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Armoured dinoflagellates from the Norwegian, Greenland and Barents seas collected in the cruise of the RV "Oceania" in August 1992

ABSTRACT: Phytoplankton samples were collected at 74 stations in the European Arctic seas, 28 species of the armoured dinoflagellates being found. Thirteen dinoflagellates are illustrated by original drawings. The data on synonyms, size or size variation, localities and environmental factors (temperature and salinity) at the surface are given.

K e y w o r d s: Arctic, Norwegian – Greenland – Barents seas, phytoplankton, dinoflagellates.

Introduction

Diversity of the dinoflagellates in the plankton of the European Arctic is to be compared only with that of the diatoms. However, the taxonomy and systematics as well as biogeography of the dinoflagellates are much less investigated. In the previous paper (Okolodkov 1993) the drawings of 22 dinoflagellate species are given based on the phytoplankton samples collected from the Greenland, Norwegian, western Barents seas and the Faroe — Shetland Islands area. The present article fills up the gap in our knowledge on the armoured dinoflagellates from the areas.

Material and methods

Phytoplankton samples were collected at 74 stations in the Norwegian, Greenland and western Barents seas, in August 1 to 26, 1992 during the expedition "AREX-92" on board of the RV "Oceania" organized by the

Institute of Oceanology, Polish Academy of Sciences (Fig. 1). The fjords of Spitsbergen were studied more thoroughly. Dates, sounding depth, temperature

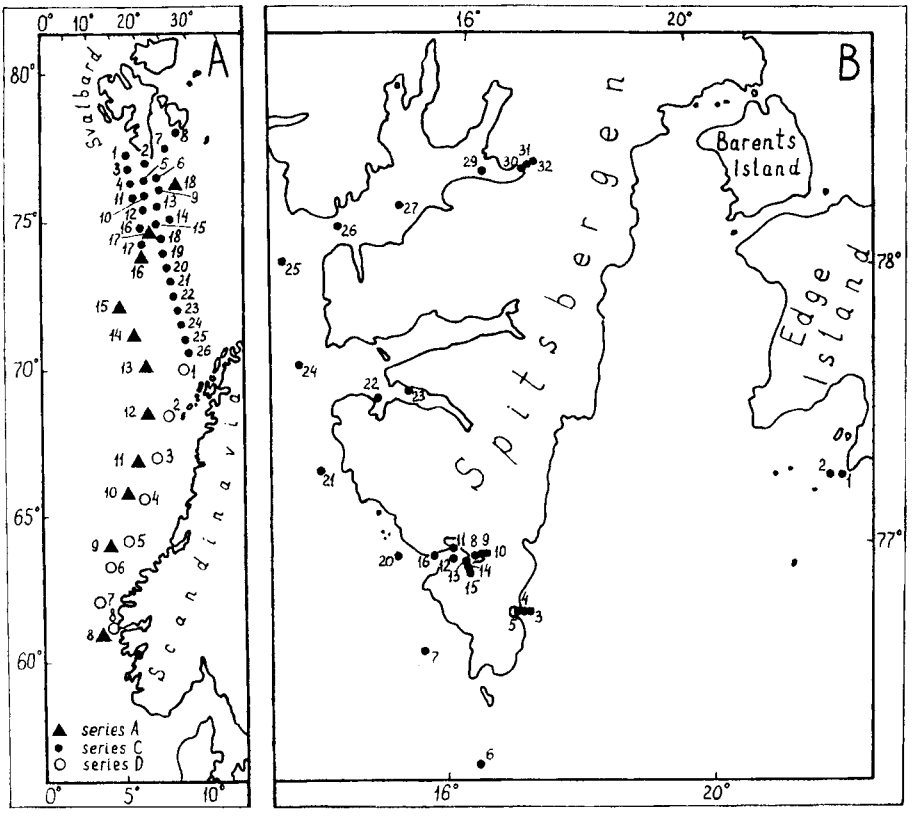

Fig. 1. Distribution of planktological stations of the RV "Oceania" in the Norwegian, Greenland and Barents seas in August 1992: A — stations of the series A, C and D; B — stations of the series B.

