NATURAL HISTORY OF THE DANISH LICHENS

ORIGINAL INVESTIGATIONS BASED UPON NEW PRINCIPLES

BY

OLAF GALLØE
PH. D.

PART III

H. ASCHEHOUG & CO. · DANSK FORLAG
COPENHAGEN · MCMXXXII

DANISH LICHENS

NATURAL HISTORY OF THE DANISH LICHENS

ORIGINAL INVESTIGATIONS BASED UPON NEW PRINCIPLES

BY

OLAF GALLØE
PH. D.

PART III

Omnis vera cognitio speciei e cognitione individui.

H ✶ A & C
DANSK FORLAG
1926

H. ASCHEHOUG & CO. · DANSK FORLAG

COPENHAGEN · MCMXXX

PRINTED AND PUBLISHED AT THE EXPENSE OF THE CARLSBERGFOND

PRINTED BY J. JØRGENSEN & CO. (IVAR JANTZEN)

LECANACTIS

LECANACTIS Eschw.

Phylogeny. The two Danish species belonging to this genus agree very much in the structure of the spore and in the other parts of the apothecium, and, besides, resemble each other very much in the structure of the thallus. If we compare them with other genera among the lecideine and cyclocarpic lichens, it must be admitted that they take up a somewhat isolated position among them. The spore bears a close resemblance to that of the genus *Bilimbia* or of some species of *Bacidia;* on the other hand, however, the apothecium differs in many respects so much from the apothecia of *Bilimbia* and *Bacidia* — especially in the occurrence of a deep brownish pigmentation in stipes and calyx — that the relationship does not seem very close. For this reason the genus was formerly generally included in the *Graphidineæ,* and, perhaps in future, when the structure of the latter, species by species, is better known than at the present moment, the same arrangement may again be acknowledged.

At any rate, with my present knowledge of the structure of the genera *Bilimbia* and *Bacidia,* I do not consider them to be closely related to the genus *Lecanactis.* I do not look upon *Lecanactis* as the prototype of these two genera, nor does it seem likely that *Lecanactis* should have originated from either of them. In all probability, *Lecanactis* must be supposed to be immediately derived from a lichenized fungus without any intermediate link with other known species of lichens.

The spore is in both species narrowed at either end, colourless and pluri-locular. How the germination takes place is not known.

Anatomy of the thallus. The thallus is in both species almost homoeomerous, no separate cortical, medullary, and rhizoidal tissues being differentiated. The gonidia are distinctly chroolepoid.

The structure of the apothecia and pycnidia is described under the two species respectively.

Soredia do not occur in our species. Although the thallus is very loose in structure, there are no indications that loosened particles of it may act as soredia.

Biology. The thallus is formed by the germination of the spore and probably of the conidium too. It grows centrifugally over the substratum incorporating in itself the *Chroolepus*-algæ growing over it. Whether one single alga suffices for the formation of a thallus or several of them are gradually incorporated is not known; it seems, however, quite probable that either of these alternatives may be realised. The utilization of the gonidia does not take place by means of haustoria, and the gonidia are not killed by the symbiosis. Other species of gonidia than *Chroolepus* have not been met with in the thallus. In the present case, as in several of the genera described in Parts I and II, the utilization of the substratum is characterized by the fact that periderm-cells directly in contact with the hyphæ of the lichen, at least in *Lecanactis amylacea*, are discoloured. This fact suggests the existence of a chemical influence on the part of the hyphæ, but it is not known how this influence is brought into effect.

Ecology. Both our species live exclusively on organic substrata, *L. abietina* on dead oak-wood, *L. amylacea* on oak-periderm. Their anatomical structure is extremely primitive and shows no special structural details which could be interpreted as direct adaptations to the substratum.

Undoubtedly, both species are potentially immortal and scarcely ever die of their own accord. But considering that their hyphæ do not penetrate very deeply into the substratum, it must be supposed that the parts of the thallus which have exhausted the layers of periderm accessible for their nutrition must die, whereas the margin of the thallus gains new ground.

LECANACTIS ABIETINA.

ACH.

(PLATE 1—2—3—4).

On an oak-log. *Glorup Dyrehave.* E. ROSTRUP.

The thallus is deprived of its natural margin in the specimen examined. It is thin, somewhat rimose and uneven, chiefly on account of the roughness of the substratum. The colour is yellowish-white.

The inner structure is almost homoeomerous. The cortical, gonidial, medullary, and rhizoidal layers are not distinctly differentiated. All the hyphæ are loosely interwoven, with rather distinct intercellular spaces. The cortex is thin and poorly developed, composed of cells which in part, at least, are living. The gonidia are chroolepoid. The hyphæ of the rhizoidal layer show no signs of chemically attacking the cell-walls of the periderm.

The apothecia are scattered over the thallus without any order. They are isodiametrical or slightly oblong, in outline irregularly angular or flexuose, with a rather plane or faintly undulate surface. The margin is at first thick, in the end partly evanescent.

The stipes is composed of irregularly interwoven, dark-brownish hyphæ, above continuing into a dark-brown calyx and hypothecium. The hyphæ of the calyx are not distinctly radiating; in the peripheral parts of the calyx the hyphæ are faintly brownish, for which reason the margin of the apothecium is light. The paraphyses run through a copious hymenial gelatine; above they branch out and become entangled with each other forming a thick epithecium. The asci contain 8 colourless spores with 3—5 loculi.

The stipes, the inner parts of calyx and hypothecium are dark-brown, the pigment being principally deposited in the peripheral parts of the walls of the hyphæ. The peripheral parts of the calyx are faintly brown; the same colour also occurs in the epithecium, whereas the other parts of the paraphyses and the asci are colourless.

Pycnidia are very numerous, conspicuous and big. The wall of the perithecium is composed of brown-walled hyphæ which are continued into colourless, radiating and few-celled hyphæ lining the whole of the inner side of the perithecium and cutting off numerous conidia of a very considerable size. It must be supposed that each conidia bearing hypha gradually cuts off several conidia; in this way only is it possible to account for the pycnidium being filled with conidia right to the top.

LECANACTIS AMYLACEA.

EHRH.

(PLATE 5—6—7).

On the bark of old oak-trees, *Charlottenlund*. E. ROSTRUP

The thallus is deprived of its natural margin in the specimen examined; it is white, farinaceous and only provided with few, narrow cracks. It is loose in texture, and the cortex, the gonidial and medullary layers are not differentiated. The gonidia are chroolepoid and considerably outgrow the hyphal tissue. The hyphæ are loosely interwoven, with numerous intercellular spaces filled with air, which imparts a whitish colour to the thallus. Haustoria do not occur. The rhizoidal hyphæ only penetrate quite superficially into the substratum and do not show any distinct signs of attacking its cell-walls; the latter, however, are colourless in places where they are in direct contact with the tissues of the lichen, whereas they are brown or yellowish where they are out of reach of the hyphæ.

The apothecia are scattered over the thallus without any discernible order. They are almost isodiametrical or somewhat oblong. At first they are rather regularly orbicular, with a distinct margin; later on they frequently become more irregular in outline, and the margin may disappear. The disc gradually becomes somewhat convex. The whole visible part of the apothecium, margin as well as disc, is often quite whitish-farinose, but the margin frequently turns blackish-brown, and the disc somewhat brownish. These changes of colour are due to the fact that the outermost colourless cell-layers of the apothecium may disappear, when consequently the inner dark colours become visible.

The stipes is well developed but is totally immersed in the thallus, reaching right down to the surface of the substratum. It is composed of dark-brown hyphæ winding upwards through the stipes without any distinct parallel arrangement. Above it merges into a likewise brown calyx which continues round the sides of the hymenium. The hypothecium, which represents a direct continuation of the calyx, is coloured far more faintly than the calyx and appears almost colourless in all thin microtome sections. The paraphyses are entangled among each other at the top, forming a thick epithecium. Asci are clavate, with 8 long colourless spores, which in all cases more closely examined were 4-celled and pointed at both ends, about 16—24 μ long.

The stipes and the inner parts of the calyx are dark-brown; the peripheral parts of the calyx in the margin of the apothecium may be colourless (in which case the margin is whitish farinose). The paraphyses are colourless at the base, slightly brown or colourless at the tips (in the epithecium); in such cases the

Pycnidia were not observed.

ARTHRORHAPHIS

ARTHRORHAPHIS Th. Fr.

Phylogeny. This genus has been referred by several authors to the genus *Bacidia* as a subgenus. It differs, however, in essential respects from this genus, with which it actually agrees only in the structure of the spore. Thus it differs from *Bacidia* in the structure of the stipes, the calyx (which are both dark), and the paraphyses; moreover, the ascus is narrow, and its wall is not thickened above. In examining this genus I have been struck with something foreign in its structure and can hardly consider it as having originated from any species of recent *Bacidias,* nor can I, on the other hand, believe it to be the prototype of any of them. It conveys a strong impression of having originated directly by the lichenizing of a species of fungus, presumably a *Mycobacidia.* I therefore treat it under its old name, given by Th. Fries.

A full description of its structure is given below. Only some few details, which will not be mentioned later, are given here. The germination of the spore has not been observed, but the plant most probably develops from a spore, as pycnidia have not been seen in this species. In the literature the thallus is frequently described as sorediose, but this description does not apply to the specimens examined by me. They are all provided with a cortex and do not convey any impression of being capable of developing soredia. Consequently, it is a subject of much doubt whether the genus is propagated by soredia in this country.

The position of the apothecia directly on the hypothallus is an obvious feature, which is not known in any Danish *Bacidia.*

Th. Fries considered it to be a genuine fungus parasitic on the thallus of *Sphyridium byssoides.* This peculiar idea is hardly to be understood considering that the thallus of *Arthrorhaphis* actually bears little resemblance to that of *Sphyridium.* Therefore I cannot accept Fries's view, which, by the way, has been abandoned by all other lichenologists.

ARTHRORHAPHIS FLAVOVIRESCENS.

DICKS.

(PLATE 8—9—10—11).

On moorlands. *Ferslev* in *Jutland*. I. BRANTH.

The thallus in composed of small, citrine or yellow, scattered or confluent, cushions of an irregular and greatly varying outline. The substratum between them (sandy soil) seems to be naked, but in reality it is interwoven, right up to the surface, with a rhizoidal tissue of hyphæ ('hypothallus').

The cortex is composed of a thin layer of hyphæ, the limits of which are indistinct in many places. In the cell-walls is found a yellow, non-crystallized pigment. The hyphæ of the gonidial layer are loosely interwoven, with numerous intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. There is no distinct medullary layer, but the gonidial layer insensibly merges into the rhizoidal layer, which is composed of thin, colourless, long-celled hyphæ, penetrating the soil and intermingled with its contents of dead moss-leaves, lumps of humus, and algæ. There are no signs of the hyphæ utilizing the algæ of the soil as gonidia.

The apothecia arise singly or crowded in groups, directly on the hypothallus. The specimens examined by me do not suggest the possibility of the apothecia arising also on the gonidia-bearing parts of the thallus. Even in cases where they had apparently arisen directly in the yellow thallus, it could be pointed out that in reality they had been formed between the thallus-cushions immediately on the 'hypothallus'. At first they are orbicular, concave, with a thick margin, but later on they may become less regular in outline and more plane. The colour is deeply blackish-brown at all stages. The stipes is very short, almost absent, and continues into a well developed calyx. The hyphæ usually radiate in all directions to the surface of the calyx, on which they stand almost at right angles. The hypothecium is considerably lighter, almost colourless. In it are distinctly seen numerous hyphæ, which rise vertically and gradually are transformed into paraphyses, while the bulk of the hyphæ of the hypothecium are more irregularly entangled among each other. A very well developed and distinct ascogonium is found among these paraphysogenous hyphæ. The paraphyses are very slender, not branched or poorly branched above, not thickened at the tips. Asci are narrowly clavate; their walls are not thickened above; they contain 8 long, acicular, colourless spores with 8—12 loculi, about 40—50 μ long.

Stipes and calyx are dark reddish-brown, in thin sections distinctly light olivaceous. The hypothecium is much lighter, almost colourless above. The paraphyses are olivaceous at the tips, otherwise colourless.

Pycnidia were not observed.

MICROPHIALE

MICROPHIALE Stizen.

Phylogeny. The only species found in Denmark, *M. diluta* Pers., has been referred to different genera of the system, e. g. to *Bilimbia* and *Gyalecta.* It is, however, most appropriate to deal with it under a separate name as done here. In the structure of the thallus it strongly reminds one of *Catillaria (Biatorina) Chroolepus* O. Galløe. The apothecium bears also great resemblance to this species of *Catillaria.* I think it very possible that a relationship between them exists, the more so as their gonidia are very much alike. Moreover, it reminds one of *Bilimbia sphæroides,* especially of the specimens which are provided with 2-celled spores, as is the case with most specimens of *Bil. sphæroides* in this country. On the other hand, *Bil. sphæroides* has not chroolepoid gonidia. The most obvious structural detail, however, in which our plant differs from *Catillaria micrococca, C. Bouteillei, C. Chroolepus, Bilimbia sphæroides,* and *B. subsphæroides,* is the occurrence of a cryptolecanorine margin in *Microphiale diluta.* The structure of this margin is described more closely below.

MICROPHIALE DILUTA.

Pers.

(Plate 12—13—14—15—16).

On the periderm of *Pinus. Slæbæk.* E. Rostrup.

The thallus is very thin, with an indistinct margin. The colour is somewhat dirty-green. The form of its surface is quite dominated by the roughness of the substratum.

The cortex is poorly developed, composed of rather indistinctly limited hyphæ, the contents of which seem to be living, susceptible to staining. Otherwise the thallus is nearly homoeomerous, composed of hyphæ running rather irregularly, intermingled with numerous gonidia of chroolepoid type. Haustoria do not occur. Special medullary and rhizoidal layers are not differentiated. The deeper lying hyphæ branch like rhizoids in the upper opened cells of the periderm and do not show any signs of attacking them chemically.

The apothecia arise on the thallus without any visible order. They are orbicular, at first concave, cup-shaped, but later on they become more plane; the disc may even b

thallus may be found on the outer and lower surface of the apothecium; otherwise, it has a pure biatorine macroscopic aspect. The margin is yellow or orange-coloured; the disc has the same colour, only of a little darker shade.

The stipes and the calyx merge quite insensibly into one another and are composed of rather big-celled hyphæ, in places forming an almost pseudo-parenchymatous tissue. In the margin of the apothecium the hyphæ run upwards and outwards to the surface, on which they stand almost erect. The apical parts of the hyphæ in the periphery of the margin have much bigger cells than those forming the inner parts. A hypothecium, composed of an indistinct ascogonium and very distinct paraphysogenous hyphæ, rises from the bottom of the calyx. The paraphyses are not branched; at the base and at the tips they are big-celled; otherwise their cells are stretched. Asci are long and narrow; their wall is not thickened above. They contain 8 2-celled, colourless spores.

The stipes is colourless, but all other parts of the apothecium are very faintly yellowish from a not-crystallized pigment. This yellow colour comes out most strongly in the peripheral parts of the calyx and in the epithecium.

A very conspicuous structural feature must be mentioned here. In the calyx itself — which otherwise has the same structure as, and is homologous to, the calyx of the other lecideine species described above — occur not a few gonidia situated in the inner, small-celled parts of the calyx. Their presence is not betrayed by anything in the macroscopic aspect of the apothecium, which apparently is quite biatorine. I intend to designate an apothecium of such a structure a crypto-lecanorine apothecium as distinct from the pseudo-lecanorine apothecium, the macroscopic aspect of which is lecanorine, whereas the inner structure is truly lecideine. For further details the figures must be referred to.

Pycnidia were observed here and there. They have a somewhat dark ostiole. The wall of the perithecium is somewhat dark above, lighter below. Hyphæ-bearing conidia radiating towards the centre of the pycnidium issue from the inside of the wall. Anastomosing hyphæ are met with here and there; from their apical cells they cut off an oblong oval conidium, but conidia may be cut off also from cells at some distance from the apical cell.

PACHYPHIALE

PACHYPHIALE Lönnr.

