

TAXONOMY AND DISTRIBUTION OF SOME *CERATIUM* SPECIES IN THE ANTARCTIC OCEAN

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Abstract: Distribution of species of *Ceratium* in the Antarctic Ocean (south of 45°S) is reported. In this region, 7 species of *Ceratium*, viz. *C. pentagonum*, *C. lineatum*, *C. kofoidii*, *C. minutum*, *C. fusus*, *C. horridum* and *C. petersii* were found. *C. minutum* is new to the Antarctic Ocean. *C. pentagonum* was predominant in some specific areas. Limiting factor of distribution of *C. fusus* in the Antarctic Ocean is discussed.

1. Introduction

This report gives the results of microscopical analyses on the *Ceratium* species found in 53 samples collected from the Antarctic Ocean during the 10th cruise by the Japanese Antarctic Research Expedition 1968–1969 (JARE-10) from December 24, 1968 to March 10, 1969.

The environmental data were previously reported by TAKAHASHI (1969) and HIGANO and SARUWATARI (1970).

Information on dinophytes in the Antarctic and Subantarctic Seas between 30°E and 100°E had been scarce. After BALECH (1968), some floristic reports on species of genus *Ceratium* in the region were made by HADA (1970) and SOURNIA *et al.* (1979). HADA reported 4 species, and SOURNIA *et al.* reported 7 species along a longitude a few degrees west of the Kerguelen Islands between 43°S and 62°S.

In the present study, the distribution of 7 species of *Ceratium* in the sea between 111°03'E and 3°28.3'W in the south of 45°S is reported.

2. Materials and Methods

Materials were obtained from the sea surface by a tow net (NXX 13) and were fixed with formalin. The stations from which materials were obtained are illustrated in Fig. 1 and listed in Table 1.

Study was made with an optical microscope and a scanning electron microscope, JEOL 100B-ASID.

3. Results and Discussion

Seven species of genus *Ceratium*, viz. *C. pentagonum* GOURRET, *C. lineatum* (EHRENBERG) CLEVE, *C. kofoidii* JÖRGENSEN, *C. minutum* JÖRGENSEN, *C. fusus* (EHRENBERG)

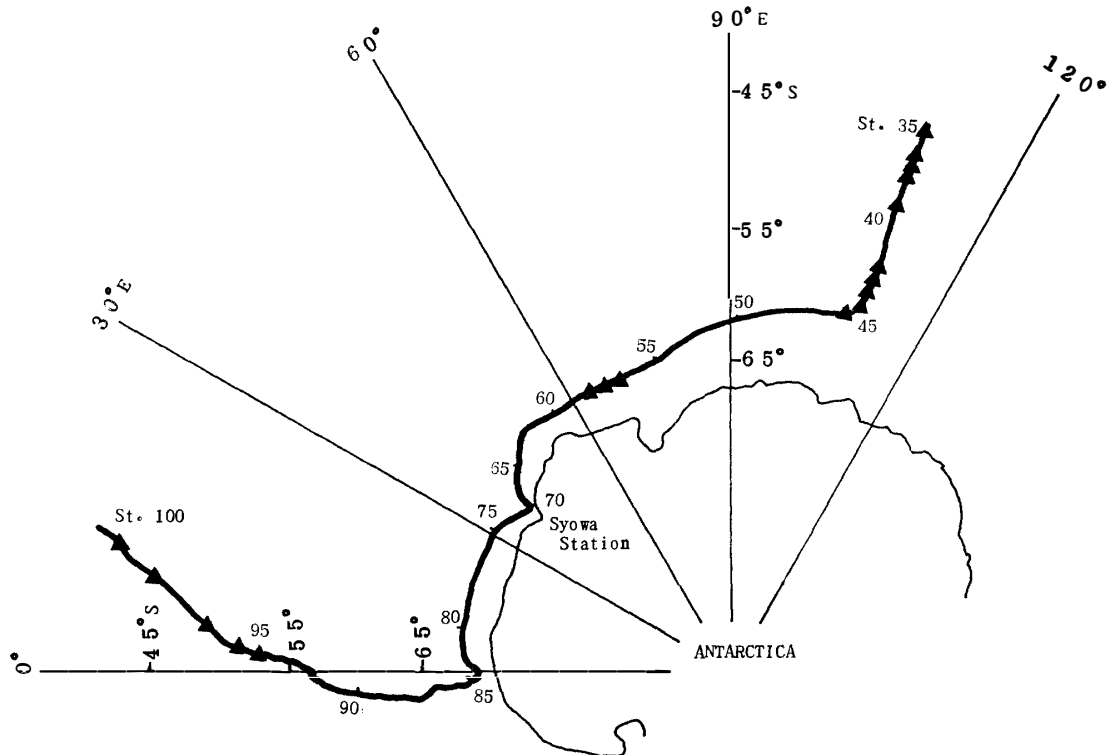


Fig. 1. Distribution of the species of *Ceratium* along the cruise track of the *FUJI* in 1968-1969 in the Antarctic Sea (▲: station where some *Ceratium* species were present).

