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THE MARINE ALGÆ OF DENMARK

CONTRIBUTIONS TO THEIR NATURAL HISTORY

VOL. II. PHÆOPHYCEÆ

I. ECTOCARPACEÆ AND ACINETOSPORACEÆ

BY

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INTRODUCTION

As mentioned by professor ROSENVINGE in the introduction to his work: On Some Danish Phæophyceæ, 1935, he had aimed—after the working out of the Danish Rhodophyceæ was finished—at dealing in a corresponding way with the Phæophyceæ and publishing the material, taxonomically arranged. However, the first groups requiring years of work he preferred to work out, from different parts of the Phæophycean system, chosen genera, which might quickly be made ready for publication.

Part of the material thus dealt with has been published in the paper mentioned above, including the genus of *Stictyosiphon* and the order *Elachistaceæ*. Moreover ROSENVINGE, before his death in 1939, had begun to deal with various other genera.

During recent years the junior author has been associated with professor ROSENVINGE in the working out of the material of the Phæophyceæ, particularly within the order *Ectocarpaceæ*, from which group several of the species were represented by an abundant material. Hence, at the death of professor ROSENVINGE it was decided that the junior author, with a grant from the Carlsberg Foundation was to try to carry on the working out of the *Phæophyceæ* for publication. The character of this working out, however, had to be another owing to circumstances. For the working out must be restricted to going through the present material, time and circumstances not permitting a supplement of the same by possible cultivation experiments and cytological observations, a supplement that would have been of great importance for the elucidation of the life-history and taxonomy of the species.

The working out will not be arranged on strictly taxonomical lines. The individual orders, however, will be dealt with collectively as far as possible. If in an order species occur the material of which is but insufficient, they are nevertheless entered in the papers, for, even if nothing but brief remarks can be made on their behalf, the work will yield a complete list of the species of the *Phæophyceæ* in the Danish waters.

The present work includes the orders *Ectocarpaceæ* and *Acinetosporaceæ*. The former order has been interpreted in a more restricted sense, much the same as did HAMEL in "Phéophycées de France", I, 1931. However, the genus *Phaeostroma*,

too, has been referred to this order in contradistinction to the method of the latter work. Hence the order in the Danish waters is represented by the genera: *Pylaiella*, *Ectocarpus*, *Sorocarpus*, *Streblonema* (incl. *Endodictyon*), *Mikrosyphar* and *Phaeostroma*.

The order *Acinetosporaceæ* is likewise interpreted as in the work by Hamel quoted. It includes in the Danish waters the genera: *Acinetospora*, *Haplospora* (incl. *Scaphospora*) and *Tilopteris*.

Of the genera enumerated the following are mainly dealt with by Rosenvinge: *Ectocarpus* (*E. tomentosus*, *E. tomentosoides*, *E. Sandrianus*, *E. granulosus*, *E. ovatus* (incl. var. *intermedius*), *E. irregularis*, *E. paradoxus*, and *E. Reinboldi*), *Sorocarpus*, and *Acinetospora*. As to several of the species the posthumous manuscripts were not in a state ready for press. Hence, in some cases it has been proved necessary to make certain alterations. Such was the case, for instance, in *Ectocarpus ovatus* var. *intermedius*, *E. irregularis*, and *E. paradoxus* as also in *Acinetospora pusilla*. Regarding other species dealt with by Rosenvinge (*E. tomentosus*, *E. irregularis*, and *E. Reinboldi*) the junior author has added observations of his own.

The manuscripts written by Rosenvinge being worked out several years ago, the recent literature has not been taken into account in the former. The question is, however, of a few treatises at most, from recent years.

The genera as follows have been dealt with by the junior author: *Pylaiella*, *Ectocarpus* (the species in the groups of *E. confervoides* and *E. fasciculatus*), *Haplospora*, and *Tilopteris*; in addition the introduction to the genus of *Ectocarpus* as also the key to the species of this genus.

The genera *Streblonema*, *Mikrosyphar*, and *Phaeostroma* are not worked out in detail. The mention of the species of these genera are based on some fragmentary descriptions of specimens, left by Rosenvinge and compiled by the junior author.

In the list of localities following the discussion of each species the name(s) or initials of the collector(s) are given in bracket after the locality, chronologically. If professor Rosenvinge himself was the collector—and such was generally the case—the name is only given in case others, too, have found the species at the place in question.

The junior author wants to express his gratitude for the great kindness and never failing interest shown him by the late professor Rosenvinge during the last part of his life.

Thanks are moreover due to the trustees of the Carlsberg Foundation for grants enabling him to share in and continue the present work.

The translation into English of the parts of the work written by the junior author has been made possible by a grant from the Rask-Ørsted Foundation. For this grant he also wishes to express his thanks. He is indebted, too, to Mrs. A. Seidelin Raunkiær, who has translated those sections.

Ectocarpaceæ.

Pylaiella Bory.

1. **Pylaiella litoralis** (L.) Kjellm.[1]

Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 99 (f. *vernalis*, f. *ferruginea*, f. *firma*, f. *compacta*); Handbok, 1890, p. 83 (α *oppositа*, β *firma*, γ *divaricata*); Jónsson, Mar. Alg. Iceland, II, Phæophyceæ, 1903, p. 153, fig. 13; Kylin, Algenfl. schw. Westk., 1907, p. 47; Entwickl. Phaeophyceen, 1933, p. 5, fig. 1, Taf. 1, fig. 1; Bemerkungen Entwickl. einiger Phaeophyceen, 1937, p. 3; Sjöstedt, Havsalg. Hallands Väderö, 1927, p. 13; van Goor, Die holländischen Meeresalg., 1923, p. 80; Knight, Studies in the Ectocarpaceae. I. Pylaiella litoralis, 1923, p. 343, pl. I—VI; Studies in the Ectocarpaceae. II. Ectocarpus siliculosus, 1929, p. 322; Setchell and Gardner, Mar. Alg. Pacific Coast Am., III, Melanophyceae, 1925, p. 402, pl. 37, fig. 32; Printz, Algenveg. Trondhjemsfj. 1926, p. 147; Lakowitz, Algenfl. ges. Ostsee, 1929, p. 210; Dammann, Entwickl. u. zytol. Unters. Helgol. Meeresalg., 1930, p. 7, fig. 2; Hamel, Phéophycées de France, I, 1931, p. 11, fig. 2 A—C; Newton, Handbook, 1931, p. 124, fig. 71; Lund, Algenveg. Stege Nor, 1934, p. 30; Hygen and Jorde, Algenfl. norw. Westk., 1935, p. 16; Levring, Algenfl. Kullen, 1935, p. 18; Algenfl. norw. Westk., 1937, p. 44; Taylor, Mar. Alg. northeast N. Am., 1937, p. 103, pl. 9, figs. 1—3.

Ectocarpus litoralis L. sp. erw. Kuckuck, Ectocarpus, 1891, p. 7, fig. 6 (α *oppositus*, β *firmus*, γ *divaricatus*, δ *varius*); no. 568 (Exsicc.) in Phykotheka universalis (β *firmus*); K. Rosenvinge, Grønl. Havalg., 1893, p. 881; Børgesen, Mar. Alg. Færöes, 1902, p. 418; Lakowitz, Algenfl. Danziger Bucht, 1907, p. 31.

Pylaiella varia Kjellman, Norra ishafv. algfl., 1883, p. 348, Tab. 27, figs. 1—12; Handbok, 1890, p. 83; Reinke, Gestalt Chromatoph., 1888, Taf. XI, fig. 2; Hygen and Jorde, Algenfl. norw. Westk., 1935, p. 16; Levring, Algenfl. norw. Westk., 1937, p. 45.

Ectocarpus varius Reinke, Algenfl. westl. Ostsee, 1889, p. 44.

An attempt has been made to classify the present material of this species in the 4 subspecies, α *oppositus*, β *firmus*, γ *divaricatus* and δ *varius*, which Kuckuck named in his *Ectocarpus* monography (1891). This classification, essentially the same as Kjellman used in his "Handbok" (1890) (3 varieties are given here: α *oppositа*, β *firma* and γ *divaricata*; *varius* being entered as a particular species, *Pylaiella varia*) proved untenable, however, which is evident, too, from Knight's work (1923).

For in Knight's work is shown how the species during its development undergoes such great alterations that in one phase it is to be referred to one variety, in another phase to another variety. These alterations, connected with the periodical

[1] As to this species, of the literature previous to 1890—91 Kjellman's work, Skand. Ectocarp. och Tilopt., 1872, only and a few others have been taken into account. Regarding the essential older literature reference may be made to the lists of Kjellman in this work and in Norra ishafv. algfl., 1883, Hauck, Die Meeresalgen, 1885, and Kuckuck, Ectocarpus, 1891.

fertilisation of the branches and the coherent shedding of the latter, gradually manifests itself by a shortening of the branches and the chains of sporangia; at the same time the chains of sporangia are gradually placed terminally. Hence I do not see any reason for separating *P. varia* from *P. litoralis*, as did Kjellman (l. c.)—provided it does not deviate as to life-history.

This alga is one of the most frequent species in the Danish waters. Not only is it widely distributed, but more, it is often found very abundantly, particularly at places comparatively sheltered. It seems to be most widely distributed in the littoral region and the upper part of the sublittoral region; it is, however, common too in deeper water. At any rate it may descend to a depth of 24 m; for instance in the Baltic near Bornholm, where it has been taken by dredge several times at this depth. It generally occurs epiphytic on a great number of other marine algae as also on marine angiosperms. In addition it is met with on wood, stones and shells, Hydroids and the like, but it may occur, too, free-floating. The attached specimens are tufted, usually up to 10—15 cm. in heigt; they may, however, become considerably larger. The colour of living plants is yellowish or brownish (yellowish brown—dark brown).

The horisontal part of the thallus consists of creeping, branched filaments, more or less coalesced, the vertical part of long, usually much branched monosiphonous filaments which may, however, here and there show a longitudinal wall in one ore more cells. The diameter of the vertical filaments is rather variable; it usually measures from 20—50 μ. The growth is generally intercalary. The ramification is very variable, now mainly opposite, now mainly scattered. In plants having unilocular sporangia the ramification is generally mainly opposite, in plants with plurilocular sporangia, on the other hand, mainly scattered, a phenomenon which Kylin (1933, p. 16) drew attention to in plants from the coast of Bohuslän, belonging to the "main form". The branches generally form acute angles to the mother axis; the angles may, however, be right in numerous specimens. The branches in many cases are hairlike above, here consisting of prolonged cells with few chromatophores only, in other cases the contents of chromatophores is normal even in the upper cells. The chromatophores are disc-shaped, rather numerous in each cell.

The unilocular sporangia have been found from January to November, hence probably occurring all the year round. They are usually seriate, less frequently they occur solitary. Generally they are intercalary; they may, however, be terminal. Not rarely, one or more sporangia of a chain are divided by one or more longitudinal walls as mentioned by Farlow (1881, p. 74), Kuckuck (1890, p. 6 and Phykotheka universalis Nr. 568), Skottsberg (1921, fig. 2 a, f. *rigidiuscula*) and others. The diameter of the unilocular sporangia measures about 37—50 μ.

The plurilocular sporangia have been noticed from March to November; they, too, are presumably to be found throughout the year. They may like the unilocular sporangia be intercalary as well as terminal. The diameter of the plurilocular sporangia measures about 25—54 μ, the length is extremely variable. The pluri-

Table 1.

The distribution of plants with unilocular sporangia exclusively, plants with unilocular + plurilocular sporangia, and plants with plurilocular sporangia exclusively in all the Danish waters.

	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total
Number of localities w. plants w. unil. spor. excl.	1	1	1	2	9	8	11	17	13	3	3	..	69
Number of localities w. plants w. unil. + pluril. spor.	..	..	1	5	13	6	6	2	4	..	1	..	38
Number of localities w. plants w. pluril. spor. excl.	..	..	..	2	13	7	3	3	6	..	..	..	34
Total number of localities, from which material is at disposal	1	1	2	9	35	21	20	22	23	3	4	..	141

locular sporangia are found partly on plants which in addition bear unilocular sporangia, partly on plants having plurilocular sporangia exclusively.

Plants having plurilocular sporangia exclusively seem to be considerably rarer than plants with unilocular sporangia and also rarer than plants with unilocular + plurilocular sporangia. In order to have an impression of the frequency of plants with unilocular sporangia, and plants with unilocular + plurilocular sporangia compared with that of specimens with plurilocular sporangia exclusively, I have made a count within the material of herbarium accessible to me, originating from all parts of the Danish waters (even if prevalently from the Belts, the Sound and the area of the Baltic). Hence it has appeared that of the 141 localities represented, 69 had yielded material having unilocular sporangia exclusively, while the material from 38 had both unilocular and plurilocular sporangia in the same individual. In plants from 34 localities only, plurilocular sporangia were found exclusively. The results of the comparison are given in table 1, from which appears, too, the period of the occurrence of the different types of plants.

Even if plants with unilocular sporangia and plants with unilocular + plurilocular sporangia in *P. litoralis* may be regarded as diploid, while specimens having plurilocular sporangia exclusively presumably are haploid as a rule, it will not, however, be right on the basis of this counts to make conclusions how frequently the diploid generation of this species will occur in the material compared with the haploid. For the present material proved later actually to include 2 species, *P. litoralis* and *P. rupincola*, the life-history of these 2 species moreover being quite different, because no alternation of generation is found in *P. rupincola*—in contradistinction to *P. litoralis*.

The species of *P. rupincola* was established 1937 by Kylin on the basis of *Ectocarpus firmus* var. *rupincola* Areschoug (Alg. scand. exsicc., II-III, 1862, no. 113), a form of *Pylaiella* which Kylin had formerly (1933, p. 5) separated from the

"main form" of *Pylaiella litoralis*. At this time, however, the present material was finally gone through, and since a repeated revision of the total material was not possible, an investigation of some of the specimens already examined, only, could be carried out. It appeared by now that *P. rupincola* occurs in the Danish waters, too. Hence the information given above is based on the study of *P. litoralis* incl. *rupincola*.

P. rupincola has later been studied by Levring at the coast of Blekinge (1940, p. 32). He arrives at the result that all forms of *Pylaiella* from the Baltic presumably belong to *P. rupincola*; *P. litoralis*, in contradistinction, is supposed not to be found here at all. Hence, in all probability the material—or at any rate the majority of it—of the Danish *Pylaiella* from the Baltic (as also from the Belts and the Sound?) belongs actually to *P. rupincola*.

P. rupincola, however, is not confined to these southern areas of the Danish waters only; it occurs, too, in the area of Kattegat. Merely judging it might probably be right to think that the part of the present material of *Pylaiella*, collected in the Kattegat, the North Sea and the Limfjord, prevalently belongs to *P. litoralis*, while the part collected in the Baltic, the Belts and the Sound, chiefly is to be referred to *P. rupincola*.

A corresponding count as to these 2 areas, like that given in table 1, shows—as will appear from table 2—that plants having plurilocular sporangia exclusively are found rather scanty in the material of the northern area, whereas they are considerably more common in the material from the southern area. The frequency of the localities as to plants with plurilocular sporangia exclusively compared with plants having unilocular sporangia exclusively + plants having unilocular as well as plurilocular sporangia is, regarding the 2 areas, 1 : 5,6 and 1 : 2,4 respectively.

If the supposed distribution of the 2 species on the whole is correct, this means that the gametophyte in *P. litoralis* may be present in about 15% at most, of the localities represented. Plants having plurilocular sporangia exclusively being common to this degree in the Baltic, the Belts and the Sound, this might indicate, that *P. rupincola* in this place is not only represented by specimens having unilocular sporangia exclusively and specimens with unilocular as well as plurilocular sporangia (as stated by Kylin from the Swedish west coast), but by plants, too, having plurilocular sporangia exclusively.

As to the life-history of *Pylaiella litoralis* investigations by Knight, Dammann and Kylin are at hand. According to Knight's observations (1923 and 1929) a haploid generation having plurilocular sporangia, as well as a diploid generation with unilocular sporangia exclusively, plurilocular sporangia exclusively or having both unilocular and plurilocular sporangia exist at Isle of Man. The haploid generation is presumed to appear in spring being bound to *Ascophyllum*, while the diploid is presumed to start early in summer on *Ascophyllum*, being found later on *Fucus vesiculosus* and *serratus*. The meiosis takes place in the unilocular sporangia. The

Table 2.

The distribution of plants with unilocular sporangia exclusively, plants with unilocular + plurilocular sporangia, and plants with plurilocular sporangia exclusively in the Kattegat + the North Sea + the Limfjord and the Baltic + the Belts + the Sound, respectively.

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total
Kattegat + Ns + Sk + Lf	Number of localities w. plants w. unil. spor. excl.	..	1	1	2	5	3	5	7	8	2	..	..	34
	Number of localities w. plants w. unil. + pluril. spor.	..	..	1	3	5	..	1	1	..	..	..	..	11
	Number of localities w. plants w. pluril. spor. excl.	..	..	..	1	..	3	1	2	1	..	..	..	8
	Total number of localities, from which material is at disposal	..	1	2	6	10	6	7	10	9	2	..	..	53
Baltic + Lb + Sf + Sb + Sm + Su	Number of localities w. plants w. unil. spor. excl.	1	..	..	..	4	5	6	10	5	1	3	..	35
	Number of localities w. plants w. unil. + pluril. spor.	..	..	..	2	8	6	5	1	4	..	1	..	27
	Number of localities w. plants w. pluril. spor. excl.	..	..	..	1	13	4	2	1	5	..	..	..	26
	Total number of localities, from which material is at disposal	1	..	..	3	25	15	13	12	14	1	4	..	88

haploid generation as well as the diploid are capable of multiplying by themselves, the haploid by means of haploid spores germinating parthenogenetically, the diploid by means of diploid spores from the plurilocular sporangia.

At Heligoland Dammann (1930) during summer found nothing but diploid plants having unilocular sporangia exclusively, or having unilocular + plurilocular sporangia. Meiosis takes place in the unilocular sporangia. The zoospores from the unilocular sporangia in cultures gave rise to haploid plants with unilocular sporangia exclusively, or with unilocular + plurilocular sporangia. In the unilocular sporangia of these plants, as a matter of course, no meiosis takes place. As to the question of an alternation of generations in nature Dammann advances the hypothesis that the zoospores from the unilocular sporangia in the course of the winter develop into haploid plants producing gametes. At the copulation of the gametes the diploid generation were established afresh.

Dammann's culture experiments on zoospores from unilocular sporangia, capable

of yielding plants with unilocular sporangia, is explained by Kylin (1937, p. 6) by presuming that Dammann has used zoospores from *P. rupincola* instead of *P. litoralis*. Kylin's culture experiments on zoospores from unilocular sporangia from *P. rupincola* have just given plants with unilocular sporangia, whereas zoospores from unilocular sporangia from *P. litoralis*—as well as in Knight's experiment (1923)—yielded plants with plurilocular sporangia. As to the fact that Dammann, in her cultures of zoospores from unilocular sporangia, obtained a haploid plant with unilocular sporangia, Kylin suggests the solution that the question perhaps may have been of *P. rupincola*, and that this species perhaps might be supposed to possess half as many chromosomes as *P. litoralis*.

On the Swedish west coast Kylin (1933, 1937), in *P. litoralis* (the "main form") observed an alternation of generation between a diploid generation, vegetatively more robust, and a haploid generation. The diploid generation, which possesses unilocular sporangia, in which the meiosis takes place, is found throughout the year, only it is much more common during winter than during summer; it is found on *Ascophyllum* and *Fucus*. The haploid generation, possessing plurilocular sporangia, the zoospores of which are gametes that copulate, occurs in spring and early summer especially. It is found prevalently on *Sertularia* (less frequently on *Ceramium*), in its turn inhabiting *Ascophyllum* and *Fucus*.

At Kullen on the Swedish west coast circumstances seem to correspond with Kylin's statement from Bohuslän (Levring, 1935, p. 18). However, some of the specimens from *Fucus* and *Ascophyllum*, collected in spring, had both unilocular and plurilocular sporangia.

At the Norwegian west coast, Levring presumes (1937, p. 44)—in contradistinction to Hygen and Jorde (1935, p. 16)—that circumstances generally correspond with that of the Swedish west coast. Plants with plurilocular sporangia on *Sertularia*, occurring on *Ascophyllum*, are supposed to represent the haploid generation, whereas plants with unilocular sporangia exclusively, plurilocular sporangia exclusively, or both unilocular and plurilocular sporangia, growing directly on *Fucus* and *Ascophyllum*, are supposed to belong to the diploid generation.

Localities. **Ns:** Havneby, Rømø; Manø (leg. Nolte June 1825); Esbjerg harbour; Nymindegab (H. E. P.); Thyborøn, on a groyne; Vorupør, the pier (S. L.). — **Sk:** Hirtshals, the pier (L. K. R., F. B.). — **Lf:** Thyborøn channel; Struer; Thisted harbour (J. P. Jacobsen, August 1869; S. L.); Nykøbing (L. K. R., Th. M., F. B.); Agersund, the pier (Th. M.); Bejstrup shore (C. M. Poulsen (?)); Hals, the pier (F. B.). — **Kn:** Strandby; Hirsholmene; Busserev; Frederikshavn harbour (L. K. R., Th. M., F. B., C. A. J., and others); GM, at Engelskmands Banke; Vesterø harbour, Læsø (C. H. O., S. L.); Læsø shore (Th. M.). — **Ke:** Gilleleje, the piers (S. L.). — **Km:** Grenaa harbour. — **Ks:** Sjællands Reef. The outer reef near the beacon; Gniben, Sjællands Odde (S. L.); Holbæk. — **Sa:** Kalø Reef, west of the ruin; Hjelm; Vorsø, Horsens Fjord (S. L.); Endelave, the pier-head (S. L.); Kolby Kaas, Samsø; Hofmansgave (Hofman Bang, Caroline Rosenberg); MP, Falske Bolsax; Nexeløbugt (Th. M.). — **Lb:** Brøndsodde, Vejle Fjord; Fakkegrav (F. B.); Rosenvold harbour (L. K. R., S. L.); east of Middelfart; Snoghøj (S. L.); Fænø Sund; Kolding harbour, on wood; Heilsminde; Aakrog Bugt at Brunshus; Bøjgden; "Little Belt" (Kjærbølling 1845); Sønderborg (δ *varius* f. *typica*, Kuckuck). — **Sf:** Dyreborg, the pier; Faaborg harbour; Nakkebølle

Fjord; Ærø (Kjærbølling); Svendborgsund near Taasinge. — **Sb:** Mullerup, the pier; Stavreshoved (S. L.); Kjerteminde; Nyborg; between Nyborg and Holckenhavn, on stone; the stony reef near Halskov; the reef outside Korsør harbour; Eegholm (Herb. Mørch); DO, Langelandsøre on Omø; Skaarupør (F. Matthiesen); UT, Langelandsbælt. Tranekjær lighthouse E. by N. 1/8 N. 2 2/3 miles, 19 m; DP, north of Onsevig; Spodsbjerg on Langeland, the pier; DQ, N. W. of Nakskov Fjord; US[1], Langelandsbælt. Gillebjerg N. W. 1/2 W., Taars lighthouse E., 20 m; UR, Langelandsbælt. Kappel church E. 1/4 N., Fakkebjerg lighthouse W. 1/2 N., 7.5 m. — **Sm:** HA, Agersøsund, 11.5 m; Skjelskør Nor; HB, at the southern end of Agersøsund, 8.5 m; VC, Venegrund, within the balloon; Knudshoved Reef (S. L.); off Vesterskovsflak; Guldborg; CQ, Smaalandshavet, N. N. E. of Kogrund; Orehoved harbour; Stubbekjøbing; Petersværft; Stege harbour (S. L); Stege Nor (S. L.). — **Su:** Hornbæk (Liebman); Hellebæk (F. B., L. K. R.); Helsingør (Liebman, C. Rasch); Rungsted (S. L.); OG, Torbæk Reef, 6 m; Charlottenlund (J. P. Jacobsen 1868, C. Rasch); København (L. K. R., C. Rasch, I. Ravn); OG[1], between Trekroner and Middelgrunden; Middelgrundsfortet; west of Saltholm, 11 m (S. L.); Kallebostrand (C. Rasch); Dragør; off Dragør and a little south of Dragør, 7.5—9.5 m. — **Bw:** Sønderhav, Flensborg Fjord; Flensborg Fjord (L. Hansen); LA, Østersøen, off Vesterskov, 7.5 m; Schönheyders Pulle, west of the broom; KT, the innermost broom at Gjedser Reef, 8.5 m. — **Bm:** QF, west of Lillegrunden; RG, Falsterbo lighthouse S. S. E. 6 miles, 11.5 m; the west side of Falsterbo Reef; Køge Bugt (Lange); QN, off Køge Søhuse; QP, Kalkgrunden, 17—22.5 m; Stevns (J. Lange (?)); VF, off Mandehoved, Stevns; bP, Kriegers Flak (O. Paulsen); E. by N. of Møen lighthouse 20 miles (C. A. J.); VH, the southern side of Böchers Grund, 8.5—10.5 m; Hesnæs harbour. — **Bb:** E. 3/4 S. of Jasmund lightship 15 miles, 21 m (C. A. J.); S. E. 3/4 S. of Adler Grund lightship 7 miles, 20 m (C. A. J.); S. 1/2 E. of Rønne harbour 8 miles; SH, Rønne Banke; SR, Rønne Banke, 15—16 m; YH, the lighthouse of Rønne harbour E. N. E. 1 1/2 miles, 24 m; Rønne harbour (L. K. R., F. B., C. A. J); "western coast of Bornholm" (Th. Schiøtz 1850); YC, the double broom at Salthammer Reef N. V. 3/4 N. 1 1/2 mile, 24 m; the bay within Salthammer Reef; S. S. E. of Neksø harbour 3 miles, 21 m (C. A. J.); Maltkværnen, north of Neksø; Svaneke (collect.?); SO, off Gudhjem; Rø (L. K. R., C. A. J.); Allinge; SN, Davids Grund, 15—16.5 m; XC, Davids Banke; Christiansø (F. B., L. K. R.); That at Christiansø.

2. **Pylaiella rupincola** (Aresch.) Kylin.

Kylin, Bemerkungen Entwickl. einiger Phaeophyceen, 1937, p. 5; Levring, Algenfl. norw. Westk., 1937, p. 45; Algenveg. Blekinge, 1940, p. 32, figs. 5, 6.

Ectocarpus firmus var. *rupincola* Areschoug, Alg. scand. exsicc., II—III, 1862, no. 113.

Pylaiella litoralis f. *rupincola* Aresch.; Kjellman, Handbok, 1890, p. 84; Svedelius, Östersjöns hafsalgfl., 1901, p. 101; Sjöstedt, Algol. stud. v. Skånes södra och östra kust, 1920, p. 23; Kylin, Entwickl. Phaeophyceen, 1933, p. 5 and 10.

Ectocarpus litoralis f. *rupincola* Aresch.; Kuckuck, Ectocarpus, 1891, p. 8; Lakowitz, Algenflora Danziger Bucht, 1907, p. 31, Taf. III, fig. 7, and fig. 21 in the text.

Pylaiella litoralis f. *prætorta* Kjellm., Handbok, 1890, p. 85; Svedelius, l. c. p. 101, figs. 13—15; Sjöstedt, l. c. p. 23.

Ectocarpus litoralis f. *prætorta* Kjellm.; Lakowitz, l. c. p. 32, Taf. III, figs. 8—10.

Ectocarpus litoralis Kützing, Tab. phycol., V, 1855, tab. 76, fig. 1.

Regarding the life-history the species has been examined by Kylin (1937, p. 5). As mentioned above it seems as if—in contradistinction to *P. litoralis*—it does not undergo an alternation of generations. In Kylin's cultivation experiments zoospores from unilocular sporangia again gave rise to plants with unilocular sporangia.

As to further particulars of *P. rupincola* see *P. litoralis*.

Localities. Probably common and widely distributed, presumably particularly in the Belts, the Sound and the Baltic.

Ectocarpus Lyngbye.

Lyngbye, H. C., Tentamen Hydrophytologiæ Danicæ, 1819, p. 130.

Mainly tufted algae, generally epiphytic (or inhabiting stones, wood, and the like), less frequently endophytic. The erect part of the thallus generally consists of branched, monosiphonous filaments; the basal portion is formed of creeping filaments horizontally expanded. The growth in the erect filaments is either terminal or intercalary, or a trichothallic meristem is instrumental. The branches in most species taper into a thinner, hairlike tip, consisting of longer cells with more sparing contents of chromatophores, in other species the cells of the top branches are not hairlike and their contents of chromatophores are normal. The chromatophores are either ribbon-shaped or disc-shaped. This character is of taxonomic importance, the individual species usually having chromatophores of one type only.

Of reproductive organs are found partly oval-ovoid unilocular sporangia, partly plurilocular sporangia, the shape of the latter being very varying, in several cases elongated into a hairlike tip. The plurilocular sporangia are, by far, the more common; they are generally evacuated through a single, apical orifice. The unilocular sporangia usually occur in plants, bearing in addition plurilocular sporangia.

An alternation of generations (or phases) has been demonstrated in *E. confervoides* f. *siliculosa* by some investigators. A meiosis takes place in the unilocular sporangia, the zoospores, produced in the latter, being haploid. The zoospores develop into gametophytes, or they copulate, in the latter case being gametes. The plurilocular sporangia are of two types depending on whether they occur in haploid or in diploid plants. In the first case they produce haploid isogametes capable of copulating or developing parthenogenetically; in the other case they form, on the other hand, diploid, asexual zoospores.

The genus in a paper of Hamel, recently published (Sur la classification des Ectocarpales, 1939, p. 65) has been divided into more genera. Hence the actual genus of *Ectocarpus* includes nothing but the species belonging to the form groups of *E. confervoides* and *E. fasciculatus*. Of other species inhabiting the Danish waters Hamel includes *E. Sandrianus* and *E. granulosus* in the genus *Giffordia*, while *E. irregularis* and *E. paradoxus* are referred to a new genus, *Feldmannia*. To *E. tomentosus* Kützing's old name *Spongonema* is applied. As the majority of these species are finally worked out in the posthumous manuscripts of professor Rosenvinge under the generic name of *Ectocarpus*, the species are here referred to under this name.

Key to the Danish species of Ectocarpus.

1. endophytic ..... 5. *E. tomentosoides.*
1. epiphytic.
   2. chromatophores ribbon-shaped.
      3. erect shoots usually simple ..... *E. confervoides* f. *pygmaea.*
      3. erect shoots branched.
         4. filaments entangled into string-like chords ..... 4. *E. tomentosus.*
         4. filaments free or only loosely entangled.