Phylogeny. The species found in this country, *P. carneola* Ach., has been placed under different genera of the system, e. g. under *Bacidia* (owing to the structure of the spore) and under *Gyalecta* (owing to the deeply-concave apothecium and the occurrence of chroolepoid gonidia). From our present knowledge of the structure of *Bacidia* it may be said with great certainty that *P. carneola* does not show any other likeness to *Bacidia* than the occurrence of acicular spores, but not in the structure of the thallus nor in that of the apothecium. In all other details, especially in the occurrence of crypto-lecanorine apothecia, it differs so completely from *Bacidia* that it cannot possibly be referred to that genus. A minute comparison with the species of *Gyalecta* cannot be made until the latter have been investigated and figured in all anatomical details. By the structure of the spore and the thallus, however, it seems to be so far removed from *Gyalecta*, more particularly *Secoliga*, as to justify its being established as a separate genus. Accordingly, whether our species may be imagined to have arisen from some other recent species cannot be settled with any certainty, because anatomical investigations of its nearest relatives, and especially figures of them, have not been published as yet.

As to the structure of the species the description below is referred to.

About its biological conditions it may be remarked — in addition to what is evident from its structure without any further explanation — that the specimen described here was found with very young apothecia, just about to break through the surface of the thallus, on the 31st of March, at a season still cold and wintry in this country. This is one of the very few season-biological phenomena known in lichens. This fact suggests that the formation of young apothecia may possibly begin in the cold season, but the interpretation is not certain. Still undeveloped apothecia may be imagined to have hibernated.

The propagation, probably, proceeds by spores only. There are no sure signs of the thallus, however loose in texture, setting free so
been found in this country.

PACHYPHIALE CARNEOLA.

ACH.

(Plate 17—18—19—20.)

On the periderm of oak. *Vindum Skov;* I. BRANTH.

The thallus is thin, even; the form of its surface is quite dominated by the roughness of the substratum. The colour is whitish.

The thallus is almost homoeomerous, there being no pronounced differentiation into cortical, gonidial, medullary, and rhizoidal layers. It is composed of very irregularly interwoven hyphæ, intermingled with chroolepoid gonidia. Haustoria do not occur. In several places the gonidia reach the surface of the thallus, in other places they are covered by hyphæ, which, however, have no pronounced cortical aspect. The rhizoids do not show any signs of attacking the substratum chemically.

The apothecia are scattered over the thallus without any order, young and old mixed together. At first their margin is covered by particles of the thallus, which particles may disappear later on. Their outline is rather isodiametrical or oblong. At first the margin may be almost uniform in thickness round the whole apothecium; later on it may become variously thickened, well-developed, and at times somewhat sinuose. The disc is concave. The young apothecia are light reddish-yellow, but gradually they become more brownish-red. The margin is often more reddish and somewhat darker than the disc.

The stipes is very short and of the same structure as the thallus, but without gonidia. It is provided with richly developed intercellular spaces and merges into a well-developed calyx, which in part is continued into the hypothecium, and in part forms a well-developed cuplike margin round the hymenium. In the margin the hyphæ run upwards and outwards towards the periphery, in which their apical parts become considerably more thickwalled than are the inner parts of the calyx.

The hypothecium consists of paraphysogenous hyphæ, irregularly entangled, and furthermore, of very distinct ascogenous hyphæ.

The paraphyses are slender, filiform, not branched, not thickened at the tips, conglutinated by a slightly developed hymenial gelatine.

Asci are clavate, thickest round the middle, somewhat tapering above; their walls are only slightly thickened above. They contain a varying number (often about 15—16) of long, acicular spores with 9—15 loculi. The spores are 44—66 μ long.

The inner parts of the apothecium are almost all colourless. The apical parts, however, of the hyphæ forming the margin of the apothecium are brownish just as the still lighter coloured epithecium, which seems quite colourless in thin microtome sections. The pigment is non-crystallized, deposited in the walls of the hyphæ.

In the specimen examined here was found a similar condition as in *Microphiale diluta*, viz. the occurrence of some gonidia in the calyx itself. Consequently, the apothecium may be designated as crypto-lecanorine, because the occurrence of gonidia does not at all betray itself in the macroscopic aspect of the apothecium.

Not a few dead apothecia were found, appearing as empty, light cups of the same colour as the thallus, from which all remnants of a hymenium had disappeared. Whether this phenomenon is due to a pathological condition of the lichen or may be considered as quite normal, could not be settled on the basis of the present investigation.

In some apothecia were found brown hyphæ of a fungus, intermingled with the paraphyses. The fungus seems to be the same as is met with in several species of *Catillaria* and other lichens mentioned in this book. In *Pachyphiale* too there is no sign of this fungus doing the lichen any harm.

Pycnidia were not observed.

BRYOPHAGUS

BRYOPHAGUS. Nitschke.

Phylogeny. The only species, found in this country, agrees in many respects with certain species of *Gyalecta*, particularly with the subgenus *Secoliga*, in the structure of the apothecium and partly also in that of the thallus. It differs, however, from *Secoliga* in having bluish-green gonidia. Whether otherwise it takes up a more primitive position in taxonomic or biological respects than the subgenus in question cannot as yet be settled with any certainty, as no detailed investigations or figures of the latter have hitherto been published. Whether it may be considered as having originated from any recent species of *Secoliga*, or vice versa, is a problem which cannot be solved with certainty at the present moment; anatomical researches of the species of *Secoliga* will, however, be likely to answer the question. In order to avoid giving the same name to two genera of lichens, differing in the structure of the spores and of the gonidia as well, I shall retain the name *Bryophagus*, at the same time, however, pointing out that the present species most probably represents a cyanophilous genus analogous to the chlorophilous genus *Secoliga*.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

(Plate 21—22—23—24—25.)

On moorland. *Ferslev* near *Aalborg*. J. BRANTH.

The borderline between the thallus and the substratum is not very distinct. The thallus is gelatinous, in moistened state somewhat transparently greenish-black. Its structure is homoeomerous, composed as it is of scanty hyphæ branching without any visible order in all directions through a gelatine formed of different *Cyanophyceæ*, mainly *Chroococcaceæ*. There is neither a definite cortex nor any rhizoidal zone; the whole thallus may be considered as a gonidial layer. The hyphæ do not send any haustoria into the gonidia. The latter belong to different types, figured in full details in the figures 72 and 73.

The apothecia are markedly urceolate in shape, immersed in the thallus. Only their margin is visible; it is whitish-yellow, partly covered by the thallus. The exciple is formed of a deep calyx, without any proper stipes; at the base it merges into a hyphal tissue rich in intercellular spaces filled with the Cyanogonidia and their gelatine. From the base of the stipes issues a dense calyx, in which the hyphæ rise upwards towards the surface of the thallus, running more or less parallel. In the periphery of the calyx, however, the hyphæ are arranged in periclinal, concentric layers. The hypothecium is placed at the bottom of the calyx. It is rather thin, provided with distinct paraphysogenous hyphæ and indistinct ascogenous hyphæ. The paraphyses are filiform, not thickened at the tips. Asci are narrowly clavate, their walls slightly thickened above. Apparently they contain only 4 colourless, long, narrow spores, which are somewhat twisted round each other and provided with about 8 loculi. They are 24—28 μ long.

All parts of the calyx are slightly yellowish, whereas the hymenium appears colourless, at any rate when examined in thin microtome sections.

Pycnidia were not observed.

In P. J. HELLBOM'S 'Bornholms lafflora' there is on pag. 65 a note concerning the present species. In it some doubt is expressed whether this plant is a real alga or a lichen.

In DEICHMANN BRANTH and ROSTRUP »Lichenes Daniæ« the description of the anatomy of the thallus is not quite correct. From the description given above it is evident that the feeling of doubt and uncertainty as to the nature of this plant is due to the fact that the thallus is gelatinous and thus greatly differs from the thallus occurring in lichens provided with common *Chlorogonidia*. I cannot find any reason for doubting that our species is a true lichen in biological respects. Should ever apothecia be found of the structure described here, living on the naked soil without any symbiotic *Cyanophyceæ*, the species would have to be considered a fungus, but the occurrence of such a plant is unknown to me. Our specimen, however, must be considered a true lichen in quite the same biological meaning as every other cyanophilous lichen, even if in future it should be unveiled as a facultative lichen only. In that argument I find a justification for describing and mentioning it in this book.

BIATORELLA

BIATORELLA Th. Fr.

Phylogeny. In our country this genus is represented by one corticolous species only, growing in the interior and on the surface of naked wood, viz. *B. moriformis*, which is partly endoxyline, partly epixyline. Its structure is exceedingly primitive, as more closely mentioned in the description of the species in question. It is very probable that this species (or another, extinct or recent, similar species) is the prototype of the other species growing on other substrata, although absolutely sure evidence of this supposition cannot be procured. On the other hand, there is no probability of any saxicolous species being the oldest prototype, since it seems next to impossible for a true fungus to establish a lichen-symbiosis immediately upon rocky substratum, where it is exposed to conditions of life differing in almost every respect from its habitual heterotrophic mode of living. The symbiosis seems most likely to have been initiated on some organic substratum.

B. moriformis, or a similar species, may thus be considered as the probable prototype of the whole genus, and it would be very interesting to ascertain whether this species would be able to live as a true fungus, without gonidia.

On the other hand, some or other species of *Lecidea* may be considered as the prototype of the present genus, but most probably the genus is descended from a fungus, which already in its fungal stage had an ascus containing a very great number of spores, thus being provided with the structural features especially distinctive of the genus *Biatorella*.

NATURAL HISTORY OF THE DANISH SPECIES OF BIATORELLA

The **spore** in our species is very small, globular or oval, about 2—4 μ long, and colourless. Its wall is very thin. The interior space of the asci varies somewhat, but even in the smallest asci the number of spores amount to hundreds *(B. moriformis)* or even to some thousands.

By the germination of the spore, which has not been observed directly, there is formed a **thallus**, which is crustaceous and endoxyline or epixyline *(B. moriformis)*, calcicolous *(B. pruinosa)* or saxicolous *(B. simplex, B. clavus)*. In *B. moriformis* the thallus appears to be very poorly developed and is completely wanting in the specimen examined by me.

The gonidia are 1-celled, roundish and possibly of both cystococcoid and pleurococcoid type (Fig. 88). No haustoria were found anywhere.

As regards other structural details of the thallus, the special descriptions of the single species are referred to.

The **apothecia** are formed without any visible order, scattered over the thallus. They have an exciple, composed of stipes and calyx. In *B. moriformis* the stipes is rather short, in *B. clavus* it is grossly developed, and in *B. pruinosa* and *B. simplex* of medium size. In all the species it is composed of hyphæ running parallel and radiating above in all directions, thus forming a big calyx, in which the hyphæ run outwards to the surface of the apothecium, on which they stand approximately erect.

In the hypothecium the ascogenous cells are not very conspicuous. From these issue the asci, the walls of which are moderately thickened above.

The paraphyses are imbedded in a well developed hymenial gelatine. Their tips are slightly thickened or not at all so.

As a rule, only the peripheral parts of the apothecium are provided with pigments, which accordingly are deposited in the tips of the paraphyses, the apical parts of the hyphæ of the calyx, and the peripheral parts of the stipes. Small amounts of pigments may, however, be deposited in other places besides these, e.g. in the wall of nearly the whole paraphysis in *Bi. clavus* and especially in *Bi. simplex* (Fig. 96, 97 and 98). On the other hand, the hypothecium is generally faintly coloured, most deeply in *Bi. simplex*.

In all our species the apothecia, when seen with the naked eye, appear nearly quite black, and in these species as in other lecideine genera a distinction between light and dark apothecia and, especially, an establishment of sub-genera based upon such differences, is quite artificial.

Pycnidia and **soredia** are not met with in our species.

Biology. The mycelium formed by the germination of the spore captures the algæ necessary for the establishment of the symbiosis. In what manner the algæ are captured has not been actually observed, nor how many are captured by the single individual. It is, however, a matter of course that *Bi. moriformis*, which is partly endoxyline, incorporates many algal individuals, as the daughter-cells of the first captured algæ as a rule cannot be carried by the hyphæ across the many obstructions of the substratum.

How the gonidia are utilized may only be guessed at. We may suppose that nutritive matters are exchanged between the algæ and the hyphæ in places where these components are in close contact. On the other hand, there is nothing to show that the gonidia are killed by the symbiosis.

The usual tissues: the rhizoidal, medullary, gonidial, and cortical layers are differentiated during the further growth of the thallus.

The rhizoids attack the substratum in different ways. In *Bi. moriformis* it is evident that the hyphæ most easily grow longitudinally in the stretched cells of the woody substratum (Fig. 80).

Any visible sign of the hyphæ attacking the substratum chemically was not observed in this species. They must, however, be supposed to absorb at any rate inorganic matter from the substratum, even if this process does not manifest itself in any visible or recognizable alteration in the structure of the wood. Whether organic matter too is absorbed cannot be directly seen. But gradually, the substratum will be more or less emptied of inorganic salts, and thus its nutritive matter will become insufficient as plant-nutrition for the nourishing of the plant; in such places the thallus will accordingly die and the gonidia will probably be set free, while the margin of the thallus will continue its growth. It is easily understood that the duration of life of the lichen is contingent on the utilization of the substratum through the rhizoidal hyphæ. *Bi. moriformis* must be supposed to be potentially immortal as far as it does not die of its own accord, from inherent causes, but only because the substratum has been emptied of suitable, nutritive matter.

In *Bi. pruinosa* the rhizoidal hyphæ penetrate into limestone and form a coarsely developed tissue, which evidently in a high degree attacks the substratum chemically. In this species, too, the duration of life is conditional on the gradual emptying of the nutritive matter of the substratum.

In *Bi. simplex* growing on a rocky substratum of eruptive origin the attack of the rhizoidal hyphæ on the different grains of minerals has not been closely examined.

A well developed medullary layer occurs in *Bi. simplex* only.

The cortex, i. e. the tissues covering the surface of the gonidial tissue, is more grossly developed in the saxicolous species than in the partly endoxyline *B. moriformis*.

The duration of life and causes of death of the single species have been mentioned above. As to ecological conditions I only wish to point out that there exists — as it is evident from the facts described above and from a closer examination of the single species (which see) — a very conspicuous relation between the structure of the thallus and the nature of the substratum, so that the endoxyline, calcicolous, and saxicolous species represent as many types of the structure of the thallus as is indicated by the number of substrata.

Morphologically there is the usual difference between the distinctly areolated thalli in the saxicolous species and the smooth continuous thallus in *Bi. moriformis* growing on a woody substratum.

BIATORELLA MORIFORMIS.

ACH.

(Plate 26—27—28—29).

On an oakpost. *Tved (Fyn)*. E. ROSTRUP.

The thallus is extremely thin, for the greater part endoxyline, whitish and indistinctly bordered. It is composed of groups of gonidia, more or less densely crowded and intermingled with hyphæ forming on the surface a primitive, slightly developed cortex. The latter may be termed a cortex, inasmuch as it seems to form on the whole of the thallus a superficial protecting layer over the gonidia, which thus in no place project to the surface of the thallus. On the surface of this cortex, almost everywhere, is found a layer of covering remains of the woody substratum, so that the thallus may be characterized as endoxyline. The hyphæ form no haustoria. The gonidia are 1-celled, apparently cystococcoid. In the basal parts of the thallus the hyphæ penetrate into the open wood-cells, but do not show any signs of being able to attack them chemically.

The apothecia are scattered over the thallus without any order, young and old intermingled. They are fairly isodiametrical and orbicular or somewhat irregular in outline, from the very beginning greatly convex, almost semi-globular, without any visible margin. Their colour is black.

The stipes is rather short, composed of fasciate hyphæ, above continuing into a well developed calyx, the hyphæ of which are somewhat more irregularly interwoven. From the calyx the hyphæ radiate more regularly upwards and outwards into the margin. The hypothecium is thick and contains numerous very distinct ascogenous hyphæ. The paraphyses are not branched, not thickened at the tips; they are embedded in a thick hymenial gelatine. The asci are rather short, somewhat inflated and clavate, with walls greatly thickened, especially at the top. They contain a great number of extremely small, globular and colourless, spores, about **1** μ across.

The stipes, the interior parts of the calyx, the margin, together with the hypothecium, the asci, and the bases of the paraphyses are nearly colourless. The peripheral parts of the margin and the whole of the epithecium are dirty-olivaceous from a non-crystallized pigment deposited in the peripheral layers of the hyphæ of the calyx and in the hymenial gelatine of the epithecium.

Pycnidia were not observed.