Table 1. Locality and water temperature of the stations and distribution of *Ceratium* species (December 24, 1968-March 10, 1969).

Stn.	Latitude	Longitude	Water temp.	Species
35	45°03.1'S	111°05.2'E	9.5°C	<i>C. fusus</i> , <i>C. lineatum</i> <i>C. kofoidii</i> , <i>C. pentagonum</i> <i>C. petersii</i> , <i>C. horridum</i>
36	47 28.2	111 41.9	8.6	<i>C. fusus</i> , <i>C. horridum</i> <i>C. kofoidii</i> , <i>C. lineatum</i> <i>C. minutum</i> , <i>C. pentagonum</i>
37	48 42	111 45	6.2	<i>C. fusus</i> , <i>C. kofoidii</i> <i>C. pentagonum</i>
38	49 37	111 46	5.6	<i>C. pentagonum</i>
39	52 00	111 46	2.9	<i>C. pentagonum</i>
42	56 41	112 31	1.1	<i>C. pentagonum</i>
43	57 50.2	112 05.5	0.9	<i>C. pentagonum</i>
44	58 51.7	111 28	0.8	<i>C. pentagonum</i>
45	61 01.3	108 40	0.3	<i>C. pentagonum</i>
46	61 09.3	106 31.4	0.9	<i>C. pentagonum</i>
47	61 24.2	103 51.7	0.4	absent
48	61 49.5	98 45.8	0.2	absent
49	62 03	96 18	0.2	absent
50	62 14	94 15	0.4	absent
51	62 38.4	88 13.7	-0.3	absent
52	62 51	85 35.9	-0.4	absent

Table 1. Continued.

Stn.	Latitude	Longitude	Water temp.	Species
54	63°27.5'S	77°16.7'E	-0.1°C	absent
55	63 36.8	74 41	0.0	absent
56	63 46.9	72 21.9	-0.2	absent
57	64 14.7	65 50.5	-0.6	<i>C. pentagonum</i>
58	64 06.7	63 57	0.1	<i>C. pentagonum</i>
59	64 19.5	61 29.8	0.4	<i>C. pentagonum</i>
60	65 00.2	54 59.3	-0.5	absent
62	64 54	51 48	0.4	absent
63	65 03	47 42.7	-0.4	absent
64	65 27.3	45 43.1	-0.1	absent
66	67 00	41 42.5	-2.0	absent
67			-1.4	absent
68			-1.0	absent
71	69 00	39 36	0.1	absent
72	69 01.3	39 16.5	-1.0	absent
75	68 44.8	31 13.2	-0.7	absent
76	68 34.2	29 44.9	-0.5	absent
77	68 45.9	29 15.7	0.0	absent
78	68 45.8	20 37.8	0.2	absent
79	68 44.1	17 13.1	-0.5	absent
80	68 31.2	12 11.2	0.1	absent
81	68 11.2	8 11.8	0.3	absent
82	68 02	4 07.2	0.6	absent
83	68 09.4	2 25.9	0.7	absent
85	68 35.4	1°58 'W	0.6	absent
86	67 58	2 10	0.8	absent
87	66 25	1 53	1.3	absent
88	65 14	2 51.6	1.8	absent
89	65 52.3'	3 28.3	2.4	absent
90	61 20.6	3 26.9	2.0	absent
91	58 42.8	1 35.8	2.0	absent
92	57 14.3	0 16.5	2.1	absent
93	55 00	2°35.7'E	2.0	absent
94	53 25	3 48.5	1.7	absent
95	50 55.1	5 44.8	4.4	<i>C. pentagonum</i>
96	49 34.8	6 41.8	4.3	<i>C. pentagonum</i>
97	47 13	8 30.8	6.2	<i>C. pentagonum</i>
99	43 10.3	11 50.9	9.5	<i>C. petersii</i> , <i>C. pentagonum</i>
100	41 51.3	12 54.8	13.0	<i>C. fusus</i> , <i>C. horridum</i> <i>C. petersii</i> , <i>C. pentagonum</i>

DUJARDIN, *C. horridum* (CLEVE) GRAN and *C. petersii* STEEMANN NIELSEN were found in the Antarctic Ocean.