5. main axes marked, branch fascicles pronounced.
   6. length of cells of main axes usually 1—2 × diameter; branches of fascicles often arcuate or zigzag-shaped; tips of branches only slightly tapering ..... 2. *E. fasciculatus.*
   6. length of cells of main axes usually ½—1 × diameter; branches of fascicles not, or only rarely, slightly arcuate or zigzag-shaped; tips of branches tapering ..... 3. *E. draparnaldioides.*
5. main axes not marked ..... 1. *E. confervoides.*
   6. branch fascicles absent.
      7. plurilocular sporangia usually lacking a hairlike elongation.
         8. plurilocular sporangia ovoid—spindle-shaped, usually 100 µ (65—156 µ) × 20—30 µ ..... *E. confervoides* f. *typica.*
         8. plurilocular sporangia most frequently ovoid—oval, 60- well over 100 µ (—165 µ) × 20—29 µ ..... » » f. *arcta.*
         8. plurilocular sporangia cylindrical, 53—205 µ × 12—23 µ ..... » » f. *dasycarpa.*
      7. plurilocular sporangia often having a hairlike elongation.
         8. plurilocular sporangia subulate-cylindrical, usually 150—250 µ (—450 µ) × 20 µ (10—25 µ) ..... » » f. *siliculosa.*
         8. plurilocular sporangia conical—coarsely subulate, 150—550 µ × 20—40 µ (—53 µ) ..... » » f. *hiemalis.*
   6. branch fascicles present ..... » » f. *penicillata.*

2. chromatophores disc-shaped (in *E. granulosus* the lower cells may have ribbon-shaped chromatophores).
   3. loculi of plurilocular sporangia each having an orifice ..... 11. *E. Reinboldi.*
   3. plurilocular sporangia with one orifice only, apical.
      4. marked trichothallic meristem.
         5. all meristems trichothallic.
            6. thickness of the filaments 12—21 µ ..... *E. ovatus* var. *intermedius.*
            6. » » » » 21—60 µ ..... 10. *E. paradoxus.*
         5. in addition to primary, trichothallic meristems secondary intercalary occur ..... 9. *E. irregularis.*
      4. marked trichothallic meristem absent.
         5. ramification scattered; branches frequently in unilateral series. Plurilocular sporangia often seriate on the inner side of the branches ..... 6. *E. Sandrianus.*
         5. ramification often opposite.
            6. main filaments 60—80 µ (—116 µ); plurilocular sporangia 60—90 µ (—120 µ) × 38—53 µ (—65 µ), scattered or seriate on the inner side of the branches ..... 7. *E. granulosus.*
            6. main filaments 15—35 µ; plurilocular sporangia 26—44 µ (—95 µ) × 18—25 µ (— 30 µ), partly opposite ..... 8. *E. ovatus.*

1. **Ectocarpus confervoides** (Roth) Kjellm.[1]

Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 67.
Ceramium confervoides Roth, Catalecta bot., Vol. I, 1797, p. 151.

The works of major importance dealing with the interpretation of species within the form group of *Ectocarpus confervoides* are Kjellman: Skand. Ectocarp. och Tilopt. (1872) and Handbok (1890), and Kuckuck: Ectocarpus-Arten d. Kieler Föhrde (1891). In the first of the works mentioned Kjellman by E. confervoides means an extensive species, represented in Scandinavia by 6 main forms: f. *arcta* Kütz., f. *siliculosa* (Dillw.), f. *spalatina* Kütz., f. *Confervoides* Roth (= *E. confervoides* s. s. Kjellm.), f. *penicillata* C. A. Ag., and f. *hiemalis* Crouan. Moreover, a closely allied species, *E. pygmaeus* Aresch., is mentioned here. In the later work (1890), on the other hand, he regards 4 of these forms: f. siliculosa, f. Confervoides, f. penicillata, and f. hiemalis as particular species, whereas f. arcta (and E. pygmaeus) are referred as forms to the new E. confervoides and f. spalatina as a form to the new E. hiemalis. A tolerably corresponding view as that in Kjellman's last mentioned work is expressed by Kuckuck (1891); however, he includes f. hiemalis and f. arcta as forms in E. siliculosus. In addition Kuckuck establishes a new species, *E. dasycarpus*, closely related to E. confervoides and E. siliculosus.

According to Kjellman's modified view in 1890 f. *confervoides*, f. *siliculosa*, and f. *penicillata* are generally maintained as particular species. Some authors, however, e. g. Debray (1899, p. 66) and Newton (1931, p. 119) have joined f. confervoides and f. siliculosa into one species. Similarly f. *hiemalis* has been interpreted as a species by some authors (for instance by Kylin (1907, p. 56) and Printz (1926, p. 154)), while others have followed Kuckuck's (l. c.) (and Foslie's (1891, p. 127)) examples, e. g. Hamel (1931, p. 22). Others again, e. g. Arwidsson (1936, p. 101) and Levring (1937, p. 43 and 1940, p. 31) quite simply refer E. hiemalis to E. siliculosus as a synonym. F. *arcta* in the literature after 1890—91 has by some authors been interpreted as by Kjellman in 1890 (e. g. Kylin, l. c., Printz, l. c., Hamel, l. c.), by others as by Kuckuck (e. g. Børgesen (1902, p. 404 and 1926, p. 15)). In contradistinction van Goor (1923, p. 86) gives it as a species, E. arctus Kütz. F. *spalatina* is referred to by Kylin (l. c. p. 56) in the same way as by Kjellman 1890. On the other hand, it is included by Kuckuck (l. c. p. 17 and 20, footnote) in E. siliculosus. As to *E. pygmaeus*, finally, it may be mentioned that in the literature after 1890 it is regarded in the same way as in Kjellman's work from that year.

On the basis of a very large material of the form group of *E. confervoides*, originating from the Danish waters I think it right, on the whole, to keep the taxonomy used by Kjellman in 1872. The four forms, in 1890 raised to species, seem to be variable to such a degree that it will not be possible to maintain a

[1] As to this species, of the literature previous to 1890—91 Kjellman's work, Skand. Ectocarp. och Tilopt., 1872, only and a few others have been taken into account. Regarding the essential older literature reference may be made to the lists of Kjellman in this work, Hauck, Die Meeresalgen, 1885, and Kuckuck, Ectocarpus, 1891.

principle of species. F. *arcta* and f. *spalatina* seem to be maintenable as special forms at most. F. *arcta* is closely related to E. confervoides and E. siliculosus, while f. *spalatina*—of which form typical specimens, for that matter, have not been found in the material—shows a transition to E. siliculosus and E. hiemalis. *E. pygmaeus* I regard as f. *pygmaea*. Similarly it will probable be most correct to regard *E. dasycarpus* as f. *dasycarpa*. In the following passages further particulars of the variation within the form group are given. The variation particularly depends on the different morphological development of the plurilocular sporangia.

The taxonomical variation of Ectocarpus confervoides sens. lat. Although it has been possible to refer a great number of specimens either to *E. confervoides* s. s. or *E. siliculosus* a number of intermediate forms exist which, owing to the varying shape of the plurilocular sporangia may sometimes be difficult to identify.

1. Thus numerous plants bear plurilocular sporangia of the confervoides type as well as of the siliculosus type, even if one of the two types in several cases seems to be dominant. Thus for instance is the case of some plants from the buoy at Skagen Reef in the northern Kattegat. Here the plurilocular sporangia were chiefly ovate—spindle-shaped, but in addition the latter were accompanied by some longer, slender plurilocular sporangia often bearing a hairlike, sterile elongation (cp. fig. 4).

If one type of sporangium is dominant as in this case the plants are referred to the form, characterised by this form of sporangium. If on the other hand both types of sporangium are nearly equally numerous, the determination of the plants becomes much more difficult.

In a great number of cases plants have been found the plurilocular sporangia of which in the basal part of the plant almost exclusively belonged to the arcta or confervoides type, while those in the upper part all were of the siliculosus (or hiemalis-penicillatus) type, often bearing a hairlike elongation. Similar cases, for the rest, have been mentioned by Foslie (1891, p. 128) and Printz (1926, p. 154). Thus the confervoides-arcta type might perhaps be supposed to be more primitive than the siliculosus type.

It appears, for the matter, from Knight (1929, p. 310, pl. II), too, that E. siliculosus in addition to subulate—long cylindrical plurilocular sporangia is capable of producing shorter plurilocular sporangia approaching the confervoides—arcta type. For in this treatise it has been shown how the forms of sporangia in E. siliculosus change during the period of growth. The form first found is long, typical, but gradually the length decreases so that the plurilocular sporangia at the end of the period of growth are short and obtuse.

2. A great number of plants—besides plurilocular sporangia of the confervoides and (or) the siliculosus type—further possess a greater or smaller number of plurilocular sporangia, which are to be interpreted as transition forms including almost all transitions from typical confervoides to typical siliculosus sporangia.

3. Again, in other cases the plurilocular sporangia in a specimen seem almost all to have to be designated as transition forms. Such sporangia of transitional forms in some cases closely resemble the confervoides type, actually differing only in being a little longer than is generally the case in the latter; at the same time they often terminate in a point. By means of a greater elongation of a confervoides plurilocular sporangium and a coincident decrease of the diameter in the basal portion the siliculosus type is gradually reached through a series of transition stages. If the length of the sporangium increases slightly only, the diameter on the other hand decreasing rather much, a peculiar short type frequently occurring is reached, which is most closely related to siliculosus. If the length of a confervoides plurilocular sporangium increases, whereas the diameter is constant—or decreasing slightly only—forms are reached which have a strong resemblance to penicillatus.

Nor does a sharp distinction exist as to the occurrence of the sterile, hairlike elongation, so frequently found, at the tip of the plurilocular sporangia in E. siliculosus (and E. hiemalis). For in a few cases a hairlike elongation like this has been noticed, too, in typical confervoides plurilocular sporangia belonging to plants completely consistent with E. confervoides s. s.

As to the vegetative parts the two "species" may often be distinguished by the character that the tips of the branches in E. confervoides s. s. are not hairlike, which in contradistinction is the case in E. siliculosus. This characteristic, however, does not always by far seem applicable, transitional stages in that respect, too, occurring; for the tips of the branches in E. confervoides are sometimes more or less hairlike.

Nor does it seem possible, in the Danish material, to draw a limit between *E. siliculosus* and *E. hiemalis*. Even if typical specimens of E. hiemalis exist (as to the plurilocular sporangia agreeing best with Areschoug, Exsicc. no. 220) a number of plants—particularly those collected in deep water (p. 33)—show more or less affinity in E. siliculosus (cp. Foslie, l. c. p. 127; Printz, l. c. p. 154).

On the other hand, a gradual transition seems actually to exist between *E. confervoides s. s.* and *E. hiemalis* too. In a plant from the southern Kattegat the majority of the plurilocular sporangia belonged to the confervoides type (some of these, indeed, rather long); in the upper part of the plant some sporangia approached the hiemalis type (135—156 μ (—193 μ) long by 23—29 μ in diameter). Similarly in a specimen from the North Sea most of the plurilocular sporangia belonged to the confervoides type, although on an average they were rather long. A great number, however, showed a transition to hiemalis. The length of the latter measured (85 μ—) 115—156 μ (—210 μ), the diameter 24—33 μ (—37 μ).

It seems difficult to solve the problem of the justification of retaining f. *spalatina* as a special form, equal to the other forms given by Kjellman in 1872, from the Danish material. At any rate, in the Danish waters plants do not seem to have been met with the plurilocular sporangia of which, all or most of them, have be-

longed to this type. Some plants are so closely related to *E. siliculosus* that a distinction is impossible. Others are to be regarded as transition forms to *E. hiemalis*; for they bear partly oblong conical, sessile plurilocular sporangia lacking hairlike elongations, partly typical, stalked hiemalis plurilocular sporangia. For the present I prefer referring the f. spalatina-like plants, recalling f. siliculosa, to that form, whereas plants, showing affinity in f. hiemalis, are referred to the latter.

While *E. siliculosus* thus seems to overlap E. confervoides s. s., E. hiemalis, and E. spalatina, the boundary, too, to *E. penicillatus* seems difficult to set. E. siliculosus often has dense ramifications—even if not actual branch fascicles—so that the appearance will have a strong resemblance to the specimens of E. penicillatus, in which the branch fascicles are not so distinctly marked, but rather loose or elongated. The shape of the plurilocular sporangia is then of importance. However, in certain cases specimens of E. penicillatus with open branch fascicles, in addition to oblong-conical plurilocular sporangia, possess plurilocular sporangia, too, having affinity in the siliculosus type. Hence in such cases the identification may cause difficulties.

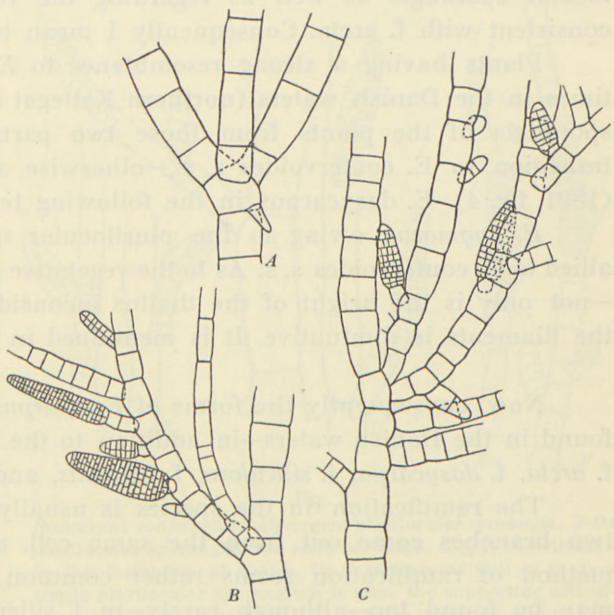


Fig. 1.
Ectocarpus confervoides. Parts of plants showing peculiar methods of ramifications. In *A* og *B* 2 branches issue from the same cell, side by side. In *C* 2 branches, too, issue from the same cell, but one beneath the other. — Rosenvold harbour, Vejle Fjord, 20-V-29 (S. L.) — × 173.

Kylin (1907, p. 55) states the vegetative characteristic that the "fascicles" in E. siliculosus are chiefly formed by dichotomy, the branches being arranged densely. In E. penicillatus, on the other hand, a large number of the branches in the fascicles are known to be lateral branches.

In specimens of *E. penicillatus* having loose branch fascicles, not well marked, and rather elongated plurilocular sporangia, otherwise typical, the resemblance to *E. hiemalis* may be rather strong (cp. Areschoug, Exsicc. no. 220. The specimen in 1872 was regarded by Kjellman as f. penicillata, in contradistinction to his interpretation in 1890 as E. hiemalis).—No. 174 in Areschoug's Exsicc. seems to me a doubtful specimen. It is regarded as E. penicillatus by Kjellman (1890 p. 76) and Kuckuck (1891, p. 23). As branch fascicles do not occur at all (in the specimen kept in the Botanical Museum in Copenhagen), I cannot refer the individual to this species, although the majority of the plurilocular sporangia probably are of

the penicillatus type (some of them, indeed, belong to the siliculosus category). It will perhaps be correct to refer it to f. hiemalis.

It does not seem likely that f. *arcta* should be a well-defined form judging from the fact, mentioned above, that numerous specimens bear, in the basal part, plurilocular sporangia of the arcta (-confervoides) type, in the upper part on the other hand those of the siliculosus type. However, in samples from Vejle Fjord in the Little Belt I have found a number of specimens, which in respect to the plurilocular sporangia as well as regarding the vegetative parts on an average were consistent with f. arcta. Consequently I mean to maintain this form.

Plants having a strong resemblance to *E. dasycarpus* have been found a few times in the Danish waters (northern Kattegat and the Little Belt). The plurilocular sporangia of the plants from those two parts of the waters, show, however, a transition to E. confervoides s. s.,—otherwise agreeing well with Kuckuck's figure (1891, fig. 4). E. dasycarpus in the following text is considered a form.

E. pygmaeus, owing to the plurilocular sporangia, seems to be rather closely allied to E. confervoides s. s. As to the vegetative parts it is, indeed, very much reduced —not only is the height of the thallus inconsiderable but, moreover, the diameter of the filaments is diminutive. It is mentioned in the following passages as f. pygmaea.

Now, consequently the forms of *Ectocarpus confervoides* (Roth) Kjellman 1872 found in the Danish waters—in addition to the main form—are: f. *typica*, f. *pygmaea*, f. *arcta*, f. *dasycarpa*, f. *siliculosa*, f. *hiemalis*, and f. *penicillata*.

The ramification in the species is usually scattered. Now and then, however, two branches come out from the same cell, not opposite, but side by side. This method of ramification seems rather common in f. penicillata, but as it seems it may be found too—although rarely—in f. siliculosa and f. hiemalis. In fig. 1 this structure has been elucidated in detail in a specimen having a certain affinity in f. penicillata without, however, possessing actual branch fascicles. In some cases it is a question of two branches of nearly equal size (fig. 1 *A*), in others of a larger one and a smaller one (fig. 1 *B*). It may happen indeed, that one branch is sent out below another from the same cell (fig. 1 *C*).

Opposite branching is very rare; it has been noticed in a few cases only. In one case a plant belonging to f. typica showed 2 opposite branches, of which the tip of one had developed a plurilocular sporangium.

The chromatophores are ribbon-shaped (fig. 10 *D*), never disc-shaped as figured by Newton (1931, fig. 70 *B*). They are not infrequently arranged longitudinally in the cells or they form a very steep screw.

In the majority of the forms the branches terminate in hairlike tips. In f. typica the apices of the branches, however, generally consist of cells having normal contents of chromatophores even if more or less hairlike apices exist, too. F. pygmaea seems to correspond to f. typica. In f. dasycarpa the tips of the branches usually are fertile; if sterile they are hairlike.

The main form.

To the main form I refer those specimens of the species which cannot be classified in any of the forms named. The great majority, owing to the plurilocular sporangia, are to be considered transitional forms between f. *typica* and f. *siliculosa*, probably generally more closely allied to the latter. On the other hand, others form a transition to f. *hiemalis* or f. *penicillata* or between these reciprocally.

Very common in the Danish waters from the littoral region down to a depth of 31 m, where it forms tufts up to the height of 15 cm on many different algae and on *Zostera*. Very common, too, on wood, stones, and shells. Moreover, it has been noticed on ascidians, *Flustra*, and *Stenorhynchus*. The colour, in dried specimens, is very variable, usually, however, brownish (light brown, yellowish brown) or greenish (yellowish green).

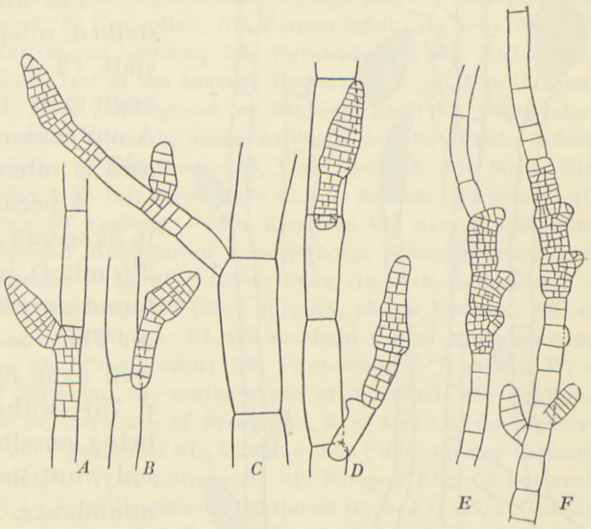


Fig. 2.
Ectocarpus confervoides. Divergent plurilocular sporangia. *B-D*: plurilocular sporangia, the stalk of which, too, is contributive in the formation of spores. In *C* further—as well as in *A*—a sessile plurilocular sporangium is seen, the supporting articulation of which is fertilised. *E, F*: parts of young plants with intercalary plurilocular sporangia. — *A-D*: 3 miles S. S. E. of Neksø harbour, Bornholm, 21 m, 16-VI-23 (C. A. J.); *E, F*: the Little Belt Bridge, pillar 3, 22-VIII-34 (S. L.). — *A-F*: × 237.

The plurilocular sporangia are usually stalked or sessile; they are very variable as to shape and size. In plants from the littoral region they frequently seem to belong to the confervoides type, although often rather long. The plurilocular sporangia in the upper portion of these plants are not infrequently slightly conical, in this way, as it seems, showing affinity in f. *hiemalis* (cp. p. 16). The plurilocular sporangia occur presumably throughout the year; they have been noticed in January and from April to December.

Intercalary plurilocular sporangia have been met with a few times. Such was the case in some young plants from the Little Belt Bridge. For in this plants in addition to a great number of small ovoid plurilocular sporangia a few sporangia, forming chains, occurred (fig. 2 *E, F*.).

In a specimen from the Baltic (3 miles S. S. E. of Neksø harbour, Bornholm, 21 m), the sporangia of which were short and slender, ovoid—subulate, the stalk of the sporangia, totally or partly, in several cases was transformed into a sporangium, too (fig. 2 *B, C, D*). If the sporangia are sessile, the articulation, from which the sporangia issue, might be fertile (fig. 2 *A, C*).

The unilocular sporangia have been recorded from April—September. The frequency of their occurrence in the different months appears from the table p. 30.

They occur in the same plants which bear plurilocular sporangia. Generally, however, one of the two kinds of sporangia in a certain plant seems to be represented more numerously than the other. Often specimens are met with which, besides bearing unilocular sporangia in abundance, possess only a few young, plurilocular sporangia. This seems to indicate that unilocular sporangia develop earlier than plurilocular.

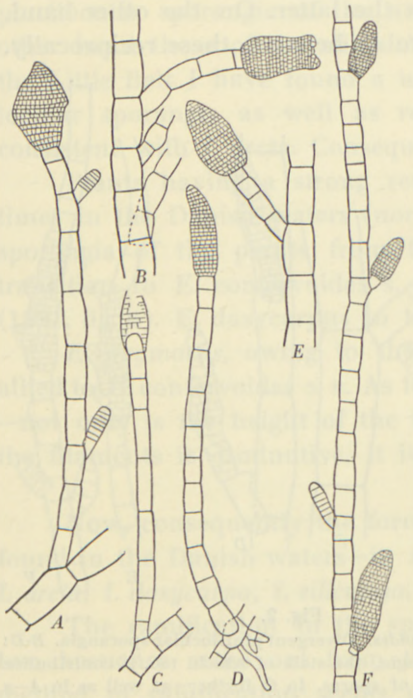


Fig. 3.
Ectocarpus confervoides from Skagerak, growing on *Flustra*. Specimens with plurilocular sporangia. — Hirtshals lighthouse in S. E. 2½ miles, 12-15 m, 1-VIII-01. — × 115.

The unilocular sporangia are sessile or short-stalked, often situated more than one on the same stalk (2 or 3). Now and then a unilocular sporangium is observed to be inserted into another. A unilocular sporangium after having been evacuated is often passed through by a young one.

A peculiar form has been noticed a few times in Skagerak (no. 7078, Hirtshals lighthouse in S. E. 2½ miles), where the plants in question have been found growing on *Flustra* in the depth of 12—15 m. They seem to show affinity in f. *typica* as well as in *E. Crouani* Thuret[1] (in Le Jolis 1863, p. 75)—without, however, reference to these forms being possible. The plants were slightly branching only, but they possessed plurilocular sporangia in abundance. In the filaments, the diameter of which amounted to 33—41 μ, in a few cases was observed a longitudinal division in one of the vegetative cells. In most cases the plurilocular sporangia had a one-celled stalk (fig. 3 *F*); several, however, were sessile or terminal on rather long branches (fig. 3 *A-C*, cp. *E. Crouani*). A number of plurilocular sporangia were terminal on short or long, unbranched basal shoots (fig. 3 *D*). In most cases the plurilocular sporangia were ovoid—spindle-shaped; in some cases they were irregular at the top (fig. 3 *B*). The length usually measured 90—130 μ (—156 μ), the diameter 30—45 μ (—50 μ).

Localities. **Ns:** Nordby, Fanø; Esbjerg, salt marsh of *Zostera* in the eastern harbour; Harboøre, groyne 33, presumably f. *typica* → f. *hiemalis*; aF, Thyborøn beacon in S. E. ½ E. 14½ miles, 31 m, for instance on *Flustra*; Thyborøn beacon in N. W. ½ W. 15 miles, 31 m, on ascidians; aD, Lodbjerg lighthouse in S. E. ¾ S. 4½ miles; aE, Lodbjerg lighthouse S. by W. ½ W. 7⅓ miles. — **Sk:** N. W. of

[1] It seems to me that this species—which I have had the opportunity of studying on the basis of Le Jolis' Exsicc. no. 206 and of some specimens of Thuret from Cherbourg—is to be regarded, most correctly, as *E. confervoides* f. *Crouani* (Thuret). It seems to be rather closely related to f. *typica* with which form it mainly agrees as to the shape of the plurilocular sporangia. It differs from the latter form chiefly in the ramification being slighter as also in some of the plurilocular sporangia often being long-stalked. In addition the diameter of the plurilocular sporangia not infrequently seems to be greater.

Hirtshals (Flammegrund), 15 m; Hirtshals lighthouse in S. E. 2 1/2 miles (the shoal), 12 m and over (fig. 3). — **Lf:** Thyborøn harbour; Lemvig; Kobberød; Rønnen N. of Lemvig, on *Stenorhynchus*; Struer; MH, Skandrup, on the shoal; Sallingsund (Th. M.); Nykøbing (Th. M.); Beistrup shore (collector?). — **Kn:** FE, Trindelen; Skagen Reef, the double broom (C. H. O.); Skagen harbour; east of Hirsholmene (Boye P.); Tyskerens Reef; Hirsholm; Laurs' Reef; Holmehavn Reef; Borrebjerg's Reef; Brune Reef, on the buoy; Rønnerne near Frederikshavn; Frederikshavn harbour (L. K. R., C. A. J.); S. of Frederikshavn (E. Bay); abeam Sæby; VT, Nordre Rønner lighthouse S. hardly 2 1/2 miles; NG, N. of Nordre Rønner; the northern end of Nordre Rønner; TL, Nordre Rønner lighthouse E. by N. 1/4 N. 1 1/3 miles; Østerby harbour, Læsø. — **Km:** Søndre Rønner beacon E. N. E. 4 miles; ND, Fornæs lighthouse S. by W. 1/2 W. 11 3/4 miles; BK, the balloon on Tangen. — **Ks:** Grenaa harbour; NB, Havknudeflak; MZ, Hjelm lighthouse S. by E. 2 miles; Sjællands Reef, the outer reef at the beacon; Hammeren E. of Ourø (f. *typica* → f. *hiemalis*). — **Ke:** Groves Flak, 26 m; IA, Store Middelgrund. — **Sa:** Kalø Reef; AS, the western side of Meilgrund; the northern end of Besser Reef; Sønderby shore, As Vig (S. L.); MP, Falske Bolsax; Paludans Flak; Odense Fjord (Caroline Rosenberg). — **Lb:** Rosenvold, Vejle Fjord (S. L.); Strib; Middelfart (C. Rasch); the Little Belt Bridge, pillar 4 (S. L.); Fænø Kalv (S. L.); Assens; Hornenæs; dG, Hesteskoen, E. of Als; Sønderborg. — **Sf:** buoy off Faaborg. — **Sb:** Kjertinge Vig near Kjerteminde; Kjerteminde; GY, W. of Gjellegrund, S. of Sprogø; Knudshoved near Nyborg; Strandby stone reef, Langeland; LB, off Holmegaard, Kjelsnor lighthouse W. hardly 4 miles; Fyen (in herb. E. Rostrup). — **Sm:** Raagø Sund; Guldborg; Grønsund. — **Su:** Blokhusgrund (Boye P.); bN, abeam Vedbæk; PS, off Charlottenlund; København, Skudehavnen (S. L.); København; RI, the southern end of Middelgrunden, between the balloon and the double broom; SA, Flinterenden; SB, Flinterenden, 3/8 mile S. W. of Oscarsgrund lighthouse; RH, Knollen, W. of Saltholm, the southern end of the shoal; the lightbuoy "Drogden C", Drogden (S. L.). — **Bw:** dO, the northern side of Bredgrund, S. of Als; LE, the northern edge of Vejsnæs Flak; KY, Femerbælt; Skjelby (Johs. Schmidt); KU, Schönheyders Pulle; Gjedser harbour; KT, innermost broom at Gjedser Reef. — **Bm:** QF, W. of Lillegrund; bP, Kriegers Flak (O. Paulsen); QS, Møens Klint S. S. W. 7 miles; 7 miles N. E. 1/2 W. of Hestehoved lighthouse (C. A. J.); KS, off Ulfslev. — **Bb:** XZ, Davids Banke, 21 m; SL, Allinge; 3 miles S. S. E. of Neksø harbour, 21 m (C. A. J); 8 miles S. 1/2 E. of Rønne harbour (C. A. J.); SX, That near Christiansø.

Ectocarpus confervoides f. typica Kjellm.

Kjellman, Norra ishafv. algfl., 1883, p. 342.

Ectocarpus confervoides s. s. Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 77.

Ectocarpus confervoides (Roth) Le Jol. ad part. Kjellman, Handbok, 1890, p. 77 (the main form); Kuckuck, Ectocarpus, 1891, p. 19, fig. 3 (f. *typica*, f. *nana*, f. *penicilliformis*); K. Rosenvinge, Grønl. Havalg., 1893, p. 883, fig. 21 (α, *typica*); Kylin, Algenfl. schw. Westk., 1907, p. 54 (f. *typica*); Sjöstedt, Algol. stud. Skånes södra och östra kust, 1920, p. 24; Havsalg. Hallands Väderö, 1927, p. 14; van Goor, Die holl. Meeresalg., 1923, p. 85; Setchell and Gardner, Mar. Alg. Pac. Coast N. Am., III, Melanophyceae, 1925, p. 412; Printz, Algenveg. Trondhjemsfj., 1926, p. 154; Børgesen, Mar. Alg. Canary Isl., II, Phæophyceæ, 1926, p. 7, figs. 1, 2; Lakowitz, Algenfl. ges. Ostsee, 1929, p. 218; Hamel, Phéophycées de France, I, 1931, p. 23; Knight and Parke, Manx Algae, 1931, p. 61, pl. VIII, figs. 3, 4; Lund, Algenveg. Stege Nor, 1934, p. 32; Levring, Algenfl. Kullen, 1935, p. 21 (f. *typica*); Algenveg. Blekinge, 1940, p. 32; Taylor, Mar. Alg. northeast. N. Am., 1937, p. 109, pl. 8, figs. 1—3; Feldmann, Alg. mar. Albères, 1937, p. 104.

Ceramium confervoides Roth, Catalecta bot., I, 1797, p. 151.

Ectocarpus littoralis var. Areschoug, Alg. scand. exsicc., II—III, 1862, no. 111.

Common in the Danish waters from the North Sea to Bornholm, but it does not seem to be found so abundantly, by far, as f. *siliculosa*. It forms tufts, up to the height of 12 cm, of a dark green, brownish yellow or dark brown colour. It is

an epiphyte on algae (e. g. *Fucus, Laminaria digitata, Chorda filum, Punctaria, Chondrus, Nemalion*) and marine angiosperms (*Zostera, Ruppia*) as well as on *Flustra*. Further on wood and stones. Noticed from the littoral region to a depth of about 24 m. It seems to be of greatest luxuriance in the littoral region—not respecting vegetative growth only, but respecting fertility too; moreover, the plurilocular sporangia seem to be larger from this zone than from deeper water. With the increasing depth the vegetative abundance as well as the fertility seem to decrease to some degree; similarly the majority of the sporangia seem to be less well-grown. The shape of the plurilocular sporangia tends to a resemblance of that of the arcta type.

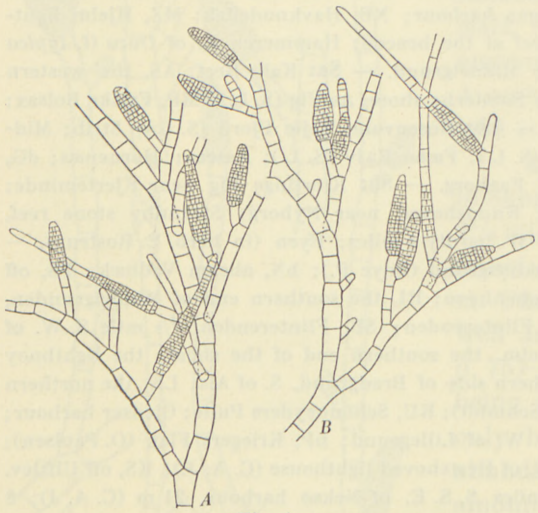


Fig. 4.
Ectocarpus confervoides f. *typica*. Parts of the upper portion of a plant with plurilocular sporangia. — Skagen Reef, the double broom, 2-V-07 (C. H. Ostenfeld). — × 115.