The specimen mentioned here was formerly determined by NYLANDER as a *B. improvisa* NYL. and may thus be considered as an authentic *B. improvisa*. For the name *Bi. moriformis* ACH. I take the authority of TH. FRIES, who quotes the name given by NYLANDER as synonymous with that given by ACHARIUS. I have not seen the type-specimen of ACHARIUS myself.

In the structure of the thallus the present specimen is very primitive and conveys to us an idea of the way in which the oldest and most primitive lichens were probably formed by fungal hyphæ branching in the dead organic substratum, the wood. The latter originally constituted their only nutriment before by degrees they entered into symbiosis with the common algæ of the substratum — a symbiosis at first of a facultative nature, later on becoming fixed and obligate.

Undoubtedly, a species like the present one must be imagined to represent the original and oldest link of a phylum, from which other more differentiated species have developed in the course of time.

BIATORELLA (SARCOGYNE) PRUINOSA.

SM.

(Plate 30—31—32—33.)

On a block of limestone. *Magaard Strand*. E. ROSTRUP.

The thallus is somewhat areolate, with confluent areoles of an irregular outline and a rather plane, somewhat rugose surface. The colour is greenish-grey. Scanty radiating, mycelial and colourless hyphæ occur in the margin of the thallus. The areoles have a thick cortex, the upper cell-layers of which are differentiated into a cuticle with still discernible cell-lumina. This cuticle is wanting in the vertical sides of the areoles. Even in thin microtome sections the hyphæ of the cortex are somewhat brownish. The hyphæ of the gonidial layer stand chiefly erect and run straight, or sometimes somewhat undulating, upwards through the areole. They do not send any haustoria into the gonidia. The latter are 1-celled, apparently cystococcoid, or some of them perhaps pleurococcoid. The medullary layer is thick, colourless, composed of densely interwoven hyphæ, which however are provided with intercellular spaces. The rhizoids branch copiously and densely in the substratum; they are represented by partly big-celled, and partly small-celled hyphæ. In the big-celled hyphæ, which according to the usual terminology would be designated spheroidal cells, no oil-drops were found. Numerous grains of limestone occurred in the rhizoidal and medullary layers.

The apothecia are scattered over the thallus without any order, young and old intermingled. They are more or less isodiametrical, somewhat angular and irregular in outline, but may sometimes be regular. At first they are concave, later on they become plane or even slightly convex, with a persistent, rather thick margin. The colour is black.

The stipes is fairly well developed, completely embedded in the thallus. It is composed of parallel hyphæ; above it continues into the calyx, the inner parts of which, below the hypothecium, are formed of irregularly undulating hyphæ, whereas the margin is formed of hyphæ radiating outwards in all directions and standing almost erect upon the surface. The hypothecium contains rather distinct ascogenous hyphæ. The paraphyses are filiform, not thickened at the tips. The asci are broadly clavate, their walls are not particularly thickened. They contain numerous oblong, colourless spores, about 4 μ long.

The stipes, the bottom of the calyx, the inner parts of the margin, the hypothecium, and the main parts of the paraphyses are colourless. The peripheral parts of the calyx together with the whole of the epithecium are brownish from a non-crystallized pigment deposited in the peripheral parts of the walls of the hyphæ.

Pycnidia were not observed.

This species is a pronounced calcicolous lichen with numerous grains of limestone deposited among the hyphæ, partly (yet scantily) in the cortex, partly (in large amounts) in the gonidial layer, and also (in very large amounts) in the medullary layer; finally all the intercellular spaces between the rhizoidal hyphæ are filled with limestone. This distribution of the grains gives us some intelligence of the way in which the thallus increases in thickness.

If we try to imagine the thallus with the aspect immediately attained when it is formed by the germination of the spore, we must of course suppose it to be free from any grains of limestone. Now, if the whole of the epilithic part of the thallus was formed by growing upward from the surface of the stony substratum, it would not at all be intermingled with grains of limestone. Such grains would occur only in the endolithic rhizoidal zone. When nevertheless the medullary layers — and partly the gonidial layers too — are completely filled with lime, this fact suggests that theoretically the medullary layer must be considered endolithic and attaining through an intercalary growth a very considerable size. The original surface of the stone was situated near the lower surface of the gonidial layer, which means that originally the gonidia were lying free upon the surface of the stone, where they were captured by the first germinating mycelium. The numerous grains of limestone in the medullary layer thus represent the original coherent surface of the limestone, which was disintegrated into single grains through the intercalary growth of the hyphæ of the medullary layer. Compare with this the occurrence of particles of the periderm in the medullary layers of numerous bark-lichens.

Grains of limestone may sometimes occur even in the calyx (Fig. 89). This fact suggests that the calyx originated from the medullary layer, or, in any case, deep down in the thallus. From the thallus the grains were by degrees intermingled with the young hyphæ of the calyx and later on lifted upwards through the whole of the thallus, when the apothecium broke through its surface. Indeed, the grains are most copious in the margin, whereas they are absent in the hypothecium and in the hymenium, which tissues undoubtedly are both formed of an originally very small mass of hyphæ surrounding an ascogonium ('carpogonium'). Even if some small grains of lime were originally placed among these hyphæ, the whole tissue would later increase so much in mass and extent that such particles of lime would not fill any space worth mentioning in proportion to the hyphæ themselves. It remains to be said that I did not find any lime at all in the central parts of the apothecium of the specimen mentioned here.

BIATORELLA (SARCOGYNE) SIMPLEX.

Br. & Rostr.

(Plate 34—35—36—37.)

On stone. *Lillerød.* O. Galløe.

The thallus is composed of small, scattered, plane, partly confluent grey areoles of a very irregular outline. The naked substratum is visible between them. Colourless, slender hyphæ connecting the areoles with each other spread over the substratum.

The cortex is composed of irregularly arranged hyphæ with distinct lumina. The uppermost layer is brownish-greyish from a non crystallized pigment deposited in the walls of the hyphæ. The hyphæ of the gonidial layer are somewhat looser in texture than those of the cortex. No haustoria occur. The gonidia are 1-celled, apparently cystococcoid or pleurococcoid. The medullary layer is brownish and even looser in texture than the gonidial layer, and is provided with big intercellular spaces.

The apothecia are situated in the vicinity of the areoles, never directly upon the hyphæ connecting the areoles. Apparently they are placed upon the areole; it cannot, however, be settled with full certainty whether they have arisen in an areole provided with gonidia or stand in the narrow space between contiguous areoles. They are more or less isodiametrical and generally very irregular in outline from the very beginning. The margin is very thick, undulating, and provided with radial furrows.

The disc is plane or somewhat verrucose and may sometimes gradually become furrowed like the margin. The colour is black at all ages.

The stipes is well developed and composed of parallel hyphæ insensibly continuing into the calyx. The sides of the latter are composed of hyphæ radiating in all directions towards the surface, on which they stand almost erect. The hypothecium is thick and contains distinct ascogenous hyphæ. The paraphyses are filiform, not thickened at the tips, greatly conglutinated; they do not separate from each other even when exposed to a strong pressure. The asci are narrowly clavate; their walls are somewhat thickened above. They contain numerous small, oblong spores, about 2 μ long.

The inside of the stipes is colourless; in the periphery the hyphæ are dark-brownish. The same colour occurs in the peripheral parts of the calyx and in the epithecium. The inner parts of the calyx, below the hypothecium and upwards alongside of the hymenium, are considerably lighter brownish. The whole of the hymenium and the hypothecium are very faintly brownish.

Pycnidia were not observed.

The relationship between the present species and *Biatorella (Sarcogyne) clavus* is very conspicuous in several respects, as Th. Fries rightly points out in his work *Lichenographia Scandinavica*. There are, however, many differences in structure between them, as it is evident from a comparison between the figures of the two species given in the present work. The most striking difference occurs in the structure of the hymenium: in *B. simplex* the ascus is considerably longer than in *B. clavus*. On the contrary, the spore is about twice as long in *B. simplex* as in *B. clavus*.

BIATORELLA (SARCOGYNE) CLAVUS.
D. C.

(Plate 38—39.)

On granite. *Hammershus* on *Bornholm*. Grønlund.

The specimen examined is the only one existing in any Danish collection and consists of some few apothecia isolated from the substratum, of which nothing at all is present. Accordingly, no material of the thallus has been at my disposal for examination. In other Scandinavian specimens the thallus seems to be very poorly developed. Thus, Th. Fries writes in *Lichenographia Scandinavica* pag. 409, ‘Thallus indistinctus; infra apothecia adsunt tamen illius minutissima vestigia, gonidiorum glomerulas continentia.’

The apothecia are big and stipitate. The young ones have a rather regular outline, but are however a little sinuose at the margin. The old ones are extremely irregular, with a margin undulating so much that it divides the disc of the apothecium into several lobules. The surface of the disc of old apothecia is convex, and in places deeply furrowed. The young apothecia are deeply reddish, the old ones more purely black.

The stipes is well developed and long, so that the whole apothecium is somewhat turbinate. It is composed of parallel hyphæ running upwards through it; from these hyphæ issue horizontal, dark hyphæ, forming an outer protecting layer on the stipes. Above, the stipes is continued into a very thick calyx, the bottom of which is composed of rather irregularly arranged hyphæ with numerous intercellular spaces. Among these hyphæ are situated numerous roundish groups of a colourless, apparently crystallized substance, the single crystals of which seem to belong to the rhombic system. The sides of the calyx are formed of hyphæ, which radiate in the usual way in all directions towards the surface, on which they stand nearly erect. The hypothecium is thick; the paraphyses are conglutinated, filiform, not thickened at the tips. The asci are broadly clavate; their walls are somewhat thickened above. They contain numerous oblong spores, about 4 μ long

The inner parts of the stipes and the calyx are colourless; the outer, peripheral parts, on the contrary, are black, i. e. rather dark brown. The hypothecium and the hymenium are very faintly yellowish. The tips of the paraphyses are darker brownish-yellowish. The very uppermost layer of the epithecium is, however, colourless, cuticle-like, and is apparently formed of the dead and colourless apical cells of the paraphyses.

Pycnidia were not observed

MYCOBLASTUS

MYCOBLASTUS Norm.

Phylogeny. This genus, which in our country is represented by one species only, is characterized by its peculiar, very big spores, the walls of which are double and contain hundreds of cell-nuclei. Sometimes the ascus contains two spores; Danish specimens, however, have most often only one spore.

In the structure of the thallus it stands at a higher state of development than most of its nearest relatives. The thallus is highly granular or approximately microphylline, thus resembling to some degree several species of the genus *Psora.*

The genus in question has been referred to different families in the system, e. g. as a subgenus of the genus *Lecidea.* It seems, however, more probable to me that it cannot be considered as a particularly primitive lichen, but — more likely — as a higher developed descendant of some species of lichen provided with a polysporous ascus, possibly a species of *Biatorella.* Accordingly, I feel greatly inclined to consider the genus as having arisen from some primitive corticolous *Biatorella,* which during the phylogeny has ceased to differentiate its numerous cell-nuclei into as many spores, and which — as a reminiscence of former conditions — has retained one feature, viz. each of the spores germinating through numerous hyphæ.

MYCOBLASTUS SANGUINARIUS L.

(Plate 40—41—42—43.)

On oak-wood. *Jægersborg Dyrehave.*

The thallus is provided with rather indistinct, colourless mycelial hyphæ along the margin. Scattered roundish, cushion-shaped, in places confluent, areoles occur inside the mycelial margin. Nearer to the centre of the thallus these areoles unite into a coherent thallus, developing a common medullary layer. The outline of the single areoles may by degrees become very irregular, and the areoles partly overlap each other. The areoles, which are thus overshadowed, gradually lose their gonidia. The colour of the thallus is brown.

The cortex is composed of hyphæ, which are indistinctly limited to each other, and with lumina, distinct only in places. A non-crystallized, brown pigment is deposited in the whole of the cortex.

The gonidial layer is composed of irregularly interwoven, short-celled hyphæ. The gonidia are roundish, 1-celled. No haustoria are found. The medullary layer is considerably looser in texture, composed of long-celled, branched hyphæ with big intercellular spaces. The hyphæ of the medullary layer are here and there stained blood-red from a non-crystallized pigment.

The apothecia are scattered over the thallus without any distinct order. At first they are orbicular, convex, without any margin; later on they may become more irregular in outline, partly overlapped by the areoles of the thallus and more plane. The colour is black at all ages.

The stipes is short in proportion to the diameter of the apothecium. It is composed of rather irregularly interwoven hyphæ with big intercellular spaces. An arrangement in bundles is not recognizable.

The calyx is composed of densely interwoven hyphæ, running from the stipes upwards into the margin. Ascogenous hyphæ, partly very distinct, are found in the hypothecium. The paraphyses are conglutinated, filiform, branched at the tips, but not thickened. The asci are big, clavate; their walls are thickened above. In the specimen investigated they only contain one single spore. The wall of the latter is at first thick and consists of only one layer; later on it is differentiated into two layers, of which the innermost is the thickest and provided with irregularly scattered pores, operative, presumably, during germination. The cytoplasm contains numerous cell-nuclei.

The inner colours of the apothecium are distributed in the following way: the stipes is yellowish, with a big, blood-red spot just below the calyx. The calyx and the hypothecium are faintly yellow. The paraphyses are greyish, apparently a mixture of yellow and blue.

Pycnidia were not observed.

BLASTENIA

BLASTENIA Mass.

Phylogeny. The only species occurring in this country, viz. *Bl. ferruginea,* belongs to a genus, which in other countries is represented by numerous species growing on organic as well as on rocky substrata. The species *Bl. ferruginea* itself is found in this country growing both on bark and on stone.

A. Zahlbruckner refers this genus to *Caloplacaceæ* together, among others, with the genus *Protoblastenia,* which in this country is represented by one species only, called in the present work *Lecidea rupestris* and described in Part I among the *Lecideas* on account of the structure of the spore.

I think that Zahlbruckner is right in grouping these two genera together, and I am inclined myself to consider them so closely related as to maintain that *Blastenia* is descended from *Protoblastenia.* This supposition is supported by the fact that *Protoblastenia* includes species growing on bark and provided with a thallus, which is so primitive in structure that it may be considered a directly lichenized fungus, e. g. *Lecidea (Protoblastenia) cinnabarina* Smrft.

Whether *Protoblastenia* again originated from other undoubted *Lecideas,* I dare not maintain with any certainty. For the time being no true estimate of such a relationship can be formed, because sufficiently detailed descriptions and pictures of *Lecidea (Protoblastenia) cinnabarina* do not yet exist Still, I do not think such a relationship to be impossible nor incompatible with my knowledge of the structure of *Lecidea rupestris* described in the present work, Part I.

As regards the natural history of the Danish species of *Blastenia* the following description is referred to.

BLASTENIA FERRUGINEA.

Huds.

(Plate 44—45—46—47—48—49—50—51—52.)

Specimen 1. On oak-bark. *Lolland.* E. Rostrup.

The thallus is even, smooth, here and there somewhat rimose, partly owing to the presence of fissures formed through tensions in the substratum. The margin borders on a *Lecanora subfusca.* The thallus is greenish; the limiting line is black.

The cortex is well developed, composed of hyphæ, which for the greater part seem to be dead. However, several undoubtedly living hyphæ are intermingled with them. Intercellular spaces are found here and there. The hyphæ of the gonidial layer are more loosely interwoven and short-celled. The gonidia are 1-celled, without haustoria. The medullary layer is thick, rich in intercellular spaces. The hyphæ of the rhizoidal layer make their way between the cells of the periderm, but show no clear sign of attacking them chemically (see, however, below).

The apothecia are scattered over the thallus without any order, here and there arranged in groups. At first their outline is rather regular, orbicular or somewhat oblong, with entire thick margin and with a plane or somewhat concave disc. Later on the margin becomes greatly sinuate and crenate, for which reason the outline of the apothecium becomes exceedingly irregular, but the disc is persistently plane or faintly convex and the margin thick and persistent. The colour at all ages is deeply orange-coloured or ochraceous.

