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ON SOME DANISH PHÆOPHYCEÆ

BY

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WITH CONTRIBUTIONS BY

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WITH 41 FIGURES

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After finishing my survey of the Danish Rhodophyceæ I have undertaken the examination of the Phæophyceæ. I had intended to treat them in the systematical order, but as the first groups to be dealt with according to this arrangement would call for much labour, I prefer to begin by publishing some genera which have been worked out.

A number of the figures have been drawn by Mag. A. Sjödal, others by Miss Ingeborg Frederiksen under my supervision, or by Mag. Søren Lund.

Mag. Søren Lund has assisted me in the work. Especially in the *Elachistaceæ* he has worked out independently special questions, which are given below by his own words.

Stictyosiphon Kützing.

The genus *Stictyosiphon* was founded in 1843 by Kützing (Phycol. generalis p. 301) on *St. adriaticus* found in the Adriatic Sea. In 1873 Areschoug described a new genus *Phloeospora* founded on the species *Ph. subarticulata* which had formerly been confounded with *Dictyosiphon foeniculaceus.* Hauck has (Meeresalgen Deutschlands u. Oesterreichs, p. 374) united the two genera under the oldest name. Of sporangia only unilocular ones were known till Reinke showed in 1892 (Atlas deutscher Meeresalgen, Heft 2, p. 49, Taf. 31, 32) that the supposed unilocular sporangia of *St. tortilis* were really plurilocular, the septa disappearing before the setting free of the zoospores.

1. Stictyosiphon tortilis (Rupr.) Reinke.

Reinke, Algenflora d. westl. Ostsee, 1889, p. 55. *St. subarticulatus* Rke., ibid., p. 54; Atlas deutscher Meeresalgen, 2. Heft, 1892, Taf. 31 und 32, p. 47. Kuckuck, Beitr. z. Kenntn. d. Meeresalgen; Wissensch. Meeresuntersuch. V. Bd, Heft 3, 11, Die Fortpflanzung der Phaeosporeen, 1912, p. 163, Taf. VIII, Fig. 2.

Scytosiphon tortilis Ruprecht, Tange des ochotskischen Meeres, Middendorff's Sibirische Reise, Theil 2, 1856, p. 373.

Dictyosiphon tortilis Gobi, Brauntange d. Finn. Meerbusens, St. Pétersbourg, 1874, pag. 15, tab. 2, figs. 12—16.

Phloeospora subarticulata Aresch., Botan. Notiser 1873, p. 163, Observ. phycologicae III, 1875, p. 25, Tab. III, figs. 2—5; Exsicc. Fasc. 2 et 3, 1862, No. 104 *(Dictyosiphon foeniculaceus* var. *subarticulatus*); Kjellman, Handbok, 1890, p. 54.

Scytosiphon foeniculaceus Lyngb. ex pte. Hydr., 1819, p. 64.

Phloeospora tortilis Areschoug, Botaniska Notiser, 1876, p. 34; Kjellman, Spetsb. mar. klorofyllför. Thallofyter II, 1877, p. 40, tafl. I, fig. 21; Areschoug, Exsicc. 1879, Fasc. IX, No. 413; Kjellman, Handbok, p. 55.

The fronds spring from a fairly thick brown disc of parenchymatic structure, composed of large quadrangular cells divided by horizontal walls and thus arranged in vertical rows. A disc frequently grows over another disc, and the whole basal portion may thus obtain a considerable thickness. A number of fronds are usually given off from the same basal disc (fig. 3).

The structure of the frond has been described by Reinke at length and illustrated by Kuckuck in Atlas d. M. The frond contains inmost four rows of long, cylindrical cells without any hole in the centre. The diameter of the central cells is larger than that of the surrounding cells which form a cortex of one or two layers. The cells contain a number of chromatophores each. When several fronds spring from each basal disc, the particular fronds usually bear no branches below but only in the higher part.

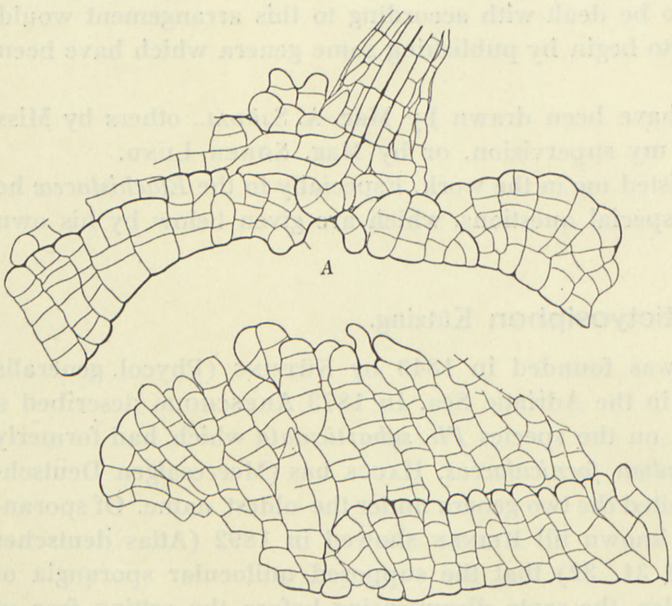

Fig. 1.
Stictyosiphon tortilis. Vertical sections of basal discs. *A*, with an erect shoot. *B*, two crusts growing over each other. 202:1. A. Sjödal del.

The plurilocular sporangia have been observed in almost all seasons, but most frequently in high-summer; they were met with in January and April to September. They are often very protruding. The sporangia agreed fully with the exhaustive description of Reinke and the excellent figures of Kuckuck (also 1912). When ripe they may be much like unilocular sporangia, but it is easy to find stages showing straight walls separating the zoospores (figs. 4, 5). It has also been possible to me to see the septa of the sporangia by using eau de Javelle, and in some few cases I have been able to see the non-dissolved sporangial walls in partly emptied sporangia. When Sauvageau (1929, p. 392) explains that he has not been able to see the walls between the spores in a herbarium specimen sent to him by Kuckuck designated by him as bearing plurilocular sporangia, even after treatment with eau de Javelle, and that the spores appeared to have the arrangement as "des noix dans un sac", it must be said that the zoospores in the ripe sporangia may really show this arrangement (comp. Atlas, plate 32, figs. 8—12), and that it must provisionally be supposed that only plurilocular sporangia are known in this species.

The species is spread in all the Danish waters except the North Sea and it has only been met with in one place in the Skagerak, and in one locality in the western Limfjord. It usually grows between 2 and 20 meters' depth but may occur in more shallow water (0—2 m), and has been met with in down to 35 meters' depth (Lille Belt). It often grows in bundles of close long plants from a common basal disc, the plants reaching a length of 20 to 32 cm or longer, up to 50 cm, with a main axis, simple below, but branched only at a higher level, or having usually only short branches on the lower portion. The main shoots can be distinguished to the top of the bunch. The shoots terminate in a monosiphonous point which divides by transverse and later by vertical walls and bears a terminal and several lateral often opposite or verticillate hyaline hairs.

The branches are alternate, rarely opposite.

The species has been met with at all seasons. The growth takes place principally in spring and generally ceases at the end of summer, and many plants or parts of plants are then dying, but growing plants may be met with in winter, e. g. in January, when fructifying specimens with growing apices have been gathered near Copenhagen.

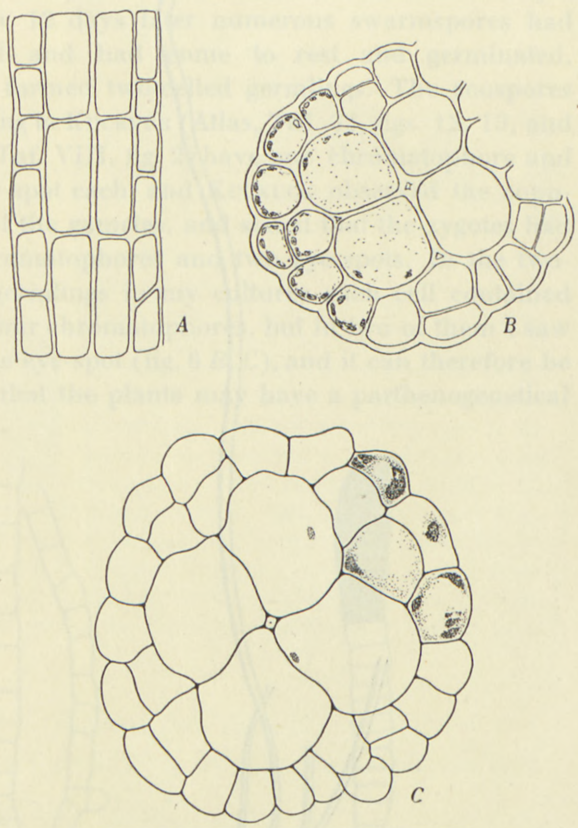

Fig. 2.
Stictyosiphon tortilis, frond growing on *Aporrhais*. *A*, longitudinal section. *B*, and *C*, transverse sections of frond, *C*, A. Sjödal del. *A* 200:1, *B* 346:1, *C* 420:1.

In the neighbourhood of Frederikshavn an alga was repeatedly met with growing on the tests of *Aporrhais pes pelecani*. It formed grey-brown tufts, 2—5 cm high, springing from a thick basal disc like that of *Stictyosiphon tortilis*. The shoots were unbranched, 77—140 μ thick. The upper end was thrown off. Hairs were wanting. The structure of the stem agreed with that of *Stictyosiphon tortilis*, having four rows of large, long cells in the middle, surrounded by one or two layers of smaller cells. I have once found in a tuft of this plant a shoot bearing branches fully agreeing with *Stictyosiphon tortilis*, and I have therefore no doubt of the identity of these plants, so much the more as typical, much branched specimens have been found growing on the same substratum. I think that the plants here described were the lowermost portions of old plants which had thrown off the upper fructifying portions of the frond. The lowermost remaining portions

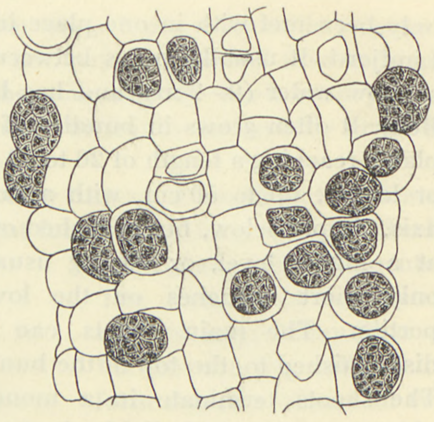

Fig. 4.
Stictyosiphon tortilis, mostly unbranched, growing on *Aporrhais*. Frond with plurilocular sporangia. 280:1. I. Frederiksen del.

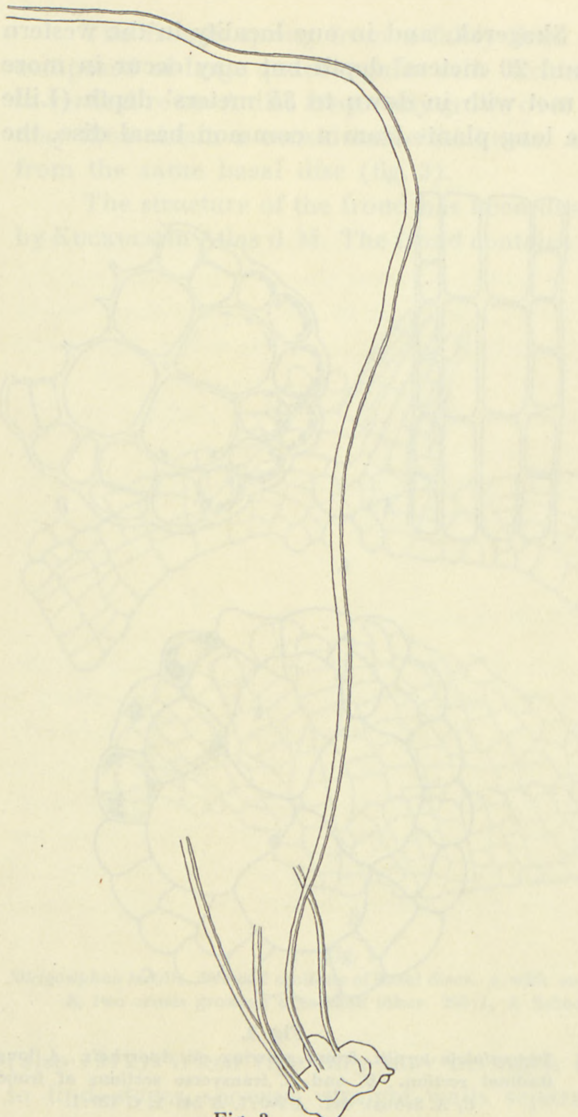

Fig. 3.
Stictyosiphon tortilis, growing on *Aporrhais*. Basal disc with erect shoots. 9:1.

Fig. 5.
Stictyosiphon tortilis, growing on *Aporrhais*. Plurilocular sporangia. 350:1.

were for the rest often fructifying and showed plurilocular sporangia like those of the typical species.

The above-mentioned unbranched specimens further agree in structure with *Pogotrichum filiforme* var. *setiforme* K. Rosenv., Grønl. Havalger, 1893, p. 869, fig. 18, found in West Greenland. The Greenland plant, however, becomes thicker and is more attenuated toward the base. The relationship of this form must be left for further investigations, but I think it is a real *Pogotrichum* (*Litosiphon*).

Cultures from zoospores from the plurilocular sporangia were arranged in Frederikshavn in the Laboratory of Marine Biology in July 1933. On the 11th July plants were put in glass vessels with smooth or sandblown slides on the bottom or in an oblique position. 12 days later numerous swarmspores had escaped and had come to rest and germinated, having formed two-celled germlings. The zoospores according to KUCKUCK (Atlas, Taf. 32, figs. 12, 13, and Beitr., Taf. VIII, fig. 2) have one chromatophore and one eye-spot each, and KUCKUCK observed the copulation of the gametes, and stated that the zygotes had two chromatophores and two eye-spots. In the two-celled germlings in my cultures each cell contained two to four chromatophores, but in two of them I saw only one eye-spot (fig. 6 *B*, *C*), and it can therefore be stated, that the plants may have a parthenogenetical

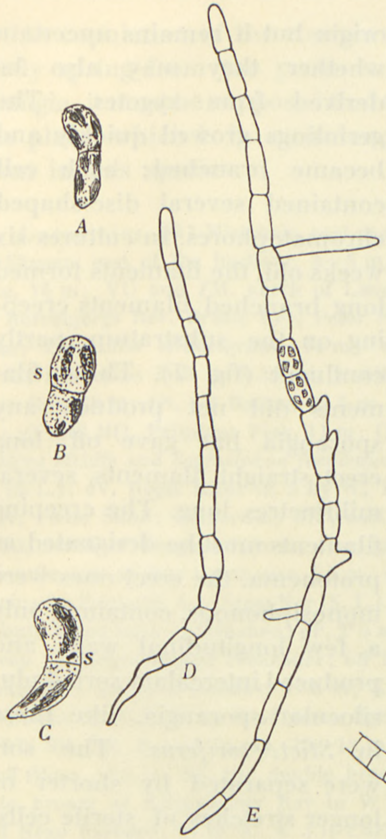

Fig. 6.
Stictyosiphon tortilis. Germinating zoospores, *A-C*, *D*, *E*, germlings two weeks old. *A*, *D*, *E*, 300:1, *B*, *C*, 520:1. *s* in figs. *B* and *C* stigmas.

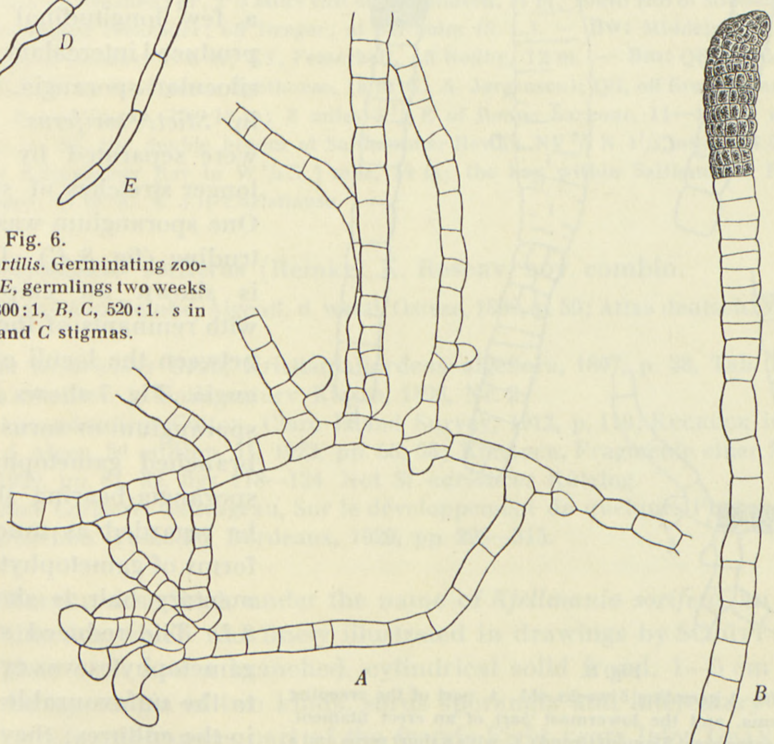

Fig. 7.
Stictyosiphon tortilis, germling 5 weeks old. Horizontal filaments partly confluent. Erect filament, the upper part in *B* with a long plurilocular sporangium or sorus. 280:1. I. F. del.

