical horns. Girdle circular with narrow lists. Sulcus straight, reaching up to the centre of hypotheca. lists not identical. Theca reticulate.

Tabulation: Ortho, hexa.

Dimensions: $l = 50 - 60$ micron
 $d = 52 - 56$ micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Stations I, II, III.

General Distribution: English Channel (Lebour, 1925); Port Hacking, N.S.W. to Moreton Bay, Queensland, Solomon Is., Swan River (Wood, 1954); Bay of Chaleurs (Brunel, 1962). Gulf of California (Klement, 1964); North eastern Gulf of Mexico (Balech, 1967); Amazon estuary (Wood, 1968).

P. pentagonum Gran
 (Fig. 7)

Paulsen 1908, P. 59, Fig. 76-77.

Wood, 1954, P. 253, Fig. 150a.

Klement, 1964, P. 351.

Wood, 1968, P. 107, Fig. 321.

Cell pentagonal, compressed dorsoventrally, kidney shaped in apical view. Epitheca conical, equal to hypotheca. Hypotheca trapezoidal, margins straight, base concave. Girdle left handed, depressed. Sulcus round short. curved to the left, not reaching to base. Tabulation: Ortho, hexa.

Dimensions: $l = 63 - 112$ micron
 $d = 65 - 110$ micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Station II.

General Distribution: Eden, Cape Byros, N.S.W., east coast, Port Phillip, Vic. Swan River, W.A. Solomon Is. (Wood, 1954); Gulf of California (Klement, 1964); North eastern Gulf of Mexico (Balech, 1967); Straits of Florida (Wood, 1968).

P. depressum Bailey
 (Fig. 8)

Paulsen, 1908, P. 53, Fig. 67.

Lebour, 1925, P. 111. Pl. XXIII, Fig. a-f.

Grontved & Seidenfaden, 1938, P. 185, Fig. 61.

Graham, 1942, P. 18, Fig. 14.

Wood, 1954, P. 255, Fig. 155 a-b.

Curl, 1959, P. 305, Fig. 113.

Brunel, 1962, P. 196, Pl. 59.

Klement, 1964, P. 349.

Wood, 1968, P. 100, Fig. 295 a-b.

Cell broad and short, flattened obliquely, dorso-ventral axis very oblique. Epitheca tapering into conspicuous apical horn: Hypotheca having two hollow long antapical horns. Girdle slightly left-handed, with broad lists. Sulcus short, with lists ending into spinelet inside the antapicals. Theca reticulate. Tabulation: Orthoquadra.

Dimensions: $l = 150$ micron

$d = 90$ micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Stations I & II.

General Distribution: English Channel (Lebour, 1925); West of Greenland (Grontved & Seidenfaden, 1938); Apalachee Bay (Curl, 1959); Atlantic Ocean, Pacific Ocean (Graham, 1942); Bay of Chaleurs (Brunel, 1962); Gulf of California (Klement, 1964); Straits of Florida, Benguela Current, Brazil (North coast); Caribbean Sea (Wood, 1968).

P. oceanicum Vanhoffen

(Fig. 9)

Paulsen, 1908, P. 54, Fig. 69.

Grontved and Seidenfaden, 1938, P. 192.

Lebour, 1925, P. 120, text — Fig. 366B.

Graham, 1942, P. 25, Fig. 32-33.

Wood, 1954, P. 256, Fig. 157 a-b.

Klement, 1964, P. 350, Pl. I, Fig. 1 & 2.

Wood, 1968, P. 105, Fig. 313.

Cell elongate, oblique to vertical axis, flattened dorsoventrally. Epitheca with distinctly concave sides, tapering into long apical horn. Girdle lefthanded, very oblique, not depressed, provided with lists. Sulcus short with lists on each side. Tabulation: Ortho, quadra.

Dimensions: l = 145 — 162 micron

d = 125 — 142 micron

a = 103 — 132 micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Stations I, II, III.

