Acta Botanica Neerlandica 7 (1958) 589-604

THE GENUS CALLITHAMNION LYNGB. IN THE NETHERLANDS

A TAXONOMIC AND OECOLOGICAL STUDY

R. BODDEKE

(*Hugo de Vries Laboratory, Amsterdam*)

(*received April 8th, 1958*)

PREFACE

In compiling this article I have met with much kind co-operation. Prof. Dr. J. Heimans, Dr. J. Th. Koster, Mr. C. den Hartog assisted me with good advice.

Mr. P. C. Diegenbach took several of the photographs, and he also assisted me in staining nuclei.

Mr. K. P. Louwrier estimated the salt content of the water samples. Messrs. C. Swennen, H. Huysman, A. Tulp, J. Blauw, collected valuable material. Mr. C. v. d. Hoek supplied important information.

Messrs. A. Mulder and J. A. W. Lucas put their collections at my disposal.

Miss Chamberlain, of the British Museum of Natural History, was most helpful when on a visit to London I wanted to study some of the material and the books preserved at the Museum.

The Kew Herbarium and the Laboratoire de Cryptogamie in Paris (M. P. Bourelli) sent samples on loan.

I am most grateful to each of the above-mentioned persons and institutions.

Without their help and co-operation this work could not have been accomplished.

INTRODUCTION

The species of the genus *Callithamnion* are all marine.

Species of this genus are found all over Europe, from the Finnish Southwest coast to West England and from the Faroër Islands to the Mediterranean.

In the Netherlands five autochthonous species occur.

Of two other species specimens were found washed ashore.

Vegetative propagation organs do not occur in the Netherlands. All native species are of separate sex.

GENERIC DESCRIPTION

Callithamnion Lyngby 1819

Thallus consisting of septate filaments.

Ramification dichotomous or alternating.

Main axes sometimes corticate, c.q. the cortication consisting of small filaments.

Cystocarps usually in pairs; carpospores rounded, bedded in jelly. Antheridia: rounded shoots on the axes. Tetraspores tetrahedral.

TAXONOMIC REMARKS

The division of the genus *Callithamnion* into two genera, viz. *Aglaothamnion* and *Callithamnion*, suggested in 1940 by Mme FELDMANN–MAZOYER in her book "Recherches sur les Ceramiacées de la Mediterranée occidentale", has not been followed by me.

The two points on which Mme. Feldmann bases this division, are: *Aglaothamnion*, cells uninuclear; gonimolobes lobate, and *Callithamnion* cells plurinuclear; gonimolobes rounded.

In order to estimate the number of nuclei per cell, the nuclei have to be stained, and to this end Haidenhain's ferric haematoxylin and Brazilin are the most suitable stains.

However, either fresh material has to be used, or else, material that has been fixed in a way described for the staining method. Dried material and material fixed in alcohol are totally unsuitable. Consequently it is impossible to define the number of nuclei in herbarium material.

This is a considerable practical objection against the use of this character as a diagnostic, as most of the material available for taxonomic study comes from herbaria.

I have seen preparations of *Callithamnion corymbosum* stained according to Haidenhain's method. In complete agreement with the results of Mme Feldmann, the cells, with the exception of the apical cells, proved to be plurinuclear. In this species the size of the cells increases rapidly from the top to the base, and this increase in size is accompanied by an increase in the number of nuclei.

The presence of additional nuclei must be seen as an adaptation to the large size of the cells found in this species.

Unfortunately I have not been able to stain the nuclei in *C. granulatum* and *C. tetragonum*.

The value of the antithesis lobate against rounded gonimolobes is in my opinion very dubious, as the division is based only on species occurring in the Mediterranean.

Callithamnion roseum is not mentioned in the work of Mme Feldmann, but J. FELDMANN (1954) refers it to the genus *Aglaothamnion;* arguments however, are not produced.

Callithamnion roseum, however, has clearly rounded gonimolobes, and the latter are used even as an identification mark in various works, i.a. in KOLDERUP ROSENVINGE (1924), p. 308. The photographs published with this article do not leave the slightest doubt with regard to the rounded form of these gonimolobes.

The gonimolobes of *C. byssoides* (*C. furcellariae*) are sometimes lobate, but I have never seen gonimolobes which were as strongly lobate as those pictured by Mme Feldmann.

Gonimolobes develop to a lesser degree in the Netherlands than in the Mediterranean.

In the Dutch form of *C. byssoides* the "lobate" gonimolobes differ

so little in form from the "rounded" gonimolobes of *C. roseum* that it is impossible to distinguish it from the latter in this way. In *C. scopulorum* I have many times observed mature carpogonia. The gonimolobes were, without exception rounded. This applied also to the gonimolobes of *C. hookeri* another species that was referred by J. Feldmann to the genus *Aglaothamnion.*

C. tetragonum, C. granulatum and *C. corymbosum* all three have more or less rounded gonimolobes.

Thanks to the cooperation of Prof. Dr. J. Heimans, Dr. J. Th. Koster (Leiden), M. P. Bourelli (Paris), and Miss Chamberlain (London), I had the opportunity to study a large amount of material of species that do not occur on the Dutch coast, viz. of *C. tetricum* Ag., *C. caudatum* J.Ag., *C. arbuscula* Lyngb., *C. tripinnatum* Grat., *C. rabenhorstii* Cr., and *C. dudresnayi* Cr.

This has enabled me to arrive at a notion of the genus in so far as it occurs in Europe, though it is still a somwehat incomplete one.

A division of this genus in the way proposed by Mme Feldmann–Mazoyer is, in my opinion, undesirable in view of the doubtful value of the distinction between lobate or rounded gonimolobes, and the impracticability of the criterium of the uninuclear and the plurinuclear cells.

KEY

1*a*) Plants bushy, attached at one point, on or below low-water mark 2

b) Plants forming sods between the tidemarks; thallus composed of creeping axes, provided with feathery fronds *C. scopulorum*

2*a*) Main axis either without cortication or with a few cortical filaments near the base 3

b) Main axis over a considerable distance covered with cortical filaments. 5

3*a*) Ramification dichotomous, cells of the axes 4–10 times longer than wide, topcells short much ramified, giving a corymbose air to the top of the frond . . . . . *C. corymbosum*

b) Ramification distichous 4

4*a*) Plant small, at the most 3 cm high, branches of the last order provided with pinnulae from the very base; pinnulae clearly bent upward. . . . . *C. byssoides*

b) Plant up to 10 cm high; branches of last order with pinnulae only at the higher end; pinnulae straight, not bent upward . . . . . *C. roseum* (slender form)

5*a*) Secondary branches polystichous; branches of last order repeatedly dichotomous; only washed ashore *C. granulatum*

b) Branches of the last order distichously ramified 6

6*a*) Branches of the last order clothed with tufts of distichously branched pinnulae; only washed ashore. . . *C. tetragonum*

b) Pinnulae not tufted. 7

7*a*) Pinnulae distichous; pinnulae short and pointed; cells of the pinnulae 2–1 times longer than wide . . . . . .*C. hookeri*
b) Pinnulae polystichous; pinnulae long and thin cells of the pinnulae more than twice longer than wide . . . *C. roseum*

Callithamnion scopulorum C. Ag.