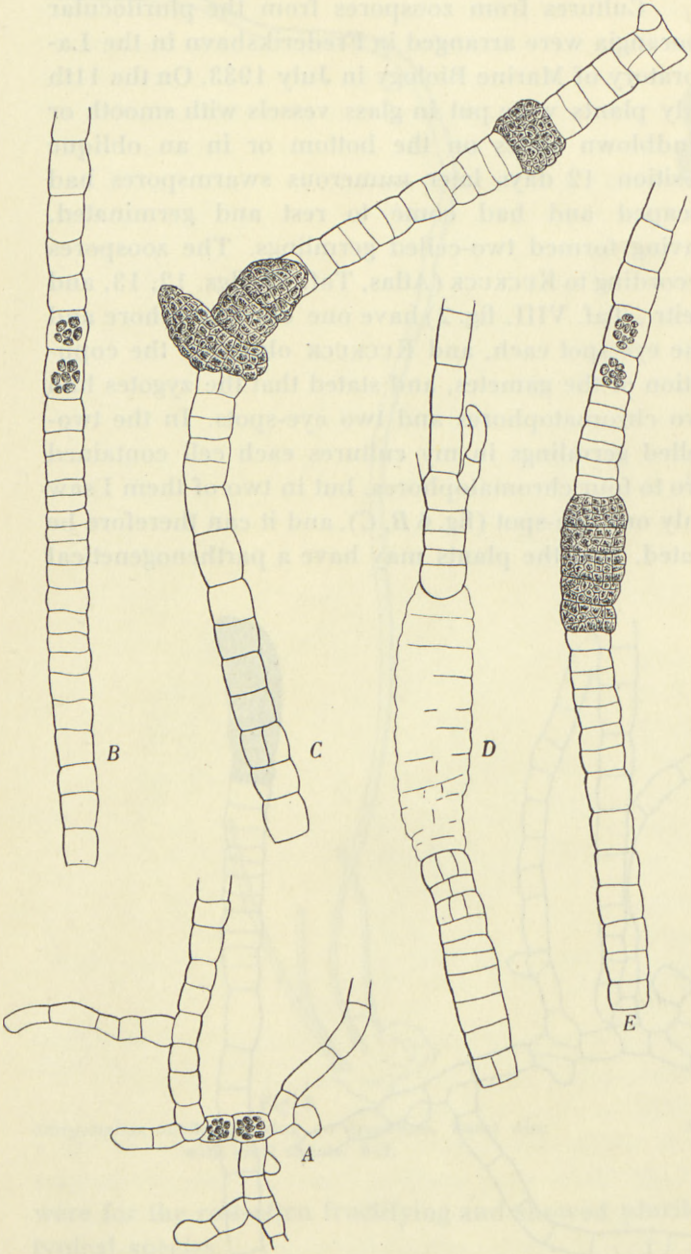

Fig. 8.

Stictyosiphon tortilis. A germling 5 weeks old. *A*, part of the creeping filaments, protonema, and the lowermost part of an erect filament. *B—E*, parts of the same erect filament (frond). *C*, with a short sorus and a single plurilocular sporangium. *D*, emptied sporangium or sorus. *E*, sorus. In some of the vegetative cells the chromatophores are shown. Some few vertical dissepiments occur. 280:1.

origin but it remains uncertain whether they may also be derived from zygotes. The germlings growed quickly and became branched; each cell contained several disc-shaped chromatophores. In cultures six weeks old, the filaments formed long branched filaments creeping on the substratum, partly confluent (fig. 7). These filaments did not produce any sporangia but gave off long erect straight filaments, several millimetres long. The creeping filaments must be designated as protonema, the erect ones were monosiphonous, contained only a few longitudinal walls and produced intercalary sori of plurilocular sporangia, like those in *Stict. soriferus.* The sori were separated by shorter or longer stretches of sterile cells. One sporangium was very protruding (fig. 8 *C*). In fig. 8 *D* is shown an emptied sorus with remnants of the thin walls between the loculi of the sporangia. Fig. 7 shows a terminal sporangium or sorus on an unbranched gametophyte. These sporangia-bearing shoots must be regarded as much reduced forms of gametophytes. A rudimentary hair is shown in fig. 8 *D*. The reduced state of the gametophytes was evidently due to the unfavourable conditions in the cultures; they were several millimetres long and unbranched.

As copulation of the zoospores do not seem to occur and as new gametophytes directly spring from the protonema and in my cultures produced new plurilocular sporangia, it must be supposed that the plants are diploid and that no reduction division takes place, which is in accordance with the fact that unilocular sporangia are unknown in this species.

Localities. **Sk:** Hirtshals, reef near land; cast ashore. — **Lf:** Near Rønnen at Lemvig, c. 4 m. — **Kn:** Skagen, east of the harbour, 4—5 m, east mole of the harbour; FF, Trindelen, 15 m; Tønneberg Banke, 15 m; VU and ZM, north of Læsø, 15 m; N. Rønner; Klokkebøjen, Marens Rev, Deget, Laurs Rev, Borrebjergs Rev, Brune Rev, Peter Poulsens Rev. — **Ke:** Fladen, 11 and 17 m; EK, Groves Flak, 26.5 m; EH, Lille Middelgrund, 14 m; Vesterlands Grund near Gilleleje. — **Km:** VQ, Svitringen. — **Ks:** aU, Lumbsaas mill in S 32° W, 2 miles, 13 m; OY, Yderrevet at Sjællands Rev. — **Sa:** PG, W. of Hatter Rev, 20 m; fN, off Ballen, 22.5 m and 13 m; aV, Vestborg lighthouse in E by South 5½ miles, 10 m; gT and MQ, Paludans Flak, 11 m; OH′, Lillegrund; GC, N. of Fyn; ad Hofmansgave (Lyngbye, s. n. *Gigartina viridis* and *Scytosiphon foeniculaceus*). — **Lb:** AX, Bjørnsknude, 9.5 m; Vejlefjord, at Stenhøj, 3 m, (S. L.); cV, Røgle Klint in S by W, 19—30 m; cX, between Strib and Nederballe, 35—44 m; Middelfart; Fænø Sund; Linderum; dH′, east of Hesteskoen; Knudshoved Strand; Sønderborg (Reinke). — **Sb:** AG, north of Klæpen, Romsø, 4 m; gG, off Bovense; UE, at Vresens Puller, 7 m; UF, at Hov Sand; fP, ½ mile east of Hov lighthouse, 5.5 m. — **Sm:** KQ, Grønsund, off lille Æblevig, 4 m; bay of Stege, 3 m, off Nymarke Nakke (S. L.); Stege Nor (S. L.). — **Su:** NV, NW of Lous' Flak, 10 m; RZ, south of Hveen, 13 m; QB, south of the buoy at Pilhaken; gP, 2½ miles east of Skovshoved, 11 m; south end of Middelgrund, 4.5 m; between Middelgrund and Trekroner; off Dragør; at Saltholm (S. L.). — **Bw:** Middelgrund south of Als (Reinke); LC, south of Gulstav, 11.5 m; KY, Femerbelt, off Rødby, 12 m. — **Bm:** QR, Gyldenløves Flak, 7.5 m; Dana St. 3133, E by N of Møens lighthouse, 19 m (C. A. Jørgensen); QG, off Bredegrund, Skanør. — **Bb:** ST, SH, SR, Rønne Banke, 16—18 m; 8 miles S ½ E of Rønne harbour, 11—19 m; near Allinge; YE, off Øleaa, 10.5 m; YC, the double broom at Salthammer Rev in NV ¾ N 1½ miles, 24.5 m; YD, the double broom at Salthammer Rev in W ¼ S 1 mile, 19 m; the bay within Salthammer Rev; 3 miles SE of Nexø harbour, 21 m (C. A. J.); Christiansø.

2. **Stictyosiphon soriferus** (Reinke) K. Rosenv. nov. combin.

Kjellmania sorifera Reinke, Algenfl. d. westl. Ostsee, 1889, p. 59; Atlas deutsch. Meeresalg., I, 1889, Taf. 3.

Kjellmania striarioides Gran, Kristianiafjordens algeflora, 1897, p. 38, Tab. I, figs. 8—9. Videnskabsselsk. Skrifter. I. Math. naturv. Klasse, 1896, Nr. 2.

Stictyosiphon adriaticus Cotton, Clare Island Survey, 1912, p. 119; Kuckuck in Oltmanns Morph. u. Biol. d. Algen, 2d edition, II, 1922, pp. 55, 56; Kuckuck, Fragmente einer Monogr. der Phæosporeen, 1929, pp. 81, 82, figs. 118—124. Not *St. adriaticus* Kützing.

Stictyosiphon Corbierei Sauvageau, Sur le développement de quelques Phéosporées. Bull. Stat. biolog. d'Arcachon. Tome 26, Bordeaux, 1929, pp. 298—315.

In 1889 Reinke described, under the name of *Kjellmania sorifera*, an alga from the western Baltic Sea which was finely illustrated in drawings by Schütt in Atlas d. Meeresalgen, plate 3. It had a branched, cylindrical solid frond, 1—5 cm long, and bore plurilocular sporangia of two kinds, sorus sporangia and intercalary sporangia, the latter in the monosiphonous part of the frond. Eight years later Gran described another species of the same genus, *Kjellmania striarioides*, which resembled it much but differed by a greater size, and by the inner cells of the frond being large and roundish, and Gran laid special stress on the difference in structure of the sporangia, the particular sporangia according to Reinke's description consisting of two, more rarely of four cells arranged in a row, having a separate apicular opening, while in *Kj. striarioides* only one or at most two openings correspond to each sporangial mother cell. Algologists seem to have taken no notice of Gran's description, although it contained a diagnosis in Latin and was accompanied by good figures.

In May 1911 Cotton dredged in Clew Bay, Clare Island, Ireland some specimens of an alga which he referred to *Kjellmania sorifera.* A fragment was sent to Dr. Kuckuck, who confirmed the identification; but he declared that Reinke's plant was synonymous with *Stictyosiphon adriaticus.* Unfortunately, Kuckuck has published nothing on this question, but he has left behind several figures of the plant which he referred to *St. adriaticus* and these drawings have been published in the second edition of Oltmanns' Morph. u. Biol. d. Algen 1922, and in Kuckuck, Fragmente 1929, but he has left no text to these figures. The drawings show both intercalary and sorus sporangia, but figs. 121—123 must be supposed to represent unilocular sporangia. Kuckuck's figures fit with *Stictyosiphon striarioides* Gran, at least as to the plants bearing plurilocular sporangia.

Sauvageau described in 1929 a *Stictysiphon Corbierei* met with near Cherbourg. This plant agrees so well with Kuckuck's figures of *Stictyosiphon adriaticus* that I have no doubt of their identity. But I cannot approve the identification of Kuckuck's plant with *St. adriaticus* Kütz. This species has a hollow frond, while the frond in Kuckuck's plant is solid, and the interior of the frond is filled up with large globular cells which usually appear in a number of four in the transverse section of the frond, (comp. Kuckuck, Fragmente fig. 122, Sauvageau, l. c. fig. 5, *C, D, E*), and there are also other differences, in particular in the ramification, the branches in *St. adriaticus*, according to Kützing (Tab. phyc. **6**, Taf. 50, c, d) being principally opposed or even verticillate, while in Kuckuck's and Sauvageau's species they are alternate. The origin of Kuckuck's plant is unknown, but it is probably derived from the North coast of France (comp. Sauvageau, l. c. p. 300), at all events I agree with Sauvageau that they cannot be referred to *St. adriaticus.* On the other hand, it is interesting that Kuckuck has identified Cotton's plant with *Kjellmania sorifera*, and that he has declared this as synonymous with the plant which he has figured as *Stictyos. adriaticus.* This shows that he has recognized that Reinke's species also comprises coarser forms.

I have, since 1891, dredged in numerous places in the Danish waters, in particular in the northern Kattegat, a *Stictyosiphon* which agrees completely with *Kjellmania striarioides* Gran. I have, through the kindness of Professor Nordhagen in Bergen, had an opportunity of examining the original specimens of Gran which showed full accordance with the Danish specimens. Further, I have received, by the courtesy of Mr. A. D. Cotton, from the Herbarium of the Kew Gardens, for examination, a specimen collected by him at Clare Island and which was referred by Kuckuck to *St. adriaticus.* I found that it fully agreed with *Kj. striarioides* from Norway and with the Danish specimens. Fig. 9 shows a photograph of this specimen with Kuckuck's annotation above. I have, further, received

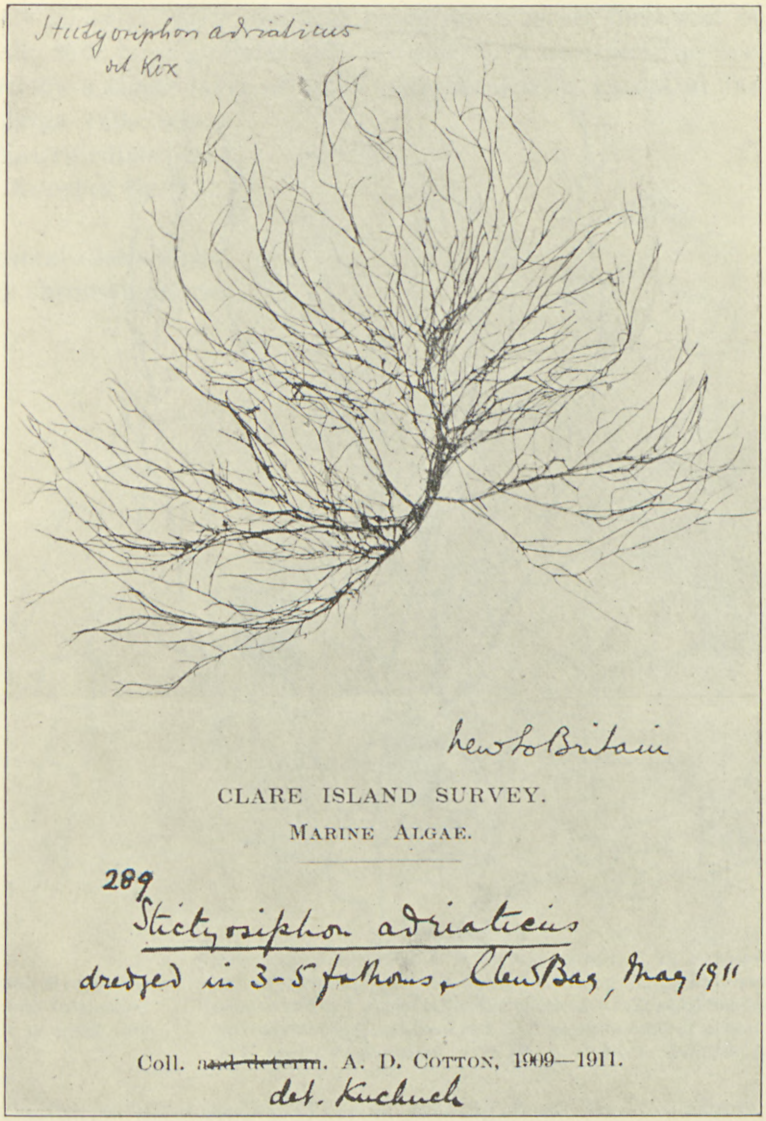

Fig. 9.
Stictyosiphon soriferus. Specimen collected by COTTON at Clare Island, Ireland, referred by KUCKUCK to *Stictyosiphon adriaticus.* Nat. size. K. GRAM phot.

typical specimens of the same species from dr. MARY W. PARKE who has recorded it from the Isle of Man and referred it to *Stict. adriaticus* (Algol. Records for the Manx Region. Fortysixth Ann. Report of the Mar. Biol. Station of Port Erin, Isle of Man, 1933, p. 36). Finally, professor C. SAUVAGEAU has greatly obliged me by sending me a series of preparations of *Stictyosiphon Corbierei* which he has described so well. An examination of these well conserved specimens confirmed my supposition of its identity with *Kjellmania striarioides.*

All the above named specimens from Norway, the British Isles and France had plurilocular sporangia like those described by REINKE.

It remains to compare *Kjellmania sorifera* Rke with *Kj. striarioides* Gran. REINKE's description and the drawings of SCHÜTT are made from a very thin Baltic form which does not show the large medullary cells characteristic of *Kj. striarioides.* I have through the courtesy of dr. CURT HOFFMANN in Kiel had the opportuity of examining the whole material of REINKE's species contained in the herbarium of Kiel, and have found that they were all extremely thin and slender, not having the large roundish inner cells, but otherwise agreeing with thin specimens and young branches

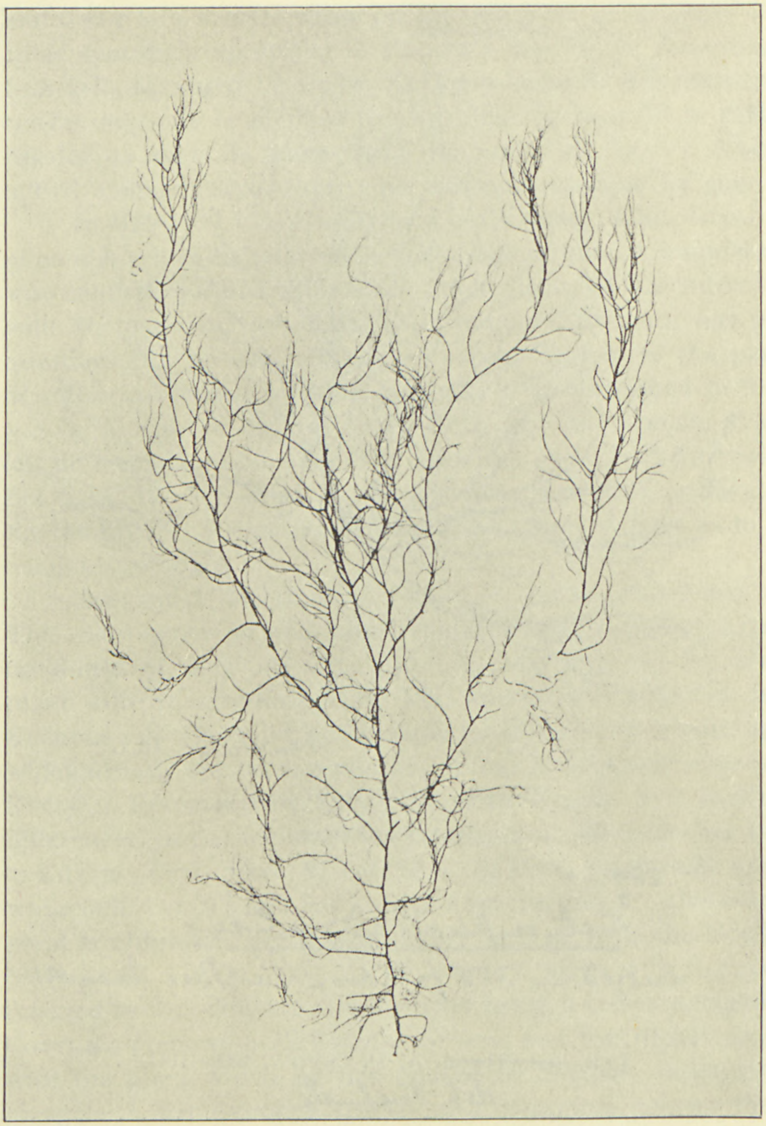

Fig. 10.
Stictyosiphon soriferus. From the outer side of the Nordøstrev at Hirsholmene, July 1904. Nat. size. K. Gram phot.

of the species found in the Danish waters. I therefore do not hesitate to regard them as belonging to the same species as this. The differences in the openings of the sporangia adduced by Gran will be mentioned later. As *Kjellmania sorifera* is the first name under which the species has been described, although only in the slender Baltic form, I think it necessary to retain this specific name for the species, but, as done by Kuckuck and Sauvageau, to refer it to the genus *Stictyosiphon.* It must be noted that intercalary sporangia have been met with in germinating plants of *Stict. tortilis* obtained in cultures (fig. 8).