Ceratium pentagonum GOURRET 1883 (Plate 1, Figs. 1-3)

This is a medium-sized species (total length = 177-280 μm ; width = 70-90 μm). The frustule has a straight or slightly bent apical horn, with short antapicals. The right horn is usually less than 2/3 of the length of the left one, and slightly diverges. The

shape of this species, for example, the length of the apical horn (50–150 μm) and the width of the winged list between antapical horns (absent–12.5 μm), changes gradually (Plate 1, Figs. 1–3).

This species is distributed in the temperate Atlantic waters including the Mediterranean Sea to 45°S, in the Indian Ocean, in the Pacific Ocean, along the east and south coasts of Australia (WOOD, 1954), in the north Atlantic Ocean to 45°N and in the north Pacific Ocean as far as 52°N (GRAHAM and BRONIKOVSKY, 1944). In the present study, the species was found at Stns. 35, 36, 37, 38, 39, 42, 43, 44, 45, 46, 57, 58, 59, 95, 96 and 97. Especially at Stns. 38, 95, 96 and 97, the species was the predominant phytoplankton (Table 1; Plate 2, Fig. 12).

With the exception of the notes by HART (1934), the *Ceratium* species reported from the Antarctic Ocean were usually much fewer than other phytoplankters. In the present study the percentage of the species to the total phytoplankters was 75% at Stn. 38, 99% at Stns. 95 and 96, and 82% at Stn. 97.

Ceratium lineatum (EHRENBERG) CLEVE 1899 (Plate 1, Figs. 4–5)

This is a small to medium sized species (total length = 127.7–217.9 μm ; width = 33.3–64.3 μm). The apical horn is distinct, long and tapering slightly. Antapicals are straight, more or less diverging, with right horn 1/3–2/3 of the length of the left one. Thecae bear conspicuous lines and pores.

The species was recorded in the Red Sea, in the Indian Ocean, in the Bering Sea, in the Atlantic Ocean extending from 26°S in the Sargasso Sea to 60°N near Greenland (CLEVE, 1901), in the Subantarctic Sea (WOOD, 1954), and also in the Antarctic Ocean (BALECH, 1968; HADA, 1970). It was rare at Stns. 35 and 36. This species is supposed to be distributed as far as 70°S (BALECH, 1968), but we were unable to find it in the south of 50°S.

Ceratium kofoidii JÖRGENSEN 1911 (Plate 1, Fig. 7)

This is a small, fragile species (total length = 135.7–142.9 μm ; width = 33.3–42.9 μm). The epitheca is triangular with straight or slightly convex sides and a long, very thin apical horn. The hypotheca is slightly tapered with straight or slightly concave sides. Antapical horns are unequal in length, usually very thin and somewhat diverging. The left horn is at least twice as long as the right one. WOOD (1954) noted the species as a rare warm-water species. It was reported from the Atlantic Ocean (Azores to 10°S), the Mediterranean Sea, the Indian Ocean, the Pacific Ocean, along the coast of Japan, along the west coast of America, and along the east coast of Australia. HADA (1970) obtained the species at only one station (water temperature 6°C) in the Antarctic Ocean. In the present study, the species found at Stns. 35, 36 and 37 was in small number (Table 1). From the result of the present study, this species can still be considered to be very rare, and is never distributed in very cold waters.

Ceratium minutum JÖRGENSEN 1920 (Plate 1, Fig. 6)

This is one of the smallest species in the genus (total length = 79.8–114.4 μm ; width = 30.6–35.9 μm). The epitheca is convexly rounded. The apical horn is short, and the antapicals are slightly divergent, one of them being very short or pointed. The sides

of hypotheca are straight and tapering.

This species is distributed in the Atlantic Ocean, in the east Pacific Ocean, along the eastern, southern and western coasts of Australia (WOOD, 1954), and in the Indian Ocean (TAYLOR, 1976). In the present study, it was found at St. 36 only, but the population was large there (Table 1; Fig. 2).