and salinity in the surface layer are indicated in Tab. I. At the stations of the series B and C qualitative hauls were made with a plankton net 37 cm in diameter and mesh-size 70 μm. The net was vertically hauled beginning from the depth of 100 m or from the bottom when the sounding was less than 100 m. The quantitative samples were taken with a polyethylene pail in the surface layer of ca. 0 – 20 cm at all stations. These samples were further concentrated with the inverse-filtration device and nucleopore filters, the pore size 1 μm, the volume of concentrated water being 1 to 5 l. At the stations of the series B quantitative samples were taken with a plastic water bottles from the depths of 0, 5, 40 m and occasionally 2 and 10 m. Altogether 175 samples were collected with net (39 samples), pail (66) and water bottles (70). Living algae in the samples taken by net and pail were studied under the standard microscope BIOLAR, PZO, Warsaw, Poland, using the objectives 10/0.24 and 40/0.65. Measurements were

Table I.

Temperature and salinity in the surface layer at the planktological stations in the Norwegian, Greenland and Barents seas, August 1992 (also see Fig. 1)

Station number	Date August	Sounding	Temperature [°C]	Salinity [‰]
1	2	3	4	5
A8	1	ca. 150	15.3	–
A9	1	ca. 500	14.0	–
A10	2	ca. 290	13.8	–
A11	2	ca. 300	14.0	–
A12	3	ca. 400	13.4	–
A13	3	–	12.2	–
A14	4	–	11.8	–
A15	4	ca. 2500	10.5	–
A16	5	ca. 2000	11.1	–
A17	5	ca. 1900	9.7	–
A18	6	ca. 130	8.0	–
A19	6	ca. 150	5.3	–
B1	7	47	−0.1	32.8
B2	8	210	5.6	33.4
B3	8	90	3.4	31.9
B4	8	65	3.9	32.3
B5	8	43	3.8	31.6
B6	8	50	5.1	32.2
B7	8	46	1.3	33.9
B8	9	115	2.2	29.3
B9	9	115	2.1	29.3
B10	9	43	2.0	29.8
B11	9	110	2.1	30.2
B12	9	130	2.2	30.0
B13	9	93	2.0	30.3
B14	9	110	2.1	30.2
B15	9	130	2.1	29.8
B16	8	105	2.3	31.5
B20	8	60	3.6	33.1
B21	10	50	3.8	32.9
B22	12	8	4.5	29.6
B23	12	60	4.4	31.8
B24	10	130	4.1	33.8
B25	10	260	6.1	34.0
B26	10	420	6.1	31.4
B27	10	220	6.1	31.8
B29	11	73	7.1	29.4
B30	11	50	5.8	29.4
B31	11	25	5.0	29.2
B32	11	40	5.6	23.5
C1	12	339	6.4	34.4
C2	13	58	2.8	33.3
C3	13	ca. 1500	7.4	35.1

Table 1 — continued

1	2	3	4	5
C4	14	ca. 1500	8.5	35.0
C5	14	340	7.0	34.8
C6	14	319	6.5	34.5
C7	14	ca. 150	5.7	–
C8	15	19	1.3	–
C9	16	105	6.8	–
C10	16	380	9.0	–
C11	16	ca. 1300	7.8	35.1
C12	17	ca. 1000	7.6	34.9
C13	17	235	8.4	35.0
C14	17	180	7.5	33.8
C15	18	ca. 1300	8.7	35.0
C16	18	–	–	–
C17	18	ca. 1700	8.3	35.1
C18	19	1450	9.1	35.0
C19	19	688	9.3	35.0
C20	20	550	9.9	34.8
C21	20	560	9.9	34.8
C22	20	ca. 1200	10.3	34.7
C23	21	ca. 1400	9.9	34.6
C24	21	ca. 2000	10.7	34.8
C25	22	ca. 2200	10.8	34.9
C26	22	ca. 2500	11.0	34.8
D1	22	–	11.2	–
D2	23	ca. 150	12.5	–
D3	23	ca. 350	12.5	–
D4	24	–	13.2	–
D5	24	ca. 330	12.4	–
D6	25	–	12.0	–
D7	25	–	13.6	–
D8	26	ca. 350	13.4	–