The plurilocular sporangia are ovoid—spindle-shaped, they are sessile or short-stalked (fig. 4). Sometimes they come out from rhizhoids, which may be found in varying number on the main branches. They have been noted in the months of April—November. They usually amount to about 100 μ in length or a little less (65—156 μ); the diameter is rather variable, generally, however, 20—30 μ. In some cases plants are met with, the plurilocular sporangia of which, all of them, measure less than 20 μ in diameter. In a single plant the diameter of the plurilocular sporangia even measured but 12—16 μ. In other cases the diameter of numerous of the plurilocular sporangia exceeds 30 μ. In a plant from the Limfjord (Nykøbing) the plurilocular sporangia on an average were 30—40 μ in diameter (a few even up to 45 μ in diameter).

Even in plants having chiefly typical plurilocular sporangia now and then occur a number of plurilocular sporangia which approach the siliculosus type; nay, some of these may possess a sterile, hairlike elongation (fig. 4 *A*, cp. p. 15).

The unilocular sporangia are found in May, July and August; they are sessile or short-stalked; they occur in the same plants which bear plurilocular sporangia. The length of the unilocular sporangia measures 37—61 μ, the diameter 25—37 μ.

A form is to be mentioned, differing to some extent, represented by some plants from a locality in the Little Belt in a place where the current is strong (Strib, no. 1419). These plants, inhabiting wood, where they formed tufts of about 10 cm in height, have a certain resemblance to *E. tomentosus* (fig. 5). They consist of long, rather thin filaments with long cells, slightly branching, held densely together and partly intertwined into chords. The plurilocular sporangia generally seem to be of

the ordinary confervoides type (fig. 5 *D, E*), regarding form as well as size. Occasionally they were, however, somewhat longer, almost cylindrical (fig. 5 *C, B*). They are usually short-stalked, less frequently sessile, often coming out at a rather large angle (now and then at an almost right angle).

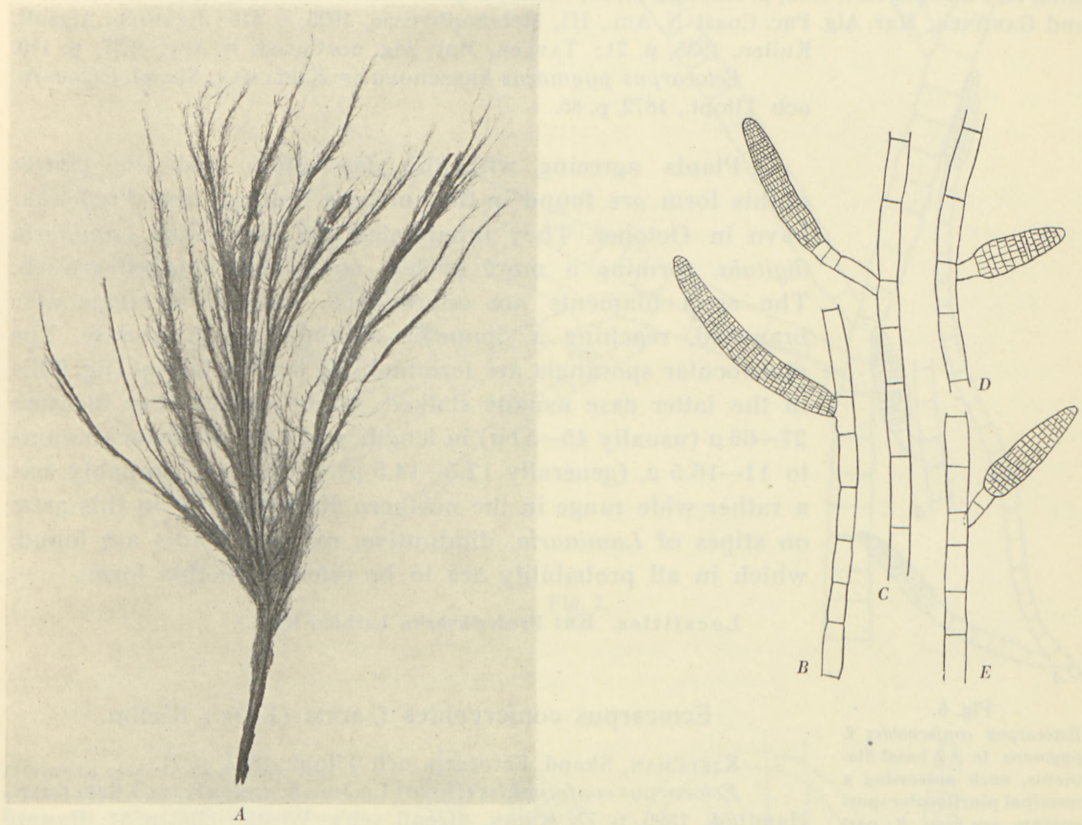


Fig. 5.
Ectocarpus confervoides f. *typica*. Divergent form from the Little Belt. *A*: picture of habit (photo); *B-E*: main filaments with plurilocular sporangia. — Strib 6-VII-91. — *A*: nat. size; photo. JUL. GRØNTVED. *B-E*: × 173.

Localities. **Ns:** Esbjerg harbour; ZQ, Jyske Reef. Lodbjerg lighthouse E. by S. 26½ miles, 24.4 m. — **Sk:** Skiveren, on wreck. — **Lf:** Nykøbing (Th. M.); Glyngøre. — **Kn:** Skagen Reef, the double broom (C. H. O.); Skagen harbour; Frederikshavn; Nordre Rønner lighthouse S. hardly 2½ miles; W. of Nordre Rønner. — **Ke:** VZ, Groves Flak; VY, Fladen. The balloon S. by E. ½ E. ⅔ mile; 18 m. — **Km:** Anholt harbour. — **Ks:** Gniben, Sjællands Odde (S. L.), — **Sa:** gH, the southern side of Hesbjerg Grund; AS, western side of Meilgrund; Vorsø, Horsens Fjord, on a crab (S. L.); Sønderby shore, As Vig (S. L.); Vrøj. — **Lb:** Aalegaardsbjerg near Rosenvold, Vejle Fjord (S. L.); Strib (fig. 5); south of Kongebro near Middelfart. — **Sf:** Svendborg harbour; Svendborgsund at the northern end of Taasinge; EA, at the northern end of the Rudkøbing fairway. — **Sb:** MN, N. of Asnæs; Mullerup pier. — **Sm:** Stege Nor (S. L.); Stege harbour (S. L.). — **Su:** Barakkebro, Saltholm (S. L.); RH, Knollen west of Saltholm. — **Bw:** LA, off Vesterskov, western Lolland. — **Bb:** YH, Rønne harbour lighthouse E. N. E. 1½ miles, 24 m.

Ectocarpus confervoides f. pygmaea (Aresch.) nov. comb.

Ectocarpus confervoides (Roth) Le Jol. f. *pygmaea* (Areschoug) Kjellman, Handbok, 1890, p. 77; K. Rosenvinge, Grønl. Havalg., 1893, p. 883; Saunders, Phycological Mem., 1898, p. 154, pl. 15, figs. 5—9; Börgesen, Mar. Alg. Færöes, 1902, p. 403, fig. 66; Jónsson, Mar. Alg. Iceland, II, Phæophyceæ, 1903, p. 155, figs. 14, 15; Kylin, Algenfl. schw. Westk., 1907, p. 54; Setchell and Gardner, Mar. Alg. Pac. Coast N. Am., III, Melanophyceae, 1925, p. 415; Levring, Algenfl. Kullen, 1935, p. 21; Taylor, Mar. Alg. northeast. N. Am., 1937, p. 110.

Ectocarpus pygmaeus Areschoug in Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 85.

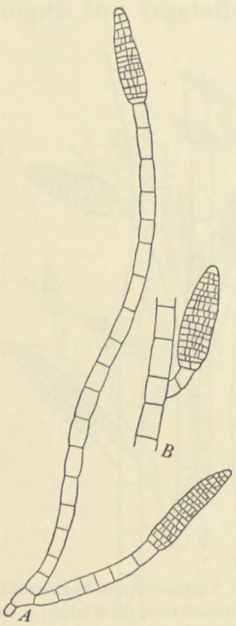


Fig. 6.
Ectocarpus confervoides f. *pygmaea*. In *A* 2 basal filaments, each possessing a terminal plurilocular sporangium, are seen. *B*: part of a filament with a lateral plurilocular sporangium. — Frederikshavn harbour 20-X-33, on *Laminaria digitata* (S. L.). — × 237.

Plants agreeing with the description and the figures of this form are found in the northern Kattegat near Frederikshavn in October. They inhabitated the lamina of *Laminaria digitata*, forming a more or less continuous, matted growth. The erect filaments are unbranched, only in a single case branched, reaching a diameter of about 10—13 μ only. The plurilocular sporangia are terminal (fig. 6 *A*) or lateral (fig. 6 *B*); in the latter case usually stalked, rarely sessile. They measure 27—66 μ (usually 45—57 μ) in length, while the diameter amounts to 11—16.5 μ, (generally 12.5—14.5 μ). This form, probably, has a rather wide range in the northern Kattegat. For in this area, on stipes of *Laminaria*, diminutive, reduced plants are found, which in all probability are to be referred to this form.

Localities. **Kn:** Frederikshavn harbour (S. L.).

Ectocarpus confervoides f. arcta (Kütz.) Kjellm.

Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 71.

Ectocarpus confervoides (Roth) Le Jol. f. *arcta* (Kütz.) Kjellman, Handbok, 1890, p. 77; Kylin, Algenfl. schw. Westk., 1907, p. 54; Hamel, Phéophycées de France, I, 1931, p. 23 fig. 2 *E*.

Ectocarpus siliculosus f. *arcta* Kuckuck, Ectocarpus, 1891, p. 18; Børgesen, Mar. Alg. Færöes, 1902, p. 404, fig. 67; Mar. Alg. Canary Isl., II, Phæophyceæ, 1926, p. 15, figs. 7, 8.

Ectocarpus arctus Kützing, Phycol. gen., 1843, p. 289; Hauck, Die Meeresalgen, 1885, p. 328; van Goor, Die holl. Meeresalg., 1923, p. 86.

Ectocarpus pseudosiliculosus Crouan, Alg. mar. Finistère, 1852 (Exsicc.) no. 27; Florule, 1867, p. 162.

The plants referred to this form, were found in the month of September at the depth of 2 m, epiphytic on *Polysiphonia nigrescens*. The main filaments were vigorously grown (fig. 7), often bearing rhizoids in abundance, particularly where large branches were inserted. The diameter of the main filaments measured 56—82 μ; where large branches were inserted and near this place usually less. Similarly the large branches were attenuated where inserted (fig. 7). The branches in the upper parts

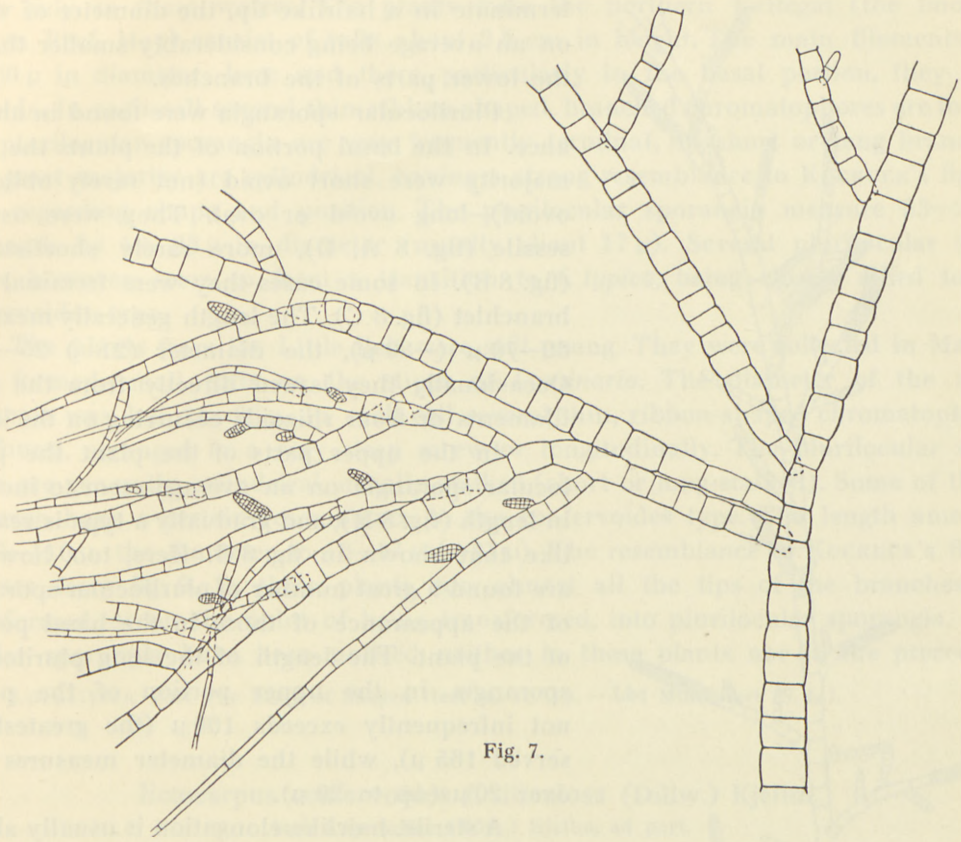


Fig. 7.

Fig. 7.
Ectocarpus confervoides f. *arcta*. Part of a plant with plurilocular sporangia. — Rosenvold, Vejle Fjord, 24-IX-36, on *Polysiphonia nigrescens* (S. L.). — × 97.

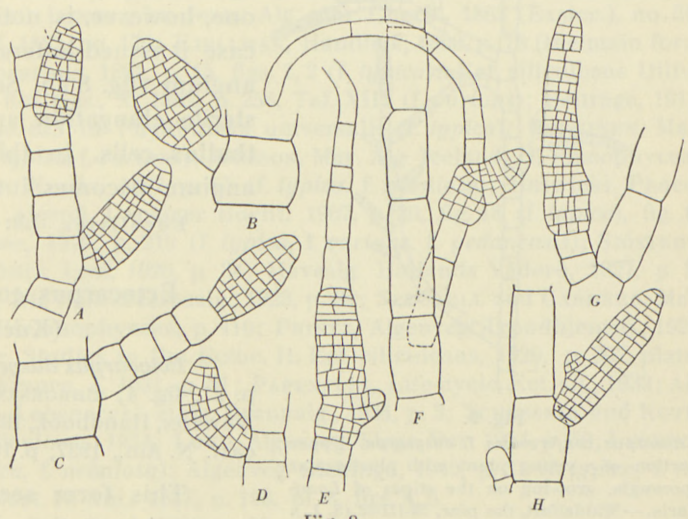


Fig. 8.
Ectocarpus confervoides f. *arcta*. *A—F:* plurilocular sporangia from the basal part of the plant, *G* and *H* from the upper portion of the plant. In *F* the plurilocular sporangium possesses a lateral, hairlike elongation. — Rosenvold, Vejle Fjord, 24-IX-36 (S. L.). — × 284.

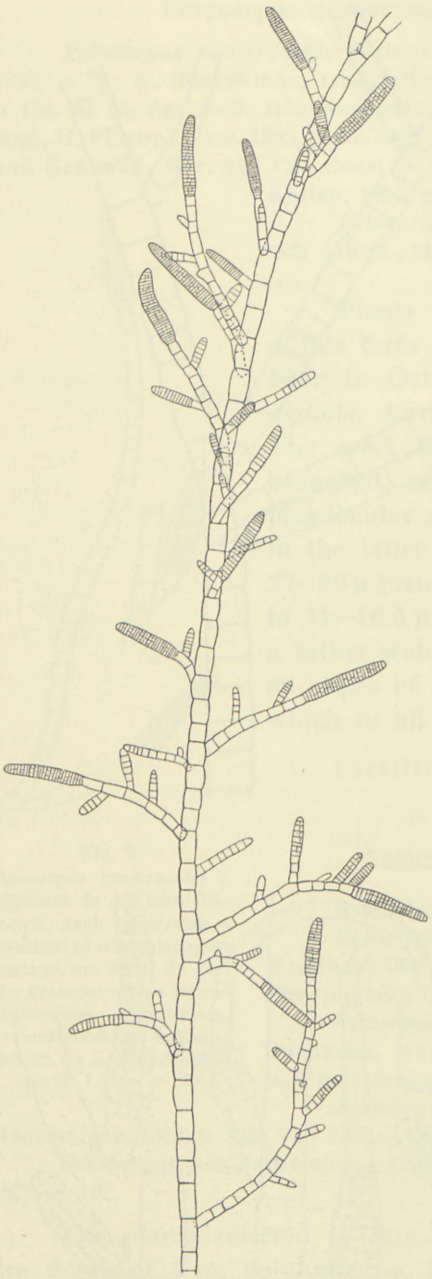


Fig. 9.
Ectocarpus confervoides f. *dasycarpa*. Upper portion of a young plant with plurilocular sporangia, growing on the stipes of *Laminaria*. — Middelfart, the pier, 24-III-33 (S. L.). — × 115.

terminate in a hairlike tip, the diameter of which on an average being considerably smaller than in the lower parts of the branches.

Plurilocular sporangia were found in abundance. In the basal portion of the plants the great majority were short ovoid (not rarely obliquely ovoid)—long ovoid or oval. They were usually sessile (fig. 8 A, D), more rarely short-stalked (fig. 8 B). In some cases they were terminal on a branchlet (fig. 8 C). The length generally measures 60—70 μ (—80 μ), the diameter (21—) 25—29 μ. Occasionally they issued directly from the main filaments or from rhizoids occurring on the latter.

In the upper parts of the plant the plurilocular sporangia on an average seem to increase in length (fig. 8 H), and gradually a type is reached like that shown in fig. 8 G. Here, too, however, are found a great number of plurilocular sporangia of the appearance of those in the basal portion of the plant. The length of the long plurilocular sporangia in the upper portion of the plants not infrequently exceeds 100 μ (the greatest observed 165 μ), while the diameter measures well over 20 μ (up to 29 μ).

A sterile, hairlike elongation is usually absent at the tip of the plurilocular sporangia. Such a one, however, is noticed in a few cases. In a single case it issued latterally from the plurilocular sporangium (fig. 8 F). Sometimes the basal cells of a sterile elongation are not hairlike, but ordinary thallus cells. In this way the plurilocular sporangium becomes intercalary (fig. 8 E).

Localities. **Lb:** Rosenvold, Vejle Fjord (S. L.).

Ectocarpus confervoides f. dasycarpa (Kuck.) nov. comb.

Ectocarpus dasycarpus Kuckuck, Ectocarpus, 1891, p. 21, fig. 4; Børgesen, Mar. Alg. Færöes, 1902, p. 409; Newton, Handbook, 1931, p. 121; Taylor, Mar. Alg. northeast. N. Am., 1937, p. 107.

This form seems to be rare in the Danish waters. As mentioned p. 18 it has been found a few

times only in these waters. The plants from the northern Kattegat (the buoy of Skagen Reef, May) consist of tufts about 2.5 cm in height. The main filaments are 49—60 μ in diameter; here and there, particularly in the basal portion, they bear rhizoids. In each cell several thin, ribbon-shaped, branched chromatophores are found. The plurilocular sporangia are very frequently terminal, on short or long branches. The great majority are cylindrical, having a strong resemblance to KUCKUCK's figure, both regarding shape and position. The plurilocular sporangia measure 53—205 μ in length by 12—23 μ in diameter (usually about 17 μ). Several plurilocular sporangia, however, seem to form a transition to f. *typica*, being closely allied to the confervoides type.

The plants from the Little Belt were still young. They were collected in March; they formed small tufts on the stipes of *Laminaria*. The diameter of the main filaments was but 21—28 μ. In each cell several thin, ribbon-shaped chromatophores are found, arranged in a very steep screw or longitudinally. The plurilocular sporangia are generally cylindrical, usually stalked (short or long-stalked). Some of them, however, have a certain resemblance to the confervoides type. The length amounts to 57—110 μ, the diameter to 16—17 μ (—21 μ). The resemblance to KUCKUCK's figure appears from fig. 9. In these plants, too, almost all the tips of the branches are transformed, or on the point of being transformed, into plurilocular sporangia. Unilocular sporangia have been noticed neither in these plants nor in the preceding.

Localities. **Kn:** The buoy of Skagen Reef (C. H. O.). — **Lb:** Middelfart (S. L.).

Ectocarpus confervoides f. siliculosa (Dillw.) Kjellm.

incl. f. *spalatina* (Kütz.) Kjellm. ad part.

KJELLMAN, Skand. Ectocarp. och Tilopt., 1872, p. 73.

Ectocarpus siliculosus (HUDS.) LYNGB.; LE JOLIS, Alg. mar. Cherb., 1863 (Exsicc.), no. 51; ARESCHOUG, Alg. scand. exsicc., IV, 1862, no. 176; KJELLMAN, Handbok, 1890, p. 78 (the main form and f. *nebulosa*); KUCKUCK, Ectocarpus, 1891, p. 15, figs. 1, 2 (f. *typica*); Ect. siliculosus Dillw. sp. forma varians . . ., Ber. Deut. Bot. Ges., X, 1892, p. 256, Taf. XIII (f. *varians*); Beiträge, 1912, p. 155, Taf. VIII, fig. 1; Exsicc. no. 623 in Phykotheka universalis (f. *typica*); BØRGESEN, Mar. Alg. Færöes, 1902, p. 404 fig. 68 (f. *typica*, f. *varians*); JÓNSSON, Mar. Alg. Iceland, II, Phæophyceæ, 1903, p. 157; KYLIN, Algenfl. schw. Westk., 1907, p. 55 (f. *typica*, f. *nebulosa*); Entwickl. Phaeophyceen, 1933, p. 16; LAKOWITZ, Algenfl. Danziger Bucht, 1907, p. 29, fig. 18 (f. *typica*), fig. 19 (f. *gedanensis*); Algenfl. ges. Ostsee, 1929, p. 219 (f. *typica*, f. *varians*, f. *gedanensis*); SJÖSTEDT, Algol. stud. Skånes södra och östra kust, 1920, p. 24; Havsalg. Hallands Väderö, 1927, p. 14 (f. *typica*, f. *nebulosa*); VAN GOOR, Die holl. Meeresalg., 1923, p. 84; SETCHELL and GARDNER, Mar. Alg. Pac. Coast N. Am., 1925, III, Melanophyceae, p. 410; PRINTZ, Algenveg. Trondhjemsfj., 1926, p. 154, Taf. VI, fig. 62(?); KNIGHT, Studies in the Ectoc. II. Ect. siliculosus, 1929, p. 307, plates I—VI; HAMEL, Phéophycées de France, I, 1931, p. 21; PAPENFUSS, Life-cycle Ect. sil., 1933; Alt. Generations Ect. sil., 1935; FØYN, Lebenscykl. einig. Braunalg., 1934, p. 3; SCHUSSNIG and KOTHBAUER, Phasenwechsel v. Ect. siliculosus, 1934; LUND, Algenveg. Stege Nor, 1934, p. 30; LEVRING, Algenfl. Kullen, 1935, p. 22 (f. *typica*, f. *nebulosa*); Algenveg. Blekinge, 1940, p. 31 (f. *typica*, f. *nebulosa*); TAYLOR, Mar. Alg. northeast. N. Am., 1937, p. 108, pl. 8, figs. 4, 5.

Conferva siliculosa Dillwyn, Brit. Conf., 1809, p. 69.

Very common in the Danish waters from the North Sea to the Baltic. It generally occurs abundantly; in the spring, specially, large, loose, tawny masses are found. It is, however, in all probability originally attached, and it is met with in that state as an epiphyte on various algae (*Fucus*, *Halidrys*, *Laminaria*, *Chorda filum*, *Furcellaria*, *Polysiphonia*, etc.) and *Zostera*. The tufts reach a height of over 30 cm. It occurs, in addition, on wood, stones, and shells. The colour is generally lighter than in f. *typica*, usually yellowish to yellowish-brown (in certain cases, however, the colour of dried specimens is green). Recorded from the littoral region down to considerable depths. Thus in the North Sea it has been noticed at a depth of up to about 38 m, while in the Little Belt it inhabits the great depth of 35—44 m. In contradistinction to f. *typica* it does not seem to be so full grown nor so common in the littoral region as in water somewhat deeper (2—20 m). Even in the maximum depth in the Little Belt it was represented by well grown specimens with long, cylindrical plurilocular sporangia in abundance.

The plurilocular sporangia are short-stalked or sessile. Sometimes they come out from rhizoids. They are very variable as to shape, size, and the presence of a hairlike elongation. They are usually subulate, sometimes slightly oblong conical; in other cases they are cylindrical. The length is extremely varied, from less than 100 μ up to 450 μ, presumably it generally measures 150—250 μ. The diameter ranges from 10 to 25 μ; usually, however, amounting to about 20 μ (15—25 μ). In some specimens a hairlike elongation is present in almost all of the plurilocular sporangia; in other plants it is found in a few cases only. Again, in other specimens plurilocular sporangia, having or not having a hairlike elongation, occur promiscuously.

In some plants collected in deep water in the North Sea, about 38 m, the plurilocular sporangia were rather small and slender. The diameter was about 12 μ only. They were usually subulate, generally lacking the hairlike elongation. These plants seem to recall the form from deeper water mentioned by Kuckuck (1891, p. 17).

Now and then short, intercalary plurilocular sporangia are met with. In several cases, however, they have arisen by the method that certain short sections of plurilocular sporangia have remained sterile (cp. Kuckuck l. c. p. 17).

The plurilocular sporangia have been noticed from March to September.

The unilocular sporangia are either sessile or stalked (fig. 10 *D*, *G*, *H*). Usually they are 40—50 μ (—57 μ) in length by 20—30 μ in diameter. Sometimes the length may be less than 30 μ as the diameter may not surpass 20 μ. They generally are found in the same plants which possess plurilocular sporangia.

In some cases, however, plants have been found bearing unilocular sporangia exclusively. The majority of these plants, originating from March, April, and July, agree with f. *siliculosa* regarding the unilocular sporangia as well as the vegetative parts of the plant, hence they have been referred to this form. A few, however, differred slightly regarding the vegetative parts, possessing here and there peculiar barrel-shaped cells while typical in other respects. In fig. 10 I have pictured some of these plants, which were collected in the month of April, inhabiting *Laminaria*

as epiphytes, in the southern Kattegat (Lysegrunden). Plants quite consistent with these are, for the matter, collected in Vejle Fjord in the Little Belt, too, inhabiting *Laminaria* as well and collected in April as well.

The unilocular sporangia have been recorded from March to September. They seem, however, to be the more frequent in spring and early summer (see table 3).

At Isle of Man KNIGHT (1929 p. 312) found that the unilocular sporangia occurred partly in very small plants at a very early date of the period of growth, partly at the end of the period of growth on old plants.

The unilocular sporangia evidently are more frequent in the Danish waters than at the Swedish west coast, where according to KYLIN (1933 p. 19) they are said to be very rare. It appears from the table that they have been stated in about 1/4 of the localities, 107 in all, from which originates the material examined. Even if the form group of *E. confervoides* is considered in a more restricted sense (this species, in the Danish waters, consists of, as appears from the statement above, chiefly the main form, f. *typica*, f. *siliculosa*, and f. *hiemalis*[1]) it appears that unilocular sporangia are found in plants from about 1/4 of the localities.

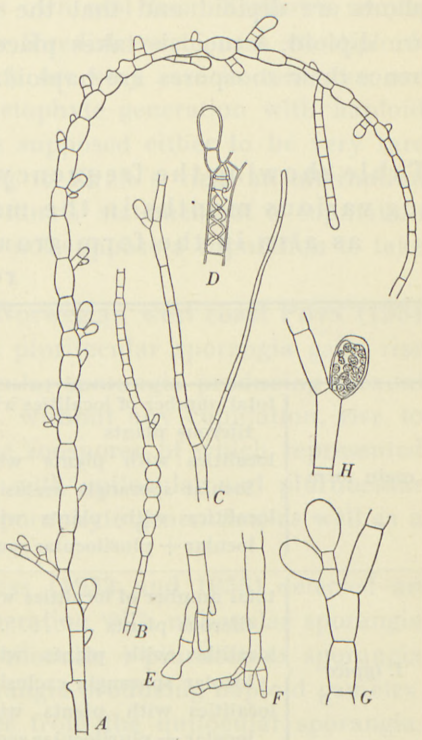


Fig. 10.
Ectocarpus confervoides f. *siliculosa*. Specimens with unilocular sporangia, growing on *Laminaria digitata*. *A*, *B*: main filaments showing barrel-shaped cells. *C*: upper part of a filament with the apex of a shoot to the right. *E*, *F*: the basal portion of main filaments. *D*: vegetative cell with chromatophores and a stalked unilocular sporangium. *H*, *G*: unilocular sporangia. In *H* differentiated spores are seen. — Lysegrunden in Kattegat, 6 m, 18-IV-94. — *A*—*C*: × 95; *D*—*H*: × 198.

The table, moreover, shows the occurrence of unilocular sporangia in this form group during the various months. Within the period April—September the unilocular sporangia occurred as follows: in April in 45.5 %, in May in 32 %, in June in 33.3 %, in July in 29.1 %, in August in 15.6 %, and in September in 6.9 % of the localities, from which fructiferous plants are at hand. Hence the frequency is the greatest during the period: April—June.

In addition to plants with plurilocular sporangia exclusively, unilocular sporangia exclusively, and unilocular + plurilocular sporangia sterile plants are frequent met with in the Danish waters. Such plants, which have been referred to this form owing to the accordance with f. *siliculosa* regarding the vegetative parts, were collected in the months of May—September as also in December.

[1] F. *pygmaea*, f. *arcta*, and f. *dasycarpa* are not taken into account, scarce material only being at disposal. Nor is f. *penicillata* which is peripheral in the form group.

As to the problem of an alternation of generations f. *siliculosa* seems to behave differently in different localities. At Isle of Man Knight (1929) found that the plants are diploid and that the zoospores produced in the plurilocular sporangia are diploid. A meiosis takes place in the unilocular sporangia being the more rare; hence their zoospores are haploid. These zoospores are gametes which copulate form-

Table 3.