Callithamnion scopulorum Agardh, 1828. Spec. Alg. 166; Kützing, 1862. Tab. Phyc. 11: 31, tab. 97; Boergesen, 1903. Mar. Alg. of the Faröes 377; Westbrook, 1927. Journ. of Bot. 65: 129–138; — *Callithamnion polyspermum* Ag, De Wildeman, 1896. Alg. de Belg. 412; — *Callithamnion tripinnatum* Ag. in error apud v. Goor, 1923. Holl. Meeresalgen 38; — *Callithamnion hookeri* Dillw., in error apud Den Hartog, 1955. Act. Bot. Neerl. 4: 126; — *Aglaothamnion scopulorum* (J. Ag.) G. Feldmann-Mazoyer, 1940. Cer. de la Med. 47.

Habit: Sod-forming in the tidal zone, with creeping parts stretching in all directions. Individual plants small. Height varying from 0.5 cm in places with a strong wash to 2.5 cm in quiet spots.

Main axis usually free of cortication with just a few filaments accompanying the axis at its base.

In very compact specimens in a strongly exposed position the base of the main axis may be almost completely covered with filaments.

Branches of the first order distichous.

In specimens bearing tetrasporangia this distichous branching is also maintained in the ramifications of a higher order.

Sterile plants or plants bearing carpogonia sometimes show a polystichous branching at the top. This phenomenon occurs especially in the compact form found at exposed places.

The cells of the main axes are approximately 3 times as long as wide, but towards the end of the axes this difference gradually diminishes to once or twice as long as wide.

Tetrasporangia are formed along the entire length of the thallus on the branches of the last order and on the pinnulae. Mainly at the inside of the axes; a single sporangium is sometimes found at the other side. The asexual generation bearing tetrasporangia occurs most frequently in the Netherlands. The number of tetrasporangia is often notably large; the inside of the pinnulae may carry a row of tetrasporangia, each cell serving as base to a tetrasporangium.

Tetrasporangia, length: 60–71 micron, width 52–65 micron. Carpogonia placed irregularly and not very numerous.

Fully developed gonimolobes were only infrequently observed.

They are rounded in shape, and occur also at the top of the plant, in opposition to *C. roseum.*

Plants bearing antheridia are also less numerous than the tetrasporophytes. The antheridia entirely cover the inside of the pinnulae.

Annual cycle: This species is no doubt a perennial plant. In a mild winter it is very common. Because of the decreased influence of the sun, the seaweed then occurs in spots where in summer it desiccates and disappears. In a severe winter *C. scopulorum* disappears completely. C. v. d. Hoek in 1953–54 made observations on its hardiness. In November 1953 *C. scopulorum* was very common at Hook of Holland,

and made an attractive zone on the wooden fence along the piers. On the 24th of January 1954 this zone had completely disappeared, probably as a result of the frost which had set in the meantime. Recovery turned out to take a long time; in August 1954 the species was still missing from these parts.

It is likely that during a severe winter rhizoids survive in the substratum. It would otherwise be impossible to explain how this species, widely scattered but nowhere numerous, would survive a severe winter, as for instance the one of 1955–56, and be found in the following summer everywhere, even though in very small quantities. In the months of December, January, February only sterile plants are found.

After a mild winter richly fructifying plants are found as early as June; scanty reproductive organs sometimes already in March, after a severe winter development does not start until July.

The peak of the reproduction is in the months of July, August and September. The reproductive organs all appear at about the same time. In the months of October and November, when the reproductive organs become scarce, only tetrasporangia are found.

List of localities where *Callithamnion scopulorum* has been found with the year when it was found there for the last time.

2	Holwerd sea-dike	1852
3	Westhoek	1953
9	Den Helder sea-dike	1954
10	Den Helder Huisduinen	1957
12	IJmuiden North pier	1956
13	IJmuiden South pier	1957
14	Scheveningen Southern Jetty	1956
15	Hook of Holland North pier	1956
20	Zijpe	1956
22	Zierikzee	1950
24	Tholen, Koffyhoek	1951
27	Katseveer	1940
28	Kortgene	1941
29	Bergen op Zoom; entrenchment	1955
31	Yerseke; entrance harbour and oysterponds	1956
38	Ellewoutsdijk	1958
39	Borsele–Ellewoutsdijk	1940
40	Veere	1940
42	Arnemuiden; Powdermill (kruitmolen)	1940
45	Flushing, Orange mill (oranjemolen)	1954
46	Flushing; Nolledijk	1956

Environment: C. scopulorum occurs in places with a normal degree of salinity (24–28 ‰). Not in brackish or polluted water.

At Scheveningen it grows on the inside of the southern jetty, but the influence of the sea in this spot is still so strong that there is no question of pollution of the water.

The species grows along the entire Dutch coast. Outside of the Netherlands in the Faröes, England, Belgium, the French West coast and the Mediterranean. It is typically a species of the tidal zone; the quantities in which it occurs are as a rule small.

The position in the tidal zone is determined by the nature of the substratum and by the degree of exposure to the sun.

The species shows a definite preference for wood as a substratum. On many sea-walls rows of wooden piles are placed to break the force of the waves. In spots where the species is rare, we find most of the specimens on the Northern face of these piles and moreover at the base between the rocks. No doubt this is due to the desiccation to which the seaweeds occurring in the tidal zone are exposed, and from which this delicately branched alga will suffer a great deal. Desiccation is less to be feared on wood that has become spongy from the effects of the seawater than it is on stone, barnacles, etc. On wood the species consequently is found much higher up than on a mineral substratum. On stone *C. scopulorum* only grows in shady spots below the middle of the tidal zone. In favourable positions a zone is formed on Balanus balanoides as well. A less frequently found substratum is Mytillus edulis. *C. scopulorum* rarely found as an epiphyte. Near Den Helder it has been found a few times on *Gigartina stellata*. Along the Dutch coast the species is not known to occur on *Fucus*.

Under the belt formed by the *Fucaceae* small shoots of this species have been found every now and then.