General Distribution: English Channel (Lebour, 1925); Holsteinsborg & Merchants Bay (Grontved & Seidenfaden, 1938); Pacific & Atlantic (Graham, 1942); St. Helens, Tas. to Solomon Is. Port Phillip. Vic. Albany (Wood, 1954); Gulf of California (Klement, 1964); North Eastern Gulf of Mexico (Balech, 1967); Straits of Florida, Caribbean Sea (Wood, 1968).

P. oblongum (Aurivillius) Cleve

(Fig. 10)

Paulsen, 1908, P. 55, Fig. 70.

Lebour, 1925, P. 121, Plate XXIV, Fig. 1 a-c.

Wood, 1954, P. 256, Fig. 158 a-c.

Cell broad and long, flattened obliquely and dorso-ventrally. Epitheca sides convex, tapering into well developed apical horn. Hypotheca with two long antapical horns. Girdle slightly left-handed, with conspicuous lists. Sulcus short with list on each side, continuous into spinelet inside the antapical horns. Tabulation: ortho, quadra.

Dimensions: l = 95 — 172 micron

d = 71 — 115 micron

L = 26 — 48 micron

R = 18 — 45 micron

Local Distribution: Manora Channel Stations I, II, III. Korangi Creek Station I.

General Distribution: English Channel (Lebour, 1925); East Australia, Bass Straits to Solomon Is. Albany Heard I. (Wood, 1954).

Table 1. Seasonal occurrence of *Peridinium* at Manora Channel.

No.	Name of Species	Apr.	May	Aug.	Sept.	Oct.	Nov.	1970			Mar.
								Dec.	Jan.	Feb.	
1.	<i>Peridinium abei</i>	—	—	—	—	X	X	—	—	—	—
2.	<i>P. conicum</i>	—	—	—	—	X	X	X	—	—	—
3.	<i>P. curtipes</i>	—	—	—	X	X	X	X	X	X	X
4.	<i>P. depressum</i>	X	X	X	—	X	X	X	X	X	—
5.	<i>P. hirobis</i>	—	—	—	—	X	X	X	—	—	—
6.	<i>P. oblongum</i>	—	X	X	—	X	X	X	—	—	—
7.	<i>P. oceanicum</i>	—	X	X	X	X	X	X	—	—	—
8.	<i>P. ovatum</i>	—	—	—	—	X	X	X	X	—	—
9.	<i>P. pentagonum</i>	—	X	—	X	X	X	—	—	—	—
10.	<i>P. steinii</i>	—	—	—	—	—	X	X	X	—	—
11.	<i>P. truncatum</i>	—	—	—	—	—	X	X	X	—	—

Discussion and ecological remarks

Most species of *Peridinium* occurred during three months from October to December (Table 1). *P. depressum*, *P. oblongum* and *P. oceanicum* were found to be cosmopolitan and euryhaline and showed a wider tolerance to salinity and temperature as compared to other species (Table 2). Out of eleven species, eight were neritic and neritic-oceanic i.e., found both in inshore and offshore waters (Table 3). This preponderance of neritic and neritic-oceanic species is true for all coastal waters subject to tides of moderate amplitude.

Table 2. Temperature and salinity ranges of *Peridinium* spp.

Name of Species	Temperature range °C	Salinity range 0/00
<i>Peridinium abei</i>	24-29	36-36.5
<i>P. conicum</i>	24.9-28.2	36.3.-36.5
<i>P. curtipes</i>	21-29.2	36.2-36.7
<i>P. depressum</i>	21-29.2	31.7-36.7
<i>P. hirobis</i>	24.9-28.2	36.0-36.5
<i>P. oblongum</i>	22-29.2	31.7-36.6
<i>P. oceanicum</i>	22-29.2	31.7-36.6
<i>P. ovatum</i>	21.5-28.2	36.5-36.7
<i>P. pentagonum</i>	26.5-28.2	36-36.5
<i>P. steinii</i>	21.5-29.2	36.2-36.7
<i>P. truncatum</i>	22-26	36.3-36.6

Table 3. Ecological classification of *Peridinium* spp.