— means lack of data.

made at the total magnitude of 150 to 600. The materials collected with water bottles and fixed with Lugol's solution with acetic acid added were analyzed under the inverted microscope ID-03, Opton, West Germany, using the objectives 10/0.22 Ph and LD 32/0.4 Ph. The following references were used for taxonomic identification: Lebour (1925), Schiller (1933, 1937), Braarud (1935), Graham & Bronikovsky (1944), Kiselev (1950), Sournia (1967, 1986) and Dodge (1982).

Results

Twenty eight armoured dinoflagellate species are given in the present paper, 13 of them being supplied with drawings, brief information on synonyms, size or size variation and localities. Those species, which are considered in detail in

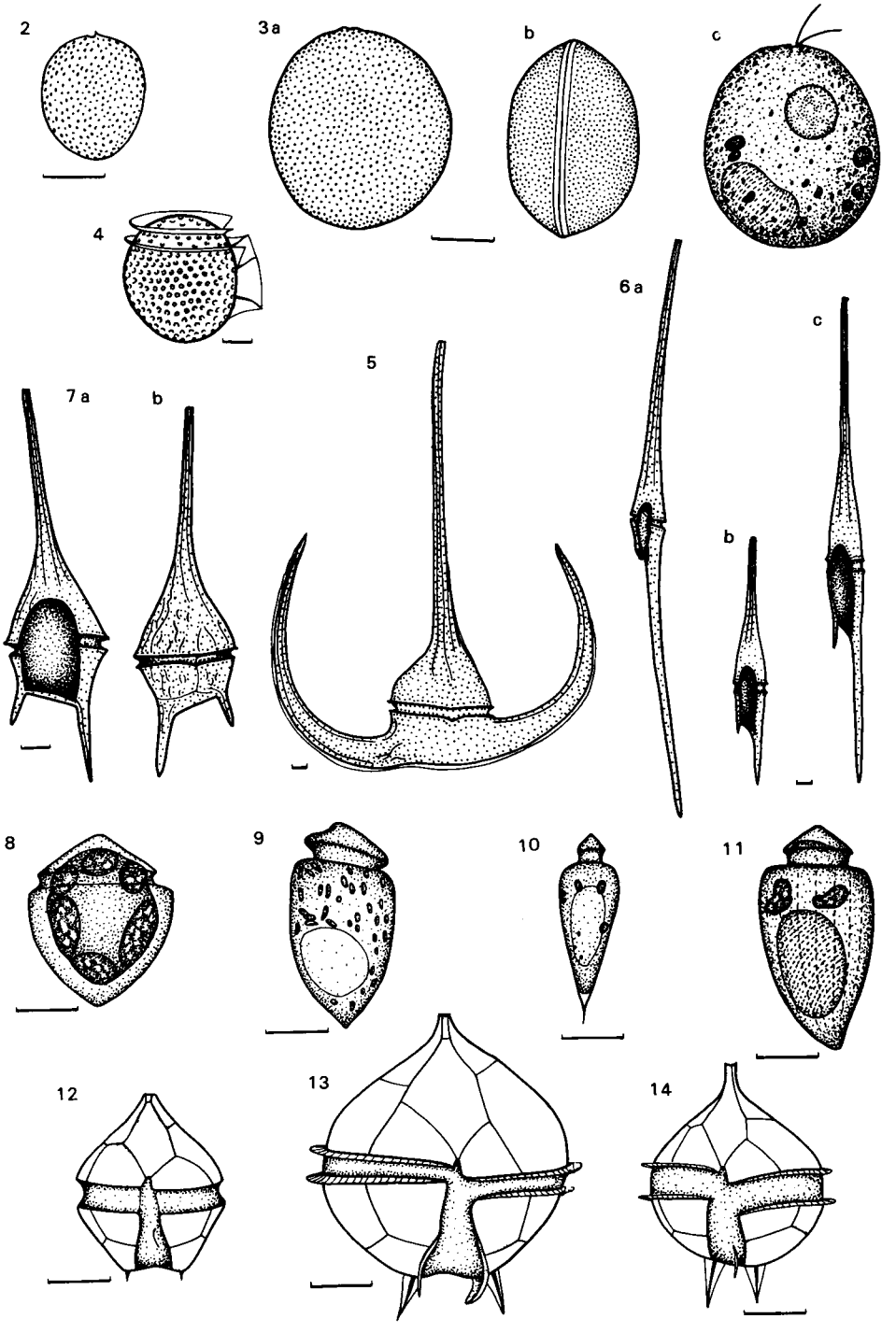

Fig. 2–14. Morphology of some collected dinoflagellates (scale bar 10 μm):
2 — *Prorocentrum balticum*; 3a–c — *Prorocentrum compressum*; a, b —theca; c — living cell; 4 — *Dinophysis rotundata;* 5 — *Ceratium arietinum* var. *bucephalum*; 6a–c — *Ceratium fusus* var. *fusus*; 7a–b — *Ceratium lineatum*; 8 — *Oxytoxum belgicae* (?); 9 — *Oxytoxum laticeps* (?); 10 — *Oxytoxum variabile*; 11 — *Oxytoxum* sp.; 12 — *Protoperidinium brevipes*; 13 — *Protoperidinium pellucidum*; 14 — *Protoperidinium steinii.*

autor's previous publication on the subject, combined with illustrations, are marked with an asterisk.

Family PROROCENTRACEAE

Prorocentrum balticum (Lohmann) Loeblich III (Fig. 2)

Loeblich III 1970, p. 906.

Syn.: *Exuviaella baltica* Lohmann 1908, p. 265, pl. 17, figs. 1a–b.