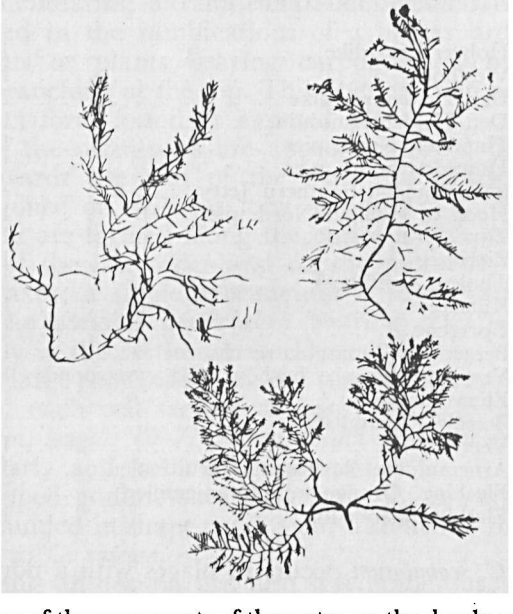
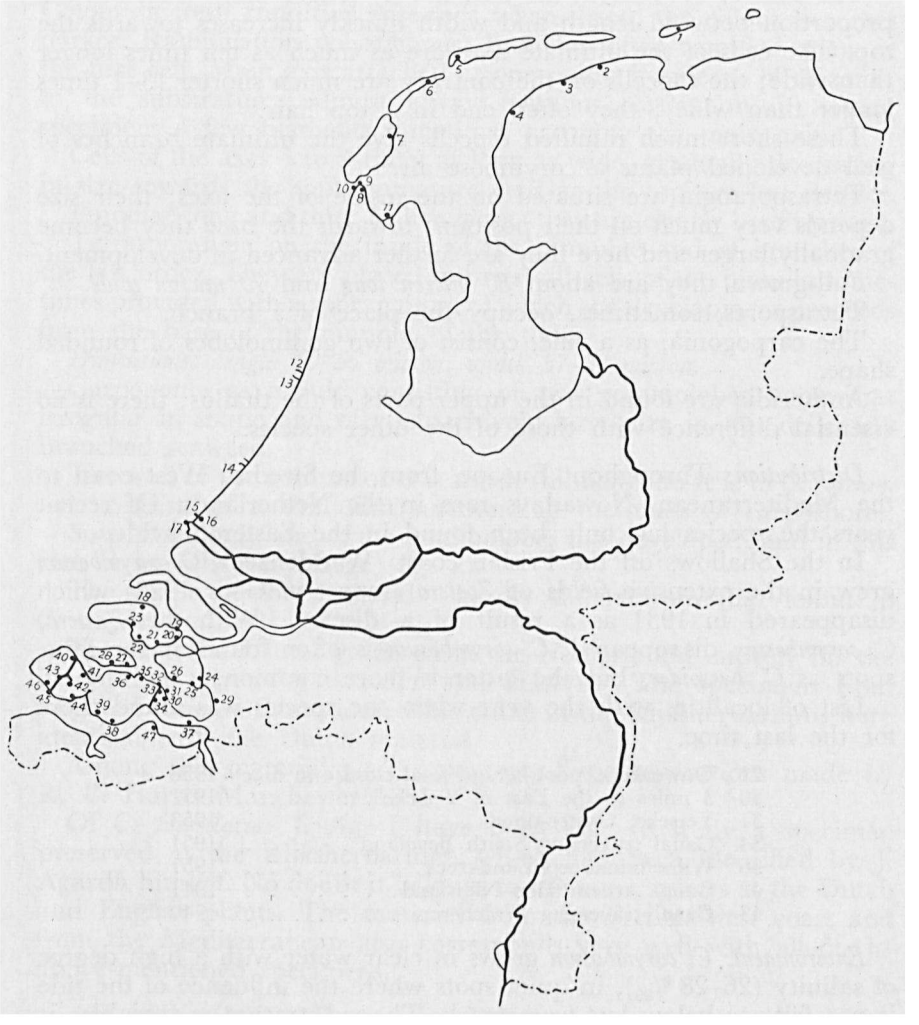


Fig. 1. Influence of the movements of the water on the development of C. scopulorum, above left, from quiet spot, above right from spot with moderate undulation, under, from strongly exposed spot. 4.5 ×

The influence of the movements of the water on the form of this species is very important. Samples from places with almost no movement of the water (Koffyhoek–Tholen) proved to be of a very spare build.

In places with a moderate movement (Zijpe, Yerseke) the structure was already more dense, and in places with a violent movement, such as Huisduinen, very compact forms arise with broad strongly ramified tops.



Map 1. Localities of Callithamnion species in the Netherlands.

Callithamnion corymbosum (Smith) Lyngbye

Conferva corymbosa Smith, 1812. Engl. Bot. pl. 2352; — *Callithamnion corymbosum* Lyngbye, 1819. 125 tab. 38c; Harvey, 1849. Man. Brit. Alg. 181; Harvey, 1871. Phyc. Britt. 2: pl. 272; v. Goor, 1923. Holl. Meeresalgen 40; Kolderup Rosenvinge, 1923–24. Mar. Alg. Denm. 3: 325; Feldmann-Mazoyer, 1940. Cer. de la Med. 475; — *Phlebothamnion corymbosum* Kützing, 1861. Tab. Phyc. 12: tab. 9 c, d.

Habit: Plants up to 6 cm high; colour rose-red. Ramification dichotomous, two equivalent cells arising from each cell, both at an obtuse angle with the mother cell. In large plants this type of ramification is less regular, and it approaches lateral branching. The base of the axes sometimes shows a slight cortication.

The cells of the axes at the base hardly longer than wide, but the proportion between length and width quickly increases towards the top. The cells of the ultimate axes are as much as ten times longer than wide; the topcells on the contrary are much shorter (3–1 times longer than wide); they often end in a top hair.

These short much ramified topcells give the ultimate branches of well developed plants a corymbose air.

Tetrasporangia are situated on the inside of the axes; their size depends very much on their position; towards the base they become gradually larger and here they are further advanced in development.

Full-grown they are about *80 micron long* and *70 micron wide.*

Tetraspores, sometimes, occupy the place of a branch.

The carpogonia, as a rule, consist of two gonimolobes of rounded shape.

Antheridia are found in the upper parts of the thallus; there is no essential difference with those of the other species.

Distribution: Throughout Europe, from the Swedish West coast to the Mediterranean. Nowadays rare in the Netherlands. Of recent years the species has only been found in the Easter Scheldt.