The stipes is well developed, composed af parallel hyphæ, continuing upwards partly into the hymenium, partly into a particularly well developed calyx, the hyphæ of which radiate outwards in all directions towards the surface, on which they stand almost erect. The hyphæ of the calyx are short celled, their apical parts are coloured by a granular pigment deposited between the hyphæ, staining red by addition of KOH. The hypothecium is extremely rich in ascogenous hyphæ, to a large extent continuing downwards into the calyx. The paraphyses are slender, slightly capitate at the tips, branched, and coloured by the same pigment as found in the calyx. The asci are narrow at the base and more broadly clavate at the top. Their walls are moderately thickened above. They contain 8 colourless spores, which at first are 1-celled; later on they become polaribilocular because the transverse wall gradually narrows the connection between the two cells into an extremely narrow channel. In some isolated cases the channel completely disappears or the one cell of the spores is not developed at all, and thus they remain 1-celled.

All the inner tissues of the apothecium are colourless; only the peripheral parts of the calyx and the tips of the paraphyses are coloured with parietine.

Pycnidia were not observed.

In the present specimen I succeeded in finding very young primordia of apothecia, which show the following development: Groups of convolute ascogonia, composed of several cells and provided with a trichogyne which reaches the surface of the thallus, are formed in the interior of the thallus, close to each other (Fig. 128). A system of hyphæ, the future calyx, is organized round and under these ascogonia. Numerous hyphæ, the first primordia of the paraphyses, are placed among the ascogonia. At the present stage the primordium of the apothecium is completely embedded in the thallus among the lamellæ of the periderm and surrounded by the gonidial layer. Some few gonidia may occasionally be embedded among the hyphæ of the calyx and continue their development in this place. They will be found even in the fully developed apothecium, which accordingly must be designated as crypto-lecanorine (Fig. 126 and 127), a fact which to some degree effaces the limits between the lecideine and the lecanorine apothecia.

The asci arise from the ascogonia, whereas the trichogynes disappear. My sections give no information about conditions of fertilization. The basal part of the calyx gradually organizes a well developed stipes, which raises the apothecium above the level of the surface of the thallus.

In some of my anatomical sections of the present specimen it was evident that the lamellæ of the periderm being in direct contact with the hyphæ of the thallus are considerably more susceptible to staining (with erythrosine) than the other lamellæ which are out of reach of the hyphæ. This fact suggests the possibility of the cell-walls being chemically attacked by the hyphæ — a fact which has been pointed out in the present work in the descriptions of several other species of crustaceous and corticolous lichens.

Specimen 2. On granite. *Gudhjem. Bornholm.* J. Lange.

The thallus is grey and somewhat mottled with black, with minute cracks here and there. The margin is black. Where the grains of quartz project above the surface of the substratum they are but imperfectly covered by the thallus, which sends dark, radiating, marginal hyphæ out over the edges of the grain (a phenomenon figured several times in this book in the descriptions of other saxicolous lichens.)

In some places the cortex is composed of colourless, erect, short-celled and living hyphæ, in other places of greyish-brown hyphæ continuing above into a dead cuticle formed of compressed, colourless hyphæ. The hyphæ of the gonidial layer stand rather distinctly erect and are rather densely interwoven. The gonidia are 1-celled, without haustoria. The medullary layer is rich in intercellular spaces, and the rhizoidal layer is even a little looser in texture than the medulla.

The apothecia are more regular than in specimen 1. At first, when they break through the surface of the thallus, they are partly covered by the greyish thallus; later on they become quite free and almost orbicular or faintly irregular in outline, with a thick margin and a plane disc. When growing older they get a crenate margin, which at last disappears, while at the same time the disc becomes convex.

The very young apothecia are nearly unicolorous, deeply orange-reddish, considerably deeper red than in specimen 1. Later on, the colour of the margin becomes invariably red, whereas the disc becomes rusty brown — a very peculiar contrast of colours. At last, when the apothecium becomes convex, it changes at the same time into blackish-brown — apparently coloured by a dark pigment deposited in the hyphæ together with the parietine already existing in the apothecium.

The stipes is less well-developed than in specimen 1, but just as in the latter it is composed of parallel hyphæ, continuing above into a hypothecium and a well-developed calyx of the same structure as in sp. 1. The hypothecium is very rich in ascogenous hyphæ. The hymenium is of the same structure as in sp. 1, both as regards paraphyses, asci, and spores (as shown in the figures 141 and 142).

The difference as to colour between young and old apothecia is shown in detail in the figures 138 and 139. The distribution of colours is as found in sp. 1: the pigment is deposited in the apical parts of the hyphæ of the calyx and in the tips of the paraphyses. Otherwise, the inside of the apothecium is colourless. In this specimen rather numerous gonidia are embedded in the calyx on the borderline between the stipes, the calyx, and the thallus. In this case, too, the apothecium is crypto-lecanorine.

Pycnidia were not observed.

As we have seen, this specimen differs not inconsiderably from specimen 1 in outer appearance, especially in the colour of the thallus and in the form and colour of the apothecia. Strictly speaking, it would perhaps be advisable to give it a specific name of its own in order to point out this difference in habit, especially because we do not know for certain whether sp. 1 and sp. 2 really belong to the same species, i. e. whether they can arise from one another by suitable culture experiments. Intermediate forms are, however, recorded from other countries, for which reason I feel quite justified in giving them the same name. In this case, too, it would be of great interest if lichenologists would take upon themselves the task of cultivating the spores of a specimen of the same type as sp. 1 on a rocky substratum and thus ascertain whether an individual of the same appearance as sp. 2 — and vice versa — would arise or not. Such culture experiments should be undertaken to a greater extent. However, they must of course be based upon detailed descriptions of the specimens; otherwise the problems cannot be properly attacked.

CATOCARPON

CATOCARPON (Körb.) Arn.

The species belonging to this genus live exclusively on substrata of stone and cannot therefore be regarded as primitive and directly lichenized fungi. They must, undoubtedly, have originated from species growing on organic substrata. If we search for their probable ancestors among their nearest relatives, we must stop at two genera, preferably to be taken into consideration, viz. *Catillaria* and *Buellia*.

In both of these genera there exist several species growing on bark, and the main difference between them is that *Catillaria* has colourless, 2-celled spores, while *Buellia* has brown, 2-celled spores.

Besides *Catillaria* the genus *Bilimbia* must be taken into consideration, too; it must, however, be remembered that belonging to the latter genus there exist several species provided in part with 2-celled or even 1-celled spores, e. g. *B. sphæroides*, *B. melænida*. Accordingly, the relationship between *Catillaria* and *Bilimbia* is so close that our deliberations hold good in the case of both genera.

If *Catocarpon* originated from *Catillaria* (or from *Bilimbia*), it has acquired a new structural feature: the spore has changed its colour and become in part dark. Thus the spores in *C. applanatum* are chiefly colourless; some of them, however, still retain their dark colour. On the other hand, in *C. badioatrum* the spores are chiefly dark, brownish. Moreover, the epispore has become gelatinous.

If *Catocarpon* originated from *Buellia* (or from *Diplotomma*), it has acquired the following new structural feature: the spores have become in part colourless and halonate.

It can scarcely be settled which alternative has been realized in nature. It seems, however, most probable that *Catocarpon* originated from *Buellia-Diplotomma*, because in the former genus we meet with scantily muriform spores like those occurring in the genus *Diplotomma*, whereas this form of spore is never met with in any species of lichen which in other respects is an undoubted *Catillaria-Bilimbia*.

To this may be added that the conidia in *Catillaria* are very short and oval (Part II, Fig. 46, 55, 64, 122, 132, 135, 161), while in *Buellia-Diplotomma* are found both very short, medium-sized *(Buellia triphragmia)*, and acicular conidia *(Diplotomma alboatrum*, Fig. 313). The latter form is again met with in *Catocarpon*.

If these considerations hold good, if the ancestors of the species of *Catocarpon* really were species of *Buellia*, it must still be added that the new qualities acquired by the spores, viz. their partial discoloration and the gelatinized epispore, cannot be interpreted as a direct adaptation to the nature of the new substratum, stone, for the same features would then occur in the saxicolous species of *Buellia* and *Diplotomma*, but this is not the case. In this case as in most cases we are faced by a wholly unintelligible alteration in structure arisen during the phylogeny of the species; we are forced to explain the new qualities of the spores as caused by the new conditions of life, although they must be interpreted as representing only an indirect and correlative adaptation, which inevitably follows the physiologically altered conditions of the plant, without being in itself of any recognizable value to the existence of the species.

From our present knowledge of the natural history of Danish lecideine lichens it appears reasonable to establish several series of genera, which have descended from each other, viz:

1. *Lecidea* (with *Biatora*), *Psora*, *Catillaria* (with *Biatorina*), *Bilimbia*, *Microphiale*, *Lecanactis*, *Protoblastenia*, *Blastenia*.
2. *Biatorella* (with *Sarcogyne*), *Mycoblastus*.
3. *Bacidia*, *Arthrorhaphis*, *Microphiale*, *Pachyphiale*, *Bryophagus*.
4. *Buellia*, *Diplotomma*, *Catocarpon*, *Rhizocarpon*.

From each of these genera other genera are derived, crustaceous lecanorine, leaf-like and shrub-like forms. About these problems nothing more will be discussed in this place; they will be mentioned in fuller details in connection with each single genus.

NATURAL HISTORY OF THE DANISH SPECIES OF CATOCARPON

The **spore** is considerable in size; the outer layer of its wall is gelatinized, 'halonate'. It is provided with at least one transverse wall, and thus it becomes 2-celled and besides somewhat constricted in the middle. We find, however, up to five transverse walls of 1st order, i. e. walls which cross the whole diameter of the spore. In some spores are found a few longitudinal walls, which make the spore sub-muriform, together with some rare transverse walls of 2nd order, i. e. walls dividing only one of the cells formed by the longitudinal divisions, but not crossing the whole diameter of the spore (Fig. 151 above to the right).

The colour of the spore varies in one and the same apothecium from colourless to lighter or somewhat darker brownish. Even one and the same spore may be dark at one end and colourless at the other end.

In some cases the spores seem to be able to germinate already when lying in the ascus (see for example Fig. 168, above to the right). A little protuberance has been observed from one end of the spore, probably representing a germinating hypha. It is not known whether more than one germinating hypha is ever formed.

Morphology. The thallus is crustaceous, with a black margin composed of hyphæ, the walls of which are deeply brownish-black from a non-crystallized pigment deposited in the outer layer of the hyphæ, while the inner layer is nearly colourless. The outermost parts of the black margin are not provided with gonidia.

The margin of the thallus is continued towards the centre into an inter-areolar, black thallus, a so-called hypothallus.

The areoles are at first black; later on they change colour and become brownish. Their first stages of development are not known with certainty, but they probably arise in places where suitable algæ have fallen on to the margin of the thallus and have been captured by it. I have observed with full certainty such a mode of development in some species of *Rhizocarpon*, and there is no reason whatever for supposing any other origin in the case of *Catocarpon*.

In the fully developed areole the hyphæ stand almost erect on the surface of tbe thallus and remain brownish-dark in the parts touching the substratum and in the cortex too, while the intermediate tissues, i. e. mainly the gonidial layer, become nearly colourless. Accordingly the 'hypothallus' is a misleading anatomical term for the inter-areolar tissues, because the word conveys the false idea that the areoles are formed on the surface of the 'hypothallus'. The real fact is that the gonidia have been overgrown by the hyphæ. The cortex of the fully developed areole is thus identical with the upper layers of the 'hypothallus', the hyphæ of which gradually rise perpendicularly upwards and thus alter their original, irregular and intricate, texture.

A cortex is gradually differentiated from the hyphæ. It is composed of hyphæ with brownish apical ends, which die out by degrees and are transformed into a colourless cuticle. Moreover, a gonidial layer of colourless hyphæ is developed.

The gonidia are 1-celled and roundish. Haustoria do not occur.

The medullary layer is brownish and merges insensibly into the rhizoidal layer.

The **apothecia** have an exciple, composed of stipes and calyx similar to other lecideine lichens. In the calyx the hypothecium and hymenium are situated. The earliest stages of development of the apothecia are unknown. Apparently they have arisen directly in the inter-areolar thallus; at any rate, there are no sure signs of their originating in the ripe areoles too. In the hypothecium are found the ascogenous hyphæ, which however are not particularly conspicuous. The paraphyses are branched and dark (brownish) at the tips, colourless at the base; they are embedded in a thick hymenial gelatine.

The asci are clavate; their walls are thickened above. The spores are described above.

Pycnidia are found in *C. applanatum*. They occur near the margin of the thallus. Their walls are formed of dark hyphæ, whereas the conidia-bearing hyphæ are colourless; at the apices they cut off long, acicular, straight conidia.

Biology. The new individual is probably formed by the germination of a spore; whether it may arise from a conidium too is not known. Soredia do not occur. The young mycelium is occupied in capturing gonidia and grows centrifugally over the substratum. Gradually the areolate thallus is formed together with its inter-areolar dark thallus ('hypothallus'), and the tissues mentioned above are differentiated in the areoles. Of these tissues the rhizoidal hyphæ, of course, procure the inorganic nutriment. The gonidia provide the lichen with organic matter, and the cortex protects it from sudden and extreme desiccation. The thick cuticle, which is formed of dead, compressed cells, is undoubtedly renewed during the growth of the lichen by new cells from the apical parts of the cortical hyphæ being forced gradually upwards and transformed into a cuticle. The latter will no doubt decompose little by little and peel off in the same way as is known in the case of the periderm of trees. The dark colour of the cortex has presumably the task of protecting the deeper tissues of the lichen, particularly the gonidial layer, against excessive light. The cuticle is wanting on the vertical surfaces of the areoles, on which the cortex too is faintly developed. This feature is easily understood if we take into consideration that the surfaces in question are much less exposed to pernicious influences of every kind than are the horizontal surfaces of the areoles.

The inter-areolar tissue and the margin of the thallus are black, and this circumstance too must be considered as a means of protection against violent insolation. The tissues in question are, it must be remembered, to some degree embryonal tissues, very much exposed — especially the margin of the thallus — to noxious influences.

In the description of the natural history of *Lecidea* it has been pointed out what great importance must be attributed to the fact that the thallus is areolate. The same considerations hold good in the case of *Catocarpon*. Immediately when one or more algæ have been captured, an areole is organized out of them, which as soon as possible differentiates a cortex and especially a cuticle for the protection of these highly important symbionts (Fig. 160). Thus the areole is established and to some degree individualized as a microcosmos, apparently fairly independent of the neighbouring areoles. However, the areoles still afford each other some measure of protection against desiccation, etc., when situated close enough to touch each other directly.

The narrow cracks between the areoles act like channels, which distribute the falling rain-water over the whole lichen in the course of an astonishingly short time. The water is rapidly absorbed into the interior of the areoles through the thin cortex of their vertical sides.

Nothing at all is known about seasonal biological phenomena in *Catocarpon*. Whether the thallus grows with the same rapidity at all seasons, whether the apothecia and the pycnidia are formed at fixed times, whether there are any fixed times of rest — all that is unknown, but may presumably be investigated by observing the species in question at different seasons.

About the duration of life of *Catocarpon* nothing is known except the one fact that the species undoubtedly are perennial and in all probability grow very slowly. They must be considered potentially immortal, as they hardly ever die from inherent, but exclusively from external causes. When during their growth over the substratum they meet keener competitors, they must succumb. On the other hand, under certain circumstances they will themselves overcome other competitors and wholly exterminate them (see for example Fig. 144).

When the thallus has been growing on the same spot for a long time, it must be supposed that the substratum becomes exhausted of the special nutritive matter necessary to *Catocarpon*, and thus a continuation of life is made impossible.

There would accordingly be some chance of a fairy-ring being formed of the thallus. This phenomenon has not been met with in any species of *Catocarpon*, while it is well known in *Rhizocarpon* (see Fig. 233). The parts of the thallus which become senile will presumably die out, but this process has not been investigated in particular for want of suitable material. Undoubtedly, the moment will come, sooner or later, when either the hyphæ or the gonidia cannot get sufficient inorganic nutrition, and thus the problem arises: Will the physiological state of equilibrium between the hyphæ and the gonidia be maintained? Will the gonidia stop dividing, or will the hyphæ kill and empty the last gonidia before they die of hunger themselves? Nothing is known about this phenomenon in the case of *Catocarpon*, but in some species of *Rhizocarpon* I succeeded in finding certain phenomena suggesting that the hyphæ of the dying areoles ultimately devour the last gonidia. Similar conditions are known in other crustaceous lichens too (see for example *Mycoblastus*), and especially so in certain species of *Cladonia*.