Prorocentrum pomoideum Bursa 1959, figs. 108–111.
Exuviaella aequatorialis Hasle 1960, p. 29, figs. 18a–b.

Size: 13–20 μm long, 13–17 μm wide, ca. 10 μm high (deep).
Recorded from Sts. C6, C13, C14, C21 and C25.

Prorocentrum compressum (Bailey) Abé ex Dodge (Fig. 3a–c)

Dodge 1975, p. 110, pl. 4E–F, figs. 2F, 4H–I.

Abé 1967, p. 373, figs. 2a–d; sine basionym.

Syn.: *Pyxidicula compressa* Bailey 1850, p. 40, pl. 2, figs. 13–14.
Exuviaella compressa Ostenfeld 1899, p. 59; 1903, p. 579.
Prorocentrum bidens Schiller 1928, p. 61, fig. 21.
P. lebourae Schiller 1928, p. 62, fig. 23.
Exuviaella oblonga Schiller 1928, p. 50, figs. 6a–c.
E. lenticulata Matzenauer 1933, p. 438, fig. 1.
E. elongata Rampi 1951, pl. 1, fig. 9.

Size: 36–48 μm long, 34–42 μm wide, ca. 30–32 μm high.
Observed in Sts. A10, C13, C18, C23, C25 and C26.

Family DINOPHYSIACEAE

Dinophysis acuminata Claparede et Lachmann

Claparede and Lachmann 1859, p. 408, pl. 20, fig. 17.

Syn.: *Dinophysis borealis* Paulsen 1949, p. 46, figs. 14K–U, 15.
D. lachmanii Paulsen 1949, p. 46, figs. 14A–H, 15.
D. boehmi Paulsen 1949, p. 45.
D. lachmanii Solum 1962, p. 9, figs. 2, 1–16, figs. 5, 4–6, figs. 9, 1–16.
D. skagii Paulsen 1949, p. 48, figs. 14, 15.

Size: 45 μm long, 36 μm wide.
Recorded from St. B1.

Dinophysis norvegica Claparede et Lachmann

Claparede et Lachmann 1859, p. 407, pl. 20, fig. 19.
Size: 36–40 μm long, 22–32 μm wide, 14 μm high.
Occurred in Sts. B20, C22 and C23.

Dinophysis rotundata Claparede et Lachmann (Fig. 4)

Claparede et Lachmann 1859, p. 6, pl. 20, fig. 16.