In the Shallows off the Frisian coast (Waddenzee), *C. corymbosum* grew in the extensive fields of *Zostera* (report v. Goor 1923) which disappeared in 1931 as a result of a disease. With the *Zostera*, *C. corymbosum* disappeared. *C. corymbosum* is often found at the same spots as *C. byssoides*, but the latter is more common.

List of localities with the year when the species was found there for the last time.

21	Ouwerkerk, pool behind final closure in dike	1956
30	3 miles to the East of Yerseke	1951
31	Yerseke, Oyster-pond	1953
34	Canal traversing South Beveland	1951
36	Wilhelminadorp–Zandkreek.	1951
42	Canal Arnemuiden–Niewland.	1941
43	Canal traversing Walcheren	1940

Environment: C. corymbosum grows in clear water with a high degree of salinity (26–28 $^0/_{00}$), in quiet spots where the influence of the tide is not felt, or below low-watermark. The substratum is variable; it may be wood, shells, stone, iron.

Annual cycle: All autochthonous finds were made between the first of June and the first of November. Consequently *C. corymbosum* is typically an aestival species.

Callithamnion byssoides Arn.

Arnott, 1833. Hooker's Flora 2: 342.
Callithamnion byssoideum (Arn.) Harvey, 1849. Man. Brit. Alg. 178; Harvey 1871.

Phyc. Britt. 3: 162; de Wildemann, 1896 Alg. de Belg. 413; — *C. furcellariae* Agardh, J. 1851. Alg. Sp. 2: 57; — *Phlebothamnion byssoides* Kützing, 1862. Tab. Phyc. 12: t. 8; — *Seirospora byssoides* (Arn.) DeToni, v. Goor, 1923. Holl. Meeresalg. 40; — *Aglaothamnion furcellariae* (J. Ag.) Feldmann-Mazoyer, 1940. Cer. de la Med. 454.

Habit: Plants up to 2.5 cm high; extremely delicate ramifications. Colour in fresh condition rose-red; when dried, the colour becomes darker. Ramification polystichous; branches often ramified anew at the first cell. Main axis attached at one point, by means of rhizoids, to the substratum. Almost always without cortication, in strong specimens a few filaments sometimes accompy the main axis.

Cells of the axes 4 to 9 times as long as wide, gradually decreasing in size towards the top. Immature cells at the top are less slender.

Pinnulae long and thin. In live plants they are clearly bent upward.

Tetrasporangia on the inside of the pinnulae and of branches of the last order. They are placed in rows; all cells of the pinnula sometimes provided with a sporangium, of which the development proceeds from the base of the pinnula to the top.

Dimensions: length 50–56 micron, width 37–39 micron.

Carpogonia as a rule consisting of two gonimolobes, somewhat irregular in shape and of comparitively large size in this delicately branched seaweed.

The wall of the gonimolobes is much thinner than it is in *C. roseum.* It consists of a thin film surrounding the mass of carpospores.

Sometimes only one of the gonimolobes has developed, and in this case it may be very large (fig. 2).

The shape of the antheridia hardly differs from that found in *C. roseum.*

The material I have gathered in the Netherlands, entirely fits the descriptions given by ARNOTT and HARVEY. The specimens from England which I found under this name at the Rijksherbarium, were identical with the Dutch material.

Among this material were some very fine preparations made by R. E. Harris Manchester 1951.

Of *C. furcellariae* J. Ag. I have been able to study a specimen preserved at the Rijksherbarium, which had been identified by J. Agardh himself. No doubt it belongs to the same species as the Dutch and English plants. The material from the French west coast and from the Mediterranean also corresponds very well with all of the above-mentioned specimens.

Area of Distribution: The whole of Western Europe from the Swedish west coast to the Mediterranean. In the Netherlands recently observed only in the waters in and around Zealand. Van Goor found the species a few times in the harbour of Den Helder (1919–1921), but since then it has disappeared from there.

However, it is possible that *C. byssoides* still occurs in the deeper parts of the Shallows (Waddenzee) off the Frisian cost.

In August 1953 a specimen of *Gracilaria verrucosa* washed ashore near the harbour of Oost Vlieland. It had a *Callithamnion* growing

on it epiphytically. Unfortunately the specimen was almost completely decomposed when I saw it. But what was left of it as well the substratum (*C. byssoides* often grows on *Gracilaria*) strongly indicated this species. Since *Gracilaria verrucosa* grows in deep parts of the Shallows (Waddenzee) it is possible that *C. byssoides* occurs here as well.

List of localities, with the year in which *C. byssoides* was found for the last time.

6	East Vlieland	Doubtful
8	Den Helder, harbour	1921
18	Scharendijke	1938
19	Bruinisse, mudflat	1956
21	Ouwerkerk, pool in dyke behind final closure	1956
23	Kistersinlaag, Schouwen	1952
26	Gorishoek	1951
29	Bergen op Zoom, mudflat	1950
31	Yerseke	1953
32	Wemeldinge	1951

Environment: The species grows below low-watermark, in water with a high degree of salinity (26–28 $^{0}/_{00}$), in quiet places.

It is a faithful companion of Codium fragile, on which the species may very often be found as an epiphyte.

Though *Codium* usually grows sublittorally, it also occurs regularly

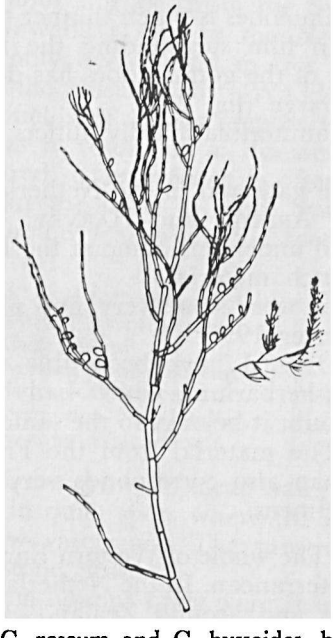


Fig. 2. C. roseum and C. byssoides, both 33 ×

on mudflats which run dry at low tide, either on the outer edge or in hollows and ditches, so that the period during which the seaweed is actually exposed to desiccation may be neglected. In addition in such places much *Codium* is washed up.

On all of the *Codium* growing here we find much *C. byssoides.*
Less frequently found as a substratum are: *Gracilaria verrucosa, Ceramium rubrum,* stones, shells, and iron objects.

Annual cycle: C. byssoides is typically a summer plant. Plants that were still attached to the substratum have exclusively been found between May and October.
In December 1956 the author collected many floating plants outside the oyster ponds at Yerseke.
This observation might indicate that towards winter the ascending parts of the seaweed detach themselves, while the rhizoids stay behind, and new plants develop from them in the next season.
The productivity of fructifying plants is considerable. Sterile plants are rarely found.
Plants with antheridia and plants with carpogonia usually grow in each other's close vicinity, sometimes even mixed, which makes the change of fertilization very high.
Repeatedly a spermatium was observed which stuck to a trichogyne.