Neritic	Neritic-Oceanic	Oceanic
<i>Peridinium conicum</i>	<i>P. hirobis</i>	<i>P. abei</i>
<i>P. curtipes</i>	<i>P. oblongum</i>	<i>P. depressum</i>
<i>P. pentagonum</i>	<i>P. oceanicum</i>	<i>P. truncatum</i>
<i>P. steinii</i>	<i>P. ovatum</i>	

Of the eleven species examined from Karachi Coast, only five species viz., *P. conicum*, *P. depressum*, *P. oceanicum*, *P. pentagonum* and *P. ovatum* (*P. globulus* var. *ovatum*), have previously been reported from west coast of India (Subrahmanyam, 1958; Subrahmanyam & Sarma, 1960). Referring to "check-list of Dinoflagellates from the Indian Ocean" (Wood, 1963) *Peridinium truncatum* appears to be a new report from the Indian Ocean.

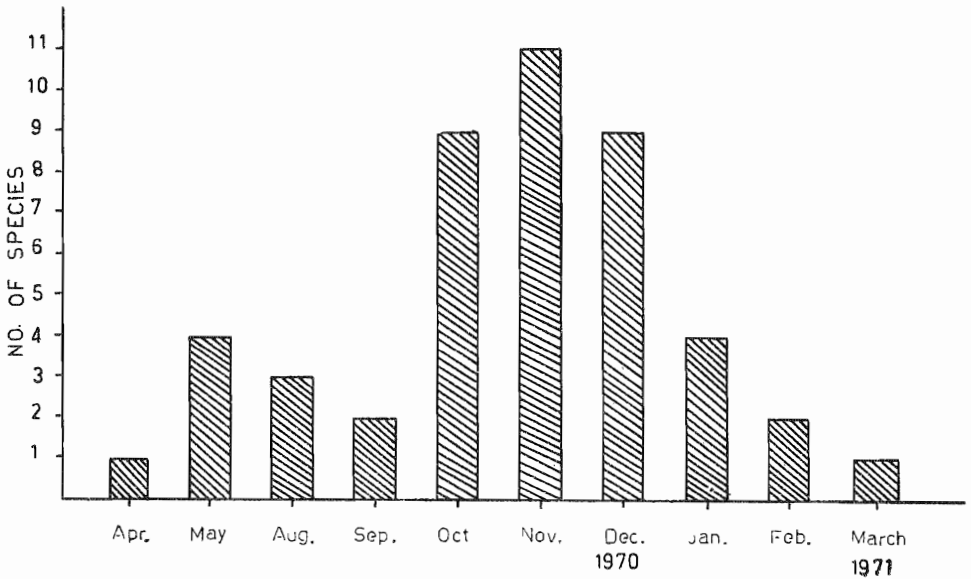


Fig. 11. Seasonal variation in species diversity of *Peridinium*.

The species diversity, measured as total number of species recorded on a single occasion (Pianka, 1966) was high during October to December with a range of 9 to 11 species recorded on one single occasion (Fig. 11). It remained very low during the rest of the period. November was the month of maximum diversity and greatest abundance (visual estimates) for *Peridinium*. The period from October to November is the post monsoon calm period during which thermal stratification establishes itself and Doe (1965) has found this to be true on the Continental Shelf of Karachi in November 1964. Before this period there was intense mixing from April onwards to September as a result of S. W. monsoon which resulted in the upwelling of nutrient rich water from moderate depths to the surface. With the onset of thermal stratification in the post-monsoon period the nutrients were trapped in the surface waters which may be responsible for the increase in species diversity from October to November and for increase in cell numbers of *Peridinium* in November.

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