Syn.: *Phalacroma rotundatum* Kofoid et Michener 1911, p. 290.

Size: 42–57 μm long, 38–48 μm wide, 30 μm high.
Recorded from Sts. B20, C24 and C25.

Family CERATIACEAE

**Ceratium arcticum* (Ehrenberg) Cleve
var. *arcticum*
Occurred in Sts. B1, B4, B7, B8, B10, B12–14, B16, B20, B22, B24, B26, B31, B32, C1–6, C8, C9, C11–19. Noticed as dominant in net hauls at Sts. C11 and C17.

var. *longipes* (Bailey) Graham et Bronikovsky
Observed in Sts. B14, C4, C6, C9–16, C18–26 and D1. Prevailed over var. *arcticum* in net hauls at Sts. C13, C14, C18 and C19.

var. *ventricosum* Ostenfeld
Size: body 70–90 μm long, 66–70 μm wide; overall length 220–250 μm; distance between the ends of left and right antapical horns 240–276 μm.
Recorded from Sts. C4, C14 and C19.

Ceratium arietinum Cleve (Fig. 5)
Cleve 1900, p. 13, pl. 7, fig. 3.
var. *bucephalum* (Cleve) Sournia
Sournia 1967, p. 429.

Syn.: *Ceratium tripos* var. *bucephalum* Cleve 1897, p. 302, fig. 5.
C. tripos var. *arietinum* Cleve 1900, p. 13, pl. 7, fig. 3.
C. bucephalum Cleve 1901, p. 211.

Size: body 70 μm long, 62 μm wide; overall length 260 μm; distance between ends of left and right antapical horns 146 μm.

A single specimen was recorded from St. C21.

**Ceratium furca* (Ehrenberg) Claparede et Lachmann
var. *furca*
Occurred in Sts. C4, C13–15, C18–23, C26, D1, D3–5.

**Ceratium fusus* (Ehrenberg) Dujardin (Fig. 6a–c)
var. *fuscus*
Recorded from Sts. A11, C1, C4–6, C11, C13–15, C18–22, C24–26, D1 and D5.

**Ceratium horridum* (Cleve) Gran
var. *horridum*
Observed in Sts. C4, C13–15, C18–22, C24–26.

Ceratium lineatum (Ehrenberg) Cleve (Fig. 7a–b)
Cleve 1899, p. 36.

Syn.: *Peridinium lineatum* Ehrenberg 1854, pl. 35a, fig. 24c.

Size: body 56–62 μm long, 35–42 μm wide; overall length 136–175 μm.
Recorded from STs. C4, C13, C14, C18, C19, C21–26 and D5.

**Ceratium macroceros* (Ehrenberg) Vanhöffen
var. *macroceros*
Occurred in Sts. C4, C13, C14, C18–20, C25, C26 and D1.

**Ceratium tripos* (O.F. Müller) Nitzsch
var. *atlanticum* (Ostenfeld) Paulsen
Observed in Sts. A11, C4, C13–16, C18, C20–26, D3 and D5.

Family GONYAULACACEAE

Gonyaulax digitale (Pouchet) Kofoid
Kofoid 1911, p. 214, pl. 9, figs. 1–5.

Syn.: *Protoperidinium digitale* Pouchet 1883, p. 443, pl. 18, fig. 14.

Size: 64–82 μm long, 44–58 μm wide.
Recorded from St. C25.

Gonyaulax spinifera (Claparede et Lachmann) Diesing
Diesing 1866, p. 382.

Syn.: *Peridinium spiniferum* Claparede et Lachmann 1859, p. 405, pl. 20, figs. 4–5.

Size: 34 μm long, 28 μm wide.
A single specimen was found at St. D4.

Family OXYTOXACEAE

Oxytoxum belgicae Meunier(?) (Fig. 8)
Meunier 1910, p. 55, pl. 16, figs. 38–41.
Identification in doubt.
Size: 27 μm long, 23 μm wide.
A single specimen was found at St. B22.
Note: the plates were not distinguished. Although our specimen is similar to *O. belgicae* in shape, it is much smaller in size.