Callithamnion roseum (Roth) Harvey

Harvey in Hooker, 1833. Engl. Flora 5: 341; Harvey, 1849. Man. Britt. Alg. 177; Harvey, 1871. Phyc. Britt. 3: 230; v. Goor, 1923. Holl. Meeresalg. 39; Kolderup Rosenvinge, 1924, Mar. Alg. of Denm. 331; — *Phlebothamnion roseum* (Harvey) Kützing, 1861. Tab. Phyc. 11: tab. 97a, b, c; — *Aglaothamnion roseum* (Harvey) Feldmann, 1954. Flor. Mar. de Rosc. Supp. 6.

Habit: Plants up to 10 cm high, attached at one point with creeping rhizoids. Main axis and lower parts of the main branches covered with small filaments.
In plants from stagnant water the cortication may be incomplete.
The thickness of the main axis depends very much on the location.
In quiet water it is between 100–250 micron; on very exposed places the thickness of the main axis may exceed 500 micron, as many layers of filaments are formed under these circumstances. From these filaments in this case many small branches arise; the main axis begins to ramify relatively far from the base. The habit of these plants rather resembles the shaggy end of a rope.
In quiet water the axes ramify closer to the base, so that the plant under water gives the impression of a small dark red cushion.
Ramification polystichous. Branches of the last order bear pinnae only at the higher cells.
The length of the cells of the pinnae and of the branches of the last order is 3 to 5 times their width, they become gradually narrower towards the top.
Tetrasporangia are formed along the higher parts of the plant. They are placed on the inside of the axes. Usually only the first 3 to 4 cells of each pinna or branch of the last order bear tetrasporangia. *Dimensions: length 65–72 micron, width 56–62 micron.*
Carpogonia: when ripe, visible with the naked eye as small dark dots on the red threads of the thallus. They consist of two rounded

gonimolobes with a thick gelatinous wall; as a result the outer wall of the gonimolobe is smooth. In *C. byssoides* the gelatinous layer is much less thick, and consequently the shape of the gonimolobe is defined by the mass of spores.

Sometimes only one of the gonimolobes has developed.

In an abundantly fructifying plant full-grown carpogonia are found

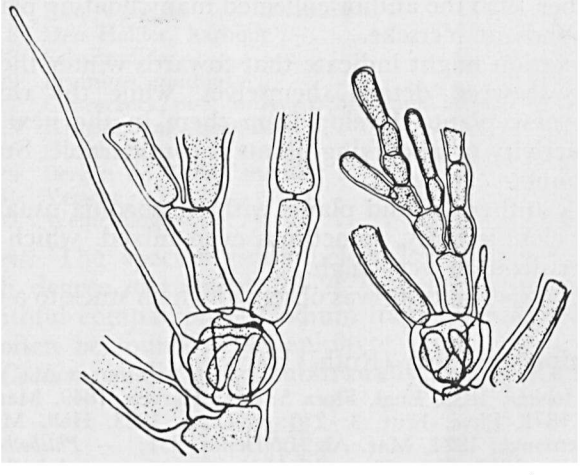


Fig. 3. Procarpia of C. roseum with trichogyne 750 ×

on the lower parts of the plant; at a higher level the carpogonia are younger, and at a certain height the oldest procarpia are found, provided with a trichogyne; further upward procarpia consist of a ew cells.

Antheridia are many ramified shoots which may entirely cover the inside of the tops of the thallus.

Male plants are built somewhat more delicately than plants bearing tetrasporangia and carpogonia; this is always so in the species of this genus.

Distribution: C. roseum is common in the Netherlands. In Europe found between the Bothnic Gulf and Brittany in France; also in England.

The species is mostly found in clear, moving water that is not influenced by the tide, but also in stagnant water, and in places with a violent undulatory movement. The greatest depth at which material has been collected, was 4 m (under low-watermark).

The greatest height approximately coincides with the level of a very low tide.

The *salinity* of the water has very little influence on the occurence and development of this species.

In the harbour of den Helder this *Callithamnion* is found outside the sluice of the Noordhollands kanaal (North Holland Canal).

Here the species is numerous and well developed. When at this

spot fresh water is sluiced, the degree of salinity of the water drops to 5 °/₀₀.

In other places in the Den Helder harbour where *C. roseum* grows, e.g. on the rafts along the quays, the salinity amounted to 16 °/₀₀.

In the waters in and around Zealand the salinity is much higher.

In the bassins of the firm of Bona Fides Oyster farm at Tholen we find a luxurious vegetation in water with a salinity of 28 °/₀₀.

In the sluice bassin adjoining the harbour of Bruinisse the species was found on August 16, 1956 by the author.

The material consisted of plants bearing tetraspores and richly ramified robust plants which, however, were almost sterile.

List of localities with the year when *Callithamnion roseum* was found there for the last time.

1	Schiermonnikoog-Creek	1952
4	Harlingen– Sea-dike	1957
5	Terschelling– Harbour	1949
7	Texel, lake "De Bol"	1954
8	Den Helder– Harbour	1956
11	Amsteldiep Sea-dike	1952
12	IJmuiden-Sluice island	1954
15	Hook of Holland pier	1957
17	De Beer, Southern pier	1949
19	Bruinisse, Sluice-basin	1956
20	Zijpe, pontoon	1951
22	Zierikzee, entrance to harbour	1950
24	Tholen, town, oyster pond	1956
25	Tholen, Stryenham	1955
26	Tholen, Gorishoek	1956
31	Yerseke, Oyster ponds	1950
32	Wemeldinge, pontoon	1951
33	Wemeldinge, inside the lock	1956
34	Canal traversing South Beveland	1951
37	Reimerswaal [1])	1957
40	Canal traversing Walcheren, Veere	1953
43	Canal traversing Walcheren, Middelburg	1940
44	Ritthem, Pontoon	1954
47	Walsoorden, jetty	1950

[1]) Reimerswaal is the name of a town that was engulfed by the sea in 1530. This specimen grew on the walls of the submerged town.

Sporadically very young procarpia occurred on these plants.

Two days earlier H. Huysman collected at Tholen material with an abundance of ripe carpogonia.

The plants grew here in moving water.

Another locality where I never observed sexual reproductive organs in specimens of this species, is the "Dasya-beach" on the inside of the Wemeldinge sluice in the Canal traversing South Beveland.