The plant of the Danish waters, which in the northern Kattegat attains a length of more than 20 cm, terminates in a long monosiphonous filament which divides by numerous horizontal walls so that the cells become much shorter than broad. The shoots usually, when sterile, terminate in a hyaline hair, and lateral hairs, too, frequently occur. The shoots branch and the branches are lateral, alternate. Opposite branches very rarely occur. In the shoots longitudinal walls soon appear and the fronds become parenchymatous, being divided by horizontal and vertical walls. But in older shoots an anatomical differentiation takes place, the inner cells becoming large, isodiametrical, nearly globular, their diameter being much larger than that of the peripheral cells. Usually four large globular cells are seen in a transverse section of the frond, only covered by a single layer of small peripheral cells, except at the interstices between the large cells where a number of small or intermediate cells are present (fig. 12 *A*, *B*; KUCKUCK fig. 122; SAUVAGEAU fig. 5 *C*—*E*).

The cells contain several disc-shaped, oblong or biscuit-shaped chromatophores.

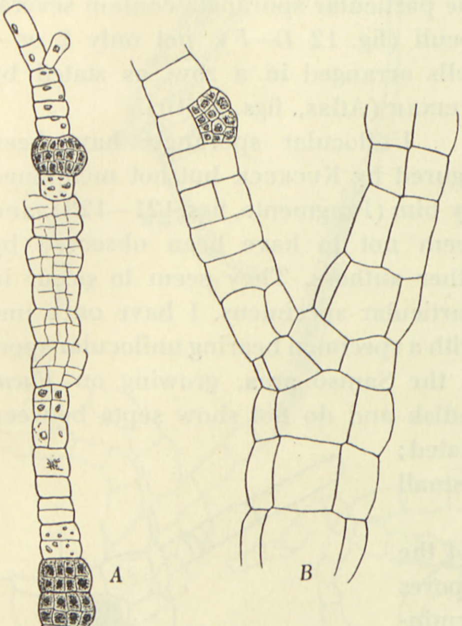

Fig. 11.
Stictyosiphon soriferus. From Jydske Rev in the North Sea. *A*, Upper end of plant with intercalary sporangia, partly emptied. *B*, part of plant with sporangium. 350:1.

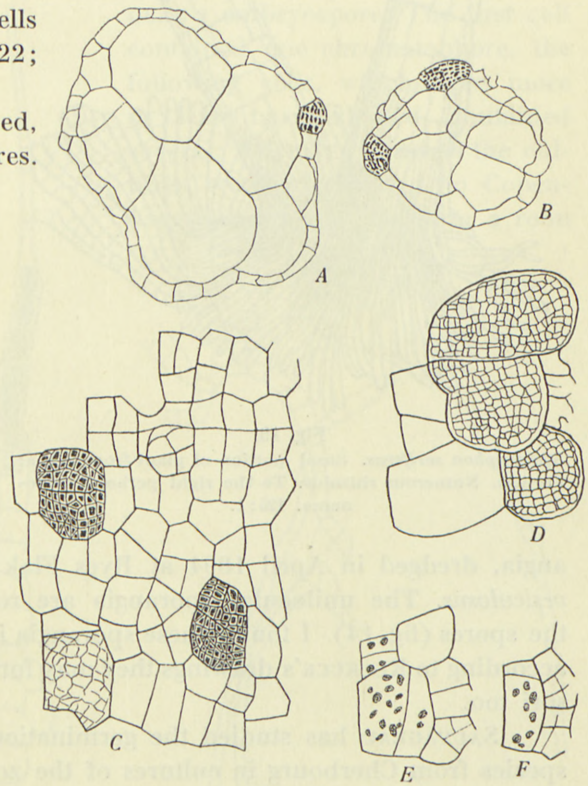

Fig. 12.
Stictyosiphon soriferus. *A*, *B*, off Marens Rev. *C*, *D*, Nordøstrev at Hirsholm. *E*, *F*, NW of Nordre Rønner. *A*, *B*, transverse section of frond with plurilocular sporangia. *C*, *D*, plurilocular sporangia seen from above and, in *D*, partly in vertical section. *E*, *F*, emptied sporangia. *A*, *B*, 200:1. *C*, 280:1. *D-F*, 345:1.

The frond is fixed to the substratum by rhizoids issuing from the lowermost part of the frond (fig. 13).

Plurilocular sporangia were present in almost all the specimens observed in the months of April and June to August. They occur in the monosiphonous and in the parenchymatic parts of the frond. REINKE called them intercalary and sorus sporangia respectively, but I think there is no essential difference between them. Both kinds of sporangia are usually associated several together in sori which in the monosiphonous parts have the character of rows. In the parenchymatic fronds the sori are usually squarish or of more or less irregular shape, but always with more or less angular outline. The outer wall is vaulted. It is not always easy to draw the limits between the

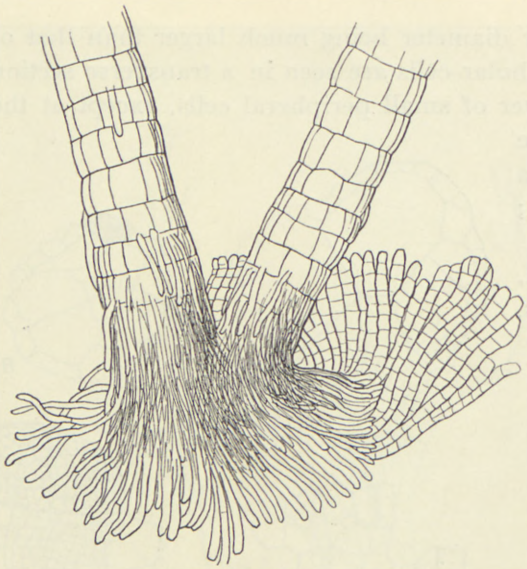

Fig. 13.
Stictyosiphon soriferus. Basal portion of plant from RQ, at Fornæs. Numerous rhizoids. To the right perhaps protonema. 125:1.

particular sporangia, but it can always be seen that the larger sporangia have several tubes for discharge, each tube corresponding to a group of zoospore mothercells, which may perhaps be considered as a separate sporangium. After the discharge of the sporangia the separating walls may be seen within the sporangia, and it can be stated that the particular sporangia contain several loculi (fig. 12 *D*—*F*), not only 2 or 4 cells arranged in a row, as stated by Reinke (Atlas, figs. 9—10).

Unilocular sporangia have been figured by Kuckuck but not mentioned by him (Fragmente, figs. 121—123), and seem not to have been observed by other authors. They seem to occur in particular specimens. I have once met with a specimen bearing unilocular sporangia, dredged in April 1894 at Ryes Flak in the Samsö area, growing on *Fucus vesiculosus*. The unilocular sporangia are roundish and do not show septa between the spores (fig. 14). I found these sporangia isolated; according to Kuckuck's drawings they may form small sori too.

Sauvageau has studied the germination of the species from Cherbourg in cultures of the zoospores from the plurilocular sporangia. The spores germinated quickly and in two weeks produced a branched protonema composed of barrel-shaped cells. The protonema did not produce any organs of reproduction but, having reached an age of three weeks, gave off straight erect filaments which later divided by longitudinal walls, assumed the character of the motherplant, and produced plurilocular sporangia.

The germination of the Danish plants was effected in the Laboratory of Marine Biology at Frederikshavn in the beginning of July 1933 and 1934. A plant with plurilocular sporangia was put in a glass vessel over slides in filtered sea-water. The zoospores germinated quickly, but it was not ascertained whether a copulation of the zoospores took place

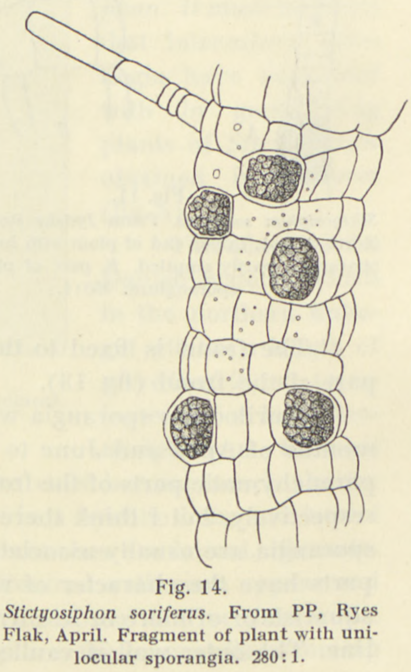

Fig. 14.
Stictyosiphon soriferus. From PP, Ryes Flak, April. Fragment of plant with unilocular sporangia. 280:1.

before the germination or not. They grew in one or two weeks into branched protonemata like those described by SAUVAGEAU (l. c. fig. 6, our fig. 15). The first cell was more elongated than in SAUVAGEAU's plants, but had a feeble swelling at the base, corresponding to SAUVAGEAU's embryospore. The first cell contained one chromatophore, the following cells, which were more or less barrel-shaped, contained several. After 3 to 4 weeks the cultures were transported to Copenhagen and were placed in a roon

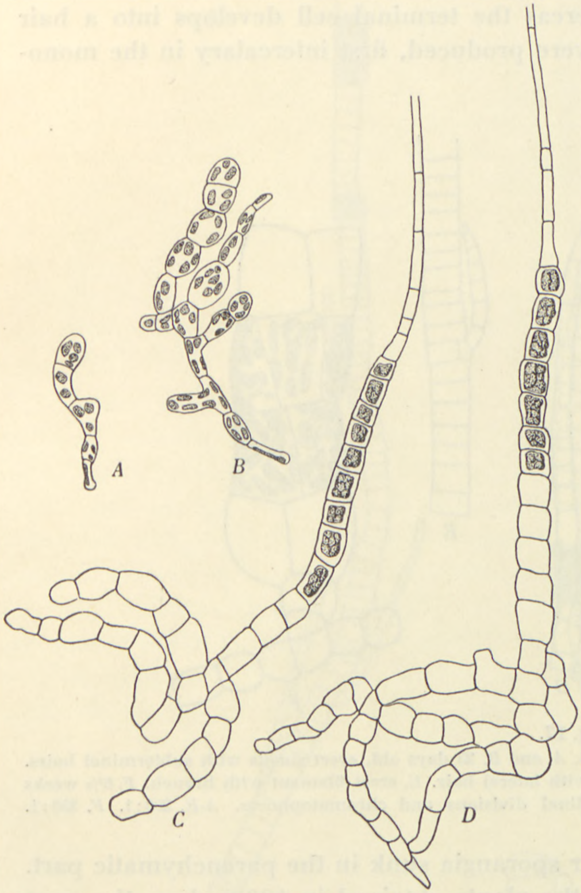

Fig. 15.
Stictyosiphon soriferus. Sporelings from cultures established July 11th, 1933. *A*, 12 days old, *B*, 17 days old, *C*, and *D*, 23 days old, showing erect filaments with a terminal hair and chromatophores in the vegetative cells. 350 : 1.

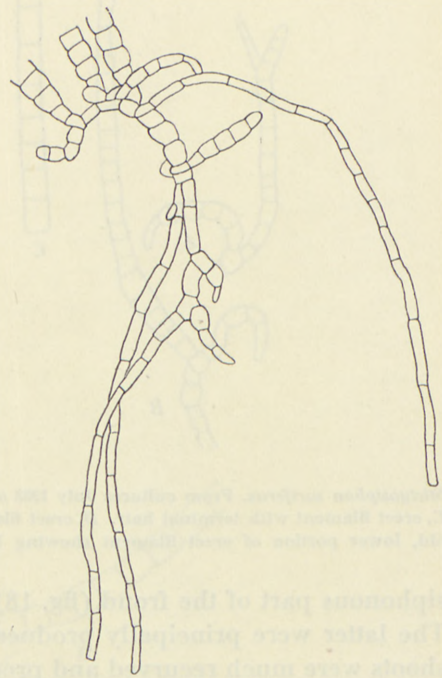

Fig. 16.
Stictyosiphon soriferus. Protonema with long rhizoids and four erect filaments. 200 : 1.

facing North. The protonema grew chiefly in a horizontal direction. When the protonemata were about two weeks old they began to produce erect filaments, which were straight, cylindrical, at first unbranched, and terminated in a hyaline hair (fig. 15, *C*, *D*). The protonemal filaments never produced sporangia; after three to four weeks they ceased to grow in this form, but they continued growing as rhizoidal filaments composed of long cylindrical cells creeping over the substratum (Fig. 16).

The erect shoots grew into new plants; after 6 weeks they were up to 4 mm long or longer. The new plants obtained in 1934 were most normally developed. They were for a long time only divided by transversal walls, later on longitudinal walls appeared in the lowermost part and they began to branch (fig. 17 *E*). It may happen that the terminal cell is pushed aside by a lateral shoot developing from the supporting cell and taking the direction of the original shoot, whereas the terminal cell develops into a hair (Fig. 17, *A*, *B*). Plurilocular sporangia were produced, first intercalary in the mono-

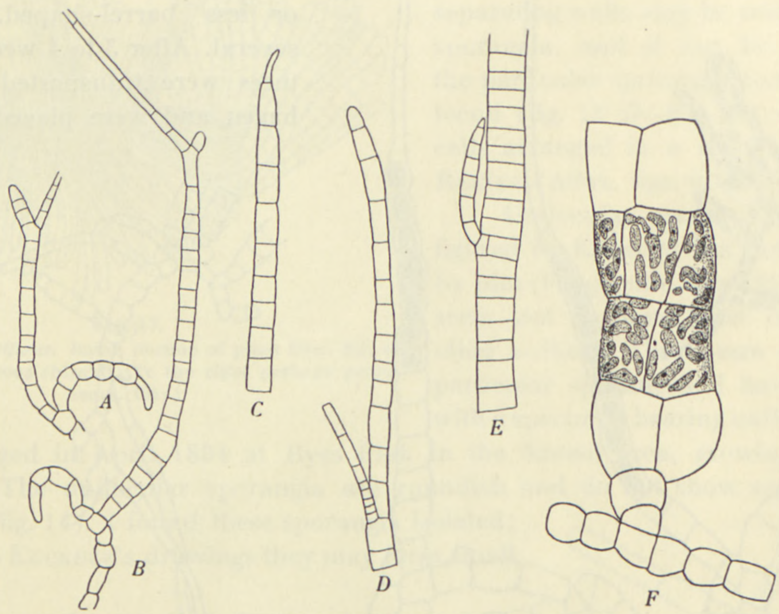

Fig. 17.
Stictyosiphon soriferus. From cultures July 1933 and 1934. *A*, and *B*, 23 days old, erect shoots with subterminal hairs. *C*, erect filament with terminal hair. *D*, erect filament with lateral hair. *E*, erect filament with branch. *F*, 6½ weeks old, lower portion of erect filament showing longitudinal divisions and chromatophores. *A-E*, 200:1. *F*, 350:1.

siphonous part of the frond (fig. 18), later sporangia sunk in the parenchymatic part. The latter were principally produced in the plants obtained in 1933 where the erect shoots were much recurved and produced several sporangia on the convex side, partly with the base sunk in the parenchymatic tissue, partly entirely outward like those described by Sauvageau in the plants of the first generation (l. c. fig. 7, *A*, *C*, our fig. 19, *C*).

As the germinating zoospores from the plurilocular sporangia produce plants with plurilocular sporangia, it must be concluded that these plants are diploid, and that no reduction division takes place in the course of their life, just as in *St. tortilis*. But as specimens with unilocular sporangia occur, apparently always in particular individuals, reduction division may probably take place in these sporangia, causing an alternation of haploid and diploid generations.

Stictyosiphon soriferus is rather widespread in particular in the northern Danish waters. It has been observed from the North Sea to the Little Belt, and it has further been dredged in the Western Baltic Sea by Reinke. It has been observed in the Danish waters in the months of April to August in down to 37.5 meters' depth, but it has also been collected at small depths, thus in the harbour of Frederikshavn at 2 m depth. It

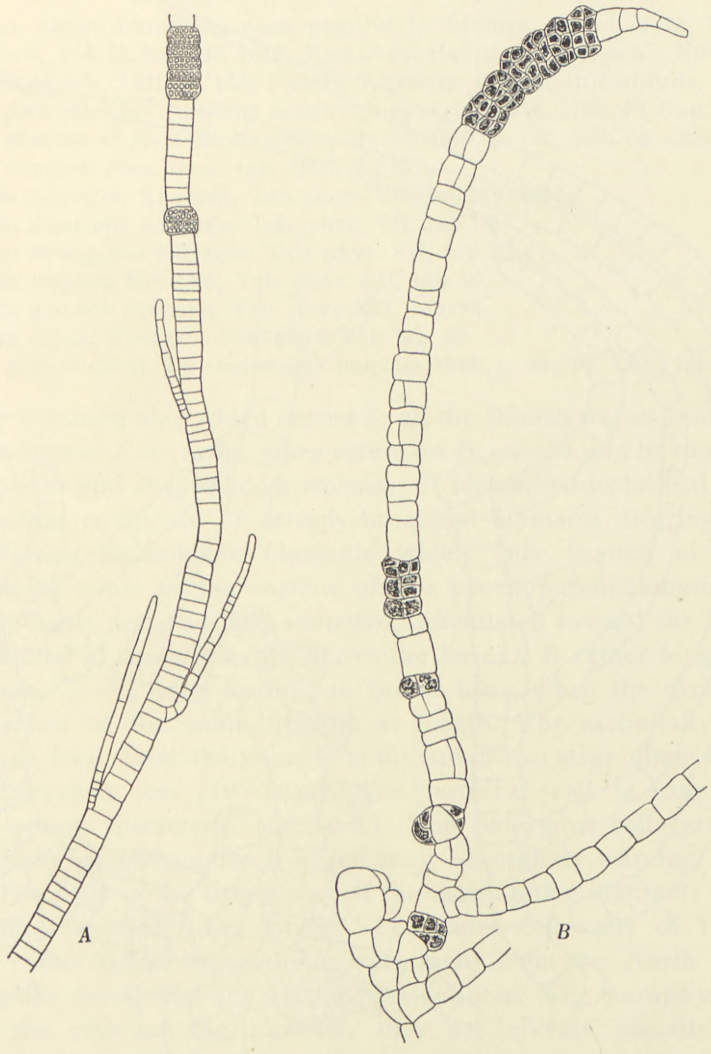

Fig. 18.
Stictyosiphon soriferus. Erect shoots from cultures in July 1933 and 1934. *A*, with branch and hairs and intercalary plurilocular sporangia, 6½ weeks old. *B*, with longitudinal divisions and plurilocular sporangia, 6 weeks old. *A*, 200 : 1. *B*, 280 : 1.

reaches its greatest length, (22 cm), in the northern Kattegat. It has been observed with sporangia, nearly always plurilocular, in the same months. The species is certainly annual. It has been met with on *Buccinum undatum*, *Stenorhynchus*, Hydroids, various algæ and on wood.