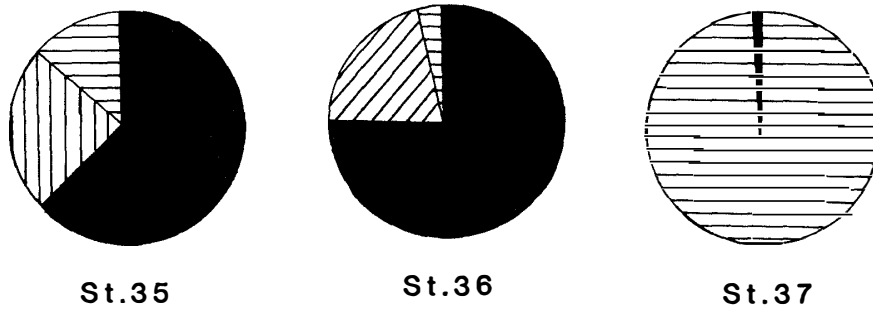


Fig. 2. Diagrams to show the percentage of cell numbers in 4 species of *Ceratium* at 3 stations (horizontal line: *C. pentagonum*; diagonal line: *C. minutum*; painted with black: *C. fusus*; vertical line: *C. petersii*).

Ceratium fusus (EHRENBERG) DUJARDIN 1841 (Plate 1, Fig. 8)

This is a very slender species (total length = 335.7–400 μm ; width = 17.9–26.6 μm). The length of hypotheca with the antapical horn is usually longer than that of the epitheca with the apical horn. The right antapical horn is reduced or absent. The epitheca tapers very gradually into an apical horn which is gently curved towards the dorsal side.

This is a cosmopolitan species (GRAHAM and BRONIKOVSKY, 1944; WOOD, 1954; DODGE, 1982). It was found at Stns. 35, 36 and 37 (Table 1). In the Antarctic Ocean, it has been reported from as far as 70°S (BALECH, 1968). However, in the present study, it was not found in the south of 50°S. In the proximity of the Subtropical Convergence, this species has sometimes been found in abundance (BALECH, 1968). In the present study, it amounted to 67% of the total number of *Ceratium* cells at St. 35 and 78% at St. 36, but the percentage decreased markedly at St. 37 (Fig. 2). HADA (1970) described that the species was rarely collected from the sea with a surface temperature lower than 7°C. NORDLI (1957) reported that 5°C was the lower limit and 15°C was the optimum for division of the cells. Therefore, the decreased abundance at St. 37 was probably caused by the low temperature.

Ceratium horridum (CLEVE) GRAN 1902 (Plate 2, Figs. 9–10)

The collected individuals were of typical form of this species, *i.e.* var. *horridum* (total length = 254.3–299.3 μm ; width = 50.9–79.8 μm). The frustule is robust with antapical horns of moderate divergence bearing teeth. The species was collected not only at Stns. 35 and 36 in the south of 45°S but also at St. 100 (41°51.3'S) in the north (Table 1). DODGE (1982) noted that this species seemed to be a cool water species and was never found in great numbers. WOOD (1954) also noted that it might be a cool-temperate form. The distribution of this species in the present study agrees well with the previous reports. Although BALECH (1968) mentioned that this species was dis-

tributed as far as 60°S, the present authors did not find it in the south of 50°S.

Ceratium petersii STEEMANN NIELSEN 1934 (Plate 2, Fig. 11)

This is a medium sized species (total length = 135.6–157.1 μm ; width = 50.9–67.9 μm). This species resembles *C. azoricum* but differs in having the apical horn with winged list and spread antapical horns.

This species is peculiar to the Pacific Ocean (GRAHAM and BRONIKOVSKY, 1944). It is distributed also in the Subantarctic waters (STEEMANN NIELSEN, 1934; WOOD, 1954) and in the west of Ireland (DODGE, 1982). In the present study, it was found not only at St. 35 but also at Stns. 99 and 100 in the northern area (Table 1).

This species is widely distributed but scatteringly.

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Plate 1

- Fig. 1. *Ceratium pentagonum*.
- Fig. 2. *Ceratium pentagonum*.
- Fig. 3. *Ceratium pentagonum*.
- Fig. 4. *Ceratium lineatum*.
- Fig. 5. *Ceratium lineatum* (SEM).
- Fig. 6. *Ceratium minutum*.
- Fig. 7. *Ceratium kofoidii*.
- Fig. 8. *Ceratium fusus*.