From this locality I have examined a great deal of material collected at different dates, and these specimens bore just a few tetrasporangia or they were completely sterile.

The water in this canal is not regularly refreshed, as it is in places where the tide makes its influence felt.

The canal is used intensively by river vessels, as it is part of the connection between Antwerp and Rotterdam.

This busy navigation has two consequences for the vegetation of algae in the canal:

1. Above the water level a wash zone occurs consisting mainly of species belonging to the genus *Enteromorpha*. In winter still higher up we find a spray zone (*Bangia*, *Ulothrix*, *Rhizoclonium*), which dries up completely in summer (see: Den Hartog–ABN 1953).
2. The water of the canal is much more polluted than that of the two sea-arms it connects. This is especially evident at the above mentioned Dasya beach, where a great number of house boats are berthed. The specimens of *C. roseum* collected here, were always covered with enormous quantities of stalked infusoria in a great variety of shape, and with blue algae belonging to the genus *Oscillatoria* are often found as epiphytes.

On the piles at the sluice many Sponges are found as well as splendid colonies of the tunicate Botryllus schlosseri.

All these organisms indicate a great abundance of food in the water; this is caused by the refuse of the house boats.

The oxygen content of the water will be much lower than normal (100 %).

From the canal traversing Walcheren I have also examined several samples, which has been collected there in the months of August, September and October by J. Brakman.

All of these plants were sterile too, with the exception of a few specimens which bore a few tetrasporangia.

The circumstances in this canal differed only slightly from those in the Canal of South Beveland. Here no influence of the tide is felt either, and the water is rich in refuse (Middelburg), so that the oxygen content is low.

As a result of these observations I am of opinion that a low oxygen content prevents the development of the sexual reproductive organs, and that it unfavourably influences the forming of tetraspores.

Annual cycle: Callithamnion roseum is most probably a perennial plant.

At a favourable spot the species reappears every year; in the half-yearly period of winter it disappears almost completely.

Only a few specimens were found in the months of January and February. A cold period in autumn suffices to kill the alga.

In October 1956 I found only a few nearly dead plants at the Oyster farm Bona Fides, in spots where the species abounds in summer.

On the 5th of November the picture was the same at the Den Helder harbour. On December 14th 1956 I had a great difficulty in collecting a single plant in the Canal of South Beveland at Wemeldinge, and the specimen was small and sterile.

Normarly *C. roseum* reappears in the months of March, April, probably because the remaining rhizoids sprout.

In May and June the first reproductive organs begin to show; the highest development of the plants is reached in July, August and September.

Tetraspores are more common than the other kinds of reproductive organs.

Substratum: This species shows very little preference for any one kind of substratum. Plants have been found on stone, iron, wood, *Zostera* roots, shells, other sea weeds such as *Fucus* spec. and *Codium*.

Especially on rafts, pontoons and similar objects going up and down with the tide *C. roseum* often grows.

Callithamnion hookeri (Dillw.) Ag.

Conferva hookeri Dillwyn, 1809. Conf. t. 106; — *Callithamnion hookeri* Dillwyn, Harvey, 1849. Man. Brit. Alg. 176; — *Callithamnion hookeri* Ag. (!), Harvey, 1871. Phyc. Britt. pl. 279; — *Callithamnion hookeri* (Dillw.) Ag., Kolderup Rosenvinge, 1924. Mar. Alg. Denm. 309; — *Phlebothamnion hookeri* Kützing, 1861. Tab. Phyc. 11: tab. 94a, b.

Habit: Plants up to 10 cm high; colour dark red.

The main axis are very clearly visible; they are thickly corticated.

The branches of the second order are not corticated. The sprouting of axes without cortication from the completely covered main axis is striking.

The pinnae are short and pointed; they are situated more or less in one plane. The cells of the pinnae and the branches of a higher order short. They are twice or as long as wide; towards the top they gradually grow shorter.

Tetraspores on the inside of the pinnae; dimensions: *length 77–87 micron; width 65–75 micron.*

Gonimolobes rounded. Antheridia are approximately of the same build as they are in the other species of this genus.

Environment: Callithamnion hookeri grows sublittorally or very low in the littoral.

Distribution: C. hookeri has been found in the Netherlands only once as an authochtonous plant.

The find consisted of two small specimens, collected March 25th 1950 in the sublittoral of Huisduinen. The plants were sterile.

Full-grown specimens with ripe reproductive organs are often washed ashore; these specimens grow especially on the basal part of *Himanthalia elongata*, which does not occur in the Netherlands.

This continuous supply of reproductive organs makes it possible that, under favourable circumstances, an incidental settlement of *C. hookeri* may take place.

I was able to compare the two specimens of *C. hookeri* collected at Huisduinen with two authentic specimens thanks to the cooperation of Dr. J. Th. Koster and of the Herbarium of Kew.

One of these two authentic specimens was collected by the Reverend Hugh Davies near Holyhead, and one by Miss Hutchinson at Bantry Bay. Both these specimens are mentioned by DILLWYN (1809).

Apart from these two authentic specimens, there were a great number from the Herbarium Hooker.

The two authentic specimens were dried on glass and consequently in a bad condition, which made the comparison difficult.

Still it seems certain that the two Dutch specimens belong to *C. hookeri*.