Localities. **Ns:** ZQ, Jydske Reef, 24.5 m; aG, Thyborøn beacon SE$^1/_2$S 19$^1/_2$ miles, 37.5 metres; aD, Lodbjerg lighthouse SE$^3/_4$S 4$^1/_2$ miles, 23.5 metres. — **Lf:** XY, off Mullerne, 6.5 m. — **Kn:** Skagen, south side of Grenen, 9.5 m (Kramp); off Skagens harbour (Boye Petersen); off Klitgaarden, 4 m; Nord-

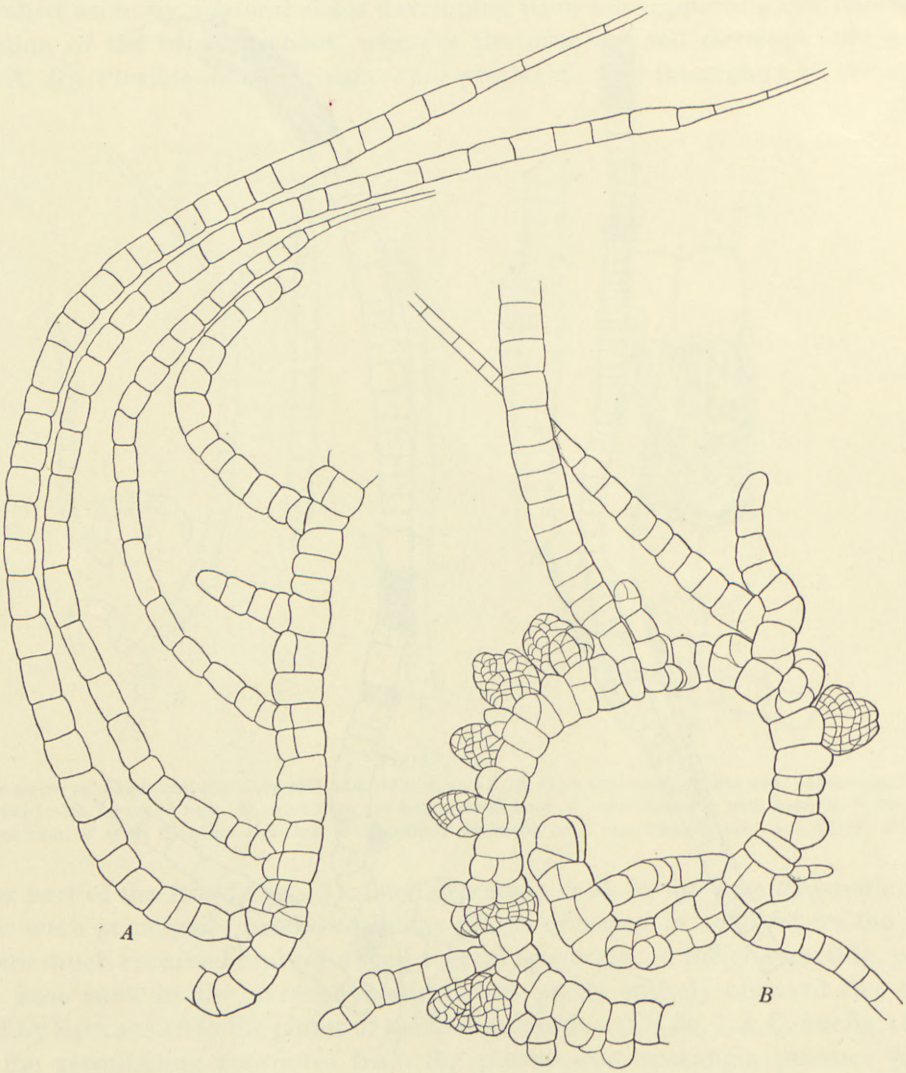

Fig. 19.
Stictyosiphon soriferus. Branched erect shoots with longitudinal divisions from culture July 1933, 6 weeks old. *B*, much curved, with prominent plurilocular sporangia. 280:1.

østrev at Hirsholm, 11 m; Marens Rev; at Klokkebøjen, Frederikshavn; Borrebjergs Rev; Laurs Rev; Deget; harbour of Frederikshavn, Nordre Tværmole and yacht basin; near Nordre Rønner, 15 m; off Sæby, 6.5 m. — **Ke:** ZJ, North end of Groves Flak, 26.5 m; XA, Kobbergrundens light-ship in N by W$^1/_2$W 6$^1/_2$ miles, 13 meters. — **Km:** FC, East of Flyndergrund, 17—18 m. — **Ks:** RQ, at Fornæs light-house, 1 mile, 17 m. — **Sa:** BD, north of Tunø, 15 m; Ryes Flak, 4.5 m, April. — **Lb:** Aarø Sund (Reinke).

Fam. Elachistaceæ.

Elachista Duby.

1. **Elachista fucicola** (Vell.) Aresch.

ARESCHOUG, Algar. minus rite cogn. pugillus L. Linnæa, 16. Bd., 1842, Taf. 8, figs. 6—7; HARVEY, Phyc. Brit., vol. II, tab. 240, 1849; KJELLMAN, Handbok, 1890, p. 45; NEWTON, Handbook of the British Seaweeds, 1931, p. 133; PRINTZ, Algenveg. d. Trondhjemfjords, 1926, p. 159.

Conferva fucicola, VELLEY, Plant. marit. icones pictæ, Bath, 1795. Fl. Dan., tab. 1484, c, 1813.
Conferva flaccida et *fucicola*, LYNGBYE, Hydr., 1819, p. 146, Tab. 50, excl. fig. B2.
Conferva flaccida, Flor. Dan., tab. 1906, 2. 1827.
Phycophila fucorum, KÜTZING, Tab. phyc. VII, tab. 95 (1857).
Phycophila Agardhii KÜTZING, Tab. phyc. VII, tab. 96.
Phycophila ferruginea KÜTZING, Tab. phyc. VII, tab. 97.
Phycophila vulpina KÜTZING, Tab. phyc. VII, tab. 98.
Phycophila gracilis KÜTZING, Tab. phyc. VII, tab. 98.
Phycophila rigida KÜTZING, Tab. phyc. VII, tab. 99.
Elachista globosa Ørst. De regionibus marinis 1844, p. 50; Fl. Dan. tab. 2459, 1843.

This very common alga which occurs in all the Danish waters is always epiphytic on *Fucus vesiculosus* or *F. serratus*, more rarely on *F. spiralis* and in some few cases on *Laminaria digitata* and *Polysiphonia violacea*. It forms hemispherical tufts, having a solid basal portion composed of densely branched filaments, bearing on its surface numerous radiating assimilative filaments which only branch at the base, beneath the growing zone, at the surface of the pseudoparenchymatic nucleus. The assimilative filaments are gradually somewhat attenuated toward the base, the dividing zone is situated at some distance above the base, it is rather long and composed of cells whic are $^1/_3$—$^1/_2$ times as long as broad, later, when the dividing activity is diminishing, about of the same breadth as length. The assimilative filaments are $^1/_2$ cm to 1.3 cm long, their thickness is in the full-grown stage about 25—35 (—46) μ, in younger specimens less (10—16 μ). The terminal cell is usually only to be found in the young specimens, (fig. 20 A). The outermost cells are very poor in contents especially chromatophores which may be entirely wanting, and these cells decay early. The cells in the upper part of the assimilative filaments are longer than broad, sometimes several times longer. The outer cell-walls of the assimilating filaments are rather thick, especially in specimens from the North Sea. The cells contain numerous small disc-shaped chromatophores. The paraphyses spring from the ends of the cells of the nucleus; they are clavate, usually more or less curved; they have been well figured in the papers of ARESCHOUG, KÜTZING and NEWTON quoted above. The last-named author says, of the genus Elachista, that hairs are formed at the base of the paraphyses. It must be emphasized that hyaline hairs do not occur in this genus.

Unilocular sporangia spring like the paraphyses from the outermost cells of the filaments of the nucleus. The assimilative filaments become gradually more long-celled, the outermost cells die, and the filaments are finally broken off about at the level of the upper end of the paraphyses, but the nucleus still remains some time with the paraphyses and the sporangia and the remnants of the assimilative filaments. This stage occurs in autumn and winter and has been described by Ørsted as a particular species, *E. globosa*. The figure in Flora Danica, tab. 2459, 1, shows well the paraphyses and the sporangia but not the remnants of fhe assimilative filaments. Unilocular sporangia are met with all the year. Young specimens occur on the upper part of the fronds of *Fucus vesiculosus* in March and April; they have a creeping basal layer bearing upright assimilating filaments and paraphyses and often well-developed sporangia, partly mature, even in March. In the month of March 1933 small wintering specimens with a feebly developed nucleus were found with numerous unilocular sporangia, partly emptied, (fig. 21 *A*). In the first summer months the nucleus increases but proportionally many specimens are sterile, though fertile specimens are always to be found. In August the specimens are mostly fertile, and in the months of autumn too. In the last months of the year many specimens seem to decay, but old specimens, though in a more or less denuded stage, are

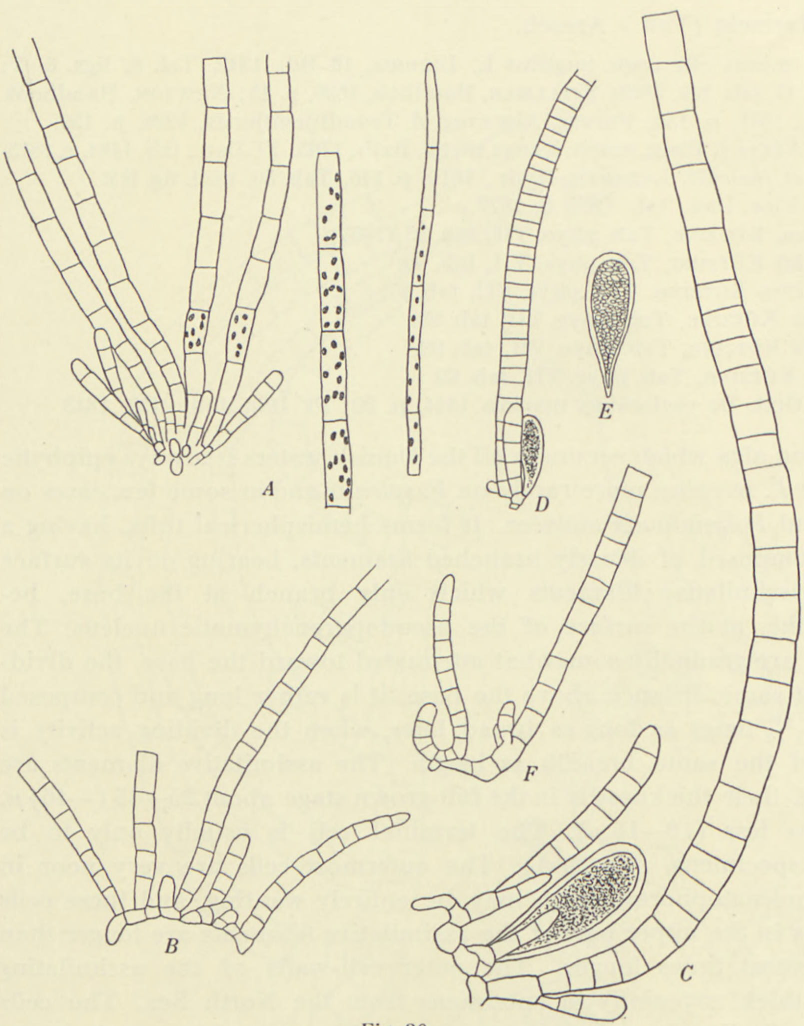

Fig. 20.
Elachista fucicola. *A*, At Sjællands Rev on *Fucus vesiculosus*. April. Fairly young specimen. To the right the middlemost and the upper part of an assimilative filament. *B-F*, on *Fuc. vesic.*, Gamborg Fjord, 23. April. *B-C*, showing creeping filaments, assimilative filaments, and paraphyses. *C*, unilocular sporangium. *D*, assimilative filament, paraphyse, and sporangium. *E*, sporangium. *F*, creeping filament with upright filaments. *A, D, E*, 200 : 1. *B, C, F*, 347 : 1.

still to be found in January. As well developed sporangia are to be met with at various seasons, it is probable that new plants arise too for a longer period, probably mostly in the autumn.

As plurilocular sporangia have been met with in *El. lubrica* Rupr. which seems to be nearly related to *E. fucicola* (comp. K. Rosenvinge, Grønl. Havalg., 1893, p. 878; Kuckuck, Fragmente 1929, p. 21), I have charged Mag. S. Lund with examining all the collected Danish specimens of the latter species for the existence of plurilocular sporangia on the assimilating filaments, but in no case was any sporangium of this kind detected.

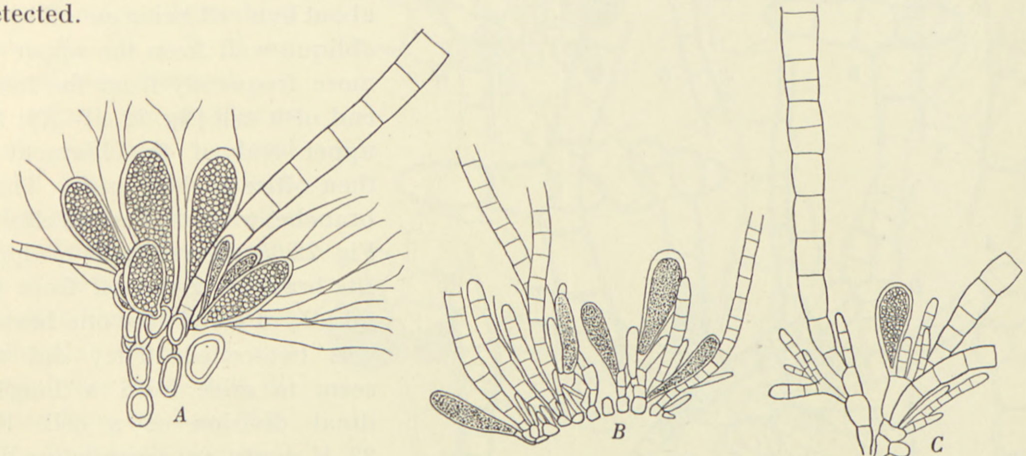

Fig. 21.

Elachista fucicola. *A*, Frederikshavn, 18. March (S. L.), small specimen with fully developed unilocular sporangia, partly emptied. *B*, Fænø, Lillebelt, 24. March (S.L.), young specimen with creeping basal filament, erect filaments, and young sporangia. *C*, Stege Nor, April (S. L.), young specimen with assimilative filaments, paraphyses, and unilocular sporangium. 200:1.

According to Printz, *Elachista fucicola* is annual in the Trondhjem Fjord; beginning its development in May, it is in vegetative development in summer but sterile; in autumn the fertility begins, and it produces unilocular sporangia through the winter and spring. In Denmark the duration of the species is longer, but it is uncertain whether it is able to fructify more than once in the year.

Mag. Søren Lund has observed peculiar ramifications on the assimilative filaments of old plants collected at Saltholm near Copenhagen in November and December 1934.

Mag. S. Lund describes them in the following words:

In the plants which were all growing on *Fucus vesiculosus* (one on *Polysiphonia violacea*), several assimilative filaments were met with in which one or two of the cells were divided by a longitudinal cell-wall, fig. 22 *A—D.* Most frequently the two cells arising by this division had produced two short branches diverging (often rectangularly) from the assimilative filament, one usually shorter than the other (fig. 22 *B*) and sometimes only one of the cells had produced a branch. The branches were always short and unbranched and consisted at most of 4 cells. The divergence between the two branches was not always 180°, frequently 90°. In other cases one of the two cells arising by the longitudinal division was divided by a transverse wall (fig. 22, *C*, *D*) or the two cells are both divided by a transversal wall (fig. 22 *E*) or one by a transversal, the other by a longitudinal or an oblique wall, the branch in the latter case becoming directed obliquely downwards (fig. 22, *C*, *G*).

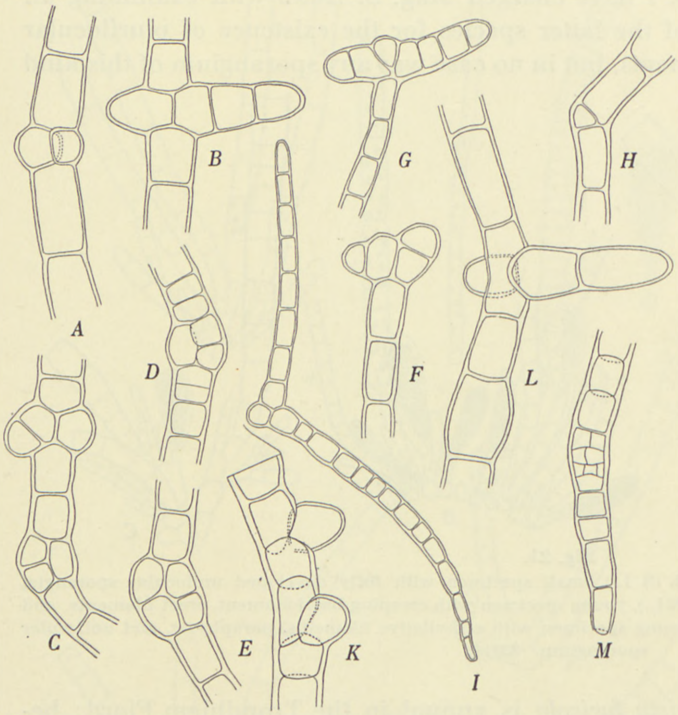

Fig. 22.
Elachista fucicola from Saltholm, growing on *Fucus vesiculosus* or on *Polysiphonia violacea* (fig. *K*), in November and December. Assimilative filaments with vertical divisions and branches. *M*, cell No. 5 from the bottom has been divided by three transverse and at least 4 vertical walls. *A-H*, and *K-M*, 174 : 1, *I*, 85 : 1. Søren Lund del.