Table showing the frequency of occurrence of unilocular sporangia during various months in the main form, f. *typica*, f. *siliculosa* and f. *hiemalis* as also in the form group of *Ectocarpus confervoides* in a more restricted sense.[1]

		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.	Total
main form	total number of localities with fructiferous plants	1	..	..	2	6	9	39	19	14	3	1	1	95
	localities with plants with unilocular sporangia exclusively	..	..	..	..	..	..	..	..	..	..	..	..	..
	localities with plants with unilocular + plurilocular sporangia	..	..	..	1	1	4	18	3	1	..	..	..	28
f. *typica*	total number of localities with fructiferous plants	..	..	..	1	3	3	15	8	4	2	1	..	37
	localities with plants with unilocular sporangia exclusively	..	..	..	..	..	..	..	..	..	..	..	..	..
	localities with plants with unilocular + plurilocular sporangia	..	..	..	..	2	..	4	1	..	..	..	..	7
f. *siliculosa*	total number of localities with fructiferous plants	..	..	1	6	15	14	43	18	10	..	..	..	107
	localities with plants with unilocular sporangia exclusively	..	..	1	2	..	..	2	..	..	..	..	..	5
	localities with plants with unilocular + plurilocular sporangia	..	..	..	2	5	5	6	3	1	..	..	..	22
f. *hiemalis*	total number of localities with fructiferous plants	..	..	1	2	1	1	6	..	1	..	..	..	12
	specimens with unilocular sporangia not noticed	..	..	..	..	..	..	..	..	..	..	..	..	..
main form + f. *typica* + f. *siliculosa* + f. *hiemalis*	total number of localities with fructiferous plants	1	..	2	11	25	27	103	45	29	5	2	1	251
	localities with plants with unilocular sporangia exclusively	..	..	1	2	..	..	2	..	..	..	..	..	5
	localities with plants with unilocular + plurilocular sporangia	..	..	..	3	8	9	28	7	2	..	..	..	57

[1] As to the number of localities it is to be noticed that some localities have been entered more than once. Thus, if from a given locality material exists, collected at different times of the year or in different years, the locality has been entered each time.

ing a diploid zygote developing into a diploid plant. Hence the haploid phase is confined to the mitoses in the unilocular sporangium and the sequent stage of swarming.

Judging from germination experiments of his own and from KNIGHT's results KYLIN (1933, p. 19) presumes that the plants at the Swedish west coast are diploid. The zoospores from the unilocular sporangia, which are very rare in this area, are haploid; they are supposed to develop into a gametophyte generation with haploid plurilocular sporangia. This generation, however, is supposed either to be very rare or perhaps not capable at all of living. According to KYLIN's view an alternation of generations does not exist any more. As to KNIGHT's statement of a copulation of zoospores from unilocular sporangia KYLIN does not suppose a copulation to take place between these zoospores.

In cultivation experiments at Herdla on the Norwegian west coast FØYN (1934 p. 6) found that zoospores from plants having but plurilocular sporangia gave rise without any copulation to new plants with plurilocular sporangia producing asexual spores. Zoospores from unilocular sporangia gave, without any copulation, rise to new plants with haploid plurilocular sporangia, the zoospores of which represented gametes copulating, thus producing asexual plants with unilocular and plurilocular sporangia. Consequently in the region of Herdla a sporophyte generation as well as a gametophyte generation are present.

At Penikese Island at Woods Hole PAPENFUSS (1933 and 1935) detected an alternation of generations between a sporophyte generation with unilocular sporangia exclusively, plurilocular sporangia exclusively, or unilocular + plurilocular sporangia and a gametophyte generation with plurilocular sporangia producing haploid gametes. The gametophytes arise directly from the zoospores from the unilocular sporangia, in which meiosis takes place. The gametophyte generation was smaller than the sporophyte generation; it seems to be bound to *Chordaria* as a host plant.

At Naples, too, are evidently occurring both a gametophyte generation with plurilocular sporangia producing haploid gametes and a sporophyte generation with unilocular + plurilocular sporangia (FØYN 1934, p. 4; SCHUSSNIG and KOTHBAUER 1934 p. 90). The sporophyte generation has been found during winter being represented by diminutive plants (SCHUSSNIG and KOTHBAUER).

At Rovigno circumstances seem to be like those at Isle of Man. According to SCHUSSNIG and KOTHBAUER (l. c. p. 87) the plants at this place are diploid. The haploid phase is confined to the divisions of the unilocular sporangium and the swarming stage following, the zoospores from the unilocular sporangia being gametes which copulate.

Localities. **Ns:** Esbjerg harbour, f. *siliculosa* ⇄ f. *penicillata*; aG, Thyborøn beacon S. E. $^1/_2$ E. 19.5 miles, 37.6 m; aF, Thyborøn beacon S. E. $^1/_2$ E. $14^1/_2$ miles, 31 m; aE, Lodbjerg lighthouse S. by W. $^1/_2$ W. $7^1/_3$ miles. — **Lf:** Sallingsund (H. E. P.); Ørodde (H. E. P.); beneath Lisehøj, the northern side of Fur; Aalborg; Hals, the pier (F. B.). — **Kn:** Læsø Trindel (F. B.); TQ, near Læsø Trindel lightship; TP, Tønneberg Banke, the Trindel lightship S. S. W. $^1/_2$ W. $2^1/_2$ miles; Herthas Flak, 20 m; east of Skagen harbour, off the lazaret; Skagen harbour; Hulsig Stene; near the broom north of Græsholm; between

Borrebjerg's and Maren's Reef; Borrebjerg's Reef; Busserev; Frederikshavn harbour, f. *siliculosa* ⇄ f. *penicillata*; VU, Nordre Rønner lighthouse S. by W. 3/4 W. 2 1/2 miles; VT, Nordre Rønner lighthouse S. hardly 2 1/2 miles; west of Nordre Rønner, south of the double broom; near the double broom west of Nordre Rønner; ZP, the broom near Nordre Rønner S. 1/2 E. 1 mile; north-west of Læsø. — **Ke:** Fladen lightship S. by E. well over 1 mile; IO, Fladen; VY, Fladen, the balloon S. by E. 1/2 E. 2/3 mile; IQ, Fladen 20—30 m; ET, Lille Middelgrund; EQ, at the balloon on Anholt Knob; Gilleleje (Lyngbye). — **Km:** VQ, Svitringen; XC, the double broom on Anholt N. W. Reef S. S. E. 1/2 E. 11 miles; FN, Fornæs lighthouse S. 1/2 W. hardly 14 miles; BH, off Gjerrild Klint. — **Ks:** OP, Lysegrunden near the 7′ knoll; Havknudeflak; MZ, Hjelm lighthouse S. by E. 2 miles; RL, the double broom of Ostindiefarergrund S. E. by E. 2 1/2 miles; Grønne Revle; Lammefjord. — **Sa:** MY, Sletterhage lighthouse N. W. by N. 3 3/4 miles; FT, Klepperne, just within the double broom; the east side of Vejrø; AS, the west side of Meilgrund; the east side of Hesbjerg Grund; GB, wood at the east point of Endelave N. E. by N. 1/2 N., the north point of Æbelø W. 1/4 N.; AZ, south of Hjarnø; AY, As Hoved; AH, Lillegrund, at the balloon; AH[1], Lillegrund; gU, the eastern side of Lillegrund; Paludans Flak; MG, south of Paludans Flak, Vestborg lighthouse N. 1/2 E. 4 miles; "Kattegat at Hofmansgave" and "At the shore of Hofmansgave" (Caroline Rosenberg); Hofmansgave and Hals Gab (Hofm. B.); GE, 1 mile N. E. by N. of Sejrø lighthouse. — **Lb:** between Rosenvold and Fakkegrav, Vejle Fjord, on *Laminaria* (S. L.); Stenhøj at Rosenvold, Vejle Fjord (S. L.); FZ, Kasserodde, the northern edge of the reef near the broom; cV, Røgle Klint S. by W.; cX, between Strib and Nederballe, 35—44 m; Middelfart (C. Rasch, F. B.); Fænø Kalv; Fænø Sund (C. G. Johs. Petersen); near Stenderup; near the broom at Thorø Reef; Helnæsbugt; LF, Vodrups Flak. — — **Sf:** Dyreborg; UX, Skjoldnæs lighthouse S. 3/4 W. 3/4 mile; Svendborg harbour and the adjacent part of Svendborgsund. — **Sb:** Off Refsnæs (C. H. Ostenfeld); MN, north of Asnæs; just within the broom at Asnæs Reef; LK, Elefantgrunden; Kjerteminde, on the dorsal fins of *Gasterosteus aculeatus*; AA, Sprogø lighthouse S. E. 5 1/6 miles, 23—26 m; between Slipshavn and Knudshoved; Palegrund; Vresen (Ove Paulsen); UF, at Hov Sand, the northern point of Langeland S. W. by W. 2/3 W. 2 1/2 miles; UK, abeam Tranekjær lighthouse 1 1/2 mile; DP, north of Onsevig. — **Sm:** Venegrund, within the balloon; Stege Nor (S. L.). — **Su:** off Ellekilde; Hellebæk (F. B., L. K. R.); Blokhusgrund (Boye P.); the stone embankment at Kronborg; Helsingør (C. Rasch); PZ, east of Hveen; RZ, Lous Flak; København; west of Saltholm, N. N. W. of Lusekosten (S. L.); QE, Nordre Røse; SA, Flinterenden. — **Bw:** bZ, at the balloon south of Sønderborg; cE, Middelgrund south of Als; dK, Pøls Reef, near the bell-buoy; LC, south of the balloon at Gulstav; Schönheyders Pulle, west of the broom. — **Bm:** QR, Gyldenløves Flak, the double broom at Hollændergrund W. 1/4 N. 2 1/2 miles; QY, Bjelkes Flak; E. by N. of Møen lighthouse 20 miles (C. A. J.). — **Bb:** S. E. 3/4 S. of Adler Grund lightship 7 miles, 20 m (C. A. J.); S. by E. of Rønne harbour 8 miles (C. A. J.); Rønne harbour (C. A. J.); S. S. E. of Nexø harbour 3 miles, 21 m (C. A. J).

Ectocarpus confervoides f. hiemalis (Crouan) Kjellm.

incl. f. *spalatina* (Kütz.) Kjellm. ad part.

Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 83.

Ectocarpus hiemalis Crouan, Alg. mar. Finistère, 1852 (Exsicc.), no. 26 (sine descriptione); Le Jolis, Liste Alg. mar. Cherb., 1863, p. 76; Alg. mar. Cherb., 1863, (Exsicc.), no. 109; Kjellman, Handbok, 1890, p. 78; Kylin, Algenfl. schw. Westk., 1907, p. 56; Printz, Algenveg. Trondhjemsfj., 1926, p. 154.

Ectocarpus siliculosus f. *hiemalis* Kuckuck, Ectocarpus, 1891, p. 17; Hamel, Phéophycées de France, I, 1931, p. 22; Taylor, Mar. Alg. northeast. N. Am. 1937, p. 108.

Ectocarpus siliculosus Lyngbye, Tent. Hydroph. Dan., 1819, Tab. 43 C, figs. 1, 3 (f. *siliculosa* → f. *hiemalis*).

Ectocarpus littoralis Areschoug, Alg. scand. exsicc., V, 1864, no. 220.

This form seems rather widely distributed in the Danish waters, although it is not plentiful. It partly inhabits other algae (e. g. *Fucus vesiculosus, Codium fragile*), partly wood, where it forms tufts up to 6 cm high, which when dried are a greenish-brownish colour. It is emphasised by KYLIN that the dark olive green colour is characteristic. According to my experience it is not, however, quite correct to attach too great importance to the colour of dried specimens, since in *Ectocarpus* it often depends on the rate of the drying procedure. It is usually found in shallow water, less frequently in deep water (down to about 20 m). The plurilocular sporangia are very variable respecting shape as well as size and position.

In the majority of the plants collected in shallow water the plurilocular sporangia are stalked, conical—oblong conical, the hairlike elongation being present or absent; generally they are not very long (usually 200—300 μ in length by 25—30 μ in diameter). Plants like these, on the whole, seem to be closely allied to ARESCHOUG's Exsicc. no. 220. In some specimens from the littoral region being distinguished for instance for a greenish, yellowish greenish colour, the plurilocular sporangia from the upper portion of the plant were conical, often rather long, lacking the hairlike elongation; the length usually was 150—250 μ (—300 μ), while the diameter was 30—40 μ (—53 μ). The plurilocular sporangia from the basal portion of these plants, on the other hand, belonged to the confervoides type (cp. p. 16).

A plant from the littoral region in Flensborg Fjord in the western Baltic showed great variation as to the shape and size of the plurilocular sporangia. In the basal part of the plant the plurilocular sporangia usually belonged to the confervoides type; in the upper portion they were generally coarsely subulate, sessile, 225—470 μ in length by 23—29 μ in diameter, the hairlike elongation almost always present (rather much resembling siliculosus plurilocular sporangia "on a large scale"). In the upper portion of this plant, however, several plurilocular sporangia of the confervoides type were found, too, or transitional forms to it.

In some plants from Rosenvold in Vejle Fjord from the depth of 2 m numerous of the plurilocular sporangia were sessile, others were borne on a stalk, both types in the basal portion fairly thick; the length measured 150—400 μ, the diameter usually 30—35 μ (20—40 μ). A hairlike elongation was present in a few cases only. These plants seem to be an intermediate form between f. *hiemalis* and f. *spalatina*.

Plants from deep water are particularly distinguished for long plurilocular sporangia, not very thick. The length of the latter usually amounts to 300—400 μ (—550 μ), the diameter to 20—25 μ (—30 μ). The majority of the plurilocular sporangia are borne on a stalk, the hairlike elongation is present or absent; they have resemblance to CROUAN's Exsicc. no. 26. In some plants several plurilocular sporangia, however, are sessile, the hairlike elongation usually present. The last-mentioned plants evidently form a transition to f. *siliculosa*.

The plurilocular sporangia have been noticed in the months from March to July, and in September. Unilocular sporangia have not been seen.

Localities: **Ns:** Hanstholm, the pier. — **Lf:** Thisted harbour, on *Codium fragile* (S. L.); Nykøbing, on *Fucus* (F. B.); Hals, the pier (F. B.). — **Kn:** Herthas Flak; Skagen harbour, the outer side; Frederikshavn harbour. — **Km:** Alsodde at Mariager Fjord, the pier. — **Lb:** Rosenvold, Vejle Fjord (S. L.). — **Sf:** Rudkøbing, on wood. — **Su:** Middelgrundsfortet. — **Bw:** Sønderhav at Flensborg Fjord, the pier.

Ectocarpus confervoides f. penicillata (C. A. Ag.) Kjellm.

Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 80.

Ectocarpus penicillatus (C. A. Ag.) Kjellman, Handbok 1890, p. 76; Kuckuck, Ectocarpus, 1891, p. 22, fig. 5; Kylin, Algenfl. schw. Westk., 1907, p. 54; Sjöstedt, Algol. stud. Skånes södra och östra kust, 1920, p. 24; Havsalg. Hallands Väderö, 1927, p. 14; Printz, Algenveg. Trondhjemsfj., 1926, p. 153; Newton, Handbook, 1931, p. 121; Levring, Algenfl. Kullen, 1935, p. 21; Algenveg. Blekinge, 1940, p. 30; Taylor, Mar. Alg. northeast. N. Am., 1937, p. 110.

Ectocarpus siliculosus f. *penicillatus* C. A. Agardh, Systema Alg., 1824, p. 162.

Ectocarpus fasciculatus Griff. var. Areschoug, Alg. scand. exsicc., II—III, 1862, no. 115.

Ectocarpus littoralis Areschoug, Alg. scand. exsicc., IV, 1862, no. 175.

It seems to be common in the Danish waters as far as to the entrance of the Baltic (from the Baltic, too, a small specimen exists (Bb, Allinge), which is possibly to be referred to this species), although it is not so abundant as f. *typica* and f. *siliculosa*. It preferably inhabits the littoral region, often in exposed places. It has, indeed, been met with at a depth of down to well over 6 m. It forms tufts up to about 10 cm high (usually they are, however, not more than about 4—5 cm) on various algae, preferably *Chordaria flagelliformis*; further in addition on *Scytosiphon*, *Fucus vesiculosus*, *Chorda filum*, and others. Finally it is met with, too, on wood and stones. The colour, in dried specimens, is greenish-brownish.

The appearance of the branch fascicles seems to be dependent on the exposition of the place; in greatly exposed places they are denser and more marked than in protected places, where the formation of fascicles is less pronounced, even if the branching is always rather dense. In the former case the form approaches *Ectocarpus fasciculatus*, sometimes to the degree that a distinction may cause difficulties, particularly since plants like these frequently possess marked main filaments. Specimens inhabiting *Chordaria flagelliformis* usually have rather marked branch fascicles (cp. Areschoug, Exsicc. no. 115). On the other hand, if the formation of the fascicles is less marked the form approaches f. *siliculosa*.

The ramification of the fascicles is often largely unilateral. Similarly the plurilocular as well as the unilocular sporangia often come out unilaterally.

The plurilocular sporangia are usually short-stalked, less frequently sessile or long-stalked. They are rather variable regarding shape as well as size. Generally they are oblong-conical, but all transitional forms from a short, thick confervoides type to some nearly siliculosus-shaped seem to exist. The confervoides type appears particularly in the basal portion of the plants as also in young plants. A hairlike elongation is not generally present, it is, however, observed in several cases. Sometimes intercalary plurilocular sporangia are found in the hairlike tip of the

branches. The length of the plurilocular sporangia usually measures between 75 and 150 μ, the diameter between 20 and 30 μ (the extremes as to the diameter: 17 and 36 μ). They have been found in the months from April to November.

Unilocular sporangia are found in the same plants, which bear plurilocular sporangia. They have been observed in the months of May, June, August and September; they have been recorded from one fourth of the localities from which the material examined originates. They as also plurilocular sporangia may occur side by side (fig. 11), and they may even occur on the same stalk as these. The point of insertion of the unilocular sporangia is not always at the base; it is often placed a little farther up on one side. In some cases one unilocular sporangium may be inserted on the other. The length of the unilocular sporangia generally amounts to 40—60 μ, the diameter to 25—40 μ.

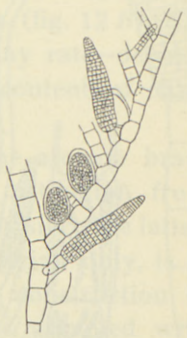


Fig. 11. *Ectocarpus confervoides* f. *penicillata*. Branches from a branch fascicle showing unilocular and plurilocular sporangia. Two of the plurilocular sporangia are evacuated, the other two show differentiated spores. — Knudshoved near Nyborg 8-VI-22.— ×115.

Localities. **Ns:** Esbjerg harbour; Sydhalen at Thyborøn; Harboøre, on a groyne. — **Lf:** Nykøbing (Th. M., F. B.); ad Hals (in herb. Liebman). — **Kn:** Strandby; Busserev; Frederikshavn harbour; BP, abeam Sæby; Jegens Reef north of Læsø; GM, Engelskmands Banke north of Læsø; Lundbæk harbour, Læsø. — **Km:** Anholt harbour. — **Ke:** Gilleleje (L. K. R., S. L.). — **Sa:** Ballen harbour; Endelave, the pier-head (S. L.). — **Lb:** Fredericia; the pillars of the Little Belt Bridge (S. L.); Bøjgden. — **Sb:** Korsør; Knudshoved at Nyborg Fjord; Vresen. — **Su:** the stone embankment at Kronborg; Helsingør (S. L.); Rungsted harbour (S. L.); the lightbuoy "Drogden 2", Drogden (S. L.). — **Bb:** Allinge (?).

2. **Ectocarpus fasciculatus** (Griff.) Harvey.

Harvey, Manual, 1. Ed., 1841, p. 40 (not seen); Phycol. Brit., III, 1851, pl. 273; Kützing, Tab. phycol., V, 1855, tab. 50, fig. 2; Crouan, Alg. mar. Finistère, 1852 (Exsicc.), no. 23; Areschoug, Alg. scand. exsicc., II—III, 1862, no. 114; Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 89; Handbok, 1890, p. 76; Farlow, Mar. Alg. N. Engl., 1881, p. 72; Hauck, Meeresalgen, 1885, p. 332; Foslie, Remarks Ectocarpus and Pylaiella, 1891, p. 127; Sauvageau, Alg. phéosporées parasites, 1892, p. 37, Pl. IV, figs. 30—35; Børgesen, Mar. Alg. Færöes, 1902, p. 409, figs. 70 (var. *refracta*) and 71; Jónsson, Mar. Alg. Iceland, II, Phæophyceæ, 1903, p. 157; Kylin, Algenfl. schw. Westk., 1907, p. 53; van Goor, Die holländischen Meeresalgen, 1923, p. 87; Printz, Algenveg. Trondhjemsfj., 1926, p. 155; Knight and Parke, Manx Algae, 1931, p. 62, pl. XI, figs. 23, 25 (var. *typica*), pl. VIII, figs. 5, 6 (var. *refracta*); Newton, Handbook, 1931, p. 121; Hamel, Phéophycées de France, I, 1931, p. 25, fig. 5, 1; Hygen and Jorde, Algenfl. norw. Westk., 1935, p. 17; Feldmann, Alg. Mar. Albères, 1937, p. 104, fig. 35 A, B; Taylor, Mar. Alg. northeast. N. Am., 1937, p. 110; Suneson, Ect. fasc. on the finspines of fishes, 1939, p. 53, figs. 1—3.

Ectocarpus pycnocarpus (?) K. Rosenvinge, Grønl. Havalg., 1893, p. 886, fig. 23; Jónsson, Mar. Alg. East Greenland, 1904, p. 37.

This species in Danish waters is mainly confined to the northern part of the west coast of Jutland and to the area of Kattegat. In Kattegat, however, it is noticed but at a few scattered localities, chiefly in the northern part. Moreover, material has been collected in the Thyborøn channel between the North Sea and Limfjorden

as also from a locality in the northernmost part of the Sound. In addition a few small, divergent specimens from the Little Belt are at hand.

It inhabits the littoral region as also the upper part of the sublittoral region, where it has been found down to the depth of 2 m. It generally occurs in highly exposed places. It is of the greatest luxuriance and of the most characteristic appearance in the localities of the coasts of the North Sea and Skagerak, in which places it is, no doubt, more frequent than anywhere else in Danish waters. From Vorupør (the North Sea) and Hirtshals (Skagerak), which both places have been visited several times at different times of the year, a number of typical specimens are at disposal. From the northern Kattegat, too, typical plants have been collected. South of Læsø in the Kattegat, on the other hand, it seems to have affinity in *E. confervoides* f. *penicillata* to the degree that a distinction from this form may cause difficulties.

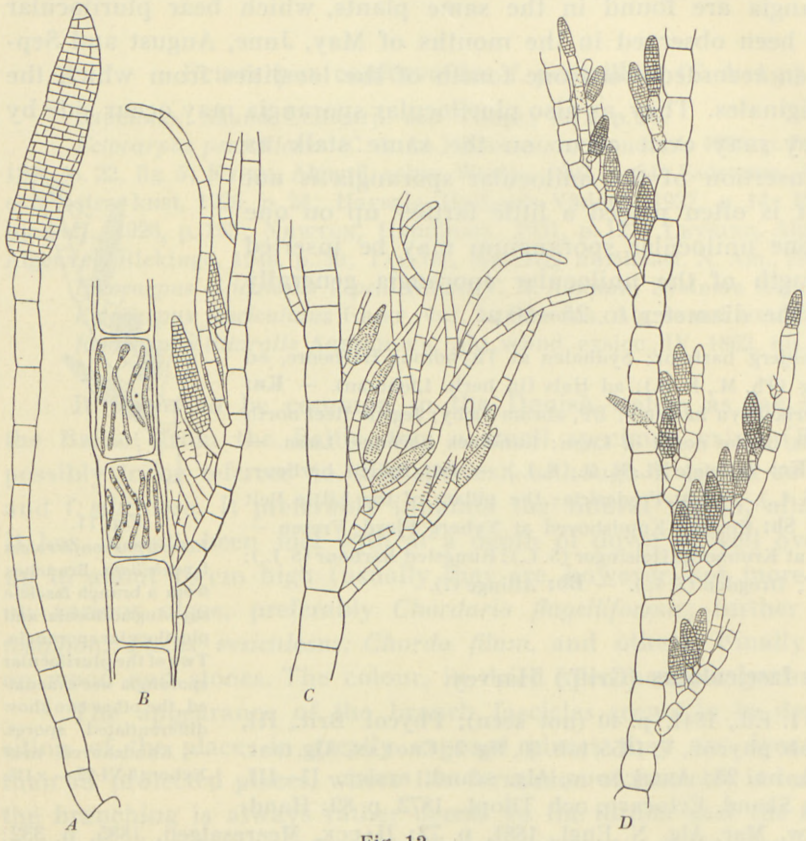


Fig. 12.

Ectocarpus fasciculatus. *A*: thin filament springing from the ground with a terminal sporangium. *B*, *C*: parts of young plants showing main axes with branch fascicles having arcuate branches and plurilocular sporangia. In *B* are seen chromatophores in 2 cells of the main axis. *D*: part of a young divergent specimen without actual branch fascicles. — *A*—*C*: Roshage 8-VIII-02, on *Laminaria digitata*; *D*: the Little Belt Bridge, pillar 4, 7-X-35, on *Laminaria saccharina* (S. L.). — *A*: × 355; *B*: × 260; *C*: × 153; *D*: × 115.

This species forms tufts of the height of 3—7 cm, less frequently up to 10 cm, on various algae, particularly *Laminaria digitata* (and *hyperborea*), further on *Chordaria flagelliformis*, *Chorda filum* and *Chondrus crispus*. In addition it is found on piers and stones. In dried specimens the colour is brownish (olive brown)—dark olive green.

The main axes are predominant; they are often twisted together at the base.

They are generally 30—60 μ in diameter; at the base, however, up to 75 μ. Rhizoids are found in abundance in the basal portion as also where the robust branches issue. The cells are cylindrical or sometimes slightly barrel-shaped, the length being on an average a little greater than the diameter (l = 1—2 × diameter), rarely a little shorter. The chromatophores are ribbon-shaped (fig. 12 *B*), often branched.

The fascicles of branches on an average are very close. The branches to a great extent issue unilaterally, they are usually more or less markedly arcuate or zigzag-shaped (fig. 12 *B, C*; cp. KYLIN l. c.). The basal branch (the oldest) in the fascicles of young plants is specially characteristic in this respect (fig. 12 *B*). The branches in the upper part—having reached a certain length, at any rate—develop into a hairlike tip consisting of somewhat longer cells having scantier contents of chromatophores. The branches are not tapering or only slightly so.

In specimens from the area of the Kattegat south of Læsø the arcuate branches are often lacking, or they are less markedly arcuate. The distinction from *E. confervoides* f. *penicillata* may therefore cause difficulties, particularly since the latter, as mentioned p. 34, often has marked main filaments. As dried material, only, is at disposal from this area, on which it is difficult to recognise the construction of the fascicles of branches, some of these determinations are to be accepted with some reserve.

Fascicles of branches are not differentiated in the lower portion of the plants; there the branches come out scattered, being often recurved. In the upper part of the plant, too, recurved branches are found in certain cases—even in typical plants. The plants in such cases have a certain resemblance to var. *refracta* (KÜTZ.) ARDISSONE (fig. 13).

The plurilocular sporangia are mainly found in the fascicles of the branches, in which place their position is largely unilateral on the upper side of the branches. They are generally short-stalked, less frequently sessile or long-stalked. They vary rather much as to shape and size. Presumably they are, however, generally oblong-ovoid—conical. They are usually 30—125 μ in length by 14—37 μ in diameter (the diameter as a rule 14—25 μ). In a specimen from Vorupør (North Sea), growing on *Chorda*, the majority of the sporangia were generally subulate—oblongconical; the length amounted to 200—225 μ, the diameter to 19—21 μ.

A hairlike elongation is generally absent in the plurilocular sporangia. It is noticed in a few cases, however. A few intercalary plurilocular sporangia are noticed, too (cp. FOSLIE 1891, p. 127, SAUVAGEAU and others). In some cases they occurred in the hairlike tip of the branches.

Plurilocular sporangia are found, besides in the branch fascicles, on the scattered branches as well, directly on the main branches as also on the rhizoids (on the basal rhizoids as well as on the rhizoids up on the main axes). In young plants the position not rarely is terminal on slender, basal filaments springing up between the main axes (fig. 13 *A*). The plurilocular sporangia have been noticed from May untill October. They are generally very numerous.

The unilocular sporangia are found on the same plants which bear plurilocular sporangia, frequently side by side (fig. 13). They are 25—50 μ in length by 25—37 μ in diameter. They may in some cases be inserted obliquely. Now and then

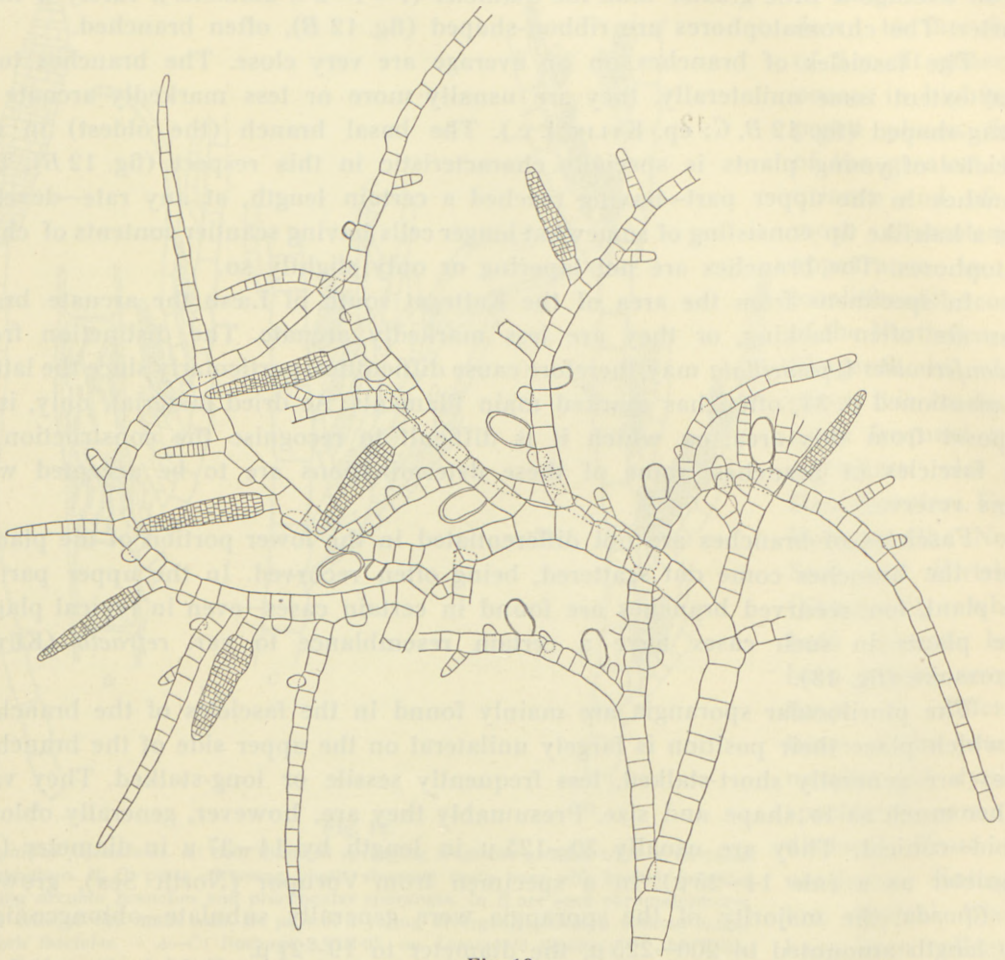


Fig. 13.
Ectocarpus fasciculatus. Part of a plant having affinity in var. *refracta* (Kütz.) Ardissone. The specimen has unilocular as well as plurilocular sporangia. — Vorupør 9-V-29 (S. L.). — × 167.

one unilocular sporangium may be attached to another. The unilocular sporangia are less frequent than the plurilocular. They have been noticed in the months of May, July and August.