(scale: 25 μm)

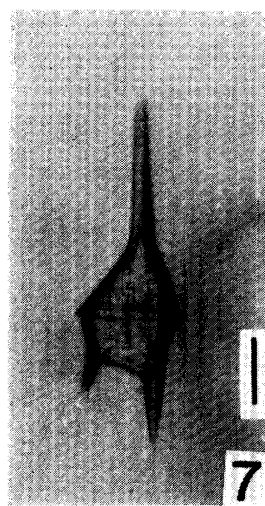
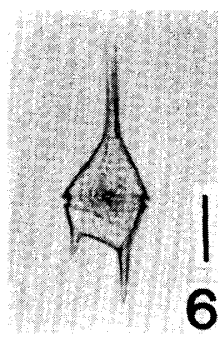
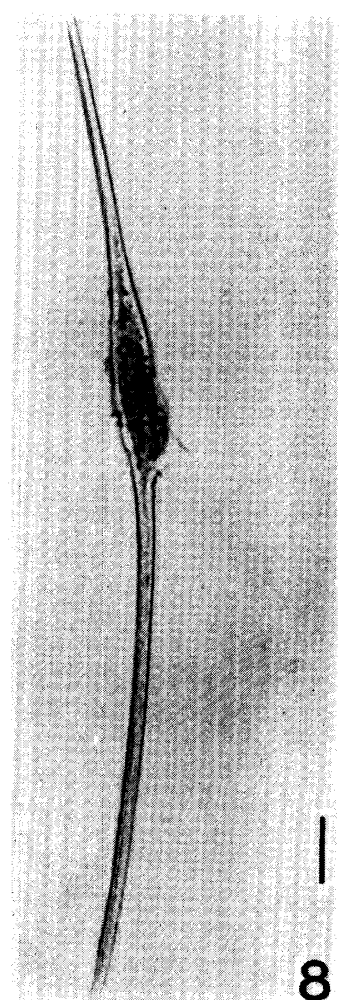
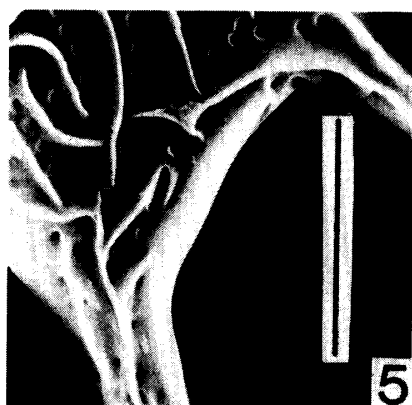
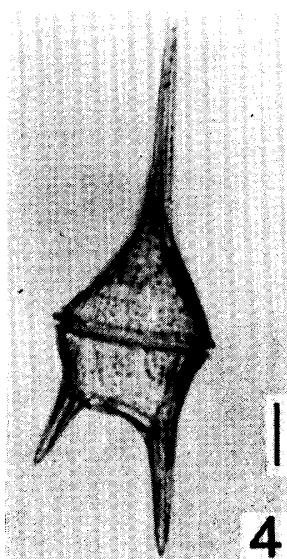
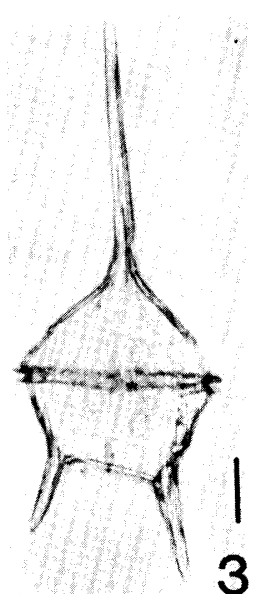
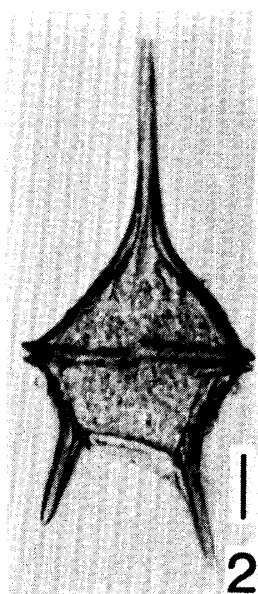
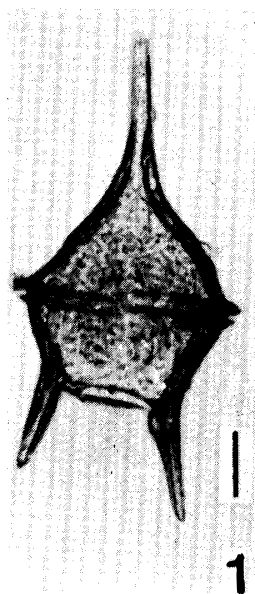


Plate 2

- Fig. 9. *Ceratium horridum*.
Fig. 10. *Ceratium horridum* (SEM).
Fig. 11. *Ceratium petersii*.
Fig. 12. General view of plankton at Stn. 96.
(scale: 25 μm)