A ramification of the assimilative cells may also be brought about by a cell being cut off by an oblique wall from the upper or, more frequently from the lower end of a cell (fig. 22, *H*—*K*); the upper end of the filament is then often pushed aside. These branches were always unicellular. Fig. 22, *L* shows a pair of opposite branches given off from the middle of a cell; the one branch was two-celled. They did not seem to arise from a longitudinal division of a cell. Fig. 22, *M* shows an assimilative filament in which the 5th cell from the bottom is divided by three transverse and at least four longitudinal divisions but no cell has protruded.

The above described divisions and ramification may take place in any part of the assimilative filaments. Thus, a longitudinal division has been observed in the third cell from the bottom and in another case in the fortieth. A branching from the lower end of a cell was met with from the 35th cell. The appearance of longitudinal walls seems, however, chiefly to occur in the lower part of the filaments, and in particular in older plants, when the upper part of the assimilative filaments has been thrown off. In such cases the divisions may perhaps be considered as a sort of regeneration, the dividing walls appearing principally in the uppermost of the still living cells of the assimilative filaments.

Assimilative filaments with branches were met with too in specimens from Stege Nor on the island of Møen, growing on *Fucus vesiculosus*, collected in October 1929. In one case the 12th cell from the bottom in an assimilative filament was by a transversal wall divided into two, one of which had grown out as a branch consisting of 11 cells. — In Vejle Fjord at Stenhøj, east of Rosenvold an old specimen was found on the 30th of December 1934 growing on *Fucus serratus* showing a branching from the 7th cell of an assimilative filament.

Among the specimens from Saltholm several were met with which produced, besides the normal unilocular sporangia at the base of the assimilative filaments, further unilocular sporangia and paraphyses at a certain distance from the base (figs. 23 *A*–*C*). It might even happen that a complete plant consisting of assimilative filaments, paraphyses and sporangia issued from a cell in an assimilative filament (fig. 23 *D*). That there is no question of germinating spores of *Elachista fucicola* on the surface of the assimilative filaments but that the new plants are really produced by a cell in the filament is seen from the fact that new cell-walls are produced in the cell bearing the sorus or the new plant, and that the new formation is directly produced by the bearing cell. The sori or new plants arise from the upper or from the lower part of the cell. They seem most frequently to be produced on the lower

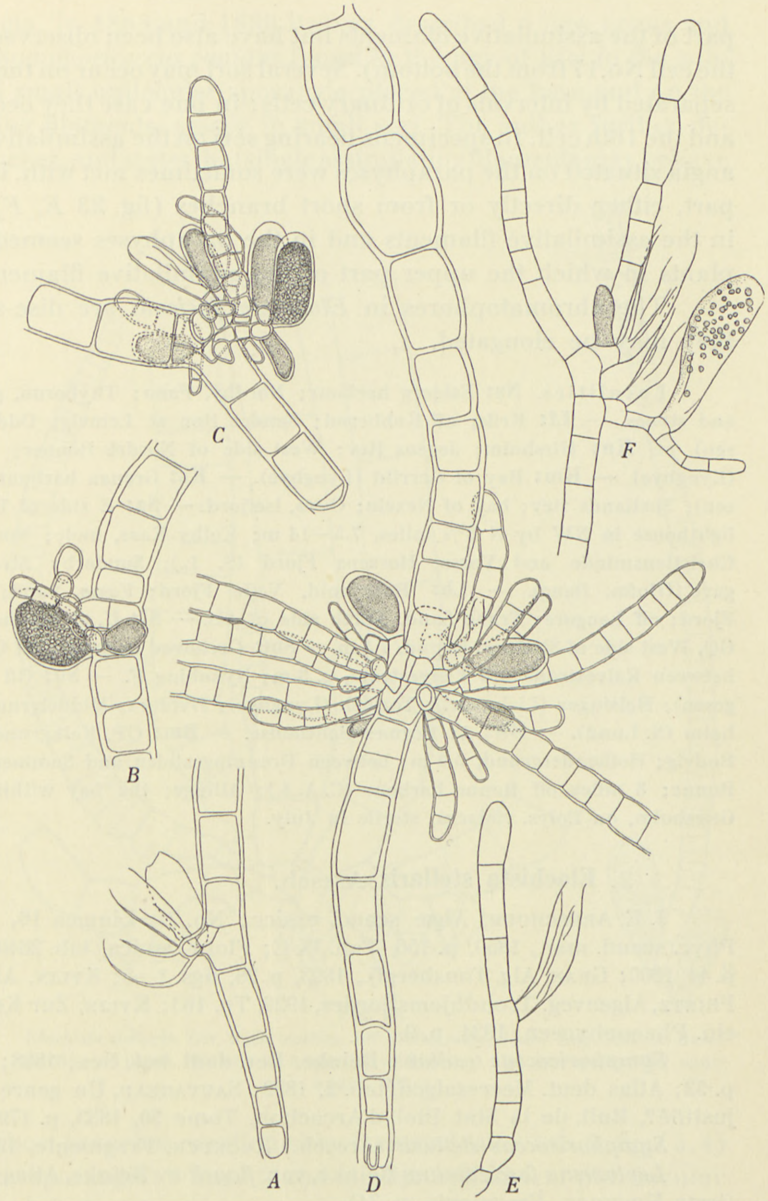

Fig. 23.
Elachista fucicola, from Saltholm. On *Fucus vesiculosus* (*C* on *Polysiphonia violacea*), December 1934. *A*-*D*, Assimilative filaments producing sori of unilocular sporangia and paraphyses or new adventitious plants from intercalary cells. *E*, paraphyse with a lateral sporangium springing from the middle. *F*, paraphyse with two branches bearing each two sporangia. 237 : 1. Søren Lund del.

part of the assimilative filaments but have also been observed at a higher level (e. g. from the cell No. 17 from the bottom). Several sori may occur on the same assimilative filament, separated by intervals of ordinary cells; in one case they occurred on the 14th, the 15th, and the 16th cell. In specimens bearing sori on the assimilative filaments unilocular sporangia situated on the paraphyses were sometimes met with, issuing from the middlemost part, either directly or from short branches (fig. 23 *E*, *F*). The sporangia occurring in the assimilative filaments and in the paraphyses seemed principally to arise in old plants in which the upper part of the assimilative filaments was thrown off.

The chromatophores in *Elachista fucicola* are disc-shaped, in the young cells they may be elongated. S. L.

Localities. **Ns:** Esbjerg harbour; Nordby, Fanø; Thyborøn, groin. — **Sk:** Hirtshals, on mole and stones. — **Lf:** Krik; off Kobberød; Søndre Røn at Lemvig; Oddesund; Sallingsund (Th. Morten sen). — **Kn:** Hirsholm; Jegens Rev; West side of Nordre Rønner; Frederikshavn. — **Ke:** Gilleleje (Lyngbye). — **Km:** Bay of Gerrild (Lyngbye). — **Ks:** Grenaa harbour; Hesselø (Lyngbye, Th. Mortensen); Sjællands Rev; bay of Nexelø; Ourø, Isefjord. — **Sa:** E side of Vejrø, 7.5—11 m; MY, Sletterhage lighthouse in NW by N $3^3/_4$ miles, 7.5—14 m; Kolby Kaas, mole; Norsminde Flak, 5.5 m; Hov, mole; Christiansminde and Vorsø, Horsens Fjord (S. L.); Sønderby Strand, As Vig (S. L.) Hofmansgave (Hofm. Bang). — **Lb:** Rosenvold, Vejle Fjord; Fænø Sund; Knudshoved N. of Haderslev Fjord; off Langøre; Trane Sand, North side of Als. — **Sf:** U, at Birkholm. — **Sb:** Kerteminde harbour; GQ, West side of Slettings Grund, 7.5 m. — **Sm:** Orehoved harbour; off Orenæsgaard; Stege Nor (S. Lund); between Kalvestrøm and Færgestrøm, c. 3 m; Nykøbing F. — **Su:** Off Ellekilde, 5.5 m; Hellebæk (Børgesen); Helsingør (Liebman!); Torbæk (Lyngbye); Hvidøre; Middelgrundsfort; Trekroner; Dragør; Saltholm (S. Lund). — **Bw:** At Kegnæs lighthouse. — **Bm:** QP, Kalkgrund at Stevns; VF, off Mandehoved; Rødvig; Hollændergrund, 5.5 m; between Dronningestolen and Sommerspiret, Møn. — **Bb:** Møllebugt at Rønne; 8 miles off Rønne harbour (C. A. J.); Allinge; the bay within Salthammer Rev; Christiansø, Græsholm, on Polys. violacea, sterile in July.

2. **Elachista stellaris** Aresch.

J. E. Areschoug, Algæ scand. exsicc., No. 71; Linnæa **16**, 1842, p. 233, Tab. 8, figs. 2—3; Phyc. scand. mar., 1850, p. 156, Tab. IX E; Flora Danica, tab. 2640,2, 1858; Kjellman, Handbok, p. 44, 1890; Gran, Alg. Tønsbergfj., 1893, p. 26, figs. 1—5; Kylin, Alg. schwed. Westk., 1907, p. 60; Printz, Algenveg. Trondhjemsfjordes, 1926, Tp. 163; Kylin, Zur Kenntn. der Entwicklungsgesch. ein. Phaeophyceen, 1934, p. 9.

Symphoricoccus radians Reinke, Ber. deut. bot. Ges., 1888; Algenfl. d. westl. Ostsee, 1889, p. 52; Atlas deut. Meeresalgen, tab. 2, 1899; Sauvageau, Un genre «Symphoricoccus» Rke est-il justifié?, Bull. de la Stat. Biol. d'Arcachon, Tome 30, '1833, p. 179.

Symphoricoccus stellaris (Aresch.) Kuckuck, Fragmente, 1929, p. 34 (exclus. fig. 30).

Leptonema fasciculatum Reinke, var. *flagellare* Reinke, Atlas deut. Meer., Taf. 10, Figs. 10, 11 (teste Kuckuck, Fragmente, p. 34).

Elachista stellaris was described in 1842 from the West coast of Sweden by Areschoug who found basal unilocular sporangia. Gran found it fifty years later in Tønsberg Fjord. He detected, besides the basal sporangia, plurilocular and unilocular sporangia on the median and upper part of the assimilating filaments forming small sori. This was confirmed by Kylin (1907), and Printz (1926) who both met with sori of unilocular and plurilocular sporangia on the assimilating filaments besides the basal unilocular sporangia. In 1888 and 1889 REINKE described a new genus and species of the *Elachistaceæ, Symphoricoccus radians* found in the bay of Kiel in the sublittoral region. He described small unilocular sporangia placed at the base and on the upper parts of the assimilating filaments, sessile in small sori. The author further describes and figures short branches, and states that single assimilating filaments may behave as stolons, a cell becoming fixed to the substratum and producing a new tuft of assimilating filaments. In the posthumous paper of KUCKUCK (1929) the species is mentioned and illustrated by several figures. He finds plurilocular sporangia at the base and on the upper part of the assimilative filaments and states the identity of *Elachista stellaris* with *Symphoricoccus*, on examining material cultivated in an aquarium with plants from Rovigno; but he thinks it justifiable to separate the genus *Symphoricoccus* owing to the insertion of the unilocular sporangia partly on the upper part of the assimilative filaments, which does not occur in any other genus of the *Elachistaceæ*. He further considers that *Leptonema fasciculare* var. *flagellare* is synonymous to this species. I think that the short branches mentioned by REINKE (Atlas, tab. 2, fig. 1 a, 4) might perhaps be plurilocular sporangia. I have found similar cylindrical plurilocular sporangia in the Danish material (fig. 26). SAUVAGEAU notes some discrepancies in the descriptions of *Symphoricoccus*. He states that REINKE only has mentioned the stolons, he has not himself observed them at Villefranche where the species always occurs as distinct tufts. He mentions also that the dimensions of the filaments and particularly of the basal unilocular sporangia are much larger in the Mediterranean plant than in REINKE's plant from the Baltic Sea.

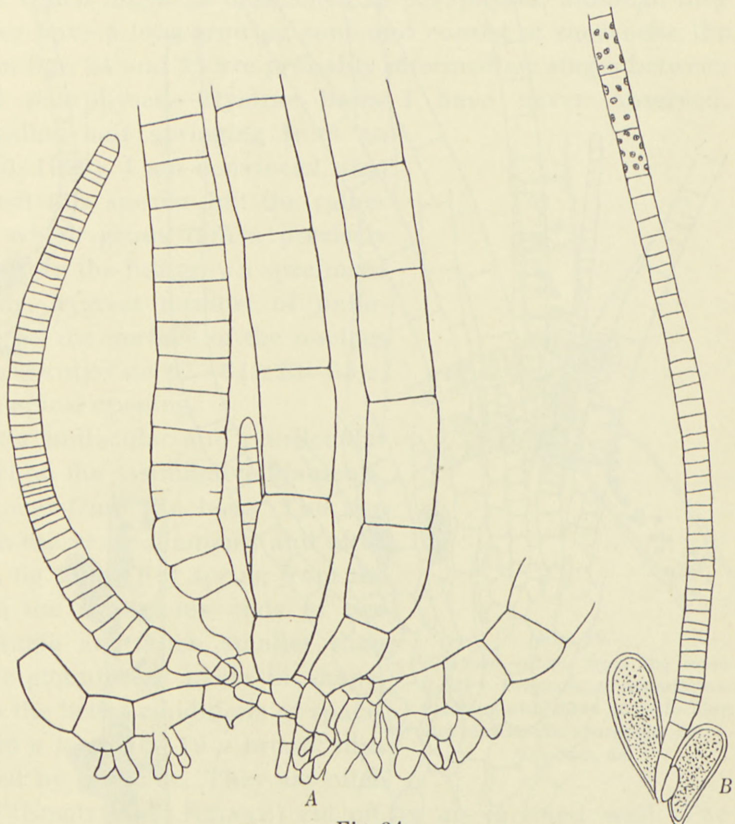

Fig. 24.
Elachista stellaris. On *Styela rustica*, off Sletterhage, 14 m, Aug. 1891. *A*, Basal portion of plant. 310:1. *B*, Assimilative filament and two unilocular sporangia. 200:1.

The species has been met with in several localities from the North Sea to the Samsø Water, at 8—24.5 metres' depth, growing on various algæ, *Stictyosiphon tortilis*, *Brongniartella byssoides*, *Chylocladia kaliformis*, *Flustra foliacea* and Ascidians. It

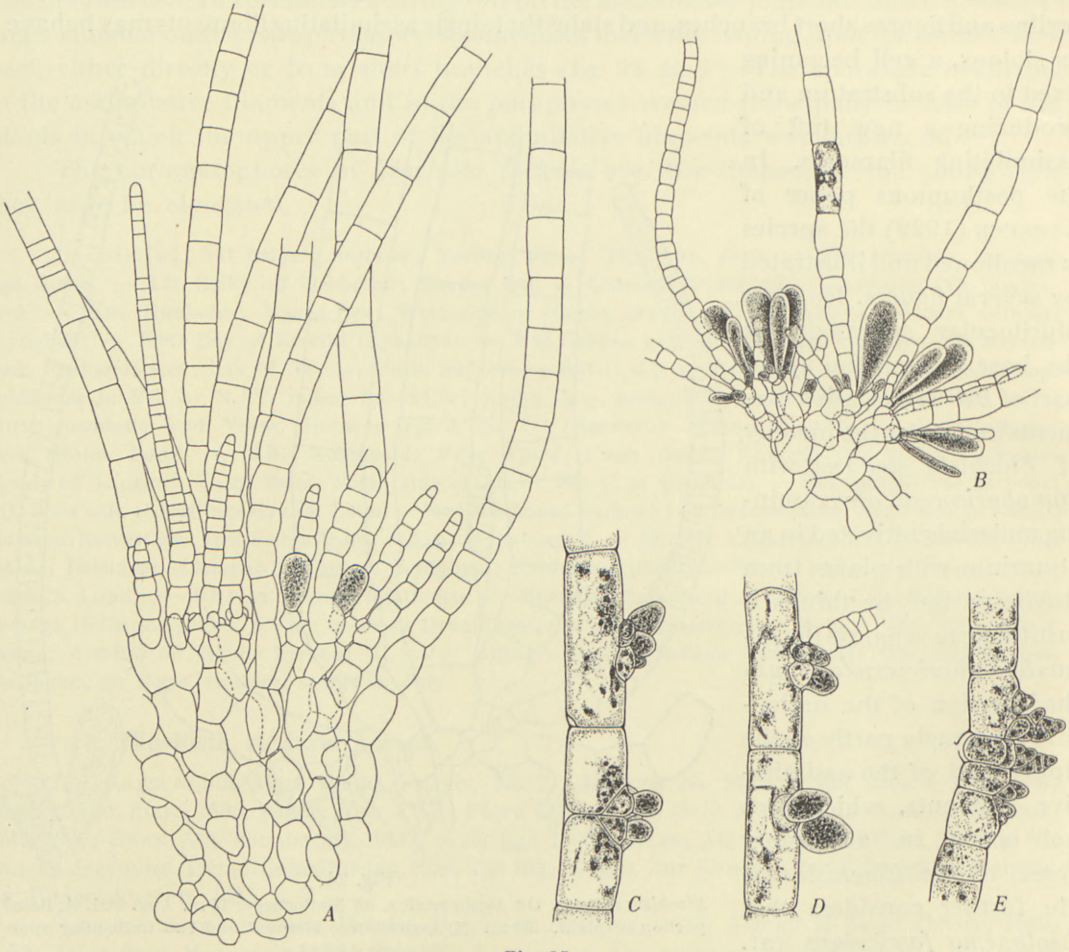

Fig. 25.