It is open to doubt whether some small specimens from a locality in the Little Belt exposed to a strong current are to be included in *E. fasciculatus*. They consist of tufts about $^3/_4$ cm in height, growing on the lamina of *Laminaria saccharina* (fig. 12 *D*). Main axes were distinctly recognisable. The branches issued under a

rather acute angle being somewhat adpressed to the main axes. Actual branch fascicles did not exist. However, a number of the branches—almost all being arcuate like the basal, vigorous branch in the fascicles of young, typical *E. fasciculatus* (cp. fig. 12 *B*)—bore plurilocular sporangia in abundance on the upper side. In some cases, in addition, among the plurilocular sporangia a few branchlets, arcuate or zigzag-shaped, were present, too. I think that these plants, which were collected in October, may be correctly interpreted as young stages of *E. fasciculatus*. As will appear from fig. 12 *D* they also have a certain resemblance to the plant figured by SAUVAGEAU, pl. 4, fig. 34.

Localities. **Ns:** Vorupør (S. L.). — **Sk:** Roshage, 2 m; Hirtshals (L. K. R., F. B.). — **Lf:** Thyborøn channel. — **Kn:** Hirsholmene (L. K. R., Boye Petersen); Deget; Vesterø harbour, Læsø (L. K. R., S. L.). — **Km:** Asaa. — **Sa:** Kolby Kaas. — **Lb:** the Little Belt Bridge, pillar (S. L.). — **Su:** a little north of Julebækshusene.

3. **Ectocarpus draparnaldioides** (Crouan) Kjellm.

KJELLMAN, Skand. Ectocarp. och Tilopt., 1872, p. 87; Handbok, 1890, p. 75; KYLIN, Algenfl. schw. Westk., 1907, p. 53; PRINTZ, Algenveg. Trondhjemsfj., 1926, p. 155; HYGEN and JORDE, Algenfl. norw. Westk., 1935, p. 17; LEVRING, Algenfl. norw. Westk., 1937, p. 43.

Ectocarpus fasciculatus var. *draparnaldioides* CROUAN, Alg. mar. Finistère, 1852 (Exsicc.), no. 24 (sine descriptione); FARLOW, Mar. Alg. N. Engl., 1881, p. 72; KNIGHT and PARKE, Manx Algae, 1931, p. 62, pl. XIX, fig. 80; HAMEL, Phéophycées de France, I, 1931, p. 27, fig. 5, 8.

In the Danish waters this species is found at a few localities only in the northern Kattegat, in which places it formed tufts up to 10—12 cm in height on various algae: *Laminaria saccharina* and *digitata*, *Punctaria*, *Halidrys*. In one of the localities, Vesterø harbour in Læsø, it occurred accompanied by *E. fasciculatus* on *Laminaria*. All the plants collected inhabited the upper part of the sublittoral region. The colour of the dried specimens is olive brown—olive green.

The diameter of the main axes most often amounts to 40—70 μ. In the basal part they often are covered by rhizoids, now and then forming local, continuous belts of cortication. The formation of rhizoids seems to be most frequent in parts from which vigorous branches issue. The main axes in the basal portion are now and then intertwined. The cells on an average are short; the length generally is $^1/_2$—1 (—$1^1/_2$) × the diameter. In the basal portion, however, the length is up to 2 × the diameter. The cells are often slightly barrel-shaped (cp. KYLIN). They contain several ribbon-shaped chromatophores, branched or unbranched, in numerous cases arranged longitudinally in the cells (fig. 14 *B*).

The ramification sometimes takes place in the method that two branches come out from the same cell, not opposite, but side by side (cp. KJELLMAN 1872, p. 88). The phenomenon, consequently, corresponds to that taking place in certain forms of *E. confervoides*, specially f. *penicillata*. In some cases one branch came out below the other one from the same cell. In fig. 14 *A* part of a main axis is pictured in which two branches issue from the same cell side by side.

The branch fascicles usually are very close. The branchlets taper into the subulate tips, the cells of which are somewhat elongated, having the contents of the chromatophores reduced (fig. 14 *C*). Only rarely they seem to be slightly arcuate as in *E. fasciculatus*.

The plurilocular sporangia generally are very numerous. They are often subulate, rarely short or long conical. They usually are 70—130 μ in length by 14—24 μ in diameter.

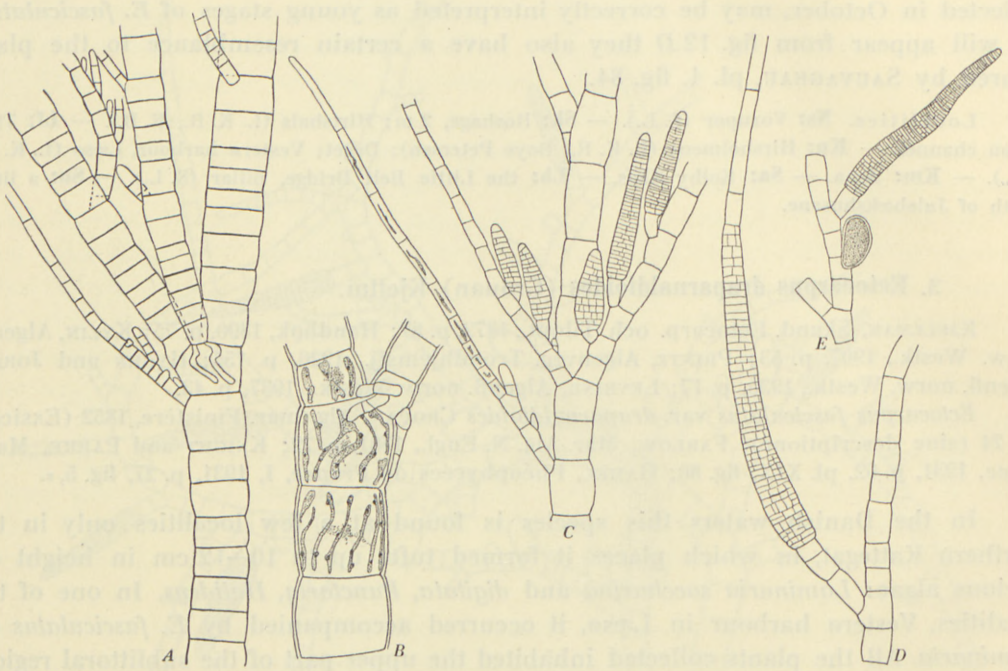


Fig. 14.

Ectocarpus draparnaldioides. *A*: fragment of main axis with 2 branches issuing from the same cell. *B*: fragment of main axis with a branch giving off small rhizoids from the lowermost cell. In the cells the chromatophores are seen. *C*: part of a plant with plurilocular sporangia. In addition a branch is seen, tapering at the tip, which consists of longer cells. *D*: plurilocular sporangium with a hairlike elongation. *E*: branch with a unilocular and a plurilocular sporangium side by side. — *A-C*: west of Busserev near Frederikshavn 28-VII-22, on *Laminaria*; *D*, *E*: Hirsholmene 4-VII-99, on *Punctaria*. — *A*: × 173; *B-D*: × 260. — *B-E*: I. Frederiksen del.

In a single specimen the length did not, however, exceed 43—90 μ and the diameter not 12—16 μ, while in another they generally measured 138—175 μ in length by 16—25 μ in diameter. A hairlike elongation is generally lacking, even if such a one, indeed, may exceptionally be found (fig. 14 *D*). Plurilocular sporangia have been noticed in the month of July only (all the present specimens were collected in this month).

Unilocular sporangia have been noticed in a single locality only (Hirsholmene), where they were plentiful on some tufts, 4—5 cm in height, collected July 4th, bearing in addition plurilocular sporangia (fig. 14 *E*). They measured 45—57 μ in length and 30—35 μ in diameter.

The species is very closely related to *E. fasciculatus*, from which however, it

is distinguished for the main axes often being somewhat elongated, in numerous cases making it appear somewhat flaccid. *E. fasciculatus* is generally much more robust and on an average less high. Moreover, *E. draparnaldioides* is distinguished for the rather short cells in the main axes, the branch fascicles—the branches of which are tapering in the upper part, only rarely slightly arcuate or zigzag-shaped—and for the subulate plurilocular sporangia.

Localities. **Kn:** Hirsholmene; Busserev; west of Busserev; Frederikshavn harbour, the outer side and the inner pier-head; Vesterø harbour, Læsø.

4. Ectocarpus tomentosus (Huds.) Lyngb.

Lyngbye, Tent. Hydr., 1819, p. 132, tab. 44 A; Harvey, Phyc. Brit., II, 1849, tab. 182; Kjellman, Handbok, 1890, p. 73; Sauvageau, Note sur l'*Ectocarpus tomentosus* Lyngbye, Journ. de Botanique, t. 9, Paris 1895; id., Seconde note sur l'*Ectocarpus tomentosus* Lyngbye, Bull. stat. biol. d'Arcachon, t. 25, 1928, p. 121; Printz, Algenveg. Trondhjemsfjordes, Oslo 1926, p. 156—157; Knight and Parke, Manx Algæ, 1931, p. 62, pl. X, fig. 16; Kylin, Studien über die Entw. d. Phaeophyceen, Svensk Bot. Tidskrift, 1918, p. 10; id., Über die Entw. d. Phaeophyceen, Lunds Univ. Årsskr., Bd. 29, Nr. 7, 1933, pp. 20—22.

Conferva tomentosa Hudson, Flora Angl., 1778, p. 594.

Spongonema tomentosum Kützing, Species Alg., 1849, p. 461; id., Tab. phyc., V, 1855, Tab. 83, I.

This species, characteristic by its habit, is distributed in all the Danish waters to the western Baltic Sea. The longitudinal filaments are more or less twisted, forming a cylindrical axis, from which spring numerous short, branched filaments bearing sporangia. The branches of these filaments are divaricate. Very frequently they are recurved, too. The filaments are (7—) 8—9.5 μ (—11 μ) thick. The cells contain a few, 1—3, more or less elongated chromatophores (fig. 15 *C*). This is in accordance with Knight and Parke, 1931, plate X, fig. 16. Sauvageau (1895, p. 5) states that he has observed, in the lower part of some filaments, cells containing a chromatophore being "un ruban unique dont les inflexions sont densement rapprochées". The filaments often end in a hairlike portion consisting of longer and narrower cells with smaller chromatophores, but true hyaline hairs do not occur.

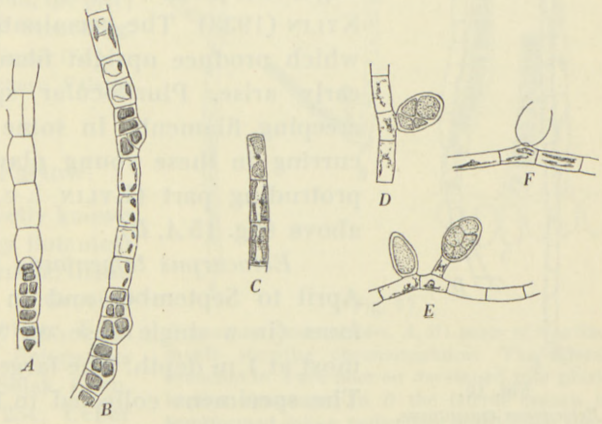


Fig. 15.
Ectocarpus tomentosus on *Fucus vesiculosus*. *A*, *B*: filaments with intercalary plurilocular sporangia. In *A*, topmost to the left, a lateral orifice is seen. *C*: cells showing chromatophores. *D-F*: filaments with unilocular sporangia. — *A*, *B*: Rosenvold harbour 30-XII-34 (S. L.); *C*: Bogense harbour 10-VI-22; *D-F*: Vejle Fjord between Fakkegrav and Rosenvold 18-IV-33 (S. L.). — *A*, *B*: × 418; *C-F*: × 260. I. Frederiksen del.

Plurilocular sporangia were met with in almost all the specimens collected and in all the seasons; they are borne on the short filaments, sessile or on short di-

varicate or recurved stalks. They are linear-ovate or oblong, 24—94,5 μ long, 11—13,5 μ broad. In very small specimens collected at the end of December 1934 by mag. S. Lund on *Fucus vesiculosus* in Rosenvold harbour, Vejle Fjord, seriate intercalary plurilocular sporangia were met with in the short filaments partly emptied through a lateral opening (fig. 15 *A*, *B*). Such sporangia have been described and figured by Børgesen in 1902 (Mar. Alg. Fær. p. 414). It is more dubious if they are identical with those described by Sauvageau (1895 p. 8) having several lateral openings "chaque logette a son ouverture, ou, plus souvent, la même ouverture sert pour plusieurs logettes."

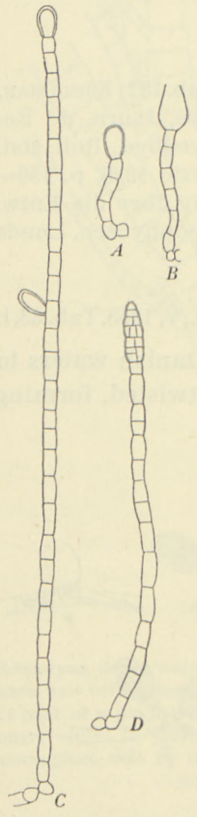


Fig. 16.
Ectocarpus tomentosus. *A-C*: unbranched filaments from the base with terminal unilocular sporangia. In *C*, in addition, is seen a lateral unilocular sporangium. *D*: unbranched filament issuing from the base with a plurilocular sporangium. — Thyborøn 21-III-06, on *Fucus vesiculosus*. — *A-D*: × 237.

The unilocular sporangia occur much more rarely than the plurilocular ones, but on the same individual as these; they were met with in very small individuals, 0,4 cm long, collected in Vejle Fjord by Søren Lund in April, in specimens collected in June in Aarøsund, and in a large specimen collected at Middelfart in June 1891. They are ovate, 27—30 μ long, 19—21,5 μ broad, sessile or borne on a short, usually unicellular stalk (fig. 15 *D-F*). The number of zoospores is proportionally small; the zoospores are, according to Sauvageau (1928 p. 126), larger than those from the plurilocular sporangia, they move more slowly and come shortly to rest.

The germination of the zoospores from the plurilocular sporangia has been examined in cultures by Sauvageau (1928) and Kylin (1933). The germinating zoospores form creeping filaments, which produce upright filaments, on which plurilocular sporangia early arise. Plurilocular sporangia may too spring from the creeping filaments. In some cases the plurilocular sporangia occurring in these young plants are seriate, each having a lateral protruding part (Kylin l. c. fig. 3 *C*, *D*, *F*), like those described above (fig. 15 *A*, *B*).

Ectocarpus tomentosus has been met with in the months of April to September and in December, growing on *Fucus vesiculosus* (in a single case on *Scytosiphon*) in the littoral region, at most at 1 m depth. The large specimens seem to perish in autumn. The specimens collected in December are very small, 0,4 cm high, and so were also the specimens from April.

After professor Rosenvinge had worked out the manuscript for this species finally, the junior author found in addition in the collections some specimens, perhaps worth a brief mention. They inhabited *Fucus vesiculosus*, and they had been collected by Rosenvinge in the North Sea at Thyborøn on a groyne on March 21th 1906. These plants were mainly very small; they possessed unilocular sporangia, of which some had been evacuated, while

others were still young. It was characteristic of the unilocular sporangia that in numerous cases they were terminal on shorter (fig. 16 *A*, *B*) or longer (fig. 16 *C*) filaments, usually unbranched, coming out at the base. In other cases, moreover, the unilocular sporangia might be sessile laterally on these filaments (fig. 16 *C*). The filaments a little older were branched, often possessing a unilocular sporangium at the apices of the branches. In one of the specimens, in addition to unilocular sporangia a single plurilocular sporangium was found, situated in the apex of an unbranched filament, coming out at the base (fig. 16 *D*).

These plants have a certain resemblance to *Ectocarpus confervoides* f. *pygmaea* (cp. for instance, Børgesen, 1902, fig. 66 to the right, and Jónsson, 1903, fig. 14 d). That they actually belong to *E. tomentosus* is for instance seen by the fact that the filaments in some plants, a little older, had a number of characteristic divaricate, recurved branches as is usual in this species.

Localities. **Ns:** Esbjerg harbour; Thyborøn. — Hirtshals, pier; Skiveren, on *Scytosiphon Lomentaria* growing on a wreck. — **Lf:** Oddesund N. — **Kn:** Kølpen; Frederikshavn; Rønnerne (C. A. J., S. L.); Jegens Reef, Læsø; Vesterø harbour, Læsø. — **Ke:** Gilleleje harbour (S. L.). — **Ks:** Hesselø (Lyngbye 1832); Gniben, Sjællands Odde (S. L.); Klintebjerg, Odsherred (J. Vahl 1844). — **Sa:** Endelave (S. L.); Hofmansgave (C. Rosenberg 1845). — **Lb:** Bogense harbour; Vejle Fjord: Rosenvold harbour and between Rosenvold and Fakkegrav (S. L.); Fredericia (Hofm. Bang,!); Middelfart; Aarø Sund, the pier; off Langøre; Barsø (Reinke, Algenfl.). — **Sf:** Svendborg. — **Sb:** off Nordskov, Hindsholm. — **Su:** Helsingør (S. L.); near Hveen (Ørsted). — **Bw:** at Skelby, southern Falster (Johs. Schmidt).

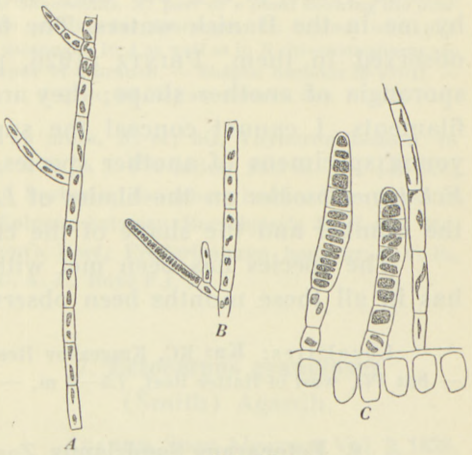


Fig. 17.
Ectocarpus tomentosoides. *A*, *B*: parts of free filaments showing chromatophores. The lateral branches in *A* are later on developed into plurilocular sporangia. In *B* the lateral branch is transformed into a pedicellate plurilocular sporangium. A short branch issues from the stalk presumably, too, developing into a plurilocular sporangium. *C*: basal, short-stalked plurilocular sporangia. At the base the cells of the host are seen. — Lysegrunden in Kattegat, 6 m, 18-IV-94, on *Laminaria digitata*. — *A*, *B*: × 260; *C*: × 418.
I. Frederiksen del.

5. **Ectocarpus tomentosoides** Farlow.

Farlow, On some new and imperfectly known Algæ of the United States, I, Bull. Torrey Botanical Club, Vol. XVI, No. 1, 1889, p. 11; K. Rosenvinge, Grønlands Havalger, 1893, p. 890 (Algues mar. du Groenl., Annales des sciences natur., Sér. 7, Botanique, T. 19, 1894, p. 116); Gran, En norsk form af *Ectocarpus tomentosoides*, 1893, Christiania Vidensk.-Selsk. Forh. Nr. 17; Kuckuck, Bemerkungen, 1894, p. 234; Ueber Polymorphie bei einigen Phaeosporeen. Festschrift für Schwendener. Berlin 1899, p. 370, Textfig. 5—7; Børgesen, Mar. Algæ of the Færøes, 1902, p. 415; Jónsson, Mar. Algæ of Iceland, II, Phaeophyceae, 1903, p. 154; Printz, Algenveg. Trondhjemsfjordes, 1926, p. 149; Knight and Parke, Manx Algæ, 1931, p. 61, pl. VIII, figs. 1—2.

Streblonema? tomentosoides (Farlow) De-Toni, Syll. Algarum, Vol. III, 1895, p. 573.

Grows on the blades of *Laminaria digitata*. The free filaments spring from endophytical filaments and form spots of matted growth on the surface of the host,

reaching a height of a few millimetres. The filaments are 5—8 μ thick and possess in the cells about 2 (1—3) chromatophores (fig. 17*)*; they bear no vegetative branches but numerous lateral divaricate plurilocular sporangia, sessile or borne on short one- or two-celled pedicels (fig. 17 *B*), as well as at the top a terminal sporangium. Many filaments, however, remain very short but produce early, after one or few vegetative cells, a terminal sporangium similar to the lateral ones (fig. 17 *C*). The sporangia are linear, consisting of a single row of cells, 4—8 μ broad, up till over 100 μ long. As shown by Gran, the terminal sporangia may sometimes be branched (l. c. figs. 4, 5).

Gran has described unilocular sporangia which were cylindrical-obovate or pear-shaped, terminal or lateral, sometimes partly intercalary. I observed them also in specimens from Greenland, but presumed that they were not unilocular sporangia; their contents were dense and refractive, and they seemed rather to be comparable with the ascocysts of the genus *Ascocyclus* (K. Rosenvinge, 1893, p. 891). Børgesen (1902, p. 415) found the same organs in specimens from the Færöes, Jónsson (1903, p. 154) from Iceland and I have myself observed them in specimens from the arctic Canada (1926, p. 19), but they were not met with at Heligoland by Kuckuck nor by me in the Danish waters. The formation of zoospores seem never to have been observed in them. Printz (1926, p. 149, pl. VI, fig. 62) has described unilocular sporangia of another shape; they are elliptical or ovoid, terminal or lateral on short filaments. I cannot conceal the supposition that they are unilocular sporangia of young specimens of another species, *Ect. siliculosus*, often growing in company with *Ect. tomentosoides* on the blades of *Laminaria*. They should be easely discernible by the number and the shape of the chromatophores.

The species has been met with in spring, in the months of April to June, and has in all these months been observed with plurilocular sporangia.

Localities: **Kn:** KC, Krageskov Reef; Frederikshavn harbour. — **Ks:** OP, Lysegrunden, 6 m. — **Sa:** PG, west of Hatter Reef, 7.5—8 m. — **Lb:** Vejle Fjord between Rosenvold and Fakkegrav (S. L.).

6. **Ectocarpus Sandrianus** Zanard.

Zanardini in Kützing, Species Algarum 1849, p. 451; Zanardini, Iconogr. phycol. adriat. II, 1865, p. 143, Tab. 74 B; Kützing, Tab. phycolog., V, 1855, tab. 52, I.

Ectocarpus elegans Thuret in Le Jolis, Algues marines de Cherbourg, 1864, p. 77, pl. II.

The species is usually easily known and not submitted to great variations. The main axes are 25—56 μ thick, below with rhizines, sometimes free. The length of the cells is $^1/_2$—$1^1/_2$ × the breadth. The branches are thinner, usually in unilateral series; they become upwards thinner and terminate in thinner, faintly coloured ends which, however, not are really hair-like (fig. 18 *C*). The cells contain a number of small disc-shaped chromatophores (fig. 18 *A*, *B*). The plurilocular sporangia are placed in unilateral series between the sterile branches on the inner sides of the branches (fig. 18 *A*, *B*), sessile, ovate or elongate, often slightly curved inward and therefore oblique, 28—47 (—60) μ long, 10, 5—21 μ broad. Unilocular sporangia were not observed.

Met with from small depth (1 m) near the coast to 37,5 m. Reaches a length of 1—6 (—11) cm. Observed in the months of July to October, in all the named seasons with fruit. It grows usually on other Algæ, e. g. *Laminaria digitata*, or on Hydroids and Ascidia.

Reinke quoted *Ectocarpus Sandrianus* var. *balticus* from Bülk near Kiel (Algenfl. d. westl. Ostsee, 1889, p. 43) in the Baltic Sea. It resembles in habit *Ect. confervoides* but differs from it by small lenticular chromatophores and small ovate, sessile sporangia; it differs from the typical *E. Sandrianus* by slighter ramification and by the sporangia being single or more rarely 2 to 4 in a series. I have not yet observed this form in the Danish waters.

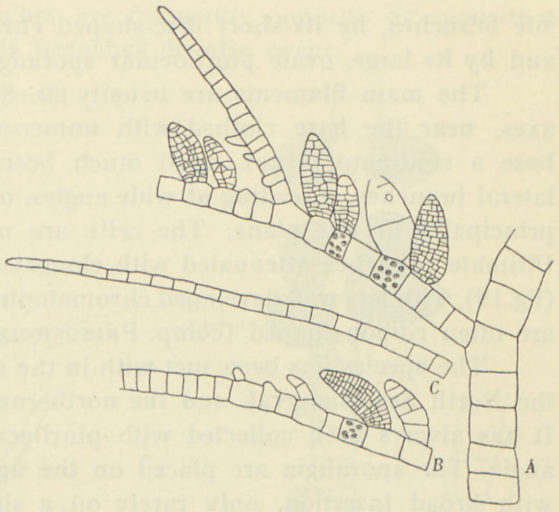


Fig. 18.
Ectocarpus Sandrianus, *A*: part of a plant showing the position of the plurilocular sporangia. *B*: branch with plurilocular sporangia. In *A* as well as in *B* chromatophores are seen. *C*: apex of a branch. — Skagen harbour 28-VII-11. — *A-C*: × 260. I. Frederiksen del.

Localities: **Ns:** Thyborøn beacon in N. W. 1/2 W. 15 miles, 31 m; aG, Thyborøn beacon in S. E. 1/2 E. 19 1/2 miles, 32.5 m; aD, Lodbjerg lighthouse in S. E. 3/4 S. 4 1/2 miles, 23.5 m. — **Lf:** XX, Nissum Bredning, 5.5 m; Oddesund, c. 10 m. — **Kn:** Skagen harbour; Tønneberg Banke, 19 m; east of Kølpen; between Borrebjerg's Reef and Maren's Reef; Frederikshavn harbour (!, F. B., C. A. J., Boye P.).

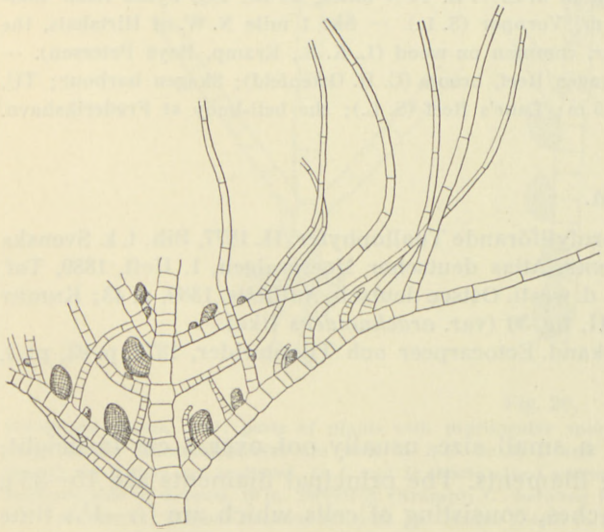


Fig. 19.
Ectocarpus granulosus. Part of a plant with plurilocular sporangia. This plant has had a period of exposure of about 6 weeks (from 9-VI to 20-VII). — Hirtshals 20-VII-25 (Kramp). — × 83. I. Frederiksen del.

7. Ectocarpus granulosus (Smith) Agardh.

Agardh, Spec. Algarum, Vol. 2, 1828, p. 45; Harvey, Phycol. Brit. II, 1849, pl. 200; Pringsheim, Sphacelarien-Reihe, 1873, Taf. 11, figs. 6—10; Kjellman, Handbok, 1890, p. 74; Kuckuck in Oltmanns' Morph. u. Biol. d. Algen, 2. Aufl., 2. Bd., 1922, p. 7, figs. 292, 293; Knight and Parke, Manx Algæ, 1931, p. 63; Sauvageau, Sur quelques algues phéosporées de Guéthary, Bull. stat. biol. d'Arcachon, 1933, p. 59—66, figs. 13, 14.

Corticularia brachiata Kützing, Tab. phyc. V. 1855, Pl. 81, I.

This species is characterised by its robust structure, by its often oppo-

site branches, by its short disc-shaped chromatophores, at least in the upper cells, and by its large, ovate plurilocular sporangia.

The main filaments are usually 60—80 μ, up to 116 μ thick, with distinct main axes, near the base clothed with numerous rhizoidal filaments, forming near the base a continous cortex, uptil much branched with opposite or alternate or unilateral branches, spreading at wide angles, often at last recurved, the branches falling principally in one plane. The cells are usually $^1/_2$—$1^1/_2$ times as long as broad. Ultimate branches attenuated with elongated cells, up to 6—8 times as long as broad (fig. 19), with less well developed chromatophores. In the lower cells the chromatophores are often ribbon-shaped (comp. Pringsheim, l. c. Tab. XI, figs. 7—8).

The species has been met with in the months of May, July, August to October, in the North Sea, Skagerak and the northernmost Kattegat. It attains a length of 10 cm. It has always been collected with plurilocular sporangia, not with unilocular sporangia. The sporangia are placed on the upper side of the branches (fig. 19), sessile, with broad insertion, only rarely on a short unicellular stalk. The sporangia are ovate, frequently concave on the acroscopic side, 60—90 μ, more rarely up to 120 μ long, 38—53 μ, more rarely up to 65 μ broad.

The species has been collected in great depths in the North Sea, 24.5—31 m, but also in small depths near land. It grows on various algæ (*Halidrys, Laminaria digitata, Punctaria plantaginea, Chordaria flagelliformis)* and animals (*Flustra foliacea, Aporrhais*).

Localities: **Ns:** aF, Thyborøn beacon in S. E. $^1/_2$ E. $14^1/_2$ miles, 31 m; ZQ, Jyske Reef. Lodbjerg lighthouse in E. by S. $26^1/_2$ miles, 24.5 m; Vorupør (S. L.). — **Sk:** 1 mile N. W. of Hirtshals, the church in the brook, 15 m; Hirtshals harbour, common on wood (L. K. R., Kramp, Boye Petersen). — **Lf:** Thyborøn channel, north side. — **Kn:** Skagen Reef, broom (C. H. Ostenfeld); Skagen harbour; TU, at the double broom east of Hirsholmene, 9.5 m; Laur's Reef (S. L.); the bell-buoy at Frederikshavn.

8. **Ectocarpus ovatus** Kjellman.

Kjellman, Spetsbergens marina, klorofyllförande Thallophyter, II, 1877, Bih. t. k. Svenska Vet. Akad. Handl., Bd. 4, Nr. 6, p. 35; Reinke, Atlas deutscher Meeresalgen, 1. Heft, 1889, Taf. 20, p. 21 (f. *arachnoideus* Rke); Algenflora d. westl. Ostsee deutsch. Antheils, 1889, p. 43; Knight and Parke, Manx Algæ, 1931, p. 63, pl. XII, fig. 30 (var. *arachnoideus* Rke).

Ectocarpus polycarpus Kjellman, Skand. Ectocarpeer och Tilopterider, 1872, p. 93, pl. I, fig. 5 (non Zanardini).

The erect filaments attain only a small size, usually not over 1 cm in height; they issue from a system of creeping filaments. The principal filaments are 15—35 μ thick, with opposite or alternate branches, consisting of cells which are $^1/_2$—$1^1/_2$ time as long as broad, more rarely up to 3 times as long. The short cells are more or less barrel-shaped. The branches are attenuated upwards and consist (in older branches) of longer cells with less well developed chromatophores, thus forming hair-like, hyaline prolongations (fig. 20 *A*). The ordinary cells contain a number of small disc-shaped

chromatophores (fig. 20 *B—D*). The branches are frequently opposite or opposite a sporangium (fig. 20 *A, B, D*). But alternate branches do also occur.