Ecology. Our Danish species of *Catocarpon* grow exclusively on rocky substrata, and their biological conditions may in many respects, as mentioned above, be considered simply as adaptations to life on rocky substrata, especially on sunny and extremely exposed stones and rocks, on which our species support life under very hard conditions.

CATOCARPON APPLANATUM

(Fr.) Th. Fr.

(Plate 53—54—55—56—57—58—59—60—61).

Speçimen 1. On granite. *Bornholm.* O. Galløe 1903.

The thallus is thin, areolate, brownish. The margin is black and radiating; immediately inside it the youngest areoles arise in centrifugal order; at first they are blackish-brown, later on they become purely brown. At first the areoles have the shape of a low cushion, with a rounded outline; later on they become thicker, irregularly angular by mutual pressure and often lobed by lateral incisions; their surface is plane or more often slightly convex. Here and there between the areoles narrow strips of thin, black inter-areolar 'hypothallus' are placed, in which young black and young brown areoles together with young apothecia, directly originating from the 'hypothallus', may be discerned.

The hyphæ of the areoles stand everywhere almost erect on the substratum from the base to the surface. On the latter a dead, colourless cuticle occurs, in which some few cell-lumina may be discerned here and there. A cortex composed of brown hyphæ with big cell-lumina and apparently without any (or at any rate with very scanty) intercellular spaces occurs under the cuticle. The gonidial layer is colourless and densely woven. The gonidia are 1-celled, without any haustoria. The medullary-rhizoidal layer is brown like the cortex and densely woven.

The inter-areolar thallus ('hypothallus') is dark brown, composed of vertical hyphæ, which are not provided with gonidia and have no cuticle on the surface.

In the present specimen the margin of the thallus borders in part on a sterile crustaceous lichen (an indeterminable fragment, presumably a *Lecanora*). It cannot be settled with certainty which of the two species will gain the victory in the competition for space. Moreover two fragments were observed, apparently belonging to the same crustaceous lichen but situated just between the areoles of *Catocarpon*, entirely surrounded by its thallus. In this place the thallus of the other lichen seems bound to succumb to *Catocarpon*.

The apothecia arise in the 'hypothallus' between the areoles; whether they may be formed in older areoles, provided with gonidia, cannot be settled with certainty in the present specimen. They are at first approximately orbicular or faintly irregular in outline; the margin is thick, the disc minute and concave. Later on they may become more irregular in outline, plane, and with a distinct margin. At all ages they are quite black.

The stipes is composed of parallel hyphæ, continuing above into a well developed calyx, in which the hyphæ radiate outwards towards the surface, on which they stand erect, and into a hypothecium with distinct ascogenous hyphæ. The paraphyses are embedded in a copious hymenial gelatine; they are branched and faintly thickened at the tips. The asci are broadly clavate. The spores are usually quite colourless or of a very faintly brownish colour, all surrounded by a very thick 'halo'. They vary much in structure: there are one, two or three transverse walls, but in some few spores a few longitudinal walls must be added to these, so that the spore may be slightly muriform. They are 30—40 μ long.

The hyphæ of the stipes are very dark brown (Fig. 147), likewise at the bottom of the calyx, while the sides of the calyx are considerably lighter, nearly colourless; the apical cells of the hyphæ of the calyx are, however, sometimes deeply dark brown. The hypothecium is nearly colourless or very faintly brown. The hymenium is colourless everywhere except at the tips of the paraphyses, which are dark brown. This distribution of colours is visible only in very thin microtome sections. Thick sections exhibit quite different features.

Pycnidia were not observed.

Specimen 2. On stone. *Egholm* by *Skelskjør*.

The present specimen agrees in nearly all details with specimen 1, in the structure and development of the thallus, the margin of the thallus, the areoles, the inter-areolar thallus, and in the anatomical structure of these parts; furthermore in the formation of the apothecia and in their morphological and anatomical structure. The chief reason for mentioning and figuring it here is the occurrence of pycnidia and some peculiar structural details of the spores of a single ascus. These two details are more fully discussed in the description of the figures (Fig 168 and 173), to which is referred.

CATOCARPON BADIOATRUM.

FLK.

(Plate 62—63—64).

On stone. *Rønne*, *Bornholm*. GRØNLUND.

The thallus is areolate; its natural margin is absent in the specimen examined, but between the areoles there occurs a distinct inter-areolar thallus. The areoles are at first roundish in outline; later on they become more angular, irregular, and crowded. Their surface is at first convex; later on it becomes plane or somewhat uneven. The colour is dark reddish-brown. The inter-areolar thallus ('hypothallus') is thin and black; in some places it forms broad strips between the areoles, in other places it is quite narrow between the densely crowded areoles. On the surface the areoles have a colourless cuticle of dead, compressed cells formed by the dying-out of the apical parts of the cortical hyphæ. This cuticle is absent on the vertical sides of the areoles.

The cortex is formed of hyphæ standing nearly erect on the surface of the areoles. The apical ends of the hyphæ are dark brown; deeper down tbe hyphæ are colourless, so that most of the cortex is colourless. The hyphæ of the gonidial layer are more loosely interwoven, with more copious intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. The cells of the medullary layer are mostly brown; those nearest to the gonidial layer are, however, colourless. The loculi of all the hyphæ, both in the cortex, the gonidial and medullary layers, are rather short.

The apothecia are in all cases formed apparently between the areoles, in the inter-areolar thallus. In the specimen examined it cannot, however, be settled with certainty whether a formation of apothecia in the fully developed areoles is impossible, but it is at any rate very rare. The outline of the apothecia is most often somewhat irregular; at all ages they are rather plane. The margin is at first rather distinct, later on indistinct or evanescent. The colour is at all ages almost quite black with a faintly reddish-brown shade.

The stipes is high, well developed, composed of parallel hyphæ, above merging partly into a hypothecium, partly into a calyx formed of hyphæ, which radiate outwards in all directions towards the surface of the apothecium, on which they stand almost erect. The paraphyses are embedded in a thick hymenial gelatine; they are branched above and only faintly thickened at the tips. The asci are clavate, their wall greatly thickened above. Most often they contain 8 spores, which are 2-celled, somewhat constricted in the middle and surrounded by a halo. They are 24—44 μ long. By far the greatest part of the spores are dark, greenish-olivaceous, but colourless spores (Fig. 176) were also found.

The stipes, the calyx, and the tips of the paraphyses are deeply red-brown from a non-crystallized pigment deposited in the peripheral layers of the walls of the hyphæ, whereas the inner layers are almost colourless. Otherwise the hymenium is colourless (Fig. 175).

Pycnidia were not observed.

As seen from the descriptions and figures this species agrees to a great extent with *C. applanatum* as to structural details. The spores, however, are chiefly dark and 2-celled, whereas in *C. applanatum* they are chiefly light. I found no longitudinal walls in the spores of *C. badioatrum* and never more than two loculi, whereas a greater number of loculi together with some longitudinal walls were observed in *C. applanatum* specimen 1. In order to emphasize this difference between *C. applanatum* and *C. badioatrum* it seems advisable to retain both names. Whether, however, one species can issue from the other and vice versa, whether they really 'belong to the same species' — as is the usual saying of botanists, although they never define or explain the meaning of that phrase — will only be settled by culture experiments.

RHIZOCARPON

RHIZOCARPON Ram.

Phylogeny. As mentioned more explicitly under the genus *Catocarpon* I consider it very likely that *Rhizocarpon* is descended from *Catocarpon* and the latter again from *Buellia.*

As a slightly muriform structure of some of the spores occurs in some species of *Catocarpon,* whereas spores with a small number of cells arranged in one series sometimes occur in the genus *Rhizocarpon* (e. g. in *Rh. Oederi*), the likeness and transition between the two genera are thus evident. Other authors usually refer them to one and the same genus, and with good reason too. Still, I retain both genera separate for the practical reason that on principle I prefer each name of a genus to comprise as homogeneous a collection of species as possible. The conception of genus, it must be remembered, cannot — as little as the conception of species — be defined briefly and logically. The natural, genetic relationship of the genera, or of the species respectively, is so close that whenever we establish a boundary between them it will, in consequence of the nature of evolution, be an artificial one, a construction of human thought, to which no analogue exists in nature.

If for instance we were to include in one genus all the species which may be supposed to have descended from each other or from some known ancestor, we should, in accordance with the considerations set forth under the genus *Catocarpon*, have to include the genera *Buellia*, *Diplotomma*, *Catocarpon*, and *Rhizocarpon* in one genus with a common name on account of their probable phylogenetic connection. Such a system of naming would, when being pushed to its consequences, lead to the establishment of a sole genus including all the organisms of the world, supposing they had all descended from one and the same primeval species!

Such a system of naming would be of little value. The same considerations, however, hold good in the case of the very comprehensive genera or species, when these are taken in so wide a sense that they are difficult to define. The proper or most important significance of any name consists in its being the name of an organism of a definite structure; in short, the name has primarily a certain practical meaning, and, secondarily, it serves to express our views, more or less hypothetical, concerning the real phylogenetic connections between the genera and the species respectively. The result which we can arrive at in this way is very modest and unfortunately always very uncertain. When authors subdivide a genus into sub-genera and a species into sub-species, 'forms', etc., the majority of the subdivisions are nearly worthless. Such subdivisions serve merely to express the views of the authors (which have never been proved and perhaps can never be proved) concerning the genetic connection of the individuals occurring in nature. Moreover, the method has another great drawback: it creates a confusion of names and a sub-dividing, carried by some authors to meaningless exaggerations.

It would be of considerably greater value to have recourse — to the greatest possible extent — to a very minute division into small comprehensive genera and into species comprising the most homogeneous collection possible of individuals.

On the basis of these considerations I retain both genera, *Catocarpon* and *Rhizocarpon,* in order to comprise under each of these names the most homogeneous collection of species possible, although I am fully convinced of their genetic connection.

In the present genus the boundaries between the so-called species are indistinct in several cases, almost to a higher degree than in the genera hitherto described. The authors have made great and laborious efforts to limit and define the 'species' as clearly as possible, without however arriving at indisputable results.

Practically, it is very difficult to 'determine' the species of *Rhizocarpon,* partly because they merge — to a great extent — insensibly into each other, partly because the authors have followed the old Linnean method of forming of each species an average description, intended to comprise all the specimens of the species occurring in nature, although the species occurring in nature frequently are very imperfectly separated from one another. The result is that even the best floras are of little use for the purpose of determining specimens.

Thus we are reduced to the type specimens of the museums, which of course cannot be submitted to an anatomical research in detail and so are of little value in cases of doubt when only a microtomising might remove our doubt. Without embarking on a renewed criticism of the use, often made by botanists, of type specimens and exsiccata of doubtful value — a use, which very often makes us sceptical although a technique for determining lichens, based on such type specimens, has been established in the course of time (all of which I have discussed more fully in the introduction to Part I) — I wish to emphasize that every plant-description which cannot be understood without a close examination of the type specimen must be looked upon as unsatisfactory. The only scientific method of plant-description is the one adopted and discussed in the present work, viz.: to describe typical specimens (individuals), with which all other individuals gathered in nature may be compared, and in accordance with which other specimens may be 'determined'. It is then at any time possible, by quoting such descriptions and referring to the accompanying figures, to illustrate to others how this or that name is to be understood. In several cases, however, some doubt will surely be felt whether the specimens to be determined really are identical with those already described and figured. The number of type specimens described will then have proved insufficient, and more individuals will have to be investigated. Other methods will not suffice, and it does not at any rate further our knowledge to acquiesce in names so badly defined as many lichen-names of the present day.

No doubt, some names employed in the present work do not at all agree with the original definitions of the authors, in spite of my efforts to get at the proper sense of the names in question. The views of the authors, however, concerning the limitations of the species are extremely obscure in many cases. Be that as it may, it is my hope that the descriptions given by me in this work will prove clear enough to show how this or that name ought to be understood, and that remains the cardinal point of every definition. Scarcely any other genus, so much as *Rhizocarpon,* has made it evident to me how absolutely necessary it is to group our individuals round, and name them after, typical single individuals described and figured in accordance with the method employed in this book.

NATURAL HISTORY OF DANISH SPECIES OF RHIZOCARPON

The spore. In all our species of *Rhizocarpon* the spore is at first colourless and retains this appearance even when it is ripe, e. g. in *Rh. calcareum, reductum, distinctum, Oederi,* and *danicum,* whereas in the end the spores become dark in *Rh. grande* and completely opaque and dark-brown in *Rh. geographicum.*

The least septate spores occur in *Rh. Oederi,* in which species the cells of the spore are arranged in one series, separated from each other by three transverse walls. Still less septate spores, however, sometimes occur in *Rh. geographicum,* in which species the number of transverse walls in some cases is confined to one, so that the spore becomes 2-celled; usually, however, the spore in this species is septate by two or four transverse walls. The 2-celled spore in *Rh. geographicum* has a thin halo; otherwise it bears great resemblance to the spore in *Buellia,* although it is somewhat or considerably darker.

After the formation of the transverse walls of the 1st order, longitudinal walls are formed in the primary cells. They are formed without any regular order; in some spores the terminal cells are septate first, in other spores the middle cells first, In each of the primary cells one or several longitudinal walls may be formed, frequently dividing the cell into four or more cells, with the longitudinal walls most often placed at right angles to each other. The primary cells having been divided in this way, secondary transverse and longitudinal walls may be formed, so that the spore in some species may be greatly septate and muriform, as e. g. in *Rh. grande* (Fig. 245).

All spores are provided with a gelatinized epispore.

In size they agree considerably more with *Diplotomma* than with *Catillaria-Bilimbia,* which fact is evident from the figures, which are all drawn to the same scale.

If we were to arrange all our species in one series, beginning with those that have the darkest spores and most resemble the spores of *Diplotomma,* and ending with those that differ most in this respect, we should have to begin with *Rh. geographicum*, which may sometimes have dark, yet thinly halonate spores, as mentioned above. Then *Rh. grande* would follow, and thereupon the species with colourless spores, viz. *Rh. danicum*, *Rh. distinctum*, *Rh. reductum*, *Rh. calcareum*, *Oederi.*

However, it is not certain that the species have really descended from one another in this order.

The germination of the spore was not observed in any species.

Morphology. In most of the species the thallus has a margin of a more or less dark colour, frequently radiating centrifugally in all directions. It is formed of hyphæ, the dark (brown) pigment of which is usually deposited in the outer parts of the cell-walls, while their inner parts are lighter or even completely colourless. In some species the hyphæ creep parallel with the surface of the substratum (e. g. in *Rh. reductum*, Fig. 186, 187), or they may have a somewhat more irregular texture. In *Rh. reductum* the deepest, basal hyphæ, directly in contact with the substratum, are colourless, a fact which suggests that the dark colour of the hyphæ of the upper layers acts as a protection against too intense a light. In *Rh. obscuratum*, in which the margin of the thallus is somewhat thicker, the inner hyphæ likewise very soon become lighter although they are still covered with dark hyphæ.

In the extreme peripheral parts of the margin of the thallus no gonidia are met with; in this place the hyphæ grow centrifugally over the substratum.

The margin of the thallus, in e. g. *Rh. calcareum*, is not formed of black hyphæ, but merges insensibly into the surrounding substratum without any distinct limits.

From the black margin of the thallus a dark tissue is formed in some species, spreading between the areoles. It is often designated by the authors as 'hypothallus', although this term — as mentioned under *Catocarpon* — is very inadequate. I prefer to designate it as the inter-areolar thallus. It is very distinctly developed in *Rh. distinctum*, *Rh. danicum*, and certain individuals of *Rh. geographicum*. In many places this tissue is of the same structure as the margin of the thallus, but not everywhere. In places where it has captured gonidia and initiated the differentiation into areoles, it may still bear a macroscopic resemblance to the other inter-areolar parts of the thallus, although it is provided with gonidia and occupied in forming areoles, which later on always have another colour.