Elachista stellaris. Off Sletterhage. *A*, longitudinal section of plant with old and young assimilative filaments and basal unilocular sporangia. 210:1. *B*, similar with numerous basal unilocular sporangia. 265:1. *C*, fragment of assimilative filament with sori of unilocular sporangia. *D*, similar with sori of unilocular and plurilocular sporangia. *E*, similar with sorus ot plurilocular sporangia. *C-E*, 415:1. A. Sjödal del.

forms radiating tufts up to 3 mm in radius, and in an advanced stage has a well developed nucleus formed by radiating filaments composed of more or less rounded cells. In a less developed stage it shows short rhizoidal papillæ springing from the lower decumbent part of the erect filaments (fig. 24). The thickness of the assimilative filaments increases more or less from the very base upwards to a few cells' height. The cells are here isodiametric or a little longer than broad, usually more or less barrel-shaped. The growing zone follows above this basal portion, and the cells are there cylindrical, 2—4 times as broad as long, but become gradually narrower and several times longer than the diameter. The diameter of the assimilative filaments is in the Danish specimens 18—30 μ. Besides the ordinary assimilative filaments, shorter and thinner filaments occur which might be designated as paraphyses, although they have no distinct length. They have a long growing zone and consist of short cells, the long, thin filaments shown in figs. 24 and 25 are probably intermediate stages between assimilative filaments and paraphyses. Hyaline hairs I have never observed. Kuckuck has figured a hyaline hair springing from an assimilating filament (fig. 30, 1929). I am convinced, that this figure does not represent this species but the rather similar *Gonodia pulvinata* which genus differs precisely by the presence of such hairs. In the full-grown specimens with well developed nucleus, a great number of unilocular sporangia are placed on the surface of the nucleus (fig. 25 *A*—*B*). The sporangia are obovate, 67—84×23—33 μ; they are emptied through an apical opening.

Besides these sporangia unilocular and plurilocular sporangia occur in small sori on the assimilative filaments, at great and various distances from the base. The two sorts of sporangia occur on the same filaments and often in the same sorus (fig. 25 *D*, fig. 26). They spring from the middle of the cell or from the contiguous ends of two cells. The unilocular sporangia are much smaller than the basal ones and they are globular or ovate in shape, the latter probably owing to the better conditions of space. Their dimensions are: 19—26 μ long, 16—19 μ broad, thus agreeing with those indicated by Kuckuck. They are often supported by a small cell ("Ersatzzelle" Reinke) cut off by an inclined wall. The plurilocular sporangia are cylindrical or conical; they consist of a row of cells, sometimes divided by a vertical or inclined wall. I have never in the Danish material observed plurilocular sporangia borne at the base of the assimilating filaments as those mentioned and figured by Kuckuck (1929, p. 33) and by Kylin (1934, fig. 6 *B*). I am not convinced that Kuckuck is right in referring *Elachista fracta* Gran (Alg. Tønsbergfjord, 1893, p. 28, figs. 6—7) to this species; it might just as well be referred to *Gonodia*. Stolons I have never observed.

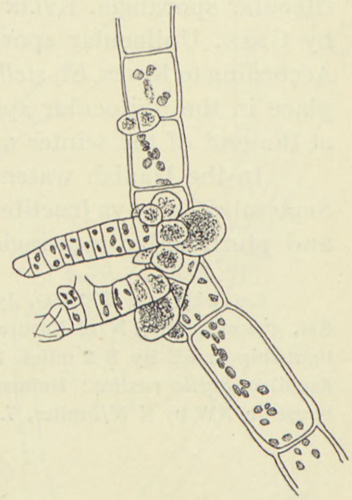

Fig. 26.
Elachista stellaris from the same locality. Fragment of assimilative filament with sorus of unilocular and plurilocular sporangia. 350:1.
A. Sjödal del.

Kuckuck thinks that the genus *Symphoricoccus* must be retained owing to the unilocular sporangia being partly placed on the assimilating filaments. I am not convinced of the correctness of this distinction, and therefore keep the species in the genus *Elachista*.

Kylin has recently described the development of *Elachista stellaris* which he studied at Kristineberg (Z. Kenntn. der Entwickl. ein. Phaeophyceen. Lund 1934, p. 9).

It was richly fructifying with basal unilocular sporangia, whereas plurilocular sporangia were only sparingly present on the assimilative filaments. By the germination of the zoospores from the unilocular sporangia each spore usually produced two germinative filaments which grew out into irregular bushes; they were still sterile at the end of August. These plants, according to Kylin, probably represented the gametophytes of *El. stellaris*. Besides these germlings another sort arose, though in smaller number (l. c. fig. 5); they produced a creeping organ, often as a *Myrionema*-like disc, and upright filaments springing from it. After two weeks the filaments began to produce plurilocular sporangia. Kylin identified the young plants with *Elachista fracta* described by Gran. Unilocular sporangia were only produced in quantity at the end of July. According to Kylin *El. stellaris* is undoubtedly diploid, and the reduction division takes place in the unilocular sporangia. The gametophytes must be supposed to be fertile at the end of the winter or in spring.

In the Danish waters the species has only been observed in July, August and September, always fructiferous, with basal unilocular sporangia and lateral unilocular and plurilocular sporangia on the assimilating filaments.

Localities. **Ns:** ZQ, Jydske Rev, 24.5 m, on *Flustra foliacea*. — **Kn:** SE of Deget, 8—9 m; EM, 4½ miles E ¾ N of Nordre Rønners light-house, 15 m, on *Stictyos. tortilis*. — **Ke:** ZG, Fladen's light-ship in SE by E 2 miles, 17 m, on *Chylocladia kalif.* — **Sa:** BF, off Sletterhage, 14 m, on the Ascidian *Styela rustica;* Hofmansgave (Car. Rosenberg), on *Brongniartella byss.*; MY, Sletterhage light-house in NW by N 3¾ miles, 7.5—14 m.

Gonodia Nieuwland.

Nieuwland, Critical Notes, IX, 1917, p. 30. The American Midland Naturalist, Vol. 5, p. 30. Setchell and Gardner, The Mar. Algae from the Gulf of California. Proc. Calif. Acad. of Science, Vol. XII, 1921, p. 722.

Myriactis Kützing, Phyc. gener., 1843, p. 330; not Lessing 1831.

Gonodia pulvinata (Kützing) Nieuwland l. c.

Myriactis pulvinata Kützing, Phyc. gen., 1843, p. 330; Tab. phyc., Bd. 7, 1857, Tab. 92, III; Thuret, Rech. s. l. Zoospores des Algues. Ann. sc. nat. IIIe Sér., t. 14, 1850, p. 237, pl. 26, figs. 1—2; Thuret et Bornet, Étud. phyc., 1878, p. 18, tab. VII; Kuckuck, Fragmente, 1929, p. 39.

Elachista Rivularice Suhr in Areschoug, Pugillus. Linnæa, Bd. 16, 1842, p. 235, Tab. VIII, fig. 8.

Elachista attenuata Harvey, Phycol. Brit., I, 1846, pl. 38 A.

Elachista pulvinata Hauck, Meeresalgen, p. 351.

The typical *Gonodia pulvinata* always grows in the cryptostomata or scaphidia of *Fucaceæ*, usually of *Cystoseira* or *Halidrys*. The lower part of the frond is sunk in the cryptostoma, the upper part of the nucleus is a free cushion consisting of straight or slightly curved, fusiform assimilative filaments, hyaline hairs and unilocular or plurilocular sporangia.

Up to November 1934, a species of this genus has been met with in several localities in the Northern Kattegat fixed on various filamentous algæ, but never in the cryptostomata or the scaphidia of the *Fucaceæ*. The species was identified with *Elachista*

Chordæ (Aresch.) Kylin which must be referred too to the genus *Gonodia* and which is closely related to *G. pulvinata*. It has been kept distinct from the latter species especially owing to its growing on filamentous algæ, whereas *G. pulvinata* has always been found only fixed in the cryptostomata of various *Fucaceæ;* but it shows much similarity with it. In November 1934 Mag. Søren Lund found a *Gonodia* species growing in the cryptostomata of *Fucus vesiculosus* at Saltholm near Copenhagen. A description of the specimens will first be given here by Mr. Lund who has examined them carefully.

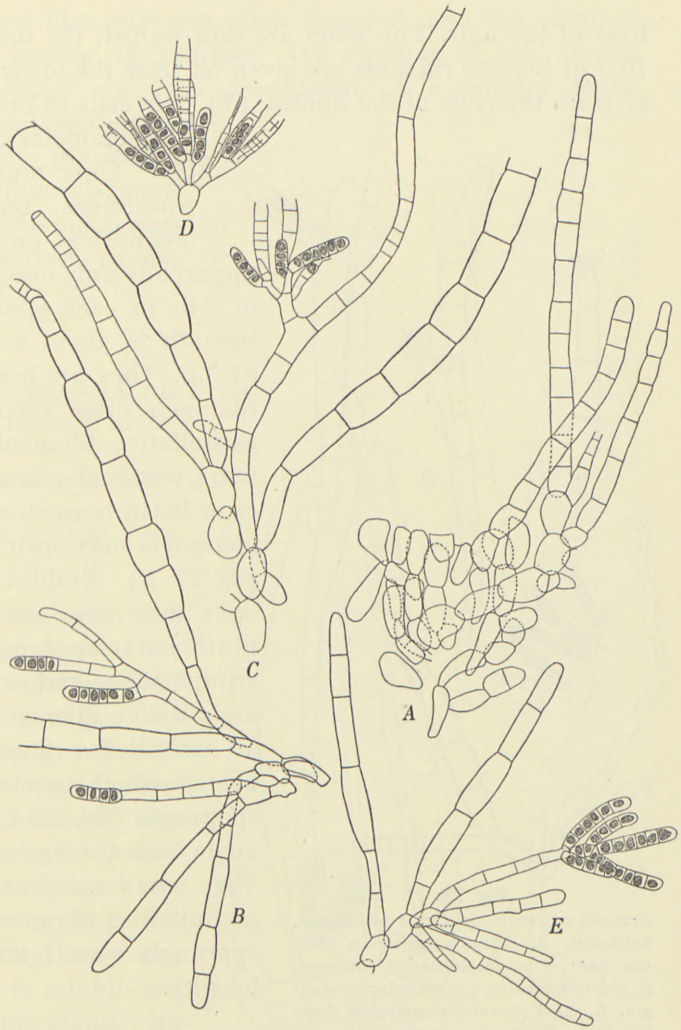

Fig. 27.
Gonodia pulvinata, on *Fucus vesiculosus*, Saltholm, Nov. 1934. *A*, part of the nucleus and assimilative filaments. *B*, assimilative filaments, one with a short terminal plurilocular sporangium, and thin filaments with normal plurilocular sporangia. *C*, assimilative filaments, a hyaline hair and a cluster of plurilocular sporangia. *D*, a cluster of sporangia. *E*, short assimilative filaments and a bunch of thin filaments, one with a terminal cluster of sporangia, the terminal one with two branches. 235 : 1. S. Lund del.

Gonodia pulvinata (Kützing) Nieuwl., Saltholm (Barakkebro) near Copenhagen, on *Fucus vesiculosus*, 1 meters' depth. The plants grew in the cryptostomata of the host which were filled with the nucleus or its lower part. The lower cells of the assimilative filaments are fairly long, narrow; they increase rapidly in breadth upwards so that the cells obtain the maximal thickness (about 21—29.4 μ). Hereafter the thickness decreases gradually toward the apex, to about 17 μ or less. The uppermost part of the apical cell may be only 6.3—8 μ thick. The thickest cells may be barrel-shaped. The proportion of the length to the breadth of the cells in the thickest part of the filaments is usually 1.2—1.5 (1.0—2.3), in the following part about 2 (1.0—3.3). The number of cells in the assimilative filaments is small, about 10. Hyaline hairs are rather rare; they often spring from the lower portion of the assimilative filaments, the dividing zone is situated a little over the base of the hair. The hairs are thin-walled, the thickness at the dividing zone about 10.5 μ. Septate rhizoids are given off from the lower part of the assimilative filaments or from the cells of the nucleus (?). The cells of the nucleus are irregularly oblong. — The diameter of the frond is about $^3/_4$ mm.

Only plurilocular sporangia occur in these specimens, but in great numbers. They are cylindrical, only divided transversally and contain apparently only one zoospore in each cell. The number of cells in each sporangium varies from 2 to 15; the breadth is about 8.5 μ, the length varies from 21 to 67.3 μ. They are borne on more or less branched, thin filaments often springing from the lower part of the assimilative filaments or from the basal part of the hairs, terminal or lateral; often scattered, but frequently crowded in dense clusters. It may then happen that lateral sporangia may spring as branches from a sporangium (fig. 27 *E*). Besides these normal sporangia similar ones may arise on rhizoids (fig. 27 *B*). And short plurilocular sporangia may occur singly or in small groups at the end or laterally on the upper part of the assimilative filaments (fig. 27 *A*, 28 *C—D*). In one case an assimilative filament had produced a short thick branch which bore at the base a group of plurilocular sporangia (fig. 28 *E*). The greater part of the sporangia were emptied in the middle of November. Very small specimens of the same form with short assimilative filaments and single short plurilocular sporangia were found in February 1935 in the same locality. S. L.

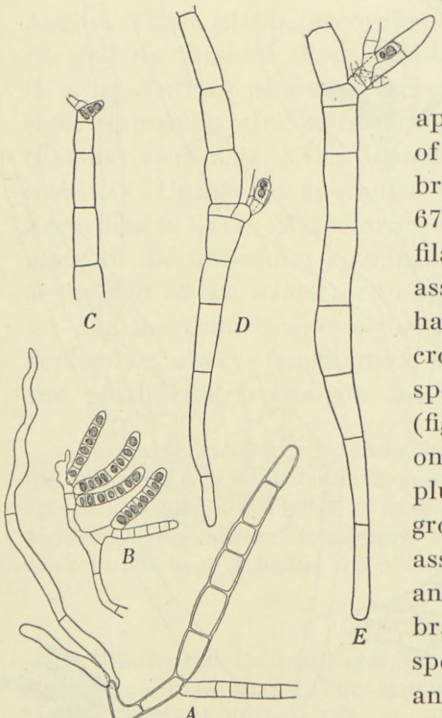

Fig. 28.
Gonodia pulvinata on *Fucus vesiculosus*, Saltholm. *A*, rhizoids springing from the base of an assimilative filament. *B*, rhizoid bearing plurilocular sporangia. *C*, short sporangia springing from the end of an assimilative filament. *D*, assimilative filament with short sporangium issuing from a short cell, divided by a longitudinal wall. *E*, assimilative filament giving off a short branch bearing at the base a whorl of plurilocular sporangia. 235:1. S. Lund del.

The cell-walls in most of the drawings in this and the foregoing figure are not given with their full thickness.

The main species has been observed at the British coasts on *Cystoseira ericoides* and *Halidrys siliquosa* and at Cherbourg on various species of *Cystoseira*.

The above described plants growing on *Fucus* have been referred to *G. pulvinata* in spite of the small number of cells in the assimilative filaments and in spite of the sporangia situated on the upper part of the assimilative filaments and on the rhizoids, which have not hitherto been observed in *G. pulvinata*. The small number of cells in the assimilative filaments (paraphyses) of the typical *G. pulvinata* is, according to the published figures, 13 to 17 (Kützing, Thuret). The small number of cells in the assimilative filaments of the specimens from Saltholm may perhaps be due to the late season; the outermost cells of these filaments are often decayed, and the number of cells may possibly have been greater in summer. On account of the quoted differences, the specimens from *Fucus* are here considered as a special form:

f. *Fucorum*. Filamentis assimilatoribus a cellulis ca. 10 constructis, sporangiis pluricellularibus vulgo basalibus longis, cylindricis, nonnunquam brevibus in parte superior filamentorum assimilatorum sita. Sporangia unilocularia ignota. In cryptostomatibus *Fuci vesiculosi*.

f. Chordæ (Aresch.)

Elachista stellaris Aresch. var. *Chordæ* Aresch, Observ. phycologicæ III, 1875. p. 18, Tab. II, fig. 3; Kjellman, Handbok 1890, p. 45.

Elachista Chordæ (Aresch.) Kylin, Studien 1907, p. 61, Fig. 15.

Symphoricoccus stellaris Kuckuck ex parte, Fragmente 1929, fig. 30, non aliæ.

A species of *Gonodia* agreeing with the description and the figure of Areschoug has been met with in the northern Kattegat north of Læsø, epiphytic on various filamentous algæ. This alga Areschoug considered a variety of *Elachista stellaris* as he had observed some intermediary forms which he thought hindered him from keeping it as a particular species distinct from the main species. Kylin has, however, rightly separated it from the said species; he found besides the assimilative filaments hyaline hairs with a basal growing zone. So at to established with more certainly the identity of my plants with Areschoug's original material, I received, on request, by the great courtesy of the Riksmuseum in Stockholm where Areschoug's collection is kept, the whole material of *Elachista stellaris* from Areschoug's collection, but it did not contain any specimen of var. *Chordæ* from Areschoug. A specimen of *El. stellaris* var. *Chordæ* collected by Strömfelt at Kristineberg 17. Aug. 1886 was, however, present. As it has been collected on the original locality of Areschoug, and as it agrees with Areschoug's description, it may replace a true original specimen. I give here (fig. 29) a figure of Strömfelt's plant which shows hairs with a growing zone above two or three long cells. The assimilative cells contained about 19 cells. Fig. 30

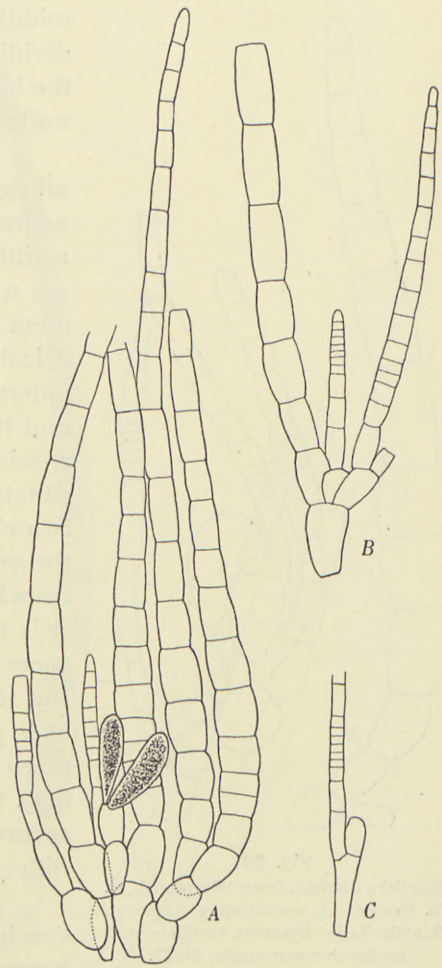

Fig. 29.