REFERENCES

AGARDH, C. A. 1824. Systema Algarum.
———— 1828. Species Algarum.
AGARDH, J. G. 1851. Species genera et ordines algarum.
BÖRGESEN, F. 1905. The marine algae of the Faeröes, Bot. of the Faröes 2.
———— 1915–1920. The marine Algae of the Danish West Indies vol. 2 Rhodophyceae, Dansk Bot. Ark. 3.
DILLWYN, L. W. 1802–1809. British Confervae.
FELDMANN, J. 1954. Inventaire de la Flore Marine de Roscoff Supp. 6.
FELDMANN–MAZOYER, G. 1940. Recherches sur les Ceramiacées de la Mediterranee occidental.
GOOR, A. C. J. v. 1923. Die Holländische Meeresalgen.
HARTOG, C. DEN. 1955. A classification for the epilithic algal communities of the Netherlands' coast. Act. Bot. Neerl. 4 (1).
HARVEY, W. H. 1870. Manual of the British marine Algae.
HAUCK, F. 1885. Die Meeresalgen Deutschlands und Oesterreichs.
HOOKER, W. J. 1883. British flora 2.
HYLMÖ, D. E. 1933. Algenimmigration nach die Schwedische Westküste.
KNIGHT, M. and M. PARKE. 1933. Manx Algae L.M.B.C. Memoirs 30.
KÜTZING, F. T. 1862. Tabulae Phycologicae 11–12.
KYLIN, H. 1944. Die Rhodophyceeën der Schwedische Westküste.
LUCAS, J. A. W. 1950. The algae transported on drifting objects and washed ashore on the Netherlands coast, Blumea *6*: 527.
NEWTON, L. 1931. A handbook of the British seaweeds.
PARKE, M. 1953. A preliminary checklist of the British marine Algae, Journ. Mar. Biol. Ass. 32.
PURASJOKI, K. J. 1937. Callithamnion spec. (furcellariae vel. roseum) eine für Finnland neue Rotalge in Tvärminne gefunden, Acta Soc. Fauna Flora Fenn. 60-Helsingfors.
ROSENVINGE, L. KOLDERUP. 1923–1924. The marine Algae of Denmark 3.
TAYLOR, W. R. 1939. Marine algae of the Northeastern Coast of North America.
WAERN, M. 1952. Rocky shore Algae in the Öregrund Archipelago Acta Phytogeogr. Suecica 30.
WESTBROOK, M. A. 1927. Callithamnion scopulorum C. Ag. Journ. of Bot. *65*: 138.
———— 1927. Callithamnion purpuriferum, Journ. of Bot. T *65*: 161.
———— 1930. Callithamnion tetricum (Dillw.) Ag. Journ. of Bot. *68*.
WILDEMAN, E. DE. 1896. Algues de Belgique.