The areoles are organized in places where gonidia present themselves in the margin of the thallus or in the inter-areolar thallus. A priori it seems probable that the hyphæ may be able to initiate a symbiosis *both* with algæ which already are lying on the substratum and gradually are overtaken by the centrifugally growing marginal hyphæ — *and* also with algæ which have fallen on to the surface of the margin. However, only the latter alternative has taken place with full certainty, as shown in Fig. 206 *(Rh. obscuratum)* and Fig. 262 *(Rh. geographicum)*. The newly captured gonidia are immediately overgrown by hyphæ and incorporated in the lichen, and thus the areole is organized. As mentioned above, these parts of the margin do not directly or suddenly change colour by this process, and so they are not easily recognizable even when examined with a highly magnifying pocket-lens, whereas they are immediately recognized in microtome-sections (Fig. 186 and 187, *Rh. reductum*; Fig. 236, *Rh. grande)*. How densely the areoles will be grouped in future depends upon the way in which they have been organized from the beginning. If the algæ have fallen densely on the margin, they will stand close together, but their further growth may play some part too. In some cases the algæ evidently fall rather densely, and thereby the areoles are formed so close together and very early become confluent in such a high degree that the inter-areolar thallus can no longer be discerned in the fully developed lichen. In other cases the areoles are very distant from each other, with broad strips of inter-areolar thallus between them (e. g. *Rh. danicum*, *Rh. geographicum* sp. 2).

As soon as the areole is constituted, the hyphæ which are to form the future gonidial layer become colourless, while the hyphæ of the future cortex as well as of the medullary and rhizoidal zones remain dark-coloured for some time. As in *Catocarpon* the cortex of the areoles is identical with the upper hyphæ of the margin of the thallus and of the inter-areolar thallus; for this reason a false notion is conveyed of the mode of development of the thallus when the term 'hypothallus' is employed to indicate these tissues. The 'hypothallus' does not constitute a hypothallus in the sense of the word that the areoles are simply formed on its surface, but the areoles are in fact formed by a gradual, local transformation of the hypothallus, during which it grows thicker; and its superficial hyphæ change colour when gradually they are transformed into cortical hyphæ of the fully developed areole.

The newly formed areoles are small and in a certain sense greatly separated, provided as each of them is with a special cortex of its own. When quite young they are often cushion-shaped. By degrees they may increase both in height and breadth. Both these categories of growth are intercalary.

In the areoles the hyphæ usually run very regularly from the surface of the substratum upwards towards the surface of the thallus, on which they stand erect. In *Rh. geographicum* (specimen 1) they run parallel with the vertical surfaces of the areoles (Fig. 274). In several other species, provided with more cushion-shaped areoles, they radiate somewhat more distinctly outwards in all directions, standing almost perpendicularly on the lateral as well as on the horizontal surfaces of the areole. The hyphæ form a cortex, the cell-walls of which are usually darker in colour, in accordance with the several colour of the thallus. The apical cells of the cortical hyphæ die away in several species and are transformed into a cuticle forming a protective layer over the erect cortical hyphæ. This cuticle gradually decays, peels off, and is constantly renewed by the cortex.

The hyphæ of the gonidial layer are colourless and send no haustoria into the gonidia.

The gonidia are roundish and 1-celled. Perhaps they are partly cystococcoid, partly pleurococcoid, but the question needs a close investigation by culture experiments.

The medullary and rhizoidal layers are in some species well developed and in other species chiefly colourless. In others again they are somewhat brownish or yellowish (e. g. in *Rh. geographicum).*

The **apothecia** are in most species placed between the areoles, but in some cases they are formed in the interior of the areoles. They arise partly in centrifugal order, the young apothecia thus occurring near the margin of the thallus, partly — as it seems — nearer the centre of the thallus among the older apothecia. On the whole the apothecia seem capable of arising in all such parts of the thallus as are still young and growing. The earliest stages of their development have not been observed in any Danish species, but their appearance when ripe suggests the existence of a mode of development similar to that of *Catocarpon.*

All apothecia rest immediately on the substratum and are provided with a well developed exciple composed of stipes and calyx formed of hyphæ, which rise from the surface of the substratum vertically upwards through the stipes, from which they spread partly outwards and upwards through the calyx, partly vertically upwards through the hypothecium and the hymenium, where they are transformed into paraphyses. Accordingly, in the hyphæ of the apothecia the same tendency may be met with as observed in the areoles, namely the tendency to grow chiefly vertically upwards from the substratum, and frequently the direction of growth may be very distinctly followed from the substratum to the tips of the paraphyses, e. g. in *Rh. geographicum* (Fig. 288) or in *Rh. Oederi* (Fig. 251). In *Rh. geographicum* it is in some cases striking how little the hyphæ of the exciple differ from the ordinary vegetative hyphæ of the areoles; they may even partly retain their yellowish colour throughout the main parts of the exciple. Otherwise the hyphæ often change colour; thus the stipes and the bottom of the calyx are always dark-brownish. The same colour is often met with in the genuine hypothecium, i. e. the tissue just below the hymenium, where the ascogenous hyphæ are placed. The ascogenous hyphæ are very distinct in most of the species.

The paraphyses are branched above and embedded in a thick hymenial gelatine. In several species two categories of paraphyses are met with: some of them are brownish, densely crowded, with thinly gelatinized walls, while others are colourless, with a thick hymenial gelatine, e. g. *Rh. reductum* (Fig. 197), *Rh. danicum*, *Rh. grande* (Fig. 246), *Rh. Oederi* (Fig. 251 and 253).

The asci are clavate, broad or narrow. The spores are described above.

Pycnidia have not been observed in any Danish species, although I have searched for them with great care. **Soredia** are not present in any Danish species.

Biology. The essential biological qualities of the species of *Rhizocarpon* will be understood in the main from the description of their structure. Some few supplementary details are given here.

The margin of the thallus and the inter-areolar thallus are, as mentioned above, engaged in the capturing of algæ and the establishing of the symbiosis by the formation of areoles. The fact that the extremest marginal hyphæ frequently are black constitutes perhaps an adaptation to the often violent insolations to which they are exposed, as the species of *Rhizocarpon* very often grow on alpine mountain-heights or on the most exposed rocks and stones of the lowlands.

The areoles often become much separated from one another. This circumstance, too, is most likely caused by the hard conditions under which they live. For if we consider the conditions gonidial algæ are subjected to when falling on to a naked rocky substratum side by side with an individual of *Rhizocarpon*, but out of reach of the lichen, it seems most probable that they cannot support life independently in such a place. On the other hand, if they fall on to the margin of thallus, it is most likely an absolute necessity for their future existence that they are instantly overgrown and covered by the hyphæ of the lichen. That is just what happens when the young areole is being organized: the gonidia are instantly covered with a protecting layer of black hyphæ, under which they begin dividing and propagating. By degrees the areole is differentiated into the tissues described above: the medullary, rhizoidal, gonidial and cortical layers with the cuticle. The structure of these tissues is mentioned above.

The chief task of the rhizoidal hyphæ is presumably that of absorbing inorganic substances from the substratum, into which some hyphæ penetrate to carry out this function.

In some species, however, I observed certain facts which make this absorption of inorganic nutriment somewhat doubtful: The examined specimens of *Rh. reductum*, *Rh. distinctum*, *Rh. danicum*, and *Rh. grande* were all gathered on smooth flint-stone with a very shiny surface, in part blown by sand-drift. It is scarcely easy for hyphæ to get a foothold on such a surface, and it must be supposed that the hyphæ are positively glued to it, although it is impossible to recognize any special structural detail which makes it intelligible how the lichens adhere to the substratum.

Besides, in some cases the lichen was observed in places to have become loosened from the substratum, possibly owing to tensions of growth *(Rh. grande,* Fig. 230). In such places new hyphæ project from the loosened lower surface of the thallus, from which they grow downwards and establish a new connection with the substratum. I have formerly mentioned a similar phenomenon in *'Buellia petræa'* (in *Danske Likeners Økologi,* Tavle 5, Fig. 19d) and also in *Catillaria Bouteillei* (Part II. Fig. 28).

It seems difficult to understand how the lichen is capable of procuring the necessary inorganic nutriment when growing over a substratum of flint. Special investigations are needed to answer the question as to what nutritive matter exists in flint, and how it is utilized by the lichen, in spite of the predominant occurrence of silica.

From observations on other saxicolous lichens we know — as repeatedly pointed out in this work — that the thallus hesitates in growing over or does not at all grow over pure grains of quartz. Similar phenomena may be observed in lichens growing on flint; such lichens frequently convey the impression of being underfed.

In the gonidial layer the algæ are often gathered into well-defined groups, which are easily made out in very thin sections, e. g. in *Rh. reductum* (Fig. 186, 187, 190), *Rh. obscuratum* (Fig. 206), *Rh. grande* (Fig. 236), *Rh. Oederi* (Fig. 249, 250), and *Rh. geographicum* (Fig. 266). In rather old areoles this phenomenon is no doubt caused by the fact that the algæ of such a group as a whole have been gradually removed from the neighbouring groups of algæ by the intercalary growth of the areole, for during this growth new bundles of hyphæ have been forced in between the gonidia, which have thus been removed from each other. To a great extent the algæ of each group of algæ may be supposed to represent the offspring of one original cell or a few original cells of the same group.

As mentioned above, the hyphæ form no haustoria; how the utilization of the gonidia proceeds is therefore unknown. Here, too, we are faced with the problem: what will happen to the gonidia when the areole at length becomes senile, which must be the case, of course, when it has exhausted the nutritive matter of the substratum to the depth accessible to its rhizoids, and when it has reached the size allowed by surrounding conditions and by internal development? It appears that the hyphæ of the areole will at length empty some of the gonidia of their living contents. In old areoles rather numerous dead and empty gonidia are sometimes found, the occurrence of which may perhaps be interpreted in this way. On the other hand, the dead gonidia may be regarded as dead remains of gonidia which have divided by free cell-divisions, thus having set free their daughter-cells.

In this connection it must be remembered that the possibilities of division and propagation of the gonidia inside each single areole depend on and are absolutely limited by the possibility of growth allowed to the hyphæ by the properties of the substratum. At a certain moment the gonidia must cease dividing because the hyphæ do not provide them with inorganic nutriment. They are then prevented from dividing, and this fact, no doubt, means for them as for all other 1-celled organisms senility and death. After death their cytoplasm disappears, whereas the cell-wall is persistent. The hyphæ may be supposed to utilize the dead cytoplasm but not the walls. How the areole as a whole decays and dies out cannot be settled by means of the material I have at hand.

That the thallus gradually dies out in the centre was observed with full certainty in *Rh. danicum,* in which species the thallus is capable of forming a fairy ring (cp. the detailed description of this species).

Concerning the biological conditions of the apothecia there is not much to be said in addition to the description given above. As regards the exciple, it is worthy of note that the stipes evidently increases in height in order to keep — at any time — the hymenium at the level characteristic of the species, the result being that the stipes becomes lower between low areoles than when placed in the vicinity of old, big areoles.

No observations of seasonal biological phenomena are at hand concerning growth, the formation of apothecia, the ripening and shedding of spores, etc. Future investigations must settle whether any connection at all exists between the seasons and the biological phenomena pointed at.

About the duration of life of the species nothing is known beyond the fact that undoubtedly they are all perennial and potentially immortal, as far as they spread centrifugally over the substratum and scarcely die on their own accord but are exclusively killed by want of nutriment or overcome by keener competitors occasionally growing on the same substratum. Several species are, as mentioned, extremely hardy plants, living on substrata insufficient for nearly every other species of lichens, living e. g. on surfaces of stones broken by severe frosts, where the decay and decomposition is as yet too little advanced to allow a settlement of more exacting lichens, or on alpine mountain heights where the climatic conditions are extremely hard on all plants.

About the ecological conditions of the species it is unnecessary to add anything more. They are all saxicolous, and their structure and mode of living is marked by this fact in numerous ways, as is made evident by the descriptions given above.

RHIZOCARPON CALCAREUM.

WEIS.

(Plate 65—66—67).

On bricks. *Asserbo Ruin, Sjælland.* O. GALLØE.

The thallus is almost orbicular, whitish. The margin merges insensibly into the substratum; there are no distinct radiating hyphæ, but the margin is formed of extremely small, somewhat scattered, grains or areoles, which gradually become crowded more closely together and at last melt into a continuous, even or slightly uneven, thallus with numerous cracks and fissures but without any distinct areolation. The cracks and fissures can scarcely be caused by desiccation (see Fig. 182).

The cortex is thick, formed of hyphæ, the lumina of which are fairly distinct; a cuticle is not developed. The hyphæ of the gonidial layer are in structure most like the cortical hyphæ; there are, however, numerous intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. The medullary layer is colourless, thick, built of hyphæ with numerous intercellular spaces. In the cortex and the medullary layer, but scarcely in the gonidial layer, are deposited numerous white, partly angular partly roundish, grains of a substance, which has not been investigated more closely, but which, judging from its occurrence, seems to be a product of excretion.

The apothecia arise in rather regular rings concentric with the margin of the thallus, but on the old parts of the thallus this regularity is effaced through the formation of other apothecia arising without any order among the old ones (Fig. 179). In places the apothecia are found in groups of two or three. Their outlines, at all ages, are rather irregularly angular or sinuose. The margin is thick and persistent; at first it is greyish, of the same colour as the thallus, and most often retains this appearance when growing older, but it may, though rarely, become dark, black as the disc, which is black and concave at all ages.

The stipes is well developed, composed of parallel hyphæ, and continues above into a calyx, the sides of which are rather thin near the bottom, above however widening into a well developed, thick proper margin. The calyx is continued above into the colourless hypothecium formed of vertical paraphysogenous hyphæ, continuing immediately into the paraphyses, and of distinct ascogenous hyphæ. The paraphyses are conglutinated and separate with difficulty from each other by pressure. They are filiform, branched above, and scarcely thickened; in the vicinity of the margin of the apothecium they are covered by a cuticle-like tissue, formed of their own colourless tips. Bundles of darker paraphyses are scattered among the normally colourless ones.

The asci are long, narrowly clavate (appearing, however, broad in teased out preparations (Fig. 184)); their walls are somewhat thickened above. They contain eight colourless spores, about 26 μ long.

The hyphæ of the stipes are brown, and also those of the calyx; they are, however, a little lighter in the inner layers of the calyx in the vicinity of the hymenium. Above, in the proper margin, there is a covering layer of lighter hyphæ, imparting to the margin the greyish shade, which is macroscopically visible. These light hyphæ are perhaps remnants of the thallus, which has been broken through during the growth of the apothecium. The supposition, however, cannot be dismissed that they represent the colourless apical parts of the dark hyphæ of the calyx themselves. The sections do not settle this question with full certainty (Fig. 183). The hypothecium is colourless, as also the asci and the paraphyses. The latter, however, are greenish-brown at the tips, but the paraphyses which stand nearest to the margin of the apothecium are covered by the cuticle-like, colourless tissue mentioned above.

Pycnidia were not observed.

RHIZOCARPON REDUCTUM.
Th. Fr.
(Plates 68—69—70—71—72—73—74).

On flint. *Sorø.* J. Lange.

The thallus is thin, areolate, light reddish grey, with blackish-grey mycelial margin. The latter is finely radiating, and immediately inside it the thallus becomes more reddish-grey from the formation of extremely thin and flat, densely grouped areoles, joined at the base. The fully developed areoles are in part confluent, so that the thallus also might be designated ‘rimose’, angular in outline, with plane or faintly undulating surfaces.

The margin of the thallus is formed of horizontal, creeping hyphæ, spreading centrifugally over the substratum; their upper layers have dark-brown walls; the deeper layers nearest the substratum are light. The hyphæ are densely interwoven; intercellular spaces are very scanty. On this mycelial margin the first beginnings of the areoles appear as small groups of green gonidia, embedded among the dark marginal hyphæ (Fig. 186) at intervals of about 0,2—0,3 millimeter (in the figured section). The sections do not illustrate directly how the gonidia have arrived at these youngest areoles, but the following possibilities may be imagined:

1. The gonidial algæ may have fallen from the air on to the dark marginal hyphæ. In that case the marginal hyphæ have sent branches over the gonidia and covered them, in which way they have been captured. It is thus easily understood that the gonidia rest upon black hyphæ.
2. The gonidia may previously have been lying on the substratum and were gradually captured by the hyphæ when during their creeping growth they reached the algæ. If this is the case, the hyphæ must partly have grown over the algæ and partly have forced their way in under them, for at later stages the gonidia are, at any rate, lifted up from the substratum and embedded among the hyphæ.
3. The modes of development, mentioned under 1 and 2, may both take place, as they appear equally probable. On the other hand, it seems scarcely probable that the gonidia should be carried centrifugally from the old areoles outwards into the young areoles by means of 'Schiebehüphen' in the sense of NIENBURG, when the great distance between the areoles is taken into consideration (Fig. 186). Each areole therefore seems at first to possess a certain degree of independence, which, however, is not of very long duration, as is evident from Fig. 189. It is seen from this figure that an old areole may easily have a diameter, even surpassing the original distance between the three young areoles (in Fig. 186). This phenomenon cannot very well be interpreted otherwise than by supposing that during their later growth the originally independent areoles have become confluent, i. e. the spaces between the youngest areoles, the inter-areolar thallus ('hypothallus'), have been provided with gonidia, which was not the case at the beginning. From where these gonidia have come — whether they have fallen on to the surface of the thallus in the spaces between the previously existing young areoles and been captured there, or whether they have been carried there by 'Schiebehyphen' from the neighbouring areoles — cannot be settled by the mere examination of microtome sections. The final result is unmistakable: the youngest, originally independent, areoles melt together in groups, which fact is clearly evident from Fig. 188.