Elachista stellaris f. *Chordæ* Aresch. From Kristineberg, legit Strömfelt, 17/8 1886. *A*, assimilative filaments, springing from the outer cells of the nucleus, at left a hyaline hair, in the middle two unilocular sporangia. *B*, assimilative filaments. *C*, hyaline hair, 200:1.

shows assimilative filaments and sporangia of an alga received from the late algologist E. M. Holmes under the name of *Elachista Chordæ* from Weymouth. I think it belongs to the same species, though the assimilative filaments are shorter and thicker than in Strömfelt's specimen; they consisted of 12 to 18 cells, the thickest cells below the middle of the filament were 30 to 35 (38) μ thick. The dividing zone of the hairs is situated at a high level, the hair proper is rather short. The specimen had only unilocular sporangia.

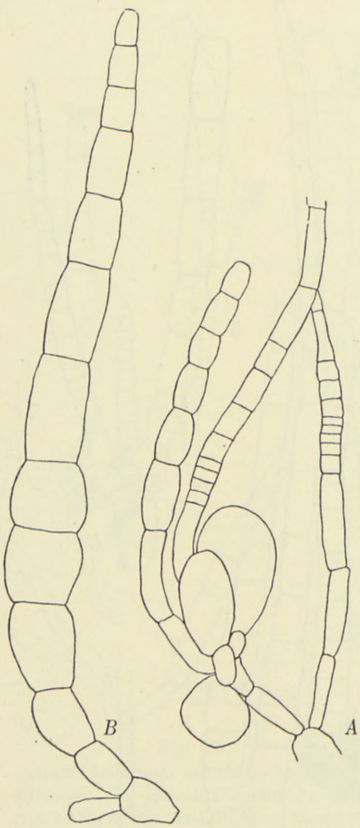

Fig. 30.
Elasticha Chordæ, from Weymouth, E. M. Holmes. *A*, assimilative filament. *B*, assimilative filament, two hairs and unilocular sporangia. 340 : 7.

The Danish specimens from the northern Kattegat all agree with the Swedish ones by their relatively short assimilative filaments which have their greatest thickness a little over the base. The cells of the lowermost part are usually more or less barrel-shaped, whereas the filament tapers gradually upwards, consisting of cylindrical cells, 2—3 times as long as broad, not longer. The outermost cells do not continue growing as in *Elachista*, and the end cells are kept much longer. Further these specimens have always hyaline hairs with a growing zone situated at a height of 2 or 3 cells above the base. These two characters show that the plants must be referred to the genus *Gonodia* (*Myriactis*), and the question then arises whether they can be kept distinct from *G. pulvinata*. It is a commonly accepted fact that this species always occurs in the scaphidia or cryptostomata of *Fucaceæ*. But if we compare the structure and the reproduction of *G. pulvinata* with that of the specimens from the northern Kattegat, which have been provisionally referred to *G. Chordæ*, it cannot be denied that we find such great accordance that the limits are difficult to draw if the different habitats are disregarded.

I shall here give a more detailed description of the specimens from a number of localities from Frederikshavn northwards. The assimilative filaments spring from a pseudoparenchymatous nucleus composed of radiating rows of roundish or barrel-shaped cells. These filaments attain a length of 700 to 1000 μ, the number of cells varies from 15 to 31, most frequently from 18 to 21 cells, the maximal breadth from 25 to 28 μ. The hairs have a short-celled dividing zone above two or three longer cells, and then a series of long cells without chromatophores. The hairs are 12—14 μ thick and are often much longer than the assimilative filaments. Most of these specimens had only unilocular sporangia (figs. 31 *A*, 3) seated at the base of the assimilating filaments; they were obovate, 82—93 μ long, 25—33 μ broad, but a specimen from a locality east of Græsholm further bore

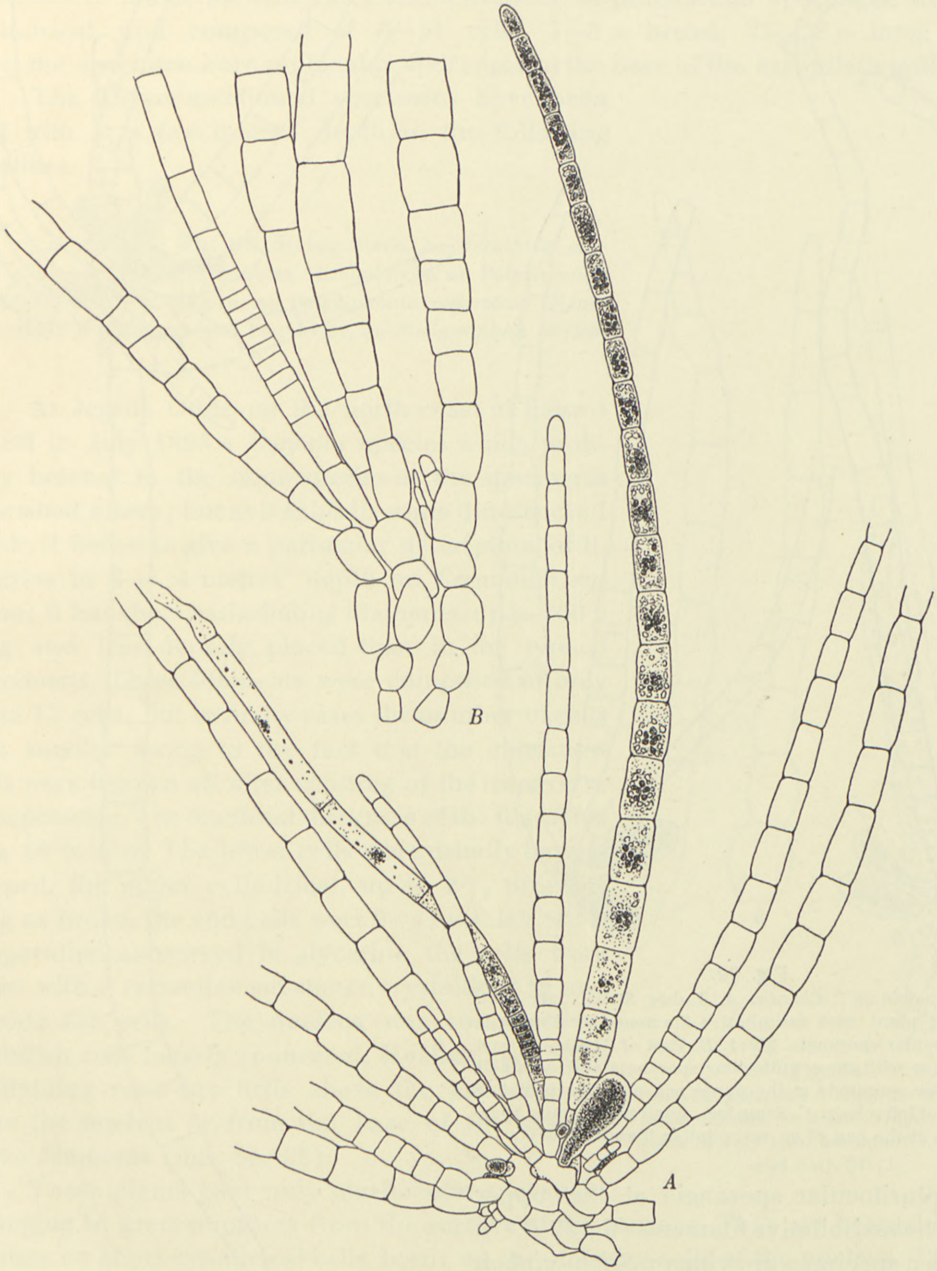

Fig. 31.
Gonodia pulvinata (Kütz.) f. *Chordæ* (Aresch.), on *Polysiphonia nigrescens*, south of Kølpen. *A*, fragment of the nucleus with assimilative filaments, a hair and a unilocular sporangium. 230:1 (del. *Sjødal)*. *B*, showing filaments of the nucleus springing from the substratum, four assimilative filaments and a hyaline hair (390:1),

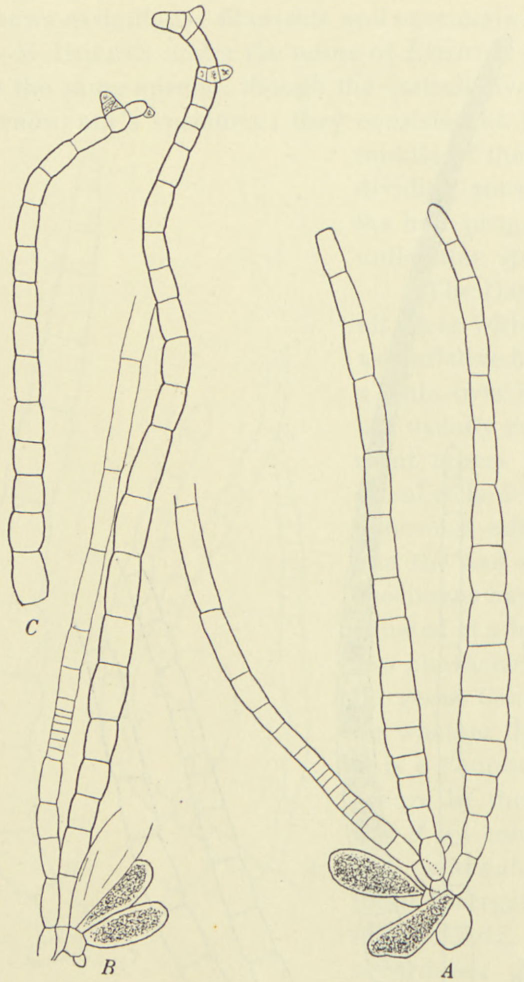

Fig. 32.
Gonodia pulvinata f. *Chordæ*. *A*. Hulsig Stene, July 1933. Portion of plant with assimilative filaments, hyaline hair and unilocular sporangia. 230 : 1. *B*. East of Græsholm, part of specimen with three unilocular sporangia and two small plurilocular sporangia at the upper end of an assimilative filament, at left a hair. *C*, Same loc., small plurilocular sporangia at the end of an assimilative filament. 200 : 1.

small plurilocular sporangia at the upper end of the assimilative filaments (fig. 32 *B*, *C*).

In a specimen growing on *Stictyosiphon tortilis* at Borrebjergs Reef one assimilative filament bears near the upper end a new formation having the character of a new adventitious plant consisting of several

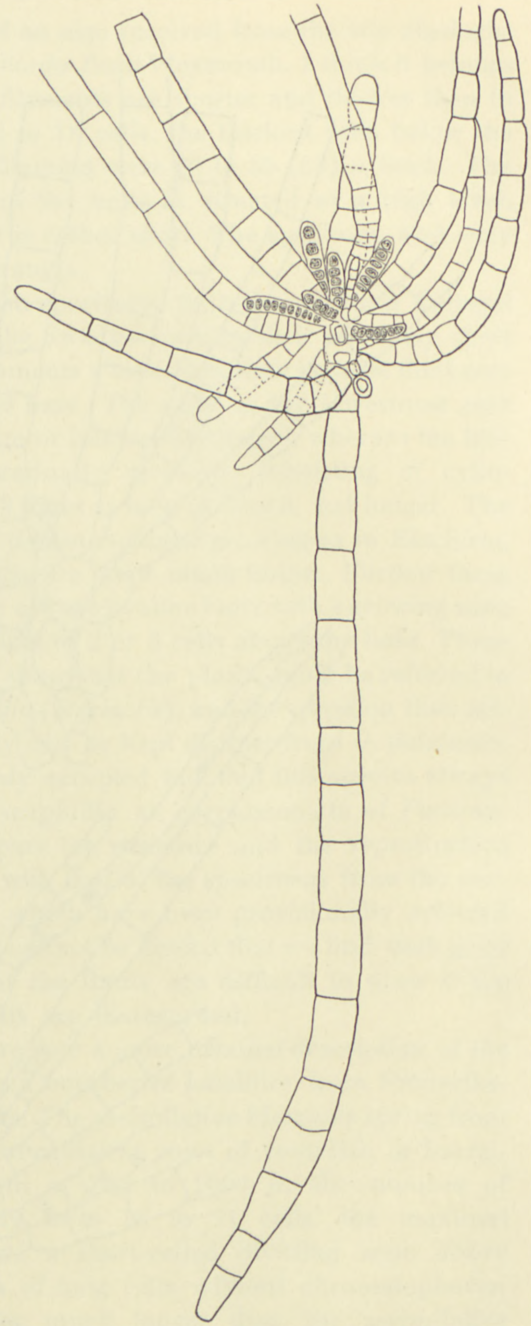

Fig. 33.
Gonodia pulvinata f. *Chordæ*. On *Stictyosiphon fortilis* from Borrebjergs Rev. July 1903. Assimilative filament from a plant with unilocular sporangia. Adventitious plant given off near the upper end, with assimilative filaments, two hyaline hairs and plurilocular sporangia. 273 : 1.

assimilative filaments, two hairs and a number of plurilocular sporangia, which are cylindrical and composed of 6—11 cells, 7—8 μ broad, 25—28 μ long. Otherwise the specimen bore unilocular sporangia at the base of the assimilative filaments.

The above mentioned specimens have been met with at a few metres' depth in the following localities.

Localities: **Kn:** hH, Hulsig Stene, on *Acrothrix gracilis* a. o.; east side of Græsholm, Hirsholmene, on *Polysiphonia urceolata;* south of Kølpen, on *Polysiphonia nigrescens* (Henn. Petersen); Borrebjergs and Laurs Rev, on *Stictyosiphon tortilis.*

At Jegens Odde on the north coast of Læsø I found in July 1895 a *Gonodia* species which probably belongs to the same species as the specimens described above; but as it exhibits some differences I think it better to give a particular description of it. It grew in 2 to 4 metres' depth on *Ceramium rubrum*; it has short assimilating filaments, up to 300 μ long and less densely placed than in the typical specimens. These filaments were composed of only 10 to 13 cells, but in many cases the number of cells was smaller owing to the fact that the outermost cells were thrown off after splitting of the transverse dissepiments. The maximal thickness of the filaments was 16 to 28 μ. The lower cells were usually barrel-shaped, the upper cylindrical, up to $2^1/_2$ times as long as broad, the end-cells were 9—11 μ thick. In a preparation conserved in glycerine the cells were filled with a refractive substance crystallised in and outside the cells. The nucleus was composed of roundish cells loosely connected. Hyaline hairs with a dividing zone two cells above the base sprang from the nucleus or from the base of the assimilative filaments (figs. 34, 35).

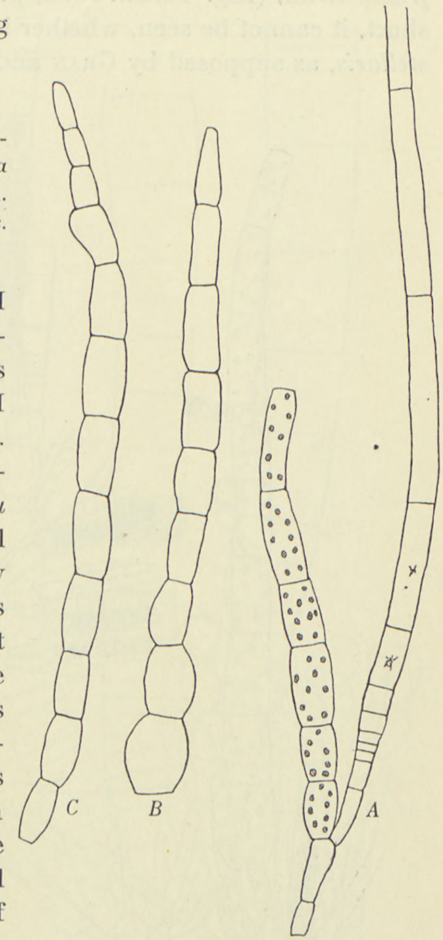

Fig. 34.
Gonodia pulvinata f. *Chordæ.* On *Ceramium rubrum*, at Jegens Odde north of Læsø in July 1895. Assimilative filaments and hair. 347 : 1.

These plants bear only plurilocular sporangia springing in great numbers from the surface of the nucleus. They are heaped in dense clusters on short cylindrical cells borne on the globular cells of the nucleus. The sporangia are cylindrical, 7—9 μ thick, containing a row of up to 13 cells and are 52—63 μ long. Plurilocular sporangia occur too, not seldom on the upper part of the assimilative filaments, forming small tufts with sterile cells at the base and sometimes with a hair from the same tuft, but I have never met with sterile assimilative filaments in these tufts. A single hair issued directly from the filament at a lower level than the tuft (fig. 35 *E*).