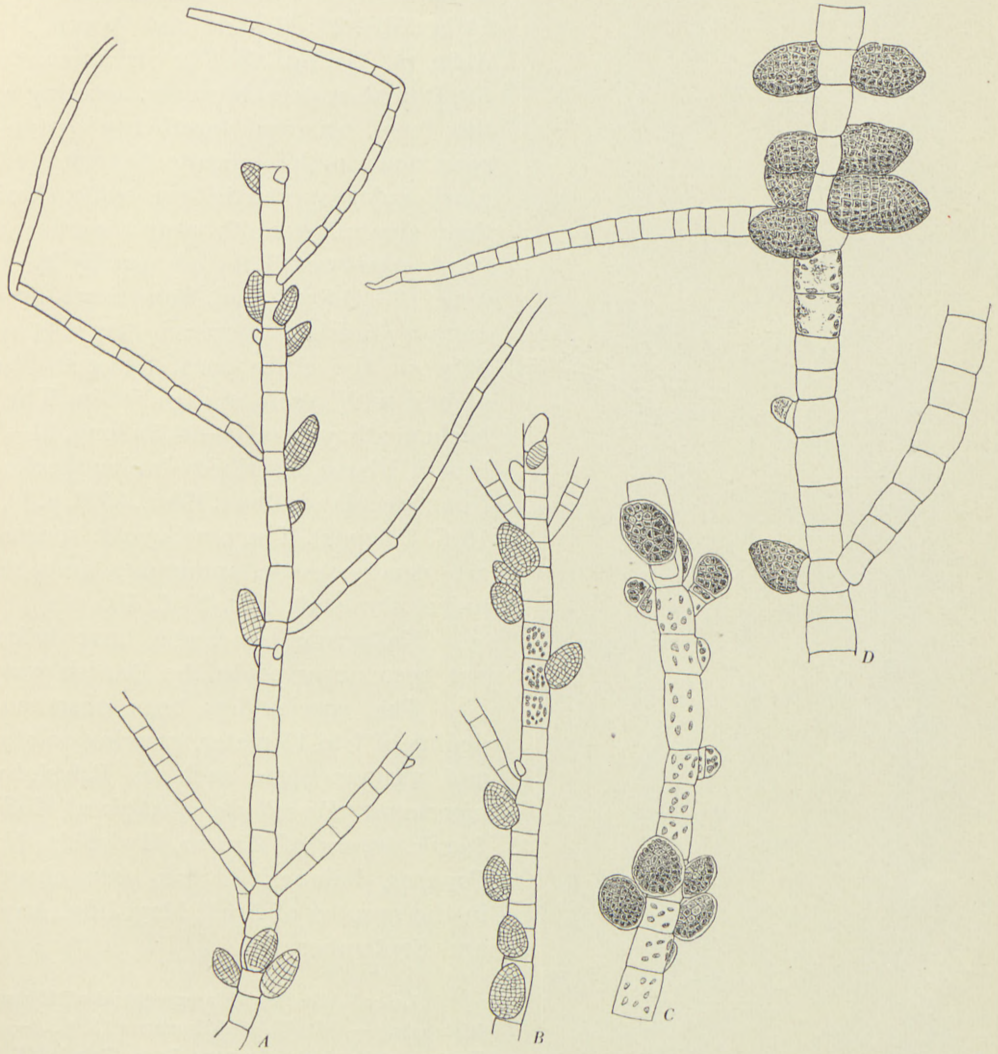


Fig. 20.

Ectocarpus ovatus. *A-D*: parts of plants with plurilocular sporangia. In *A* the branches terminate in a hairlike prolongation. Chromatophores are seen in *B-D*. In *A*, *C* and *D* the sporangia are mainly opposite or opposite a branch, in *B* they are scattered. In *C* and *D* short-stalked sporangia are seen. — *A*: Fladen, 11-12 m, 12-V-93; *B*: the southern side of Grenen, 10 m, 23-VIII-21 (Kramp); *C*: between Brune Reef and Laurs' Reef 2-VII-04, on *Desmarestia viridis*; *D*: Thisted harbour 9-VII-30, on *Codium fragile* (S. L.). — *A*: × 153; *B*: × ?; *C*: × 260; *D*: × 210.

I. Frederiksen del.

The plurilocular sporangia are frequently opposite, often several pairs on two or three consecutive joints (fig. 20, *C, D*), but scattered sporangia also occur, and

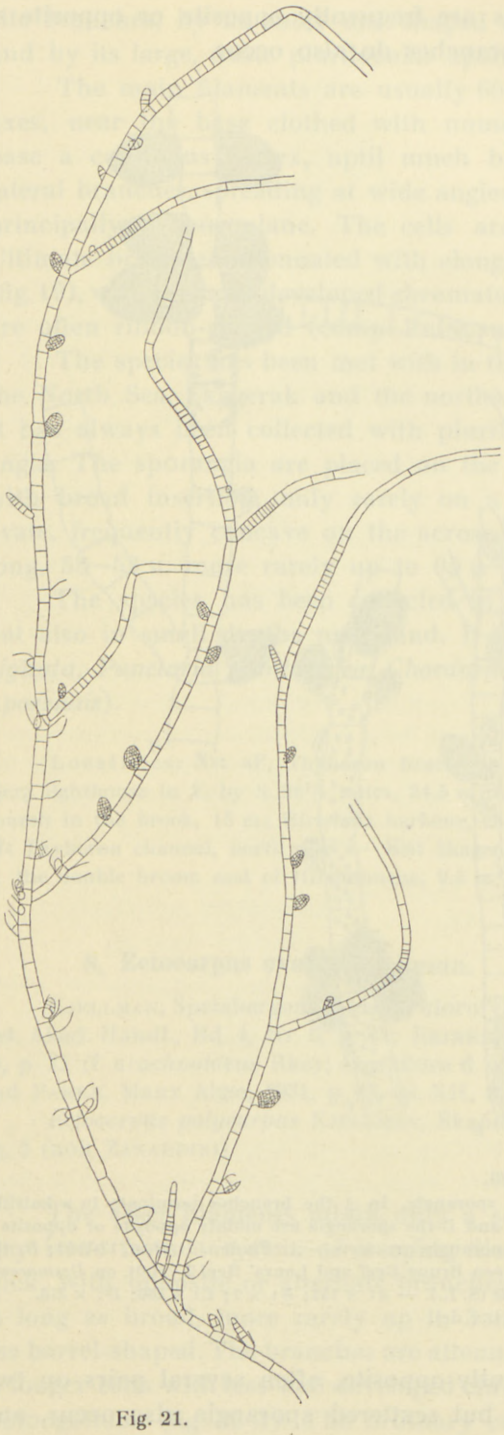


Fig. 21.

sometimes the scattered sporangia are much more frequent than the opposite ones (fig. 20 *B*), as in f. *arachnoideus* Reinke (Atlas, Taf. 20; Knight and Parke, Manx Algæ, pl. XII, fig. 30). The specimens from the Danish waters, however, agreeing with this form, occurred together with typical specimens with opposite branches. The plurilocular sporangia are ovate, having their greatest breadth near the base, upwards narrower. They are usually 26—44 μ long, 18—24,5 μ broad. Sometimes longer, more cylindrical sporangia are met with between the other ones. S. Lund found plants with such sporangia in Thisted harbour; they were 54—94,5 μ long, 24—30 μ broad. I have described similar specimens from Greenland (Deux. Mém., 1898, p. 80, fig. 16 *C*, f. *tenuis*). The plurilocular sporangia are usually sessile, sometimes on a short unicellular stalk (fig. 20 *C*, *D*).

Unilocular sporangia have hitherto not been observed in the Danish waters.

The species has been observed in dephts of 1 to 15 meter, growing on stones and various algæ, such as *Polysiphonia nigrescens*, *Furcellaria fastigiata*, *Codium fragile*, leaves of *Zostera*, Hydroids, *Hyas*, *Pagurus*, Balanes. It has been observed in the months of April, May, July, August, and September.

Localities: **Sk:** Flammegrund off Hirtshals; Hirtshals. — **Lf:** Thisted harbour (S. L.). — **Kn:** Skagen, south side of Grenen; Læsø Trindel (F. Børgesen); Krageskov Reef; N. W. Reef by Hirsholm; S. E. of Deget; Maren's Reef; Laur's Reef; Borrebjerg's Reef; Peder Poulsen's Reef; Frederikshavn, the

Fig. 21.
Ectocarpus ovatus var. *intermedius*. Part of a plant showing ramification, trichothallic growth zones, and plurilocular sporangia. — Between Laurs' Reef and Borrebjerg's Reef 7-VII-32. — × about 75. S. L. del.

small harbour for boats at the ends of the outer piers and the harbour of the boat-club. — **Ke:** IO, Fladen, 11 m. — **Sa:** East of Øreflippen, 9.5—17 m; Vorsø, Horsens Fjord, 2 m, 26-IX-36, with scattered plurilocular sporangia (S. L.). — **Lb:** Thyges Hoved at Rosenvold, Vejle Fjord, 3—5 m, March 1936 (S. L.), with many opposite branches; pluriloc. sporangia often opposite, sessile; the Little Belt Bridge, pillar (S. L.); Aarøsund (var. *arachnoideus*; Reinke, Algenfl.); Sønderborg (var. *arachnoideus*; Reinke, Algenfl.).

Ectocarpus ovatus var. intermedius K. Rosenvinge, nov. var.

Among professor ROSENVINGE's manuscripts of *Ectocarpus* a description is found of some plants, supposed to belong to a new species or a new variety. ROSENVINGE now calls them *E. intermedius*, now *E. ovatus* var. *intermedius* saying that he "has been in doubt about the relation of this species". He seems, however—as will appear from the paragraphs below—to be inclined to consider them a variety of *E. ovatus*, for which reason they are here referred to in this way. The following account mainly corresponds to ROSENVINGE's manuscript, still including some rewritings, made by the junior author.

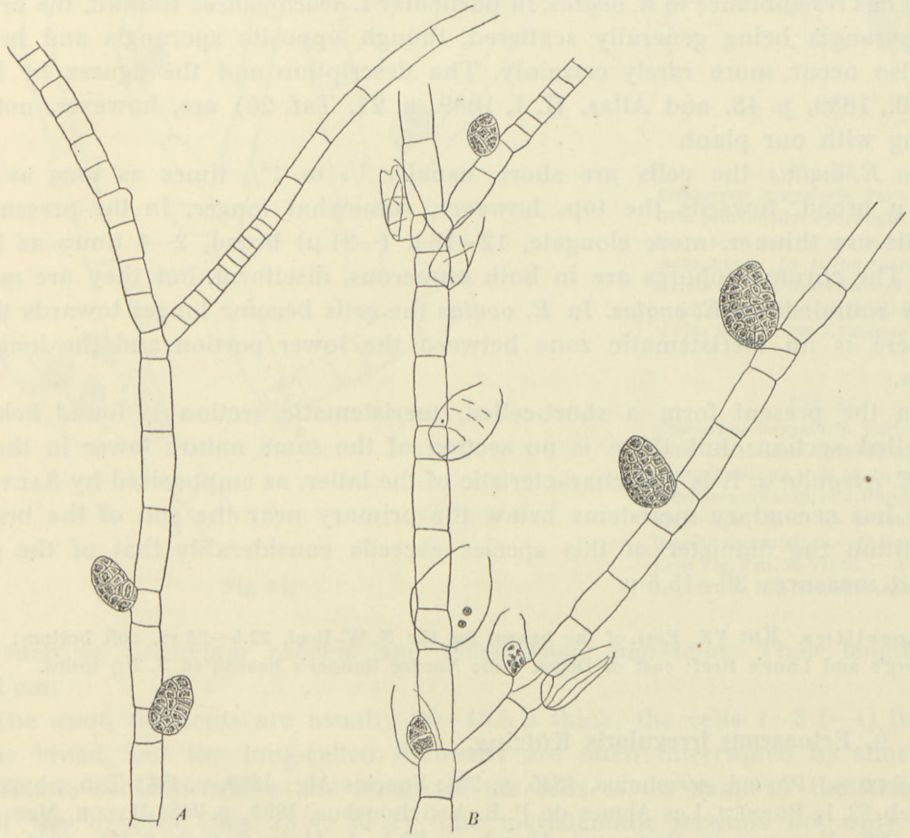


Fig. 22.

Ectocarpus ovatus var. *intermedius*. *A*, *B*: parts of plants with plurilocular sporangia. In *A* a trichothallic growth zone is shown. In *B* 2 evacuated, opposite sporangia are seen. — Between Laurs' Reef and Borrebjerg's Reef 7-VII-32. — × 210. I. FREDERIKSEN del.

The filaments are 12—21 μ broad, the cells usually 2—4 times as long as broad. Near the upper portion of the filaments a short-celled meristematic zone is present (figs. 21, 22 *A*), which is terminated by a long-celled hairlike zone with slightly coloured cells being 6—8—10 times as long as broad. No branches occur above the meristematic zone.

The sporangia are chiefly scattered (figs. 21, 22), rarely opposite (figs. 21, 22 *B*), sessile, sometimes with a unicellular stalk (fig. 21); they are ovate, 40—53 μ long, 18—33 μ broad. Unilocular sporangia were not met with.

This form has been collected in some places in the northern Kattegat, in nearly the same places as *E. ovatus*. As I am not convinced that the specimens have been fixed to the substratum at the moment of the collecting, and as it shows much resemblance to this species, I think that it might be a form belonging to it, modified by outer conditions. It is, however, only with doubt, it is regarded as a form of this species.

It has resemblance to *E. ovatus*, in particular f. *arachnoideus* Reinke, the branches and sporangia being generally scattered, though opposite sporangia and branches may also occur, more rarely certainly. The description and the figures by Reinke (Algenfl., 1889, p. 43, and Atlas, H. 1, 1889, p. 21, Taf. 20) are, however, not quite agreeing with our plant.

In *E. ovatus* the cells are short, usually $^1/_2$ to $1^1/_2$ times as long as broad, 15—35 μ broad, towards the top, however, somewhat longer. In the present form the cells are thinner, more elongate, 12—18 μ (—21 μ) broad, 2—4 times as long as broad. The chromatophores are in both numerous, disciform, but they are most distinctly roundish in *E. ovatus*. In *E. ovatus* the cells become longer towards the top, but there is no meristematic zone between the lower portion and the long-celled portion.

In the present form a short-celled, meristematic section is found below the long-celled section; but there is no section of the same nature lower in the plant as in *E. irregularis*. It is just characteristic of the latter, as emphasised by Sauvageau, that it has secondary meristems below the primary near the end of the branches. In addition the diameter of this species exceeds considerably that of the present form; it measures 30—45,5 μ.

Localities. **Kn:** YX, East of the broom for the N. W. Reef, 22.5—28 m, soft bottom; between Borrebjerg's and Laur's Reef; east of Deget, 9 m; Nordre Rønner's beacon in S. $2^1/_2$ miles.

9. **Ectocarpus irregularis** Kützing.

Kützing, Phycol. germanica, 1845, p. 234; Species Alg., 1849, p. 454; Tab. phycolog., V, 1855, Tab. 62, I; Bornet, Les Algues de P. K. A. Schousboe, 1892, p. 245; Hauck, Meeresalgen, 1885, p. 328; Kuckuck in Oltmanns, Morph. u. Biol. d. Algen, 2. Aufl., 2. Bd., 1922, p. 7, fig. 294; Børgesen, Mar. Alg. from the Canary Islands, II, 1926, K. D. Vidensk. Selskab, Biol. Medd. VI, 2 p. 25; Hamel, Phéophycées de France, Fasc. I, 1931, p. 45; Sauvageau, Sur quelques Algues phéosporées de Guéthary (Basses-Pyrénées), 1933, p. 101.

I have referred to this species an *Ectocarpus* met with in a few places in the western part of the Limfjord. The specimens were collected in July; they are mostly incomplete, fragile and broken. They appear to have been fixed to various

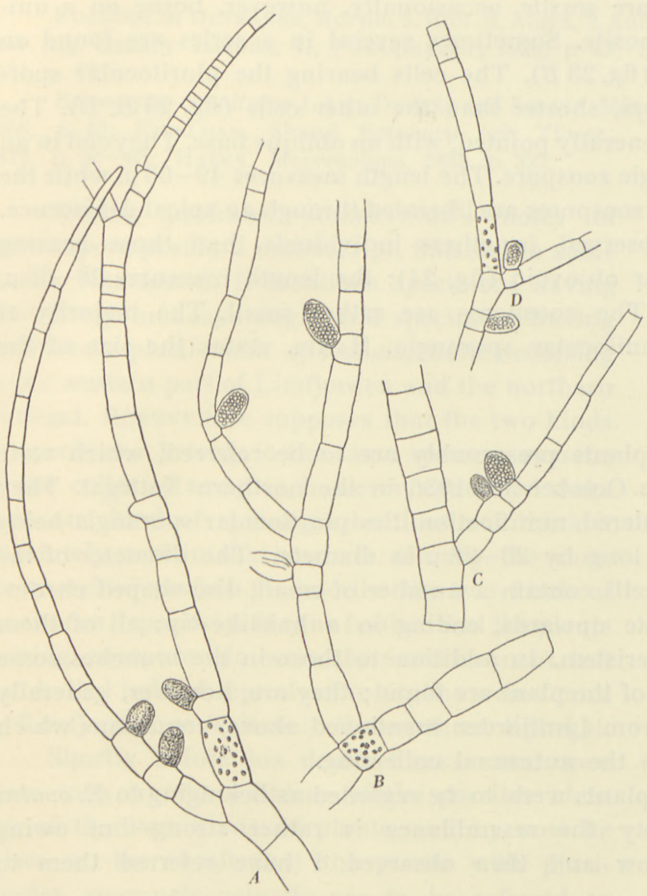


Fig. 24.

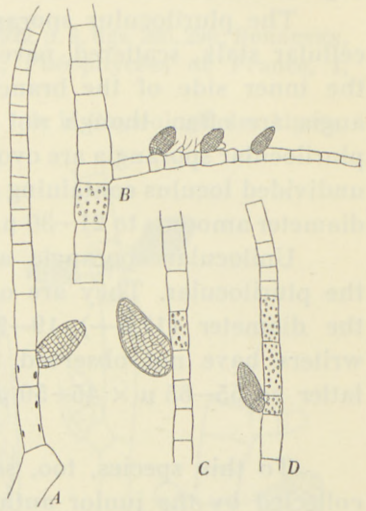


Fig. 23.
Ectocarpus irregularis. Parts of plants with plurilocular sporangia. In *A* and *D* are seen growth zones, in *A-D* chromatophores. In *B* the sporangia are seriate on the inner side of a branch. — Off Feggeklit, 4 m, 27-VII-20. — *A*, *C*: × 173; *B*, *D*: × 102. I. Frederiksen del.

Fig. 24.
Ectocarpus irregularis. Parts of plants with unilocular sporangia. In *A* a trichothallic as well as an intercalary meristem are seen; in *A*, *B* and *D* chromatophores; in *B* an evacuated unilocular sporangium.—At Rønnen near Lem Vig, 3 m. 26-VII-05. — *A-C*: × 153; *D*: × ?. I. Frederiksen del.

algæ, such as *Ceramium rubrum* and *Polysiphonia nigrescens.* Their length is at least 2 cm.

The main filaments are usually 30—45,5 μ thick, the cells 1—3 (—4) times as long as broad, but the long-celled filaments are often interrupted by short-celled meristematic sections where the length of the cells is the same as the breadth or half of the breadth (figs. 23 *A*, 24 *A*). The meristematic sections not only appear at the upper part of the filaments but also lower in the plant (fig. 24 *A*).

The branches are scattered, divaricate, upwards attenuate, often thinner than the main filaments. In the branches the same alternation between long cells and

meristematic short cells takes place. The cells are up to 4 times as long as broad—or still longer.

In the vegetative cells a number of small disc-shaped chromatophores are found (figs. 23 *A-D*, 24 *A*, *B*, *D*).

The pluriloculur sporangia are sessile, occasionally, however, borne on a unicellular stalk, scattered, never opposite. Sometimes several in a series are found on the inner side of the branches (fig. 23 *B*). The cells bearing the plurilocular sporangia are often, though not always, shorter than the other cells (fig. 23 *B*, *D*). The plurilocular sporangia are ovoid, generally pointed, with an oblique base. They end in an undivided loculus containing a single zoospore. The length measures 49—63 μ, while the diameter amounts to 21 –30 μ. The zoospores are liberated through an apical dehiscence.

Unilocular sporangia are observed in others individuals than those bearing the plurilocular. They are oval or ob-ovoid (fig. 24); the length measures 28—35 μ, the diameter (17,5—) 19—23 μ. The zoospores are rather small. The majority of writers have not observed the unilocular sporangia. Hamel states the size of the latter as 55—65 μ × 45—50 μ.

To this species, too, some plants presumably are to be referred, which were collected by the junior author on October 3rd 1936 in the northern Kattegat. They consist of small tufts having scattered ramification, the plurilocular sporangia being scattered, sessile, ovoid, 45—57 μ long by 25—28 μ in diameter. The diameter of the filaments measure 25—40 μ. The cells contain a number of small, disc-shaped chromatophores. The branches attenuate upwards, ending in a hairlike tip; all of them possess a distinct trichothallic meristem. In addition to those in the branches some growing zones in the lower part of the plant are found; they are, however, generally less marked than in the plants from Limfjorden mentioned above, conditions which may, possibly, be connected with the autumnal collecting.

At first I thought that the plants were to be regarded as belonging to *E. ovatus* var. *intermedius*—to which variety the resemblance is rather strong—but owing to the intercalary meristems, now and then observed, I have referred them to *E. irregularis*.

These plants are the only specimens of *E. irregularis* noticed in the Danish waters outside the Limfjord. They had been collected at a depth of 2—3 m near the one broom off the harbour of Vesterø in Læsø, being epiphytes on various algæ, particularly *Polysiphonia elongata* and *P. nigrescens*, in their turn inhabiting some cubical blocks of concrete which I had put in this place in order to make some examinations on the growth and the production of matter of the marine algæ. It was noticeable that the quantity of the present species was very great in this place; it constituted together with *Polysiphonia* the essential part of the vegetation of these blocks. Consequently this vegetation, which had had an exposure of about half a year (March 18th—Oct. 3rd), was to be denoted a *Polysiphonia—Ectocarpus irregularis* association.

Localities. **Lf:** ZU, at Rønnen north of Lemvig, 3 m; off Feggeklit, 4 m; bT², Knudshoved at the N. W. end of Fur, 5.5 m. — **Kn:** near the 1 broom off Vesterø harbour, Læsø, 2—3 m (S. L.).

10. **Ectocarpus paradoxus** Montagne.

Kuckuck in Oltmanns, Morph. u. Biol. d. Algen, 2. Aufl., II, 1922, p. 8, figs. 295, 296; Børgesen, Mar. Alg. Canary Islands, II, Phæophyceæ, 1926, p. 43; Hamel, Phéophycées de France, I, 1931, p. 47.

Ectocarpus cæspitulus J. Ag.; Derbés and Solier, Mémoire... de la Physiologie des Algues, 1856, p. 49; Kjellman, Skand. Ectocarp. och Tilopt., 1872, p. 60—63; Hauck, Meeresalgen, 1885, p. 327.

Among professor Rosenvinge's notes of *Acinetospora pusilla* a manuscript, finished to some extent, was found. It mentions specimens having exclusively monosporangia and specimens having exclusively plurilocular sporangia, both occurring in the western part of Limfjorden and the northern Kattegat. Rosenvinge supposes that the two kinds of specimens belong to the same species; as none of the collected samples, however, contained more than one kind of sporangia he does not think it absolutely certain that such is actually the case. He therefore prefers to describe the two kinds of specimens separately. It runs further that the plants bearing zoosporangia were the more frequent, but that both kinds of reproductive organs were found in Limfjorden as well as in the northern Kattegat.

Shortly before his death Rosenvinge once more took up the problem of the possible identity of the two kinds of plants, and by now he arises at the result that the plants with plurilocular sporangia actually are to be referred to *Ectocarpus paradoxus*, so that *Acinetospora pusilla* in the Danish waters is represented only by plants bearing monosporangia. Certainly, rather few notes on the question are at hand, but these added to the revised determinations of the material of herbarium show his modified interpretation evidently. On that account the specimens having plurilocular sporangia are mentioned here. The account as follows is a compilation of the notes mentioned and Rosenvinge's original manuscript of the specimens of *Acinetospora* with plurilocular sporangia.

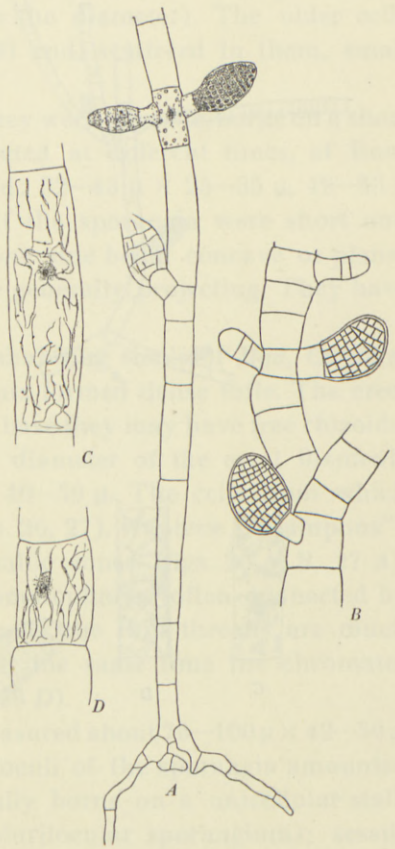


Fig. 25.
Ectocarpus paradoxus from Limfjorden. *A*: erect filament with plurilocular sporangia, one evacuated. In one of the cells chromatophores are seen. At the base creeping basal filaments are seen. *B*: part of a plant with short, obliquely ovoid plurilocular sporangia. *C, D*: rather old cells with nucleus and reticulate, branched threads with chromatophores or "pyrenoids". *A, C, D*: Rønnen near Lem Vig 26-VII-05; *B*: Ibid.17-VII-20. — *A, B*: × 153; *C, D*: × 260.
A, C, D: I. Frederiksen del.

The species is most easily identified with the *Ectocarpus "paradoxus"* pictured by Kuckuck in Oltmanns' Morph. u. Biol. d. Algen, 2. Aufl., Bd. II, 1922, figs. 295, 296. It is partly found in the western part of Limfjorden, partly in the northern Kattegat.

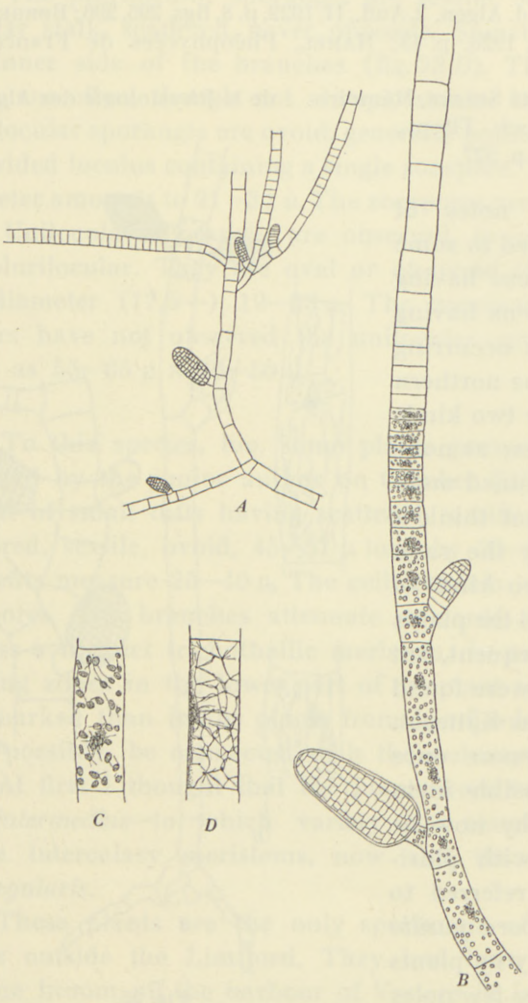


Fig. 26.

Ectocarpus paradoxus from the northern Kattegat. *A*: fragment of a plant with plurilocular sporangia, showing growth zones. *B*: upper part of an erect filament with a growth zone. In the cells chromatophores and nucleus are seen. *C, D*: vegetative cells. In *C* chromatophores with thin, hyaline threads are seen. In *D* the thin threads have formed quite a network, while the chromatophores are dwindling. — *A, C. D*: east of Maren's Reef, 16 m, 18-VII-27; *B*: east of Deget, 9 m, 7-VII-34. — *A*: × 48; *B*: × 153; *C, D*: × 260.

I. Frederiksen del.

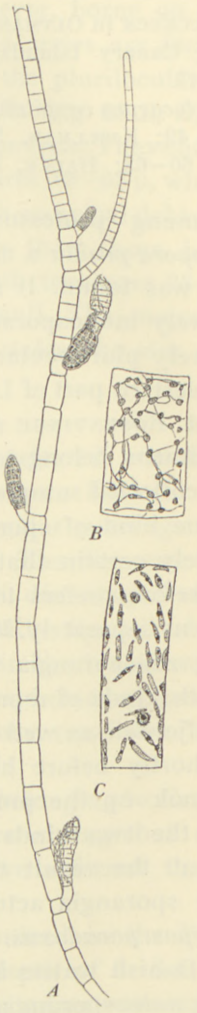


Fig. 27.

Ectocarpus paradoxus from the northern Kattegat. *A*: erect filament with long plurilocular sporangia, rather much ascendant. At the transverse walls of the cells constrictions are found. Growth zones are seen above. *B, C*: cells with chromatophores, roundish in *B*, oblong in *C*. — Between Laurs' Reef and Borrebjerg's Reef 7-VII-32. — *A*: × 78; *B*: × 208; *C*: × ?. A. Sjödal del.

In Limfjorden it was found repeatedly in Nissum Bredning at Rønnen near Lem Vig at a depth of 2—4 m, in which place it inhabited *Acrothrix gracilis* forming tufts about 1 cm in height. The basal portion of the plant consists of creeping filaments (fig. 25 *A*), creeping on the surface of the host plant or lower down among its assimilating filaments. From the creeping filaments are sent out numerous erect filaments, unbranched or only slightly branched, which, however, are not very long. The diameter of the erect filaments in some cases was 21—29 μ, in other cases 42—52 μ, and in others again 56—60 μ. The cells of the erect filaments were partly long (up to 5 times the diameter), partly short (e. g. = the diameter). The older cells often contain reticulate, hyaline threads (fig. 25 *C*, *D*) and, scattered in them, small dense bodies (chromatophores or "pyrenoids").

The plurilocular sporangia were found single or they were opposite, borne on a short unicellular stalk (fig. 25 *A*). In three samples, collected at different times, at Rønnen near Lem Vig the plurilocular sporangia measured: 32—43 μ × 25—35 μ, 49—63 μ × 39—54 μ, and 65—95 μ × 26—46 μ, respectively. If the sporangia were short and broad, they were often obliquely ovoid (fig. 25 *B*), one side being concave or plane; if longer they were ovoid-linear. The sporangia were generally projecting. They have been found in the months of July and September.

In the plants from the northern Kattegat, inhabiting shells of *Mya*, *Cardium* and the like at a depth of 9—16 m, the erect filaments formed dense tufts. The erect filaments are unbranched or slightly branched; at the base they may have free rhizoids. The branches are scattered or, rarely, opposite. The diameter of the erect filaments in some plants amounted to 29—37 μ, in others to 40—59 μ. The cells from which the branches come out are shorter than the other (figs. 26, 27). Hapteræ ("crampons") are not found. The growth takes place in trichothallic zones (figs. 26 *A*, *B*, 27 *A*). The cells contain numerous small, disc-shaped chromatophores, often connected by thin, hyaline threads (figs. 26 *C*, 27 *B*). In other cells the thin threads are much more developed, united into reticulate structures; at the same time the chromatophores have decreased into very small bodies (fig. 26 *D*).