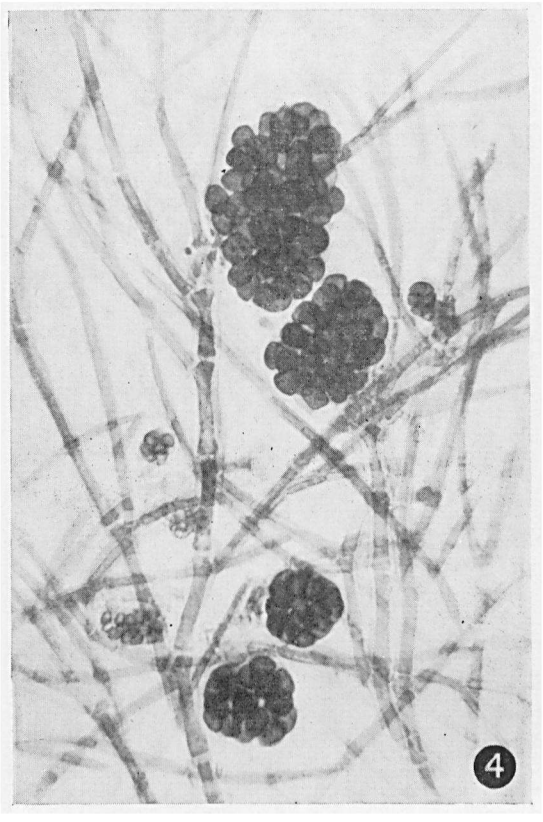


Fig. 4.
C. byssoides; carpogonia
97 ×

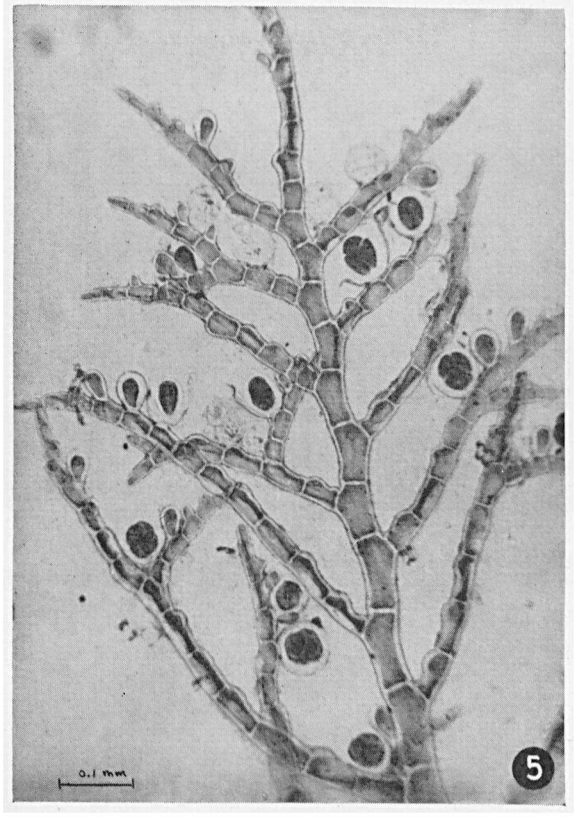


Fig. 5.
C. scopulorum,
tetraspores
97 ×

Fig. 6. Main axis of C. roseum 66 ×

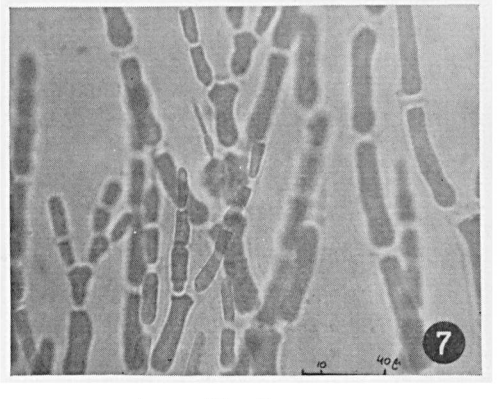


Fig. 7.
C. roseum; procarpium with trichogyne
267 ×

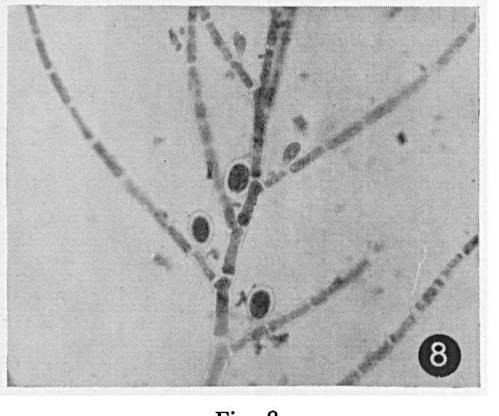


Fig. 8.
C. roseum tetrasporangia
66 ×

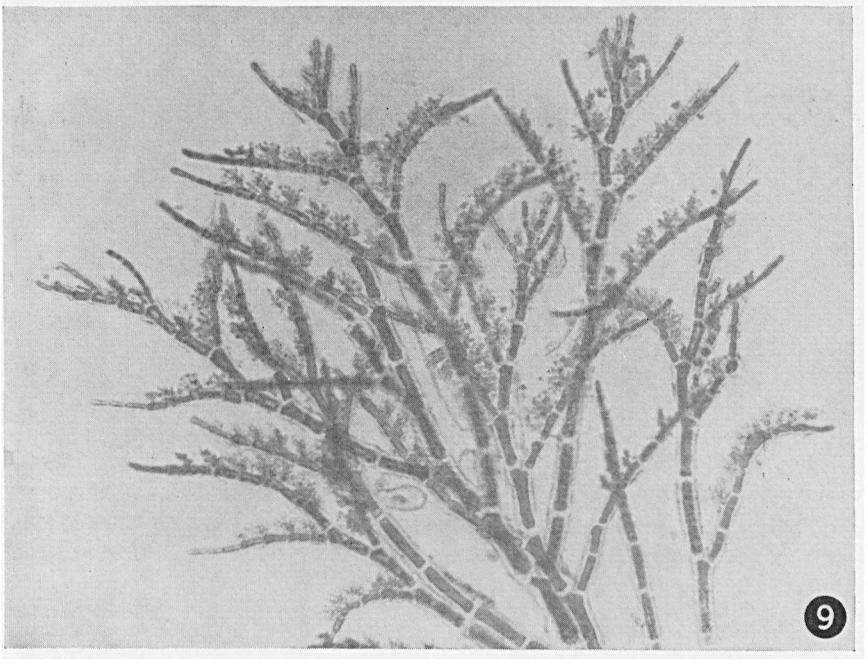


Fig. 9. C. roseum; antheridia 83 ×

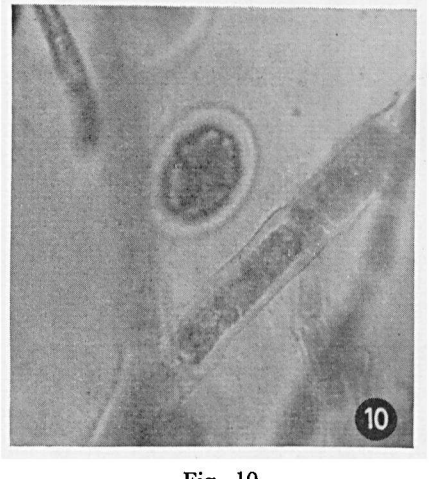


Fig. 10.
C. roseum;
abnormal tetrasporangium 300 ×

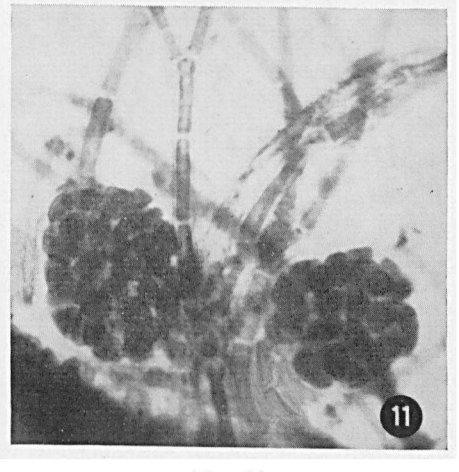


Fig. 11.
C. roseum; cystocarpium
66 ×

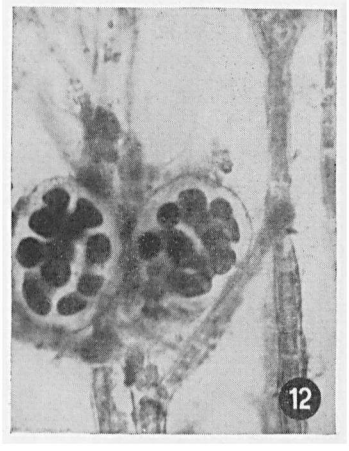


Fig. 12.
C. roseum; cystocarpium
66 ×

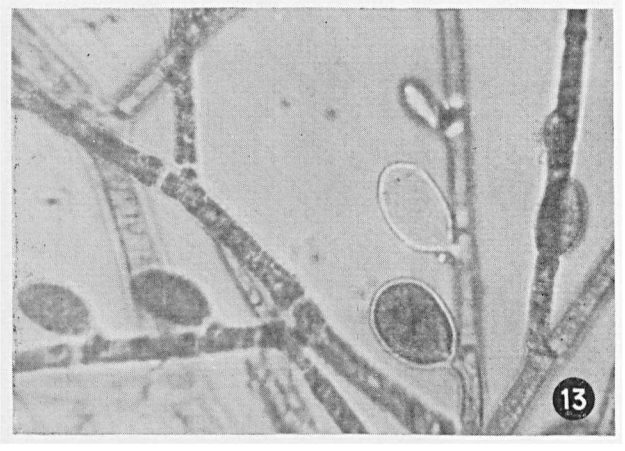


Fig. 13.C. byssoides; tetrasporangia 300 ×

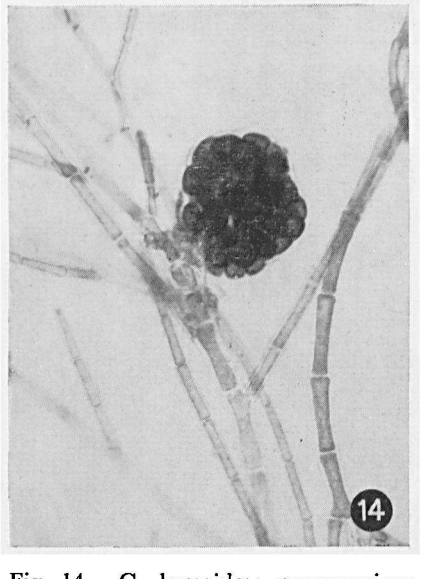


Fig. 14. C. byssoides; carpogonium, only one gonimoblast developed
97 ×

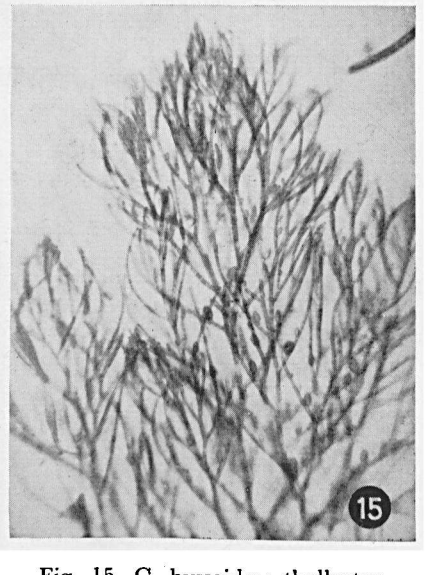


Fig. 15. C. byssoides; thallustop bearing tetrasporangia
29 ×