The lateral sporangia on the assimilative filaments remind one of *Elachista fracta* Gran, (Alg. Tønsb. 1893, p. 28); but as the description of this species is rather short, it cannot be seen, whether it is identical with *Gonodia Chordæ* or with *Elachista stellaris*, as supposed by GRAN and KUCKUCK. The latter is most probable, because the

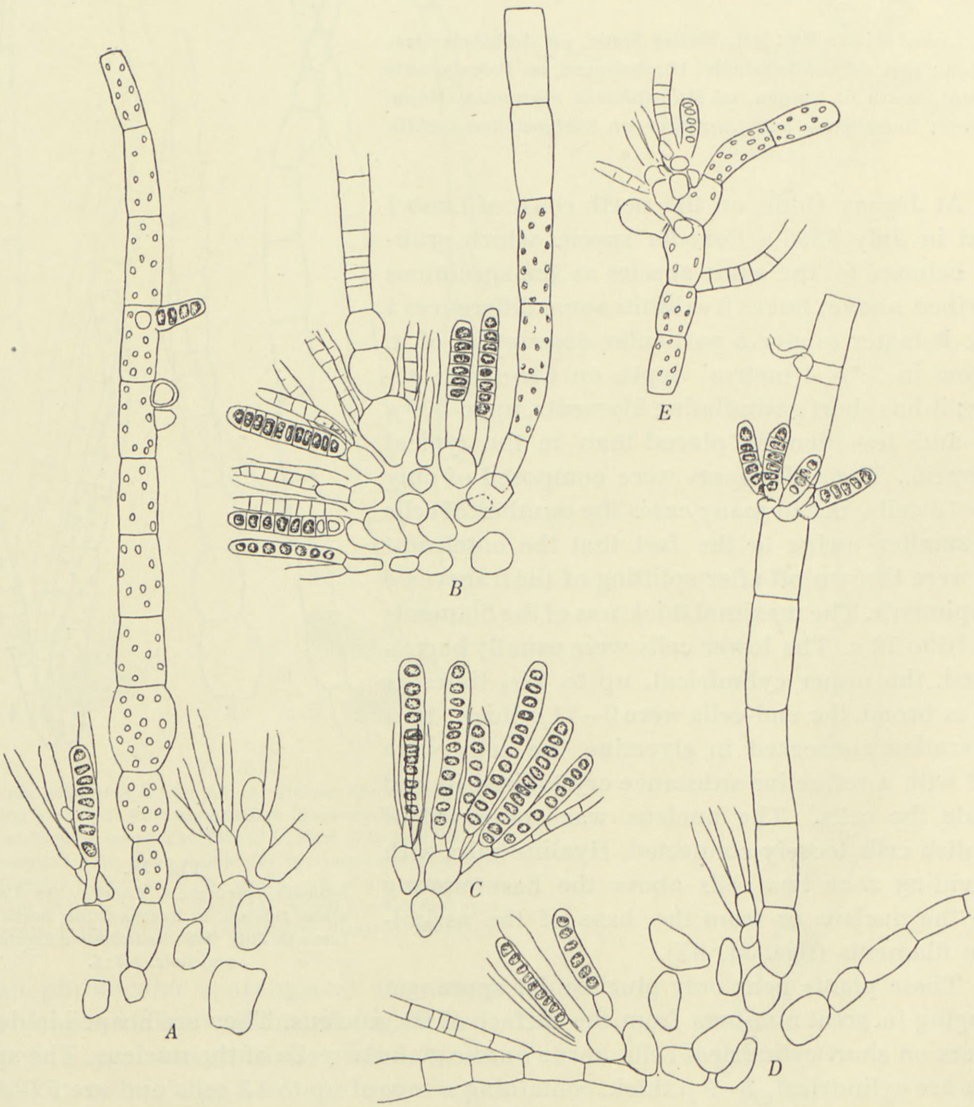

Fig. 35.

Gonodia pulvinata f. *Chordæ*. On *Ceramium rubrum*, at Jegens Odde north of Læsø in July 1895. Plant with numerous plurilocular sporangia, partly on the surface of the nucleus, partly on the upper part of the assimilative filaments. In *E* apparently an adventitious plant on an assimilative filament. In *B*, *D* and *E* hyaline hairs. 347:1.

assimilative filaments are described as in apicem longe attenuatis and the cells as up to four times as long as broad. The partly branched plurilocular sporangia also agree better with *El. stellaris*. Hairs are not mentioned in *El. fracta*.

The short assimilative filaments in the form from Jegens Odde remind one of the form from Weymouth by the short, few-celled assimilative filaments, but these specimens bore only unilocular sporangia. The form from Jegens Odde also agrees with the form from *Fucus* at Saltholm in the plurilocular sporangia; they were merely more densely crowded in the latter, and it is of interest that plurilocular sporangia also occur on the upper part of the assimilative filaments in the latter. I have thus no hesitation in considering all the forms here described as forms of the first described species *Gonodia pulvinata*.

Halothrix Reinke 1889.

Halothrix lumbricalis (Kütz.) Reinke.

Reinke, Atlas deutsch. Meeresalgen 1. Hft., 1889, Tafel I; Algenflora d. westl. Ostsee 1889 p. 49; P. Kuckuck, Fragmente einer Monogr. d. Phaeosporeen, 1929, p. 26—28, figs. 15—18.

Ectocarpus lumbricalis Kützing, Phycol. germanica, 1848, p. 233; Tab. phyc., Vol. V, Tab. 55 II, 1855.

Elachista lumbricalis (Kütz.) Hauck, Meeresalgen, p. 345.

This alga appears to be fairly common on the leaves of *Zostera marina* in sheltered localities; it has been met with in several places in the inner Danish waters. It much resembles an *Elachista* but differs from this genus in having no firm parenchymatic tissue (nucleus) at the base, in the lack of unilocular sporangia and in the position of the sori of plurilocular sporangia which form girdles around the assimilative filaments. As shown by Kuckuck (Fragmente, p. 22 and 27), the plurilocular sporangia of *Elachista lubrica*

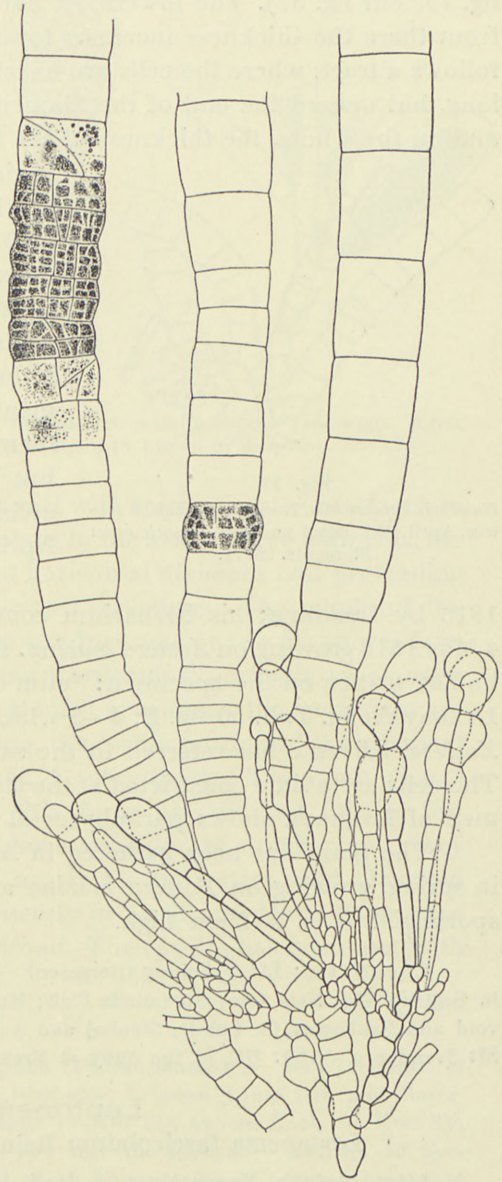

Fig. 36.
Halothrix lumbricalis. Frydenstrand at Frederikshavn, July 1909. Plant with three assimilative filaments with sori of plurilocular sporangia and with paraphyses. Sjödal del. 345:1.

are placed in analogous sori on the assimilative filaments, but the inner cells of these zones are fertile in the latter, while in *Halothrix* they are sterile.

At the base of the upright filaments septate rhizines are produced (Kuckuck fig. 15, our fig. 37). The lowermost part of the erect filaments is often very narrow; from there the thickness increases toward the meristematic, short-celled zone. Then follows a tract, where the cells are usually 20—35 μ thick and about $1^1/_2$ to 2 times as long, but toward the end of the filaments the cells become longer and often thinner, and on the whole, the thickness of the filaments and the length of the cells are fairly variable, as seen from the following figures showing the breadth and the length of the cells in μ: 40 × 45.5; 35 × 54; 33 × 84; 26 × 80.5; 24 × 108.5; 24 × 84; 19 × 101; 14 × 107; 10.5 × 73.5. The cells are more or less constricted at the transverse walls. Shoots with limited growth (paraphyses) arise in bunches on the lowermost part of the upright filaments under the meristematic zone. Fig. 36 shows them well developed, upwards thicker, moniliform, but in other cases they were less developed, with cylindrical cells, and in some plants gathered in April they were as yet undeveloped.

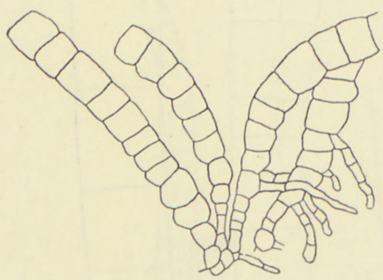

Fig. 37.
Halothrix lumbricalis. Norsminde Flak, 6 metres, April 1894. Basal portions of pour erect filaments. 280 : 1.

The species has been observed as early as 1816 by Lyngbye; his herbarium contains a specimen collected at Hofmansgave 4 May 1816 growing on *Zostera marina*. Lyngbye has referred it to *Conferva fucicola* but he has written on the specimen: "cum delineatione 8. May 1816". This is probably Lyngbye's fig. Tab. 50 fig. *B*, 4—5 which represents precisely a specimen growing on *Zostera*. Kützing has referred to the same figure in describing *Ectocarpus lumbricalis*. The cells are a little constricted at the transverse walls in Lyngbye's fig. 5. The specimen of Lyngbye shows paraphyses at the base of the filaments.

The plant has been gathered in April to July and in September, most frequent in spring, growing on *Zostera marina* at small depths, in all cases with plurilocular sporangia. It is 1—2 cm high.

Localities: **Lf:** Nykøbing (Børgesen). — **Kn:** Frydenstrand near Frederikshavn. — **Sa:** Rønnen in Begtrup Vig; Kalø Rev; Norsminde Flak; Hofmansgave (Lyngbye). — **Lb:** Vejlefjord between Rosenvold and Fakkegrav (S. Lund); Stenhøj and Aalegaardsbjerg (S. Lund); Fænø Sund; at Fænø Kalv. — **Sf:** Svendborg. — **Sb:** UE, at the buoy at Vresens Puller, 7 m; Hov Sand, 8,5 m.; Lohals.

Leptonema Reinke 1889.

1. **Leptonema fasciculatum** Reinke.

Atlas deutsch. Meeresalgen, 1. Heft, 1889, p. 13, Taf. 9 und 10, excl. f. *flagellare*, Taf. 10, figs. 10—11, Reinke, Algenflora d. westl. Ostsee, 1889, p. 50; K. Rosenvinge, Grønl. Havalger 1893, p. 879, var *subcylindrica*; Knight and Parke, Manx Algæ 1931, pp. 66, 110 plate XIII, figs. 35, 36, 39.

Elachista fasciculata (Rke.) Gran, Algeveg. i Tønsbergfj., Christ. Vidensk.-Selsk. Forhandl., 1893, p. 29; K. Rosenv., Deux. Mém. s. l. Algues mar. du Groenland, 1898, p. 75.

The species occurs spread in the inner Danish waters, growing on various algæ e. g. *Fucus vesiculosus* and *F. serratus*, *Laminaria digitata*, *Chondrus crispus*, *Halidrys*, *Zostera marina*, *Potamogeton pectinatus*, and on *Pagurus Bernhardi* and ascidians. It forms small tufts arising from a basal creeping layer and attains a length of up to 3 mm. The assimilative filaments are cylindrical without constrictions at the joints, 7—16 μ broad. The cells contain a number of small disc-shaped chromatophores. Plurilocular sporangia are nearly always present and have been met with in the months of March to August; they arise as intercalary in the assimilative filaments, the cells dividing by vertical and horizontal divisions and protruding from the segments in one or two directions. The whole of the segment is therefore used to produce one or two (or more) few-celled, more or less protruding plurilocular sporangia which open by an apical hole. In the Danish specimens the sporangia are often only slightly protruding, the fertile portion of the filament being long, nearly cylindrical, f. *subcylindrica* K. Rosenv. (l. c.,) fig. 38. The sporangia of this form are divided into a few cells only. — The unilocular sporangia are much rarer; they were, however, met with in nearly all the waters, and observed in April to July, most frequently in April and May. They were 56—112 μ long, 25—32 μ broad. The species has been met with in 4 to 15 metres' depth.

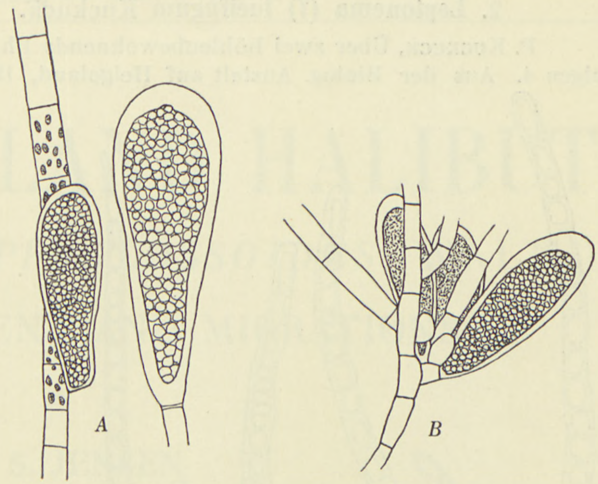

Fig. 39.
Leptonema fasciculatum, with unilocular sporangia, April. *A*, Vejle Fjord (S. Lund). *B*, Ryes Flak. 390:1.

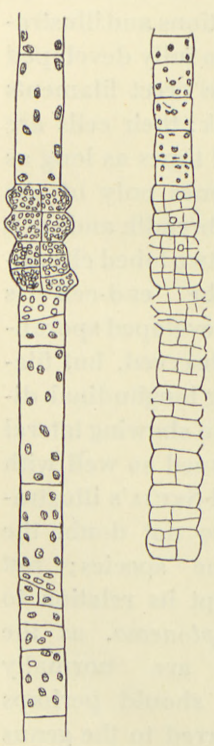

Fig. 38.
Leptonema fasciculatum. Sallingsund, May 1895. Filaments with plurilocular sporangia, to the right emptied. 650:1.

Localities: **Lf:** Sallingsund (Th. Mortensen). — **Kn:** cl[1] south of Skagens Gren, 9.5 m; South of Hirsholm; between Laurs Rev and Borrebjergs Rev; Frederikshavn (Børgesen). — **Ke:** EQ, Anholts Knob. — **Km:** XF, south of Læsø. — **Ks:** Sjællands Rev near the beacon. — **Sa:** BF, off Sletterhage, 14 m; RP, Ryes Flak, 4 m. — **Lb:** Vejle Fjord, between Rosenvold and Fakkegrav (S. Lund); Fænø Sund; Assens harbour; stony reef in Augustenborg Fjord; LF, Vodrups Flak, 9.5 m. — **Sb:** cN, SW. of Musholm, 18 m; at the buoy at Vresens Puller, 4 m. — **Su:** Drogden off Kastrup, 3 m. (S. Lund). — **BW:** DV, south of Marstal, c. 10 m, on *Cynthia grossularia*.

2. Leptonema (?) lucifugum Kuckuck.

P. Kuckuck, Über zwei höhlenbewohnende Phaeosporeen. Beitr. z. Kenntn. der Meeresalgen 4. Aus der Biolog. Anstalt auf Helgoland, 1897, p. 38. Taf. 12, fig. 20—24; H. Skuja, Rhodochorton Rothii und Leptonema lucifugum von d. Waiku-Riffen an der Westseite d. Insel Oesel. Acta Horti Botanici Universitatis Latviensis III, 1928, p. 39, Tab. 1.

This alga was met with at Rø in the island of Bornholm, at the entrance to the cavern the Sorte Gryde, as a yellow-brown covering above the common waterline. It agreed well with the quoted descriptions and illustrations but had no fully developed sporangia. The erect filaments are 6—8 μ thick; their cells are usually $1^1/_2$—2 times as long as broad, sometimes only of the same length as breadth and each contain one or two lobed chromatophores. The end-cell is longer. Fully developed sporangia were not observed, but filaments showing longitudinal divisions and one showing lateral outgrowths agreed so well with Kuckuck's and Skuja's illustrations that I do not doubt the identity of the species; but I cannot accept its relation to the genus *Leptonema*, as the erect shoots are normally branched. It should perhaps rather be referred to the genus *Ectocarpus*.

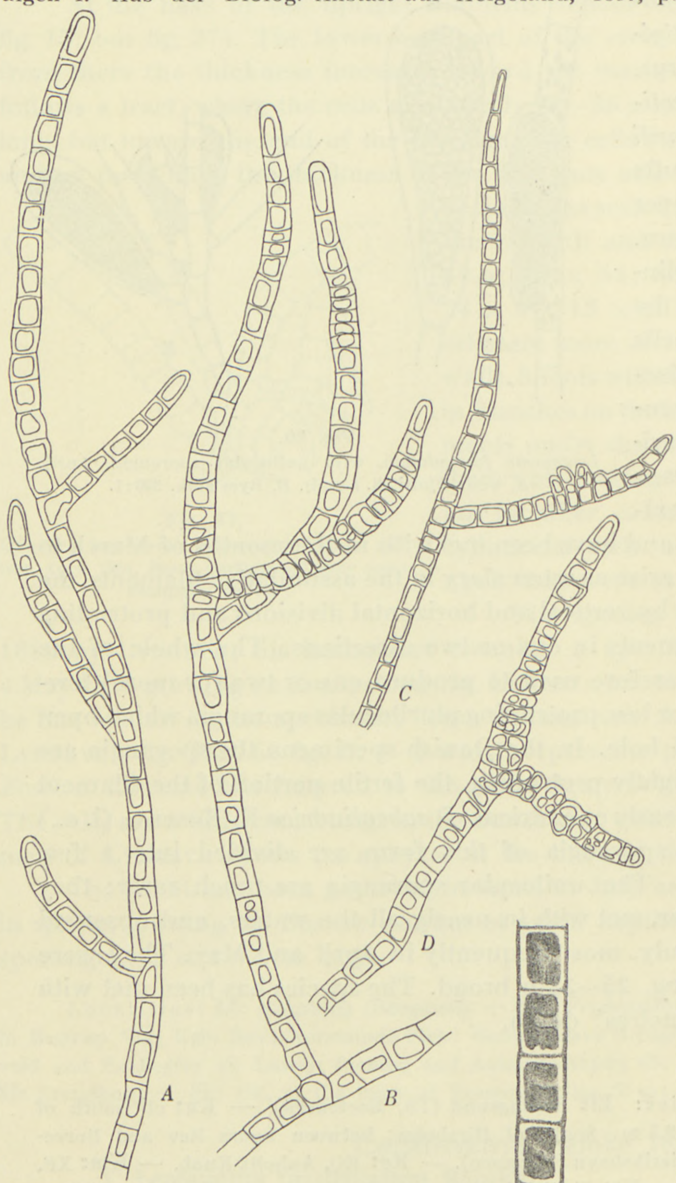

Fig. 40.
Leptonema lucifugum. Rø, Bornholm. Filaments showing ramification, *C* and *D* perhaps with sporangia. *A, B, D*, 434:1. *C* 417:1. S. Lund del.

Fig. 41.
Leptonema lucifugum. Cells with chromatophores. 835:1.

Locality: **Bb:** Rø, at the entrance to Sorte Gryde, July.