The fully developed areoles have a cortex, which is very thick and well developed but wants a proper cuticle. The lumina of the hyphæ are rather distinct. The walls are faintly brownish. The hyphæ of the gonidial layer stand clearly vertical and are brownish in the young areoles, but colourless in the old areoles. The gonidia are 1-celled. Haustoria do not occur. The hyphæ of the medullary layer in the young, but fully developed, areoles are placed horizontally nearest the margin of the thallus, as a reminiscence of their original, mycelial character (Fig.

189, the right areole). Later on the hyphæ rise more upwards, finally standing almost vertical on the substratum, from which they continue into the vertical hyphæ of the gonidial and cortical layers.

The conglutination of the areoles manifests itself in their being connected at the base by their gonidial and medullary layers (Fig. 189). The hyphæ of the medullary layer are brownish from a non-crystallized pigment.

The apothecia are originally arranged in centrifugal order and show a rather distinctly concentric arrangement. They seem to be usually formed in the spaces between the areoles and do not rise very much above the level of the latter. Their outline is at all ages somewhat irregularly angular and sinuose, both when they stand isolated and when they are crowded and in close contact with one another, which latter is very common in the apothecia arranged in rings (Fig. 185). The margin is thick and persistent, in part lighter than the disc, which is always dark, almost black, plane or faintly undulating, more rarely slightly convex or concave.

The stipes is short, issuing from the very surface of the substratum and composed of parallel hyphæ, above forming a calyx, in the sides of which the hyphæ run parallel and upwards towards the surface of the apothecium. The ascogenous hyphæ of the hypothecium are not particularly conspicuous. In the hymenium may be seen partly some paraphyses which are mostly colourless but with brown tips, partly others running in broad bundles through the hymenium; the latter are brownish in all their length and clearly represent a direct continuation of the hyphæ of the calyx. Between the light paraphyses the hymenial gelatine is very thick and the paraphyses scanty; between the dark paraphyses the gelatine is extremely scantily developed and the paraphyses very densely crowded. The asci are big; their walls are thickened above. They contain eight colourless, multicellular spores; about 35—50 μ long.

The central parts of the stipes and the calyx are dark reddish-brown; the peripheral parts of the calyx are much lighter, greyish. Above in the margin of the apothecium, however, the calyx is again almost black from a non-crystallized pigment deposited in the peripheral parts of the walls of the hyphæ. The tips of both categories of paraphyses are brown. Otherwise the description of the paraphyses given above is referred to.

Pycnidia were not observed.

In direct contact with the specimen examined two other specimens occur, separated from one another by dark margins (Fig. 185). The arrangement of the apothecia indicates unmistakably that three originally independent individuals are present (apart from the small, totally isolated, individual to the right of the others). But just on the level with the small, isolated individual two of the adjacent individuals appear to be completely conglutinated along their margins, as the black borderline between the individuals stops at a considerable distance from the margin. This phenomenon is extremely interesting, and the highest importance must be attributed to it, because it forces upon the observer the supposition that two lichen-individuals are capable of being grafted on one another. Do then the two individuals completely abandon their independent individualities, and in what does this individuality consist? Or, do they grow, side by side only, over the substratum without otherwise establishing any kind of mutuality? Concerning these questions we know nothing at all, nor can we obtain any knowledge without establishing similar conditions in culture experiments, by which the development of the mutuality may be observed during as long a period as possible. It would, for instance, be extremely interesting to investigate whether the apothecia would afterwards be arranged concentrically in proportion to each separate individual, or whether they would be arranged concentrically to quite another point of the thallus, and, if so, what point. Where would it be placed? As conditions now present themselves to the observer, they only represent a momentary state of the living together of the individuals.

The relationship between this species and *Rhizocarpon calcareum* is very obvious and is apparent from many structural details, e. g. the morphology of the areoles, the structure and arrangement of the apothecia, etc. The main difference consists in the fact that in *Rh. reductum* the margin of the thallus is distinctly black and mycelial, and the medullary layer dark, while both are colourless in *Rh. calcareum*. Besides, *Rh. reductum* has much bigger spores and asci than *Rh. calcareum*.

RHIZOCARPON OBSCURATUM.

(ACH.) KÖRB.

(Plate 75—76—77—78—79).

On sandstone. *Nexø, Bornholm*. P. J. HELLBOM.

The margin of the thallus is black and mycelial; its single hyphæ are not distinctly radiating. Just inside this margin the thallus becomes somewhat lighter, whitish-grey from air inclosed between the hyphæ. Inside this zone the thallus becomes gradually brownish from very thin, confluent grains, the young areoles, which only in places are separated from each other by narrow fissures. Inside this zone the fully developed thallus with its apothecia begins. In this thallus the areoles are usually separated from each other by deep, broad furrows, but here and there they are, however, confluent too in a similar way as has been described under

Rh. reductum. The outline of the areoles is very irregular, angular, and sinuose. Their surface is undulating or rather plane.

The black colour of the margin of the thallus (Fig. 206) is due to a deep-brown, non crystallized pigment occurring in the outer layers of the walls of the hyphæ. The hyphæ usually run more or less parallel to the substratum, but not so consistently as in *Rh. reductum.* The middle layers of hyphæ in the margin of the thallus, the future gonidial layer, are colourless. The margin of the thallus captures gonidial algæ. And in this species we find, for the first time, an absolutely sure proof of the supposition generally adopted that the gonidia *can* arrive at the thallus by falling on to its surface (Fig. 206) and there be captured by the hyphæ. Provided that this process frequently takes place, and that the algæ fall rather densely on to the thallus, it is easily understood that the areolation is at first very indistinct and does not become more pronounced till the big furrows are formed. That furrows are formed at all — that the thallus does not remain quite even and coherent, is presumably due to the fact that the thallus, for other biological reasons, needs the furrows as a protection against casual lacerations by desiccation and as a system of channels for a rational and rapid distribution of water falling on the thallus, a common phenomenon in saxicolous lichens, formerly discussed in this book, for instance under the description of the genus of *Lecidea.*

The fully developed areoles have on their surface a cuticle of dead cells but no cuticle on their sides. Below the cuticle is found a cortex of brownish, living hyphæ, standing nearly vertical on the surface. The hyphæ of the gonidial layer are looser in texture, with narrow and numerous intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. The medullary layer is thick and chiefly colourless, in places, however, provided with somewhat darker hyphæ, remains of the original dark margin of the thallus ('hypothallus'). The hyphæ are somewhat looser in texture than those of the gonidial layer, with numerous intercellular spaces. The areoles are connected with each other through their medullary layer, whereas a distinct dark inter-areolar thallus ('hypothallus') is not visible between the old areoles. The cortex is continued from areole to areole, but is thinner, and without a cuticle, at the bottom of the furrows between the areoles.

The apothecia already arise in the parts of the thallus near the margin which have not yet been individualized as independent areoles, and may consequently be said to have been formed in the areoles, not in the spaces between them (Fig. 201, 204, and 207).

Their outline is at all ages rather irregularly sinuose or, more rarely, fairly regular. The margin is thick and persistent, somewhat brownish and lighter than the black, generally uneven disc.

The stipes is very short, issuing, however, from the very surface of the substratum. It is composed of parallel hyphæ, which continue above into a calyx. The bottom of the latter is continued immediately into the hypothecium; its sides are formed of hyphæ rising nearly vertically upwards and above forming a margin. The ascogenous hyphæ of the hypothecium are not very conspicuous. The paraphyses are filiform, branched above, their tips scarcely thickened. Asci are rather short and thick, their walls thickened above. They contain eight colourless spores, which are sometimes provided with transverse walls only, while longitudinal walls may be absent. It cannot be settled with certainty whether this fact represents their final or merely transitory structure. Their length is about 18—30 μ.

The stipes and the bottom of the calyx are deep brown from a non crystallized pigment, chiefly deposited in the outer layers of the walls of the hyphæ. Among these deeply coloured hyphæ numerous, almost colourless, hyphæ are, however, intermingled; they are not visible in thick, free-hand sections but easily recognizable in very thin, microtome sections (Fig. 208). The vertical hyphæ forming the sides of the calyx are faintly coloured, light brownish; above, in the margin, their apices are dark greenish-brown. The hypothecium is composed partly of colourless hyphæ, partly of brown hyphæ, so that the general aspect becomes brownish. Some of the brownish hyphæ are continued as colourless paraphyses upwards through the hymenium, intermingled with the far more numerous colourless paraphyses. Compare with this fact the conditions existing in *Rh. calcareum* and *Rh. reductum.* All paraphyses are brownish or olivaceous at the tips.

Pycnidia were not observed.

RHIZOCARPON DISTINCTUM.

TH. FR.

(Plate 80—81—82—83—84).

On stone. *Ranum.*

The thallus has a black margin spreading over the substratum like a network, in the open meshes of which the substratum itself may be discerned. In many places distinct, black, radiating, mycelial hyphæ issue from the margin. The margin is continued as a well developed, black, inter-areolar thallus ('hypothallus') between the areoles. These arise in the vicinity of the margin of the thallus in the following manner: the margin of the thallus becomes more light-brownish in places and is differentiated as areoles, which at first are somewhat mottled by dark hyphæ, the remnants of the marginal hyphæ. The areoles probably arise in places where gonidia have fallen from the air on to the surface of the thallus and been captured by it. The fully developed areoles have an irregular outline, even if they stand isolated, and generally become still more irregular by mutual pressure, where they are densely crowded.

The margin of the thallus is formed of hyphæ with blackish-brown walls. Scattered gonidia may occur between them (Fig. 216).

On the horizontal surface the fully developed areoles have a cuticle formed of dead cells representing the apical cells of the cortical hyphæ. The cuticle gradually becomes much thinner on the vertical surfaces of the areoles. The cortical hyphæ stand nearly perpendicular on the surface, and many of them have brownish apices while others are colourless and without any distinct limits continue into the cuticle, their upper cells gradually dying away and becoming compressed. The cortex, too, is thinner on the vertical sides of the areoles than on their horizontal sides. The hyphæ of the gonidial layer are rather loose in texture, with short lumina and numerous intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. The medullary layer is very thick, somewhat looser in texture than the gonidial layer. The basal parts of the latter are in places, in the vicinity of the substratum, faintly brownish. The hyphæ stain blue with J + KJ.

The apothecia arise on the dark, inter-areolar thallus. There are no unmistakable proofs that they are also formed in the areoles (see, however, Fig. 212). Their outline is at first rather regularly orbicular, but later they become more oblong and irregular. The margin is thick and persistent, but may in part disappear in some apothecia. The disc is at first concave, but in the end it is plane or convex, frequently somewhat undulate.

The stipes is well developed and in direct contact with the substratum. It is formed of parallel hyphæ, above continuing into a big calyx-hypothecium. The sides of the calyx are formed of hyphæ, running nearly vertically upwards to the margin of the apothecium. In the hypothecium a number of big, ascogenous cells may be discerned. The paraphyses are filiform, above branched and very faintly thickened at the tips. They are embedded in a greatly developed hymenial gelatine. The asci are short, broad; their walls are somewhat thickened above. They contain eight colourless spores, which sometimes have only transverse walls but most often longitudinal walls too (Fig. 219). The length is about 24—36 μ.

The hyphæ of the stipes, the bottom of the calyx, and the hypothecium are dark-brown. The pigment is non-crystallized and deposited in the outer layers of the cell-walls. The interior parts of the sides of the calyx, nearest the hymenium, are colourless; the peripheral parts, nearest the surrounding areoles, are almost black. The tips of the paraphyses are of the same colour; otherwise the paraphyses are colourless.

Pycnidia were not observed with certainty.

In this specimen a portion of the margin of the thallus borders on the thallus of another crustaceous lichen (apparently *Lecanora sordida*), which undoubtedly overgrows the *Rhizocarpon* and is gaining ground. This fact proves that crustaceous lichens do not always stop growing when they have covered the whole of the substratum. On the contrary, it seems more probable that even these lichens compete for space with one another and dislodge one another.

RHIZOCARPON DANICUM.

O. Galløe. nov. sp.

(Plate 85—86—87).

On flint. *Binneballe Sande* by *Vejle*.

This specimen, which grows on a substratum of flint, is a good example of the formation of a fairy-ring. Originally it was oblong, nearly orbicular; later on, however, the centre of the thallus died out leaving the thallus ring-shaped and even broken in two places. The figure of the habit shown in Fig. 223 represents a fragment of this ring, the original margin of which is turned upwards in the figure, while the portion of the figure turning downwards points towards the centre of the thallus. In the fragment shown in the figure the thallus has regenerated and formed a mycelial margin with radiating hyphæ, which are about to grow in a direction opposite to the original direction, thus approaching the vanished central part of the thallus.

The margin of the thallus is black, mycelial, and provided with fine, radiating hyphæ growing centrifugally. This margin is continued between the areoles as a copiously developed, black, inter-areolar thallus ('hypothallus'). The areoles arise on it, presumably in places where gonidia have fallen from the air on to its surface. The areoles are scattered or crowded. Their outline may be rather orbicular, but often irregular by mutual pressure. They are low, cushion-shaped, convex, with even or somewhat uneven surface. The colour is very dark-brown. There is a thick cuticle of dead hyphæ and beneath it a cortex of dark-brown hyphæ standing perpendicularly on the surface. The hyphæ of the gonidial layer are looser in texture, with numerous intercellular spaces. The gonidia are 1-celled. Haustoria do not occur. The medullary layer is thin, formed of hyphæ of the same structure as those of the gonidial layer.

The apothecia arise in the inter-areolar thallus. They are scattered or gathered in small groups of two or three. Their outline is rather regular. Their margin is thick and persistent. The disc is concave, plane, or very rarely somewhat convex and a little uneven. The apothecia are completely black at all ages.

The stipes is very short and is immediately continued into a calyx and a hypothecium. In the calyx the hyphæ run outwards in all directions towards the surface, on which they stand erect.

In the hypothecium the ascogenous hyphæ are quite distinct. The paraphyses are filiform, branched, scarcely thickened at the tips, and embedded in a copious hymenial gelatine. The asci are short, thick; their walls are thickened above. They contain eight colourless spores, about 24—40 μ long.

The hyphæ of the stipes, the bottom of the calyx, and the hypothecium are deep dark-brown. The same colour occurs in the peripheral parts of the calyx and the margin, whereas the interior portions of the sides of the calyx in direct contact with the hymenium, are somewhat lighter. The same colour, a little more light-brown, mainly olivaceous, occurs in the tips of the paraphyses. Otherwise the paraphyses are colourless.

Pycnidia were not observed.

The species, which is established as a 'nova species', is undoubtedly very closely related to, and resembles in many respects, partly *Rh. distinctum*, partly *Rh. grande*. If compared with *Rh. distinctum* piece by piece *Rh. danicum* shows a great resemblance to this species, whereas it differs from *Rh. distinctum* chiefly in the olivaceous tips of the paraphyses and the totally brownish calyx, the smaller asci, and the thin medullary layer, which does not stain blue by the addition of iodine. From *Rh. grande* it differs — in spite of its great resemblance to this species — in the persistent margin of the apothecium and its light colourless spores. How great a value should be attached to the test of iodine is perhaps doubtful. Whether the present species may develop by suitable culture from other species, e. g. *Rh. grande* or *Rh. distinctum*, can be settled by experiment only. Until such experiments are made, it is at any rate necessary to give the species a special name.