The plurilocular sporangia in some specimens measured about 75—100 μ × 42—50 μ, in others 110—160 μ × 40—46 μ. The height of the loculi of the sporangia amounted to 3,5—10,5 μ. The plurilocular sporangia were usually borne on a unicellular stalk (which in a single case in addition had a lateral plurilocular sporangium); sessile plurilocular sporangia have, indeed, been noticed, too.

In some specimens, which had rather long plurilocular sporangia (111—165 μ × 43—46 μ), the sporangia most frequently had a more marked ascending position than generally (fig. 27 A). The sporangia in these plants, too, in most cases were borne on a unicellular stalk; now and then, however, they were found on a two-celled stalk or they were sessile. Most frequently the sporangia were scattered; in several cases, however, opposite. These plants, for the rest, were characterised by possessing short cells, often to a great extent (evidently long division zones); similarly constrictions at the transverse walls were frequently found (fig. 27 A). The short cells

contained numerous round, disc-shaped chromatophores (fig. 27 *B*), while the chromatophores of the long cells were oblong (fig. 27 *C*).

The plurilocular sporangia have been noticed in the northern Kattegat in July, only.

Localities. **Lf:** Rønnen near Lem Vig, 2—4 m, collected repeatedly (L. K. R., S. L.). — **Kn:** East of Deget, 9 m; east of Maren's Reef, 11.5 and 16 m; between Laur's Reef and Borrebjerg's Reef.

11. **Ectocarpus Reinboldi** Reinke.

Reinke, Atlas deutscher Meeresalgen, 2. Heft 1892, p. 61, Taf. 41, figs. 1—12.
Polytretus Reinboldi Sauvageau, Remarques sur les Sphacélariacées, I, 1900, p. 6.

This interesting species has been met with in small quantities between *Sorocarpus uvæformis* and other algæ collected on the buoy at Skagen Reef the 1. May 1904 and the 2. May 1907 by C. H. Ostenfeld. The cells are short, about as long as broad or one and a half as long or a little longer. The cells contain several disc-shaped chromatophores (fig. 28 *A*, *B*, *D*). The filaments end in a hyaline hair (fig. 28 *A*, *B*, *D*). The plurilocular sporangia are numerous, usually sessile (fig. 28 *A*, *B*), more rarely borne on a short stalk (fig. 28 *A*), irregularly cylindrical. The loculi of the sporangia each have a separate opening (fig. 28 *C*). The sporangia are usually divaricate, often partially secund, 23—39 μ long and 12—21 μ broad.

Some specimens bore ovate cells, lateral or in short series, with homogeneous brown contents, resembling the ascocysts of *Ascocyclus*, *Symphyocarpus* and other Phæophyceæ (fig. 28 *D*). They occurred together with the plurilocular sporangia, but

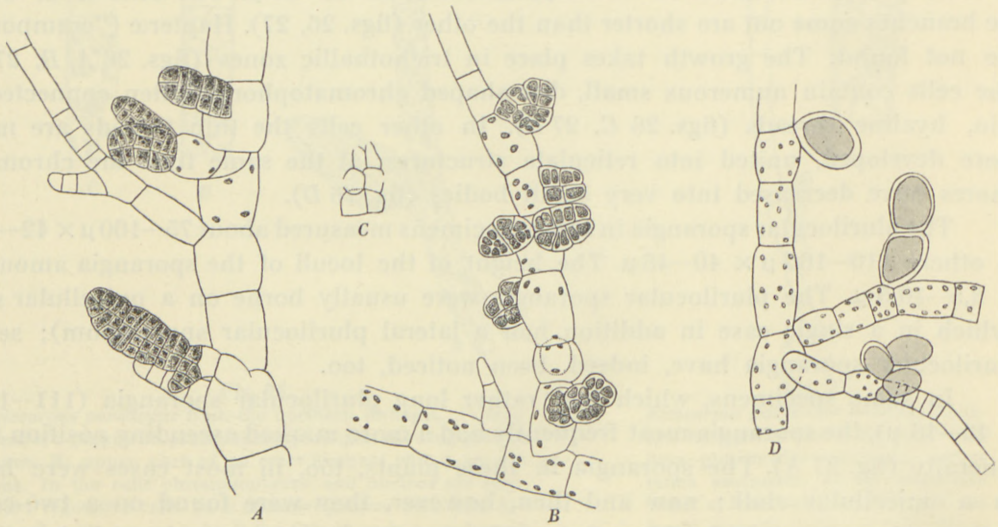


Fig. 28.
Ectocarpus Reinboldi. *A*, *B*: fragments of plants with plurilocular sporangia. In the cells chromatophores are seen. *C*: an evacuated plurilocular sporangium. Each loculus has an orifice of its own. *D*: fragment of a plant with ascocyst-like cells. — *A-C*: the buoy at Skagen Reef 2-V-07 (C. H. Ostenfeld); *D*: ibid. 1-V-04 (C. H. O.). — *A*, *C*: × 418; *D*: × 260. *A-C*: I. Frederiksen del.

it was uncertain, whether they had some relation to the plurilocular sporangia. They were about 17—23 μ long and 16—20 μ broad.

In material of herbarium of *Ectocarpus confervoides* f. *siliculosa*, collected by professor ROSENVINGE near Fladen in the eastern Kattegat at a depth of 11—12 m on May 12th 1893 a single tuft, about 5 cm long, of *E. Reinboldi* was found by the younger author. As this species is very rare in the Danish waters a short description of the present specimen is added here.

It was found accompanied by various other algæ, specially *E. confervoides* f. *siliculosa* and *Kjellmania subcontinua*, described by K. ROSENVINGE from West Greenland (1898, p. 64); moreover accompanied by *Sorocarpus uvæformis*, which was, however, very scanty. The main filaments are up to about 40 μ in diameter; they consist of cells more or less barrel-shaped, the length of which usually is like the breadth. In some cases, however, the length of the cells measures a little less than the diameter, in others a little more, up to 2 × the diameter. The main filaments are now and then covered by rhizoids, particularly in places from which vigorous branches issue. The ramification is scattered. However, 2 branches frequently issue from the same cell, not being opposite, but side by side. The branches are often somewhat divaricate or arcuate; in a number of cases they issue at an angle almost right.

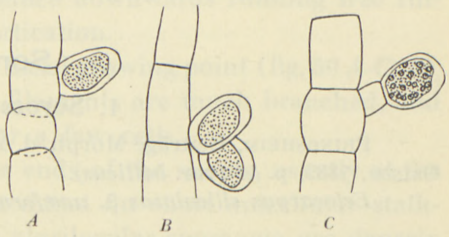


Fig. 29.
Ectocarpus Reinboldi. *A-C*: filaments with unilocular sporangia (?). — Fladen, 11-12 m, 12-V-93. — × 355.

Plurilocular sporangia are very numerous; the majority of them are evacuated. They are sessile or—less frequently—borne on a short stalk. In both cases very frequently more than one sporangium issue from the same cell. If a stalk of a sporangium consists of more than one cell, sporangia may issue from each cell. The position of the sporangia is generally quite irregular. On the upper branches, often characteristically arcuate, they are mainly secund, however (cp. REINKE, Atlas, Taf. 41, figs. 6, 7). In some cases the sporangia are intercalary.

The length of the plurilocular sporangia measures 16—57 μ, the diameter 12—21 μ. Actually, several of the sporangia are certainly to be considered sori of sporangia formed by sporangia in chains. At any rate some of the transverse walls of the sporangia occasionally are so marked that certain of the compartments seem to be sporangia of their own.

Some sporangia (or sori) are branched. The branching is carried out in the way that one of the compartments of the sporangia (or the sori) projects a little, or more from the longitudinal direction of the sporangium (the sorus).

On the same branches which possess plurilocular sporangia were found, in addition, a few ovoid—oval cells, possibly to be regarded as unilocular sporangia. The contents of plasma of these cells, which were 21—28 μ long by 15—19 μ in

diameter, were dense, occasionally differentiated into spore-like bodies (fig. 29 *C*). The conjectured unilocular sporangia were sessile (fig. 29 *A*) or short-stalked (fig. 29 *C*), sometimes obliquely inserted on the articulation, from which they issue, and obliquely descending. In one case a "sporangium" was inserted on another (fig. 29 *B*).

These cells do not seem to be identical with the ascocyst-like cells, mentioned and figured in fig. 28 *D* by Rosenvinge. The contents of these were brown and homogeneous; in my preparations dense contents of plasma were found, occasionally differentiated into spores (?).

Localities. **Kn:** Buoy at Skagen Reef (C. H. O.). — **Ke:** IO, Fladen, 11—12 m.

Sorocarpus Pringsh.

1. Sorocarpus uvæformis Pringsh.

Pringsheim, Beiträge Morph. d. Meeres-Algen, 1862, p. 9, Tafel 3 A; Reinke, Algenfl. westl. Ostsee, 1889, p. 44 (var. *balticus*).

Ectocarpus siliculosus β, *uvæformis* Lyngbye, Tent. Hydr. Dan., 1819, p. 132, Tab. 43 D.

This species was first observed by Lyngbye at Hofmansgave in 1816 and described by him in 1819 (Tent. Hydroph. Dan. p. 132) as a variety of *Ectocarpus silicu-*

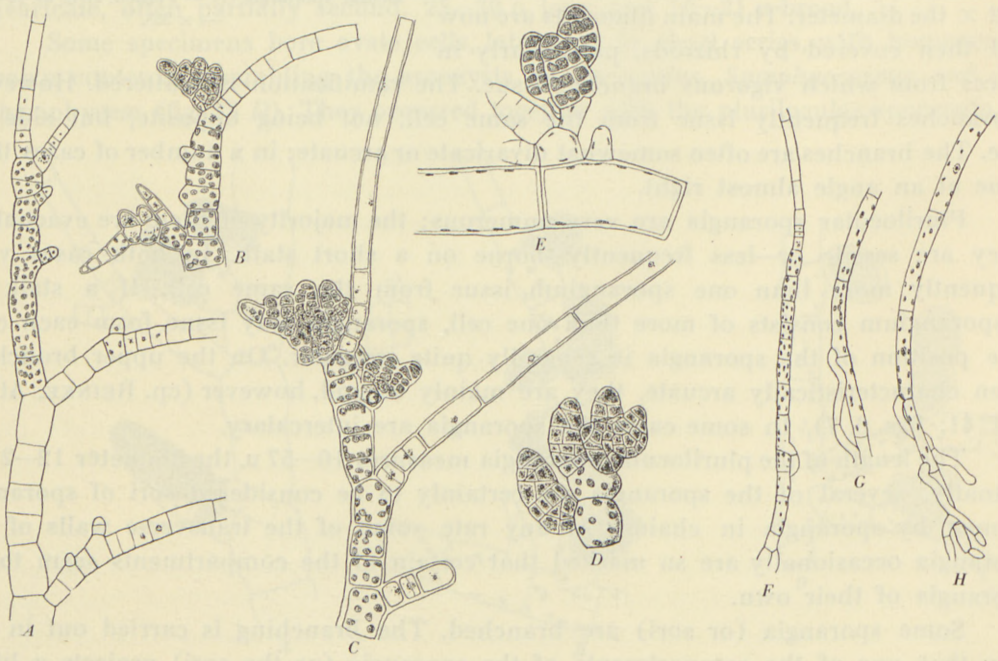


Fig. 30.

Sorocarpus uvæformis. *A*: part of a plant showing the ramification. *B*, *C*: fragments of plants with sori of plurilocular sporangia. *D*, *E*: plurilocular sporangia, partly emptied. *F-H*: lower parts of erect filaments with rhizoids growing downwards. — *A-E*: the buoy at Skagen Reef 2-V-07 (C. H. O.); *F-H*: Rosenvold, Vejle Fjord, 18-IV-33 (S. L.). — *A-C*: × 260; *D*, *E*: × 418; *F-H*: × 153. I. Frederiksen del.

losus. This form remained unnoticed till PRINGSHEIM found it at Heligoland giving a good description of it (1862) accompanied by figures. Since that time it appears to have been only rarely met with and nothing has been added to its description.

The length of the plant is about 4,5 cm. Numerous erect filaments issue from a basal disc composed of small cells arranged in radial rows. The erect filaments are 21 to 35 μ thick, in the lower parts of the filaments the cells are cylindrical, up to 6 times as long as broad; in the upper part the cells are shorter, almost of the same length as breadth and more or less barrel-shaped. The chromatophores (fig. 30 *A-H*) are numerous, disc-shaped, and their number increases in the long cells. Near the base the cells of the erect filaments produce downwards running free rhizoids (fig. 30 *F-H*), sometimes forming a loose cortication.

The filaments all end in a colourless hair with basal growing point (fig. 30 *A-C, F*), and the ramification therefore is sympodial. The filaments are much branched, and some branches end shortly in a hair, after one or a few cells.

The sori of plurilocular sporangia arise at the ends of the shoots, usually at the base of the hair or laterally; they are sessile or terminal on short unicellular stalk-cells, short-shoots which do not develop hairs. The plurilocular sporangia are densely aggregated in clusters which may be nearly globular if the sporangia are numerous. The individual sporangia are 18—25 μ long, 10,5—12 μ broad, ovate. They have always one terminal cell and are divided by transverse and vertical walls. They are emptied through an apical opening.

The species was chiefly observed in April and May, being well developed bearing numerous plurilocular sporangia. It has also been met with in July and August, but only in a few, not well developed specimens. It has always been met with in small depths. The best specimens were collected by the late professor OSTENFELD on the buoy at Skagens Reef in the first days of May.

Localities. **Ns:** Vorupør, the pier (S. L.). — **Sk:** Lønstrup, on stones near land (with *Polysiphonia violacea fibrill.*); Hirtshals, on the stony reef east of the pier; Skiveren, on a wreck near land. — **Kn:** On the buoys at Skagen Reef, triple broom and double broom (C. H. Ostenfeld); Kølpen; Døde Anders (S. L.). — **Ks:** Sjællands Reef, the outer reef near the beacon, 19. April 1894. — **Sa:** Hofmansgave, 28. April 1816 (Lyngbye). — **Lb:** between Rosenvold and Fakkegrav, Vejle Fjord, 1 m (S. L.); Thyges Hoved near Rosenvold, 2 m, March 1936, numerous plurilocular sporangia (S. L.). — **Su:** near Ellekildehage, near the coast, between *Callithamnion tetragonum* v. *fruticulosum.* — **Bw:** Middelgrund south of Sønderborg (Reinke, Algenfl. p. 44).

Streblonema Derbès and Solier.

As the demonstration of the species of this genus, which are all small and usually difficult to recognise, largely takes place during the microscopical examination of the large algae which *Streblonema* inhabits as an endophyte, the majority of the findings of *Streblonema* have been made in *Rhodophyceæ* during ROSENVINGE's going through the latter. The *Phæophyceæ*, however, to some extent are not worked out in this respect; hence it is to be expected that going through this group will give inform-

ation on new detections of *Streblonema*. Presumably *Str. sphæricum* as well as *Str. Stilophorae*, both found in Phæophyceæ, prove to belong to the flora of the Phæophyceæ of the Danish waters. For *Str. sphæricum* was detected previously on the Swedish west coast (Kylin 1907, p. 51, Levring 1935, p. 21) and in the Baltic (Reinke 1889, p. 41; Ridelius 1933, p. 79 and Levring 1940, p. 26) just as *Str. Stilophorae*, too, was found on the Swedish west coast (Levring 1935, p. 19) (and possibly in the western part of the Baltic (Reinke 1889, p. 42)).

It is remarkable that *Str. oligosporum*—found indeed in Phæophyceæ, too, but according to Levring 1940, p. 28, being so common in *Ceramium* and in *Polysiphonia violacea* in the area of Blekinge in the Baltic that old specimens of the latter plants almost always are inhabited by them—has not been mentioned by Rosenvinge. Probably this species, noticed at the Swedish west coast (Levring 1935, p. 19) and in the Baltic (Strömfelt 1884, p. 133, Svedelius 1901, p. 104, and Levring 1940, p. 27) may be found in this country, too.

As mentioned in the introduction p. 4 the species mentioned below are not worked out in detail. The account as follows is chiefly based on some fragmentary descriptions, made by Rosenvinge and compiled by the junior author.

1. **Streblonema fasciculatum** Thuret.

Thuret in Le Jolis, Liste des Algues mar. de Cherbourg, 1864, p. 73; Le Jolis, Alg. mar. de Cherbourg 1863 (Exsicc.), no. 100.

Str. volubilis Pringsheim (non Thuret), Beitr. Morph. d. Meeres-Algen, 1862, p. 13, Taf. III, fig. B.

Ectocarpus Pringsheimii Reinke, Algenfl. westl. Ostsee, 1889, p. 42.

This species has been observed as an endophyte in *Nemalion multifidum* at several localities, where it has been found at the water-mark and near it. The thallus consists of long filaments, running horizontally, the cells of which are more or less swollen (fig. 31 *B*), occasionally almost globose. In other cases the cells are almost cylindrical. The plurilocular sporangia are usually sessile or borne on a unicellular stalk, less frequently on a 2-3 — celled stalk. They differ as to form and size. Some of them are ovoid-lanceolate with a lengthened tapering conical point. Others are spindle-shaped. They were found in August, September and November.

In addition to notes of identified specimens of these species a description exists and a drawing (fig. 32) of some specimens from Lønstrup, on which Rosenvinge remarks that they recall *Str. fasciculatum*, but that he has not noticed branched, plurilocular sporangia. Here I shall describe these plants on the basis of the notes at hand and at the same time referring to fig. 32.

The specimens were found in August in *Nemalion*; they consisted of creeping filaments, from which numerous, spindle-shaped plurilocular sporangia grow outwards. The plurilocular sporangia are given off partly directly from the creeping

filaments, partly from a short stalk, formed by one to a few cells. In the latter case, again, lateral plurilocular sporangia, likewise directed outwards, may be given off from the stalk. If the plurilocular sporangia are pedicellate, the stalk-cell may be

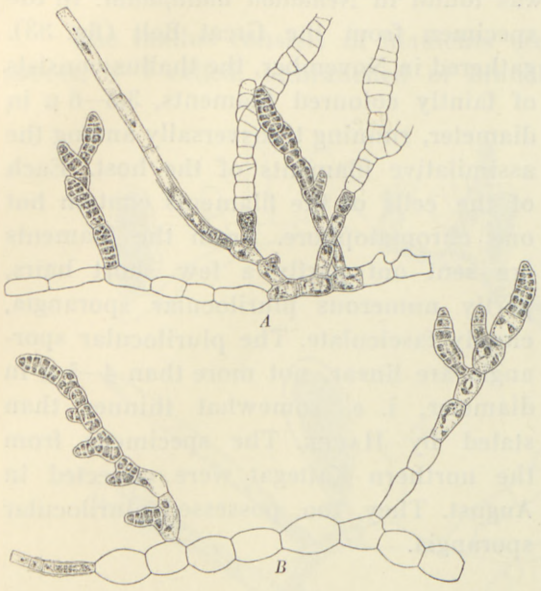


Fig. 31.
Streblonema fasciculatum. *A*, *B*: fragments of plants with plurilocular sporangia. In some of the cells chromatophores are seen. — Korsør 8-XI-92, in *Nemalion multifidum*. — *A*, *B*: × 315. A. SJÖDAL del.

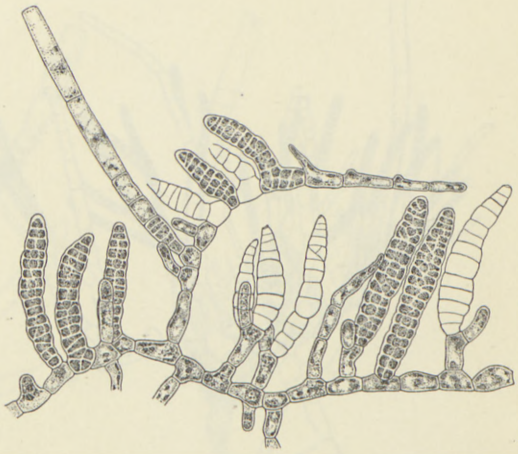


Fig. 32.
Streblonema sp. Part of a plant with plurilocular sporangia. Lønstrup, August 1890, in *Nemalion multifidum* (Warming). — × 315. A. SJÖDAL del.

comprised in the formation of spores. From the creeping filaments hair, too, having a basal growth-zone, may come out. The plurilocular sporangia are abundant. They are often fasciculate.

Localities. **Sk:** Lønstrup, August 1890 (Warming) (?). — **Kn:** Frederikshavn harbour, the northern pier. — **Ks:** Nykøbing S. — **Sb:** Korsør. — **Sf:** Rudkøbing.

2. **Streblonema aequale** Oltmanns.

OLTMANNS, Ueber einige parasitische Meeresalgen, 1894, p. 214, Taf. 7, figs. 14—16; HAMEL, Phéophycées de France, I, 1931, p. 69; LEVRING, Algenveg. von Blekinge, 1940, p. 30, fig. 4 A-C.
Phaeostroma aequale (OLTMANNS) KUCKUCK, Bemerkungen, II, 1897, p. 385, fig. 11.

Noticed with ripe plurilocular sporangia in old plants of *Chorda filum*, gathered on January 6th 1895.

Localities: **Kn:** Busserev near Frederikshavn.

3. **Streblonema tenuissimum** Hauck.

Hauck, Die Meeresalgen Deutschlands und Oesterreichs, 1885, p. 323.

This species has been gathered a few times, partly in the northern Kattegat, partly in the Great Belt. In both cases it was found in *Nemalion multifidum*. In the specimen from the Great Belt (fig. 33), gathered in November, the thallus consists of faintly coloured filaments, 3,5—6 μ in diameter, running transversally among the assimilative filaments of the host. Each of the cells of the filaments contain but one chromatophore. From the filaments are sent out partly a few short hairs, partly numerous plurilocular sporangia, closely fasciculate. The plurilocular sporangia are linear, not more than 4—5 μ in diameter, i. e. somewhat thinner than stated by Hauck. The specimens from the northern Kattegat were collected in August. They, too, possessed plurilocular sporangia.

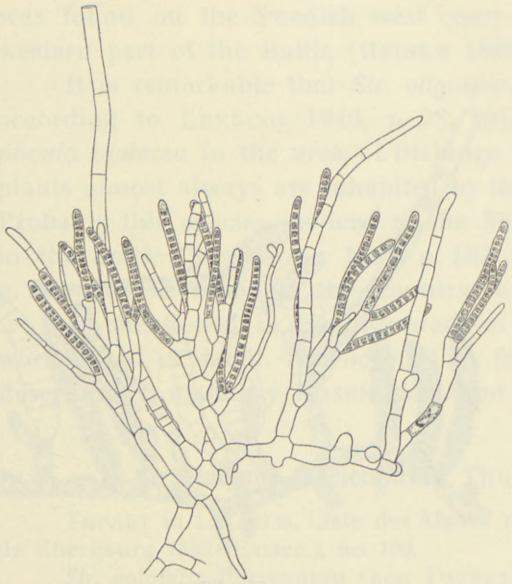


Fig. 33.
Streblonema tenuissimum. Part of a plant with plurilocular sporangia. — Kjerteminde 10-XI-92, in *Nemalion multifidum*. — × ?.— A. Sjödal del.

Localities. **Kn:** Frederikshavn. The outer side of the northern pier. — **Sb:** Kjerteminde.

4. **Streblonema effusum** Kylin.

Kylin, Algenfl. d. schw. Westküste, 1907, p. 49, fig. 13; Levring, Algenfl. v. Kullen, p. 20, fig. 3 G-K; Algenveg. v. Blekinge, 1940, p. 29, fig. 4 D-E.

Observed in *Ceramium Areschougii*, *C. diaphanum*, *Cystoclonium*, and *Polysiphonia urceolata*. From the creeping, endophytical filaments plurilocular sporangia and hyaline hairs with a basal growing-zone are sent out. The plurilocular sporangia protrude from the surface of the host; they often are borne on a unicellular stalk. They are ovoid or ovoid-conical. In the specimens from *Ceramium Areschougii* they were 42—50 μ long by 15—18 μ in diameter; in the plants from *Cystoclonium* they were shorter, the length measuring 28—34 μ, while the diameter in both cases was equal (16—18 μ). The plurilocular sporangia were observed in July and August.

Localities. **Kn:** The east side of Græsholm; Borrebjerg's Reef (Th. Mortensen); the northeast side of Deget. — **Sm:** Stege Nor (S. Lund, Algenveg. in Stege Nor, 1934, p. 30).

5. **Streblonema Thuretii (?)** Sauvageau.

Sauvageau, Second Mémoire sur les Algues phéosporées de Villefranche-sur-Mer, Bull. stat. biol. d'Arcachon, T. 33, 1936, p. 199, fig. 19 A-D.

From a few localities in the northern Kattegat a few specimens of *Streblonema*, not determined, are at hand, collected in July. Both times endophytic in *Mesogloia vermicularis*, growing between the assimilative filaments of this plant. ROSENVINGE gives the following description of them.

The thallus consists of filaments creeping horizontally, giving off short, erect shoots, 3—7 celled, unbranched or branched, 12—16,5 μ in diameter (fig. 34 *A—C*).

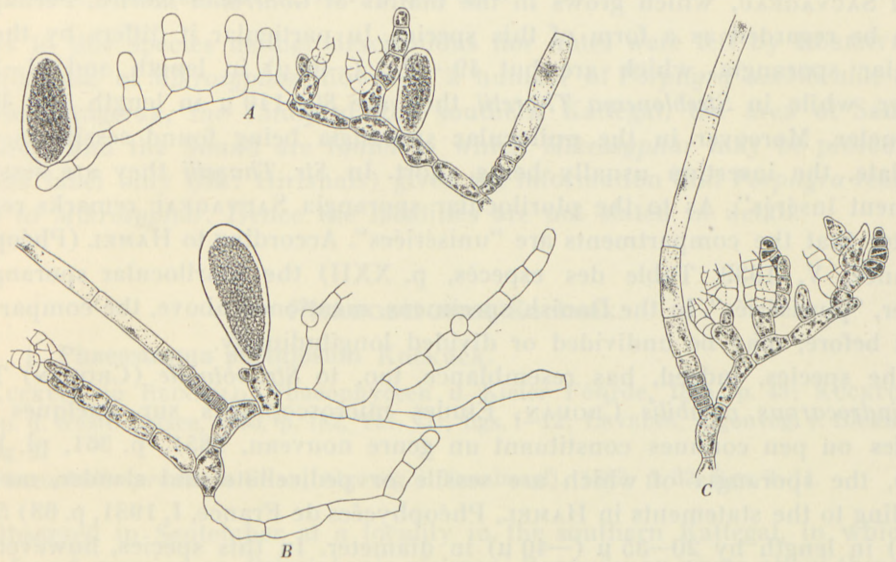


Fig. 34.
Streblonema Thuretii (?). *A, B*: fragments of plants with unilocular and plurilocular sporangia. *C*: fragment of a plant with plurilocular sporangia. Chromatophores are seen in *A* as well as in *B* and *C*. — Kølpen, 5 m, 14-VII-32, in *Mesogloia vermicularis*. — *A-C*: × 268. A. SJÖDAL del.

The cells contain numerous disc-shaped chromatophores. Hairs, having a basal growth-zone, come out partly from the creeping filaments (fig. 34 *A-C*), partly from the erect shoots. Similarly the diameter of the hairs measures 12—16,5 μ.

In the plants from one locality unilocular sporangia exclusively were present; they were 49—53 μ long by 21—30 μ in diameter. In the plants from the other locality unilocular as well as plurilocular sporangia were found. The unilocular sporangia from these plants were 58—72 μ in length (a single one, however, 90 μ) by 21—29 μ in diameter. The unilocular sporangia in both cases were oval, ovoid or ob-ovoid. They were either sessile (fig. 34 *A, B*) or borne on a unicellular (in a single case, however, on a 3-celled) stalk, coming out either from the creeping filaments directly, or from the erect shoots.

The plurilocular sporangia were 21—42 μ long by 10,5—18 μ in diameter. Probably they contain in each compartment usually one spore only; in several

cases, however, the compartments were divided longitudinally. They occur partly single, partly clustered. They are frequently borne on a short unicellular stalk (fig. 34 *C*), coming out from the creeping filaments; occasionally their position is at the apex of a longer shoot (fig. 34 *B* to the left). In other cases their position is lateral on the erect shoots (fig. 34 *A*). In a single case it was rather certain that a plurilocular sporangium was sessile, directly on a creeping filament.

This species presumably is to be regarded as closely allied to *Streblonema Thuretii* Sauvageau, which grows in the thallus of *Gontrania lubrica*. Perhaps it is even to be regarded as a form of this species. In particular it differs by the small unilocular sporangia, which are but 49—72 μ (—90 μ) in length and 21—30 μ in diameter, while in *Streblonema Thuretii* they are 80—110 μ in length and 40—55 μ in diameter. Moreover in the unilocular sporangia being found sessile as well as pedicellate, the insertion usually being short. In *Str. Thuretii* they are sessile and "largement insérés". As to the plurilocular sporangia Sauvageau remarks regarding the latter that the compartments are "unisériées". According to Hamel (Phéophycées de France, V, 1939, Table des especès, p. XXII) the plurilocular sporangia are, however, "plurisériés". In the Danish specimens, mentioned above, the compartments, as said before, may be undivided or divided longitudinally.

The species, indeed, has resemblance, too, to *Str. volubile* (Crouan) Thuret (= *Cylindrocarpus volubilis* Crouan, Études microscopiques sur quelques Algues nouvelles ou peu connues constituant un genre nouveau, 1851, p. 361, pl. 17, figs. 14—18), the sporangia of which are sessile or pedicellate and slender, measuring (according to the statements in Hamel, Phéophycées de France, I, 1931, p. 68) 50—70 μ (—80 μ) in length by 20—35 μ (—40 μ) in diameter. In this species, however, plurilocular sporangia are not known.

Localities. **Kn:** East of Tyskerens Reef, 11 m; at Kølpen, 5 m.

6. **Streblonema infestans** (Gran) Batters.

Knight and Parke, Manx Algæ, 1931, p. 60, pl. XIX, fig. 78.
Endodictyon infestans Gran, Kristianiafjordens algeflora, I, 1897, p. 47, Tab. I, figs. 12—17.

Gathered on August 8th 1905 at a locality in the North Sea at a depth of 12.5 m. The plants were found growing in Bryozoa, in their turn expanded on a shell of *Buccinum*. They could be recognized on the bryozoans as a brown patch. The plants possessed plurilocular sporangia; they corresponded with Gran's description.

Localities. **Ns:** aR, the double broom at Søren Bovbjergs Knob in S. E. to E. $^2/_3$ E. $1^1/_4$ miles, 12,5 m.

Mikrosyphar Kuckuck.

It is to be expected that this genus, in the Danish waters, will be represented by three species: *M. Zosterae*, *M. Porphyrae*, and *M. Polysiphoniae*. For *M. Zosterae*

has been recorded from the Swedish west coast (KYLIN 1907, p. 47) as well as from the Baltic (KUCKUCK 1895, p. 177; SVEDELIUS 1901, p. 105, and LEVRING 1940, p. 24). *M. Porphyrae* likewise has been found at the Swedish west coast (KYLIN 1907, p. 47; LEVRING 1935, p. 18), which applies, too, to *M. Polysiphoniae* (LEVRING 1935, p. 18). Up till now, however, *M. Porphyrae* only has been noticed in Denmark.