Oxytoxum laticeps Schiller(?) (Fig. 9)
Schiller 1937, p. 461, fig. 523.
Idenfitication in doubt.
Size: 33 μm long, 17 μm wide.

The only specimen was found at St. B6.

Note: unlike the illustrations and descriptions given by Schiller (1937) and Dodge (1982), our specimen is larger and without papilla at the anterior end and small spine at the posterior end. Chloroplasts are small, numerous, scattered around the cell, nucleus is located at the posterior end.

Oxytoxum variabile Schiller (Fig. 10)

Schiller 1937, p. 455, fig. 505.

Size: 28 μm long, 10 μm wide.

Identification reliable only from St. C21.

Oxytoxum sp. (Fig. 11)

Size: 36 μm long, 19 μm wide.

A single specimen found at St. B32 is characterized by asymmetrical posterior end, longitudinal lines on hypotheca, low conical epitheca and large nucleus situated close to the posterior end.

Family PROTOPERIDINIACEAE

Protoperidinium bipes (Paulsen) Balech

(fory synonymy see Okolodkov, 1993).

Size: body widh spines 33–36 μm, without spines 24–27 μm long, 18–21 μm wide.

Occurred in Sts. B2, B9, B11, B14, B15, B21–23 and B29.

Protoperidinium brevipes (Paulsen) Balech (Fig. 12)

Balech 1974, p. 60.

Syn.: *Peridinium brevipes* Paulsen 1908, p. 108, fig. 151.

Size: 28–29 μm long, 22–24 μm wide, 22 μm high.

Recorded from Sts. C21 and C22.

Protoperidinium cf. *cerasus* (Paulsen) Balech

Balech 1973, p. 357, pl. 3, figs. 57–62, pl. 4, figs. 63–72.

Syn.: *Peridinium cerasus* Paulsen 1907, pl. 12, fig. 12.

Size: body with spines 44 μm, without spines 36 μm long, 28 μm wide.

The only specimen was found at St. D6.

**Protoperidinium depressum* (Bailey) Balech

Found at Sts. C1, C4, C13–15, C19, C20, C24–26.

Protoperidinium divergens (Ehrenberg) Balech

Balech 1974, p. 60.

Syn.: Peridinium divergens Ehrenberg 1840, p. 201.

Size: 69 μm long, 60 μm wide, 56 μm high.

The only specimen was found at St. C18.

Protoperidinium excentricum (Paulsen) Balech

Balech 1974, p. 54.

Syn.: *Peridinium excentricum* Paulsen 1907, p. 14, figs. 17a–f.

Size: 20 μm long, 24 μm wide.

A single specimen was found at St. D6.

Note: our specimen is characterized by smaller size compared to the descriptions given in literature, e.g. in Lebour (1925), Schiller (1937), Kiselev (1950) and Dodge (1982).

Protoperidinium pallidum (Ostenfeld) Balech

(for synonymy see Okolodkov, 1993)

Size: body with spines 66–108 μm, without spines 52–90 μm long, 44–70 μm wide.

Recorded from Sts. C24 and C26.

Protoperidinium pellucidum Bergh (Fig. 13)

(for synonymy see Okolodkov, 1993).

Size: body with spines 57 μm, without spines 48 μm long, 43 μm wide, 37 μm high.

The only specimen was found at St. C4.

Protoperidinium steinii (Jörgensen) Balech (Fig. 14)

Balech 1974, p. 63

Syn.: *Peridinium steinii* Jörgensen 1899, p. 38.
P. michaelis Stein 1883, pl. 9, figs. 9–14.

Size: body with spines 38–41 μm, without spines 30–32 μm long, 28–29 μm wide, 26 μm high.

Observed from St. C4.

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Streszczenie

W pracy przedstawiono rozmieszczenie 28 gatunków bruzdnic planktonowych, zebranych z 74 stacji w rejonie Arktyki Wschodniej (Rys. 1). Dane hydrologiczne – temperatura i zasolenie oraz głębokość zaciągów — przedstawiono w Tab. I. Trzynaście gatunków zilustrowano oryginalnymi rysunkami (Rys. 2–14).