1. **Mikrosyphar Porphyrae** Kuckuck.

KUCKUCK, Bemerkungen, II, 1897, p. 381, fig. 6.

As to this species neither descriptions nor notes were left by ROSENVINGE. In the herbarium of *Mikrosyphar*, however, a number of *Porphyra umbilicalis*, deriving from the Skagerak, the Limfjord, the southern Kattegat, the area of Samsø, the Little Belt, and the Sound are found in which *Mikrosyphar* may be present. However, one label only (**Sk:** Hirtshals) gives the information that *Porphyra* really gives shelter to *Mikrosyphar*. Hence the localities are not stated in detail.

Phaeostroma Kuckuck.

1. **Phaeostroma pustulosum** Kuckuck.

KUCKUCK in REINBOLD, Phaeophyceen d. Kieler Föhrde, 1895, p. 43; KUCKUCK, Neue Phaeosp. d. westl. Ostsee, 1895, p. 182, Taf. VII, figs. 1—12; LEVRING, Algenveg. v. Blekinge, 1940, p. 24, fig. 2.

Phaeocladia prostrata GRAN, Algeveg. i Tønsbergfj., 1893, p. 32, figs. 9—11.

Observed in September at a locality in the southern Kattegat, in which place it was found growing on *Polysiphonia violacea*. ROSENVINGE wrote about these plants: "They form branched filaments on the surface of the host plant. Sporangia presumably mainly unilocular". Moreover recorded from the Little Belt in July; these specimens were found on old leaves of *Zostera* in company with *Ralfsia clavata*; they possessed plurilocular sporangia.

Localities. **Ks:** Havknudeflak, 8—9 m. — **Lb:** The beach west of Snoghøj.

Acinetosporaceae.

Acinetospora Bornet.

1. **Acinetospora pusilla** (Griff.) Bornet.

BORNET, Note sur quelques *Ectocarpus*. Bull. Soc. Bot. France, t. 38, 1891, p. 370; SAUVAGEAU, Les *Acinetospora* et la sexualité de la Tiloptéridacées. Journ. de Bot., t. 13, 1899, p. 107; KYLIN, Über die Entwicklungsgeschichte und die system. Stellung der Tilopterideen. Ber. d. Deut. Bot. Ges., 1917. Bd. 35, p. 305; NEWTON, Handbook of the British Seaweeds, 1931, p. 210; HAMEL, Phéophycées de France, I, 1931, p. 75.

Ectocarpus pusillus GRIFFITHS in WYATT, Alg. Danm., 1835, no. 212; HARVEY, Manual,

1841, p. 41; Phyc. Brit., II, 1849, pl. CLIII; Engl. Botany Suppl., Vol. IV, 1849, tab. 2872; Bornet, l. c. p. 4; Sauvageau, Note sur l'*Ectocarpus pusillus* Griffiths. Journ. de Bot., t. 9, nos. 15, 16, and 17, 1895; Sur la végétation et la sexualité des Tiloptéridales. Bull. Stat. Biol. d'Arcachon, t. 25, 1928, p. 51; Børgesen, Mar. Alg. Canary Islands, II, Phæophyceæ, 1926, p. 30. D. Kgl. D. Vidensk. Selsk., Biol. Medd. VI, 2.

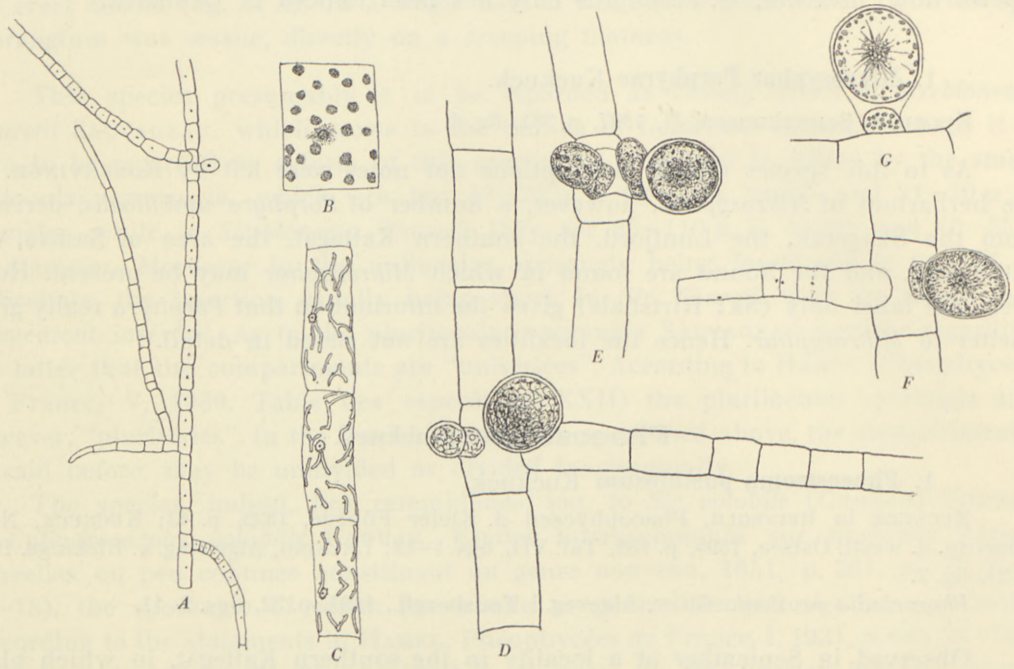


Fig. 35.

Acinetospora pusilla. *A*: part of a plant showing the ramification and the growing zones. *B*: vegetative cell with nucleus and chromatophores. *C*: 3 vegetative cells with nucleus and branched threads containing refractive granules. In *D-G* monosporangia are seen. — *A-C*, *E-F*: Mullerne, 5 m, 26-VII-05; *D*: S. E. of Deget, 8-9 m, 24-VII-03. — *A*: × 48; *B*, *F*, *G*: × 260; *C-E*: × 210. I. Frederiksen del.

As mentioned in the introduction to *Ectocarpus paradoxus* (p. 53) of this species only plants bearing monosporangia seem to occur in the Danish waters. The description of these as follows is due to a compilation made from Rosenvinge's original manuscript of the monosporangia-bearing plants, and later additional notes.

The specimens were partly found in the western part of Limfjorden, partly in the northern Kattegat near Frederikshavn. The plants from Limfjorden were dredged in July in Nissum Bredning off Mullerne, occurring in the muddy bottom at a depth of 5 m accompanied by *Cladophora gracilis* and *Polysiphonia nigrescens*. The wisps were some centimetres long, but the length of the plants was doubtful, since they were not with certainty observed attached to the substratum. The filaments were 32—45 μ in diameter; they consisted of cells which were 1—4 times as long as broad. The cells contain a single nucleus and numerous globose, disc-shaped chromatophores (fig. 35 *B*). In a number of cells, in particular probably in rather old cells, the latter are

replaced by slender, flat threads, often branched, to all appearance hyaline, frequently radiating from the nucleus, the position of which is a more or less central (fig. 35 *C*). Some very small, dense, refractive granules, the nature of which could not be made out, lie scattered in these threads. These cells seem to be faintly coloured.

The filaments are only slightly branched. The branches issue scattered and at right angles. Some are short corresponding to the hapteræ described by BORNET and SAUVAGEAU. Other branches are longer terminating in a hairlike tip, following a short-celled growing zone (fig. 35 *A*).

The monosporangia occur solitarily (fig. 35 *F*) or, more frequently, 2—3 in clusters (fig. 35 *E*). They are usually borne on a unicellular stalk generally issuing opposite or next to a branch (fig. 35 *F*). A secondary monosporangium (possibly two) not infrequently comes out from the stalk of a primary sporangium (fig. 35 *E*). The monosporangia are 45 μ long by 31—38 μ in diameter.

In the middle of the monospore is a nucleus surrounded by a dense mass of protoplasm, which radiates from the centre containing a great number of chromatophores (fig. 35 *G*). The peripheral part, too, of the sporangium contains numerous, usually roundish chromatophores. At the complete ripeness of the monospore a particular membrane is seen inside the membrane of the sporangium.

Plants quite similar were found in July south east of Deget in the northern Kattegat (fig. 35 *D*). The species occurred in this place sparingly in the depth of 8–9 m accompanied by *Polysiphonia nigrescens* and *Ectocarpus siliculosus*. The diameter of the filaments of these specimens measured 30—56 μ. The cells from which sporangia or branches issued were shorter than the other cells. Most of the sporangia were attached to a unicellular stalk; they were 46—53 μ long by 32—42 μ in diameter.

Localities. **Lf:** ZV, the beacon at Mullerne E. 2½ miles, 5 m. — **Kn:** S. E. of Deget, 8—9 m.

Haplospora Kjellm.

1. **Haplospora globosa** Kjellm.

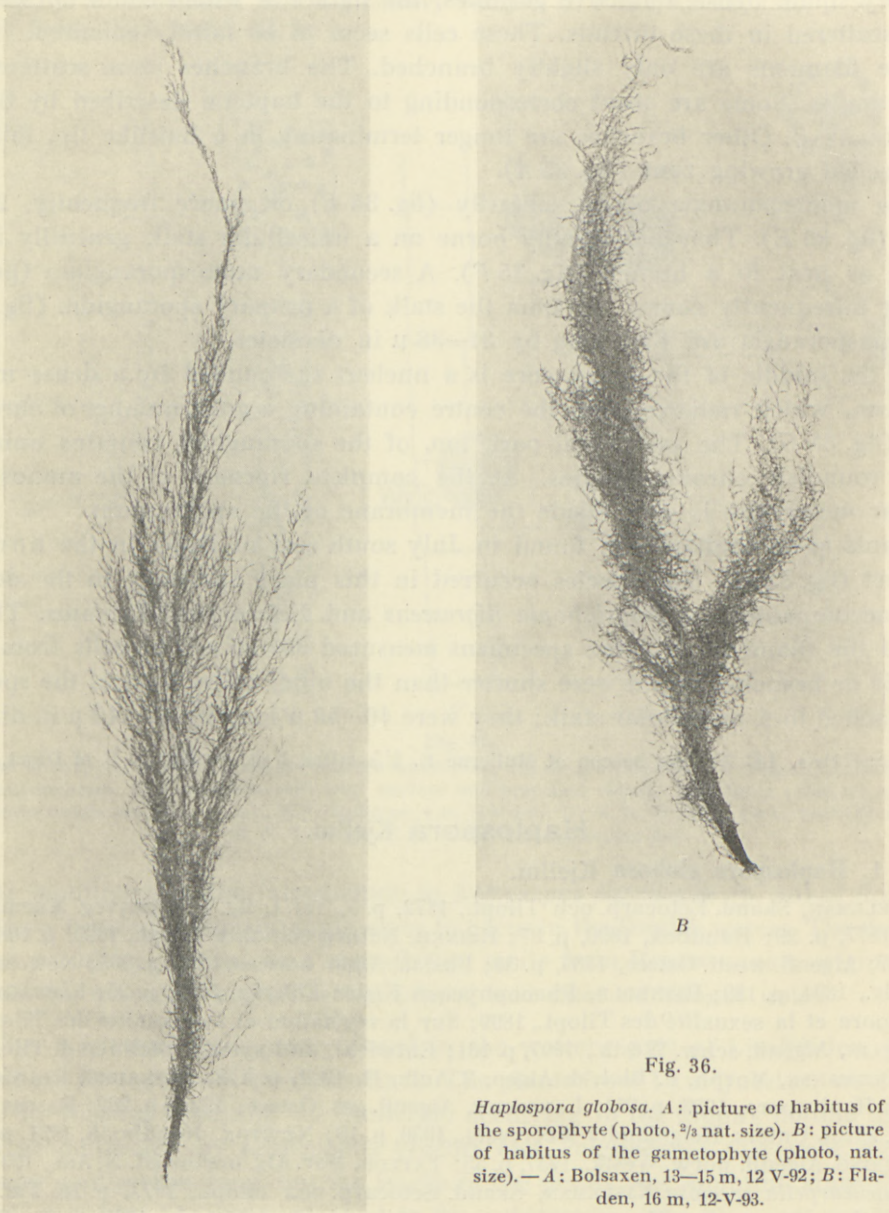
KJELLMAN, Skand. Ectocarp. och Tilopt., 1872, p. 5, Taf. I, fig. 1; Algenveg. Murmanschen Meeres, 1877, p. 29; Handbok, 1890, p. 87; REINKE, Naturgeschichte Tilopt., 1889, p. 108, Taf. II, figs. 1—17; Algenfl. westl. Ostsee, 1889, p. 34; FOSLIE, Algol. notices, 1891, p. 265; New or critical Norw. Alg., 1894, p. 139; REINBOLD, Phaeophyceen Kieler Föhrde, 1895, p. 25; SAUVAGEAU, Les Acinetospora et la sexualité des Tilopt., 1899; Sur la végétation et la sexualité des Tilopt., 1928, p. 51; KYLIN, Algenfl. schw. Westk., 1907, p. 101; Entwickl. und system. Stellung d. Tilopt., 1917, p. 299; OLTMANNS, Morph. u. Biol. d. Algen, 2. Aufl., II, 1922, p. 172; NIENBURG, Entwickl. Helgoländer Haplospora, 1923, p. 211; LAKOWITZ, Algenfl. ges. Ostsee, 1929, p. 282; DAMMANN, Entwickl. u. zytol. Unters. Helgoländer Meeresalg., 1930, p. 19; NEWTON, Handbook, 1931, p. 208, fig. 131; LEVRING, Algenfl. norw. Westk., 1937, p. 55; TAYLOR, Mar. Alg. northeast. N. Am., 1937, p. 137.

Capsicarpella speciosa KJELLMAN, Skand. Ectocarp. och Tilopt., 1872, p. 26, Taf. I, fig. 3.

Scaphospora speciosa KJELLMAN, Algenveg. Murmanschen Meeres, 1877, p. 30; Handbok, 1890, p. 88; REINKE, Naturgeschichte Tilopt., 1889, p. 125, Taf. III, figs. 1–20; MURRAY, Seaweeds, 1895, fig. 10 a.

Scaphospora arctica KJELLMAN, Algenveg. Murmanschen Meeres, 1877, p. 31, figs. 1–15; K. ROSENVINGE, Deuxième mémoire, 1898, p. 48.

The sporophyte in the Danish waters has been recorded from 14 localities generally occurring in the depth of 10—13 m. In a few places in the southern part



A *B*

Fig. 36.

Haplospora globosa. *A*: picture of habitus of the sporophyte (photo, ⅔ nat. size). *B*: picture of habitus of the gametophyte (photo, nat. size). — *A*: Bolsaxen, 13—15 m, 12 V-92; *B*: Fladen, 16 m, 12-V-93.

of the Little Belt as also from a locality in Langelandsbælt it has been found at a depth of 18—22 m. In these places, in which it is epiphytic on various Rhodophyceae

(*Polysiphonia nigrescens*, *Phycodrys*, *Delesseria* (?) and *Phyllophora Brodiaei*), it was however, much reduced being represented only by a few branched filaments. In a locality in the Great Belt (between Slipshavn and Knudshoved), it occurred as loose fragments, accompanied by the gametophyte, together with *Ectocarpus confervoides* f. *siliculosa* at the depth of 7.5 m.

Most frequently it appears as rather flaccid tufts (fig. 36 *A*), amounting to a length of up to 23 cm. The colour of the plant on drying is olive green or brownish. In addition to the host plants mentioned it has been noticed on *Rhodomela* and *Polysiphonia elongata*. In most cases, however, it is found on stones.

From the basal part of the main axis a number of attaching rhizoids come out, monosiphonous and polysiphonous. The main filaments in the basal portion are polysiphonous, now and then with secondary transversal walls, in the upper portion monosiphonous, even if here, too, longitudinal walls are found now and then in some of the cells. Cells with longitudinal walls occur, too, in the basal portion of the vigorous branches of the first order.

The ramification of the main filaments is generally scattered, however, not infrequently opposite. In the long shoots of the first order the branches, too, issue scattered, sometimes unilaterally. In the less vigorous branches of the first order as also in the branches of higher order the ramification is often unilateral, at any rate in a section of the branch.

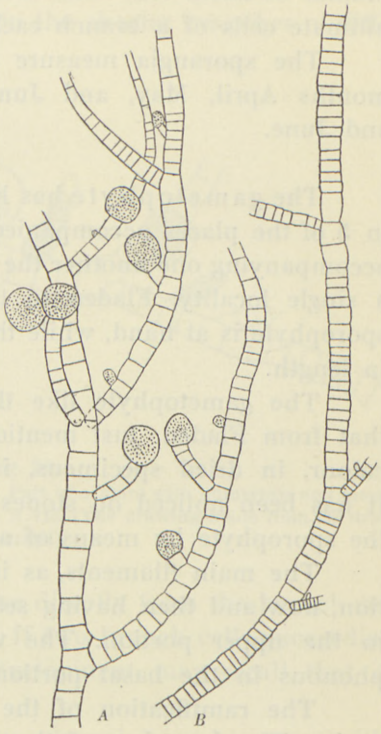


Fig. 37.
Haplospora globosa. The sporophyte. *A*: part of a plant with monosporangia. *B*: young main axis showing growing zones. — *A*: Fladen, 16 m, 12-V-93; *B*: Drogden, 14 m, 25-IV-34 (S. L.). — *A*: × 355; *B*: × 173.

In some cases two branches are sent out from the same cell in the method that one branch comes out beyond the other one. In other cases 2 branches may come out from the same cell at the same level, the angle between them, however, not reaching 180°.

In young plants all the cells of the shoots are short and capable of dividing. In plants a little older the cell division already seems to be confined to certain regions, sections with shorter cells and longer cells alternating (fig. 37 *B*). The cells contain numerous disc-shaped chromatophores and a large nucleus. In the cells, too, in the hairlike portion terminating the branches several chromatophores are found.

The diameter of the main filaments measures about 90—110 μ. It may vary, indeed, rather much in the same main filaments, even within fairly short distances. The length of the cell in full-grown cells is up to 2 × the diameter.

Quadrinucleate monosporangia generally occur terminally on branches, usually

short, sometimes somewhat arcuate (fig. 37 *A*). A great number of them are sessile, while others, again are intercalary. In the latter case the sporangium probably usually arises from a branch cell without the latter previously undergoing a longitudinal division. Now and then sporangia forming chains are met with, the 2 or 3 ultimate cells of a branch each being transformed into a sporangium.

The sporangia measure 80—105 μ in diameter. They have been found in the months April, May, and June. Evacuated sporangia have been noticed in May and June.

The gametophyte has been noticed at 6 localities at a depth of from 10—13 m, in 5 of the places accompanied by the sporophyte. If the two generations are found accompanying one another the sporophyte is generally the more abundant. Only from a single locality, Fladen in the eastern Kattegat, only very little material of the sporophyte is at hand, while the gametophyte is represented by a robust plant, 12 cm in length.

The gametophyte like the sporophyte forms tufts. The largest specimen was that from Fladen, just mentioned, the length of which was 12 cm (fig. 36 *B*). The colour, in dried specimens, is greenish (olive or dark green) or yellowish brown. It has been noticed on stones and on *Rhodomela*. It is easily distinguishable from the sporophyte by means of a lens only, because the shorter branches are recurved.

The main filaments, as in the sporophyte, are polysiphonous in the basal portion, now and then having secondary transversal walls, but monosiphonous, mainly, in the upper portion. The vigorous branches of the first order, too, are polysiphonous in the basal portion. Attaching rhizoids are found as in the sporophyte.

The ramification of the main filaments is mainly scattered, more rarely opposite. The branches of the first order are, largely, marked long shoots, which as to the ramification seem to behave like the main axes. The ramification in the great majority of the shorter branches of the first order and of 2. and 3. order is prevalently unilateral, almost always taking place from the side turned upwards.

The characteristic methods of ramification, mentioned in connection with the sporophyte, which may be found if two branches issue from the same cell, occur in the gametophyte, too.

The diameter of the main filaments measures up to 120 μ. The length of the full-grown cells is up to $1^1/_2$ times the diameter. The cells contain numerous small disc-shaped chromatophores and a large nucleus.

The plants bear antheridia as well as uninuclear monosporangia (fig. 38). In some cases the whole length of the branch bearing the antheridia is fertile, in other cases part of it, only, is fertile (the upper, the basal or the middle part. Or the branch with antheridia contains several fertile sections). The branches bearing antheridia generally are sent out from branches of 1. and 2. order, more rarely directly from the main filaments or from the branches of 3. order. Occasionally monosporangia are found, in addition, in the branch bearing antheridia.

The length of the antheridia is usually 40—175 μ; the diameter is 25—40 μ. They have been found in the months of April and May. The antheridia from April were still rather young. Some of those from May, on the other hand, were already evacuated to some extent.

The monosporangia are intercalary; they occur in the shorter branches of different orders, the number usually being 1—3 in the same branch, less frequently up to 6. However they are met with in the upper portion of the main filaments and the long shoots of 1. order, too.

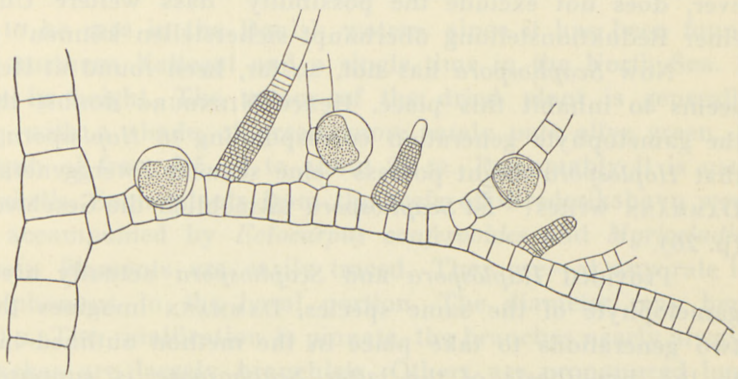


Fig. 38.
Haplospora globosa. The gametophyte. Part of a plant with antheridia and monosporangia. — Fladen, 16 m, 12-V-93. — × 115. (The drawing made from the dried material).

Usually they arise solitarily from a branch cell after this having divided longitudinally. In numerous cases, however, both of the daughter cells of the branch cell become fertile. Or the monosporangium will arise directly from the branch cell without the same having first divided longitudinally. If two branch cells succeeding one another in this manner become fertile, the development may recall that of *Tilopteris*.

In a few cases sessile monosporangia, completely external, have been met with. Such cases, however, are only rare, and plants of the kind pictured by Newton (1931, fig. 131 *B*) have not been found in the Danish waters. In this figure nearly all the sporangia (called by Newton "oogonia") are distinctly external, nay, half of them even pedicellate.

The diameter of the monosporangia is 65—82 μ. They have been found in April and May. From April, however, only young sporangia are noted; from May on the other hand several which have been evacuated.

Thus the present specimens of the gametophyte seem to be consistent with *Scaphospora speciosa* as well as *Sc. arctica*; hence, agreeing with Reinke (l. c. p. 128), I regard these plants as being identical.

That *Haplospora* and *Scaphospora* actually represent the sporophyte and the gametophyte of the same species has not been proved, indeed. Cultivation experiments on monospores of *Haplospora* have been made by Reinke (l. c.), Nienburg (1923, p. 215) and Dammann (1930, p. 19) but the seedlings did not develop reproductive organs. Nor have, presumably, the examinations of Nienburg and Dammann

on the mitosis in the sporangium of *Haplospora* proved with certainty that a meiosis actually takes place in the same.

It is true that Nienburg (l. c. p. 216) assumes that meiosis takes place. And Dammann, too, thinks it very likely that it exists, the reduction of the chromosome number having, indeed, to take place during the second mitosis. This writer, however, does not exclude the possibility "dass weitere Untersuchungen das Fehlen einer Reduktionsteilung überhaupt sicherstellen können" (p. 25).

Now *Scaphospora* has not, so far, been found at Heligoland, *Haplospora*, only, seems to inhabit this place. Hence Nienburg doubts that *Scaphospora* might be the gametophyte generation corresponding to *Haplospora*, indicating the possibility that *Haplospora* might possess "eine sexuelle Zwerggeneration" (l. c. p. 217), just as Dammann writes: "Ist *Scaphospora* tatsächlich die Geschlechtsform der *Haplospora*?" (p. 26).

Provided *Haplospora* and *Scaphospora* actually are the sporophyte and the gametophyte of the same species, Dammann imagines the alternation between the two generations to take place in the method outlined in her fig. 15, II. According to the hypothesis of the latter *Scaphospora* is supposed to possess oogonia in addition to antheridia and monosporangia. The eggs are supposed to be fertilised by the spermatozoids, giving rise to the sporophyte, in the sporangia of which the meiosis would take place. The nature of the monosporangia, on the other hand, would be asexual; they, again, would give rise to the gametophyte. — However, Dammann thinks it to be doubtful, indeed, that such a regular alternation of generations actually would take place nowadays.

Localities. **Kn:** Læsø Trindel (the sporophyte, F. Børgesen). — **Ke:** IM, Fladen (the sporophyte); IO, Fladen (the sporophyte and the gametophyte). — **Sa:** DK, Bolsaxen (the sporophyte and the gametophyte). — **Lb:** DH, Flækøjet (the sporophyte); Aarøsund (the sporophyte, Reinke); Gjenner Bugt (the sporophyte, Reinke); dH[1], east of Hesteskoen (the sporophyte); dQ, shoal south of Lyø (the sporophyte); Sønderborg (the gametophyte, Reinke). — **Sb:** between Slipshavn and Knudshoved (the sporophyte and the gametophyte); UK, Langelandsbælt, abeam Tranekjær lighthouse (the sphorophyte and the gametophyte); US[1], Langelandsbælt. Gillebjerg N. W. $^1/_2$ W., Taars lighthouse in the east (the sporophyte). — **Su:** Drogden, W. and W. N. W. of the broom "Lusekosten" (the sporophyte and the gametophyte, S. L.). — **Bw:** Flensborg Fjord (the sporophyte, Reinke).

Tilopteris Kütz.

1. **Tilopteris Mertensii** (Smith) Kütz.

Kützing, Species Alg., 1849, p. 462; Thuret, Fécondation des Fucacées, 1855, p. 6; Le Jolis, Alg. mar. Cherbourg, 1863 (Exsicc.), no. 20; Crouan, Florule Finistère, 1867, p. 163, pl. 25, fig. 160; Reinke, Naturgeschichte Tilopt., 1889, p. 155, Taf. III, fig. 21; Kjellman, Handbok, 1890, p. 89; Bornet, Note sur quelques Ectocarpus, 1891, p. 367, pl. VIII, figs. 6–10; Sauvageau, Les Acinetospora et la sexualité des Tilopt., 1899; Sur la végétation et la sexualité des Tilopt., 1928, p. 51, figs. 1–4; Kuckuck, Fortpflanzung Phaeosporeen, in Beiträge, 1912, p. 181, Taf. VIII (19), fig. 15; Kylin, Entwickl. und system. Stellung d. Tilopt., 1917, p. 303; Oltmanns, Morph. u. Biol. d. Algen, 2. Aufl., II, 1922, p. 172; Dammann, Entwickl. u. zytol. Unters. Helgoländer

Meeresalg., 1930, p. 14; NEWTON, Handbook, 1931, p. 210, fig. 132; HAMEL, Phéophycées de France, II, 1935, p. 81; TAYLOR. Mar. Alg. northeast. N. Am., 1937, p. 138.

Conferva Mertensii in Engl. Botany, XIII, 1801, pl. 999.

Ectocarpus Mertensii AG.; HARVEY, Phycol. Brit., II, 1849, pl. 132; CROUAN, Alg. mar. Finistère, 1852 (Exsicc.), no. 19.

Trichopteris Mertensii KÜTZING, Tab. phycol., V, 1855, tab. 84, fig. II.

This species seems to be rare in the Danish waters, since it has been found but a few times in the northern Kattegat and a single time in the North Sea. It forms tufts up to 10 cm in height. The colour of the dried plant is generally brownish, now and then with a shade of green, more rarely pale olive green. It has been noticed to a depth of from 6.5—8 to about 25 m. Presumably it is usually found on stones or shells. Some plants from the reefs off Frederikshavn were found on *Stenorhynchus* accompanied by *Ectocarpus confervoides* and *Myriocladia.*

In the tufts the main filaments are easily traced. They are—at any rate in several specimens—polysiphonous in the basal portion. The diameter may here measure up to about 150 μ. The ramification is pinnate, the branches nearly always being opposite. The branches are largely branchlets. Others are pronounced long shoots, while others again are intermediate forms of a very varying length. The branches taper into a hairlike portion.

The length of the cells on an average is rather short in proportion to the diameter. In the full-grown cells of the main filaments the length is up to a little more than the measure of the diameter. In the branchlets the cells are very short, frequently disc-shaped. In the hairlike portions the cells have a length of up to several times the diameter. The cells contain a large nucleus and a great number of small disc-shaped chromatophores.

Monosporangia with a single nucleus are found in abundance in the branchlets; they are intercalary. They generally occur by two in continuation of one another, in several cases, however, singly. In other cases their localisation is by 3 or 4 in continuation of each other. Now and then two fertile sections occur in one branchlet (cp. THURET, p. 6).

The length of the monosporangia usually measures 53—74 μ (—78 μ), the diameter (50—) 53—66 μ (—70 μ). Evacuated monosporangia and monosporangia quite young are often found on the same plant.

The monosporangia have been noticed in the month of July only (all the present specimens were collected in this month). Plurilocular sporangia have not been noted.

The germination of the monospores, often beginning as early as in the monosporangium, has been observed by several workers. DAMMANN (l. c.) succeeded in forcing plants, derived from isolated monospores, to fructification. These plants again produced monosporangia.

In literature the monospores are described having a single nucleus. However, REINKE (l. c.) found in plants from Heligoland, bearing nothing but monosporangia,

in the old monosporangia 2—4 or more nuclei. Now, plants having been observed in nature, too, bearing plurilocular sporangia (antheridia) in addition to monosporangia, Reinke concluded that plants bearing monosporangia exclusively, are asexual, whereas those bearing antheridia in addition are sexual. The monosporangia in the sexual plants were then to be interpreted as oogonia.

Kylin (l. c.), too, enters into this view. He presumes that a regular alternation of generations exsists between a gametophyte with monosporangia and antheridia and a sporophyte with monosporangia. Meiosis would take place in the monosporangia of the sporophyte.

According to recent investigations, however, the signification of sexual cells cannot be attributed to the monospores. Thus Sauvageau (1928) writes that they, at the French coasts, "se comportent comme des propagules" (p. 91). Dammann states similarly interpreting them as a "Nebenfruktifikationsart" (p. 19).

The oogonia are supposed, by this writer, to consist of some large cells, mainly found in the basal, more rarely in the middle portion of the antheridia. The spores of these large cells are capable of developing by parthenogenesis, forming new plants having monosporangia. However, Dammann thinks it probable that a fertilisation of these spores formerly has taken place, at any rate. If so meiosis would take place in the sporophyte, presumably in the monosporangia of the same; hence they would have four nuclei like those of *Haplospora*. For the rest see the diagram in Dammann's figure (15 I).

Localities. **Ns:** ZQ, Jyske Reef. Lodbjerg lighthouse in E. to S. $26^1/_2$ miles, 24.5 m. — **Kn:** Tyskerens Reef near Hirsholmene, 6.5—8 m; between Brune Reef and Laurs' Reef; off Bangsbostrand (in the fishing net). — **Ke:** FC, east of Flyndergrund, east of Læsø.

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