Deichmann Branth formerly determined it as a *Rh. reductum* Th. Fr., thus evidently considering it closely related to the *Rh. reductum* of the present book. The latter specimen *Rh. reductum* was determined by Deichmann Branth as a *Buellia petræa* Flot. *α genuina*. If we read the description in *Lichenes Daniæ* (p. 113), it is evident that Branth considered these two forms to belong to one and the same species and sub-species. Whether he was right or wrong in his determination can only be settled by experiment, and even if the two species, *Rh. reductum* and *Rh. danicum*, should be proved to be capable of developing from one another under certain conditions, a separate, specific name must be given to each of them, on account of their great difference in habit.

In *'Lichenes Scandinavici'* Th. Fries seems inclined to reserve the name of *Rh. reductum* for the plant which I determine as *Rh. danicum*. However, I do not feel quite sure of the Friesian limitation of the species in question. Apparently, we are here faced with one of those innumerable cases where we cannot rely upon a collective description of several individuals comprised in one 'species'. Accordingly, I was forced to give my plant a new specific name and give a description free from confusion with other individuals.

RHIZOCARPON GRANDE.

(FLK.) ARN.

(Plate 88—89—90—91—92—93).

On a smooth, sandblown flint. *Skagen.* E. WARMING.

The thallus is orbicular, the margin black and radiating, the areoles yellowish-grey, even, somewhat shining.

The margin of the thallus is composed of horizontal, creeping hyphæ, spreading over the substratum in centrifugal direction. The black colour is deposited in the outer layers of the walls of the hyphæ. A colourless cuticle is developed, resting on the dark hyphæ and formed of apparently dead hyphæ with invisible cell-lumina. Living, colourless hyphæ are placed below them, forming a dense tissue over the smooth substratum. In some isolated places of this tissue bundles of hyphæ penetrate into the cavities of the substratum.

The black margin is continued between the areoles as a thin, inter-areolar tissue ('hypothallus'), which is reticulate in places, thus rendering the substratum directly visible.

By degrees the young areoles arise in the margin, presumably in places, where gonidia have fallen from the air on to the surface of the thallus (Fig. 229, 235, 236). They are at first scattered, but gradually they become crowded. Their outline is rather regular at the beginning; later on they may become more irregular by mutual pressure. They are originally convex, but later on they may become more plane; most often, however, they are cushion-shaped, convex, when they are fully developed. The old areoles cohere at the base, and where they are densely crowded, no dark inter-areolar thallus is developed between them, but the cortical layer as well as the colourless medullary layer is continued from one areole into the other. The gonidial layer, however, is interrupted (Fig. 230).

The cuticle is highly developed on the horizontal surface of the areoles. It is formed of dead cells, the lumina of which are discernible in places. On the vertical sides of the areoles the cuticle is thinner. The cortex itself is thinner than the cuticle and is formed of living cells with distinct lumina and brownish walls. The hyphæ of the gonidial layer are looser in texture with numerous, minute intercellular spaces. The gonidia are 1-celled, apparently cystococcoid. Haustoria do not occur. The hyphæ of the medullary layer are still looser in texture than those of the gonidial layer, with numerous intercellular spaces. The basal parts of the medulla have sometimes brown hyphæ.

In the present specimen a phenomenon was observed which I have described in my treatise on the '*Ecology of Danish Lichens*' (1908), and which seems to be rather common in crustaceous lichens (see, too, *Catillaria Bouteillei*, Part II Fig. 31 and 33), viz. in places the lichen separates from the substratum, presumably owing to tensions of growth. Subsequently the lower surface of the substratum forms new hyphæ, which grow downwards to establish a new connection with the substratum.

Later on we shall find that such circumstances occurring during its growth may cause parts of the lichen to lose their foothold on the substratum. This phenomenon may possibly cause the dying out of the central parts of the thallus of some crustaceous lichens, the result being that the thallus becomes ring-shaped.

The apothecia seem to be exclusively formed between the areoles, in the inter-areolar tissue. When young they are usually irregular, angular in outline, either by mutual pressure or by pressure from the surrounding areoles. At first they have a thick margin and a narrow disc. When older they rise above the level of the areoles, grow in part over the areoles, and become more regularly orbicular in outline, convex and without a margin. They are completely black at all ages.

The stipes issues from the very surface of the substratum and is highly developed, formed of parallel hyphæ above continuing into a well developed calyx which again above merges insensibly into the hypothecium and the hymenium. The sides of the calyx are formed of hyphæ rising up towards the surface of the margin, on which they stand almost erect. The ascogenous cells of the hypothecium are very distinct in many places. The paraphyses are of two types: the majority of them are colourless at the base, thin and threadlike, branched above and very faintly thickened at the tips, and embedded in a copious hymenial gelatine — other paraphyses are darker and obviously constitute prolongations of the hyphæ of stipes-calyx; they have a poorly developed hymenial gelatine (Fig. 242), but are on the whole of the same structure as the light paraphyses. The asci are broad, their walls are thickened above. They contain eight spores, which at first are colourless, later on greenish-brown and finally darker brown, 26—34 μ long.

The hyphæ of the stipes and the bottom of calyx-hypothecium are dark brown owing to a non-crystallized pigment deposited in the peripheral layers of their walls. The hyphæ constituting the sides of the calyx are nearly colourless at the base in places where they issue from the stipes, but above, in the margin of the apothecium, they gradually turn black from a non-crystallized pigment deposited in the peripheral layers of their walls. The tips of the colourless paraphyses as well as of the brown ones are brownish.

Pycnidia were not observed.

The resemblance between the present species and the species mentioned above, *Rh. distinctum* and *Rh. danicum*, is very great in nearly all respects, and their relationship undoubtedly very close. On the other hand, *how* nearly they are related cannot be settled through a mere examination of the individuals growing spontaneously in nature. Culture experiments are needed if the question is to be properly answered. However, even if experiments should prove them capable of arising from one another under certain fixed conditions, it would nevertheless be necessary to retain separate specific names in order to characterize their differing aspects and structures.

On the whole, it must be remembered that the primary purpose for giving specific names is to characterize plants of some fixed structure or other, secondarily to express our opinions of their relationship.

In the general floristic description of *Rh. grande* the spores are more often described as 'dark'. In our present specimen, however, they are not pronouncedly dark. Nevertheless I am inclined to think that our specimen chiefly conforms with the species usually designated as *Rh. grande*, although it would perhaps be better to give it a different specific name.

RHIZOCARPON OEDERI.

(Web.) Körb.

(Plate 94—95—96—97—98).

On stone. *Bavnebjerg* by *Helager* in *Fyen*. E. Rostrup.

The thallus is minute, the margin is black, the areoles rust-coloured. The black margin is extremely thin and so firmly attached to the substratum that it proved impracticable to detach it for microscopical examination. In some fragments which were teased out no gonidia were found. The areoles arise in the black margin, presumably in places where gonidial algæ have fallen from the air on to its surface. At first they are isolated; later on they become so densely crowded that no inter-areolar thallus ('hypothallus') can be discerned between them. They are confluent, so that in many cases it is impossible to distinguish their limits; accordingly, their outline is quite irregular and their surface verrucose. The areoles are connected with each other at the base.

The fully developed areoles are provided with a cortex of rather densely interwoven hyphæ with distinct cell-lumina and conglutinated walls without any distinct limits. This cortex is continued downwards on the vertical surfaces of the areoles from one areole to the other. In its upper layers a rust-brown excretion is deposited among the hyphæ. The hyphæ of the gonidial layer are distinctly looser in texture, with big intercellular spaces. The gonidia are 1-celled, cystococcoid. Haustoria do not occur. The gonidia are found in the upper parts of the areoles and form independent layers in each of the areoles (Fig. 251). The medullary layer is thick, composed of loosely interwoven, colourless hyphæ with big intercellular spaces. In the basal parts of the medulla the hyphæ are in some places brown, somewhat thicker, and more densely interwoven than higher up in the areole.

The apothecia most probably arise in the inter-areolar thallus. Apparently they may be placed in the areoles themselves, and, of course, the possibility cannot be dismissed that they really may have arisen there (Fig. 248). However, from the apothecia examined under the microscope it was evident that the apothecia of apparently areolar origin nevertheless were placed between the areoles, the cortex of which formed an abrupt borderline to the apothecia (Fig. 251). At first they are rather regular in outline; but immediately from the beginning, too, they may be irregularly sinuose. Later on they are always irregular. The margin is at first thick; later on it becomes less distinct, because the disc gradually gets so verrucose that the whole surface of the apothecium becomes irregular and uneven, the disc as well as the margin. The colour is black at all ages.

The stipes is formed of parallel hyphæ, which rise upwards from the substratum and are continued into a calyx. The bottom of the latter is immediately continued into the hypothecium and the hymenium, the hyphæ running almost vertically from the stipes to the surface of the epithecium. In the sides of the calyx the hyphæ likewise run upwards towards the surface of the margin of the apothecium, on which they stand nearly erect. In the hypothecium the ascogenous cells are very distinct in places but not everywhere. The paraphyses are slender, filiform, branched above, and scarcely or very faintly thickened. Two types of paraphyses may occur: some are colourless at the base and embedded in a thick hymenial gelatine — others are darker, brownish, and gathered in considerably denser bundles, with poorly developed gelatine (Fig. 251, 252, 253, and 254). The asci are broad, constricted at the base; their walls are thickened above. They contain eight colourless spores provided with exclusively transverse walls; length about 22—24 μ.

The hyphæ of the stipes and the peripheral parts of the calyx issuing from the stipes and the dark paraphyses likewise issuing from the stipes are brown from a non-crystallized pigment deposited in the outer layers of the cell-wall. The same pigment occurs in all the tips of the paraphyses. On the other hand, the parts of the calyx which are in direct contact with the hymenium are colourless. The same holds good of the basal parts of the majority of the paraphyses and also of the ascogenous cells of the hypothecium.

Pycnidia were not observed.

The relationship of this plant to other species of *Rhizocarpon* is not clear. Th. Fries places it as a sub-species under *Rh. distinctum.* The two species do not, however, resemble each other very much. When Th. Fries ranges it as a subspecies, it is not clear wbat he means — or what the majority of authors mean — in so doing. If he means to say that he considers *Rh. Oederi* as having originated from *Rh. distinctum* and having been separated from it for ever, there is no reason for retaining it as a sub-species. On the other hand, if he means to say that *Rh.*

Oederi even at this day may issue from the spores of *Rh. distinctum* under certain fixed conditions, it must be emphasized that such a consideration is extremely improbable and at any rate can only be proved through culture experiments — which have not been undertaken as yet.

As characteristic, well distinguished, and recognizable spontaneous types, each of them deserves in any case to have a separate specific name, notwithstanding their possible phylogenetic connection — and will deserve so in future too, even if they should prove capable of issuing from one another.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

(Plate 99—100—101—102—103—104—105—106—107—108).

Specimen 1. On a tile. *Frerslev.*

The thallus has a black margin partly spreading free over the substratum, partly bordering on an indeterminable fragment of another crustaceous lichen, with which it competes for space on the substratum. It cannot be settled with any certainty which of the competitors will force the other back. In the margin of the thallus the areoles arise in places where gonidia fall on to the surface of the margin. This is made evident from Fig. 262, in which two gonidia are seen on the point of being captured by the dark marginal hyphæ. The latter creep over the substratum, forming, however, a more irregularly branched system of hyphæ than in *Rh. reductum.* The deep dark-brown pigment is non-crystallized and chiefly deposited in the peripheral parts of the walls.

When the gonidia have been captured, the hyphæ which are in direct contact with them become colourless while the hyphæ both below and above this juvenile tissue remain dark-brown for some time yet, so that the youngest areoles when seen under a low power do not at all show their presence by the characteristic, yellow colour with which the older areoles are provided. By degrees the youngest areoles become a little more light-greyish, later on yellow (these transitions of colours from black through grey to yellow are seen in Fig. 261). The young areoles are at first somewhat confluent, but later on they become more clearly separated from one another. Confluent areoles, however, may be met with in places. The outline of the individual areoles is angular and irregular by mutual pressure, and an inter-areolar thallus cannot be observed between them. They are, however, connected at the base. The horizontal surface is nearly plane.

The cortex is in places cuticle-like and colourless, formed of dead, colourless cells, which evidently represent the upper dead cells of the cortical hyphæ. In other places this cuticle is absent. The cortex itself is formed of yellow hyphæ standing erect on the surface of the thallus. The cells of the gonidial layer are similar to those of the cortex, but the intercellular spaces are more numerous and very minute. The hyphæ are most often colourless; in some few cases, however, they may be yellow. The gonidia are cystococcoid. Haustoria do not occur. The medullary layer is of the same structure as the gonidial layer, apart from the gonidia; it is rather thick, and the hyphæ are yellow. Only the very lowest hyphæ near the surface of the substratum are brownish in places. The areoles are connected with each other at the base, but the gonidia are not continued from one areole to the other. All hyphæ in the fully developed areole run very regularly perpendicularly upwards from the substratum, standing erect on the surface of the thallus and parallel with the vertical sides of the areole (Fig. 274). The yellow pigment is deposited in the whole wall of the hypha.

The apothecia may be formed both directly on the inter-areolar thallus and in the margin of the areoles. Their outline is generally very irregular, especially in the inter-areolar apothecia, whereas the areolar apothecia may be somewhat more regular. The margin is low, but rather persistent; the disc is nearly plane or a little irregularly verrucose, particularly in the young apothecia. The colour is chiefly deep black, but faint shades of yellowish may occur both on the margin and on the disc, which fact is easily understood by an examination of the anatomical structure.

The stipes issues from the very surface of the substratum and is usually rather short in proportion to the slight thickness of the thallus. It is formed of hyphæ, which, like the common vegetative hyphæ of the areole, run almost perpendicularly from the base of the apothecium to its surface, or spread a little outwards through the calyx during the growth of the apothecium (see Fig. 265 and 275). In the hypothecium the ascogenous cells are very distinct in places. The paraphyses are filiform, branched, and very much thickened at the tips; they are embedded in a thick hymenial gelatine. The asci are constricted at the base and contain eight spores, which are at first 1-celled, light-grey; later on 2-celled (Fig. 283) and then pluri-locular and very dark, nearly opaque, with a faintly brownish shade; length about 22—32 μ. They are thinly halonate.

The colours of the interior parts of the apothecium vary a good deal, as seen in Fig. 265, 266, and 267, in accordance with their different origin. The central and basal parts of the stipes are chiefly dark-brownish; the same brown colour always occurs in the peripheral hyphæ of the calyx, whereas the inner parts of the calyx, in direct contact with the hymenium, are either yellow or brown. The apices of the hyphæ of the calyx (in the margin of the apothecium) are deep greyish-black, even if the other parts of these hyphæ are yellowish. In places, however, the yellow hyphæ of the calyx are pure-yellow to the very tips, which fact manifests itself by the presence of the yellowish portions of the margin of the apothecium (Fig. 261) and even of the disc, in which the tips of the paraphyses may sometimes have a yellowish shade when the apothecium is very young. The hypothecium and its ascogenous hyphæ are quite colourless. The tips of the paraphyses are in the end greyish-black.

Pycnidia were not observed.

Specimen 2. On stone. *Brudager*, *Fyen*. E. Rostrup.

The thallus has a black margin spreading freely over the substratum without any hindrance from other lichens. Narrow ribbon-shaped bands of hyphæ radiate in places from the rest of the margin, which is reticulate here and there, so that the substratum may be observed in the empty meshes. The black margin of the thallus is continued as a black, thin, inter-areolar thallus between the areoles. All the black parts of the thallus are of the same structure as in specimen 1.

On the margin of the thallus the areoles arise, very distinctly independent of each other, as small cushion-shaped, yellow bodies, presumably in places where gonidial algæ fall on to the surface. The mature areoles are high, with a roundish or fairly sinuose outline, here and there angular by mutual pressure, but most frequently placed at a rather considerable distance from each other. Their surface is markedly convex. The anatomical structure of the areoles is entirely like that of specimen 1.

The apothecia are formed as in specimen 1, partly in the inter-areolar thallus, partly in the margin of the areoles. Their internal structure is in all respects like that of specimen 1, the following details excepted: All the hyphæ, even the paraphyses, of the apothecium are more or less brownish in colour. All ripe spores are so dark-brownish that they are finally completely opaque and their lumina invisible.

As regards details the plates are referred to (Fig. 288—300).

The relationship with specimen 1 is unmistakable in spite of the differences in habit and anatomical structure. When in the present work they are referred to the same species, it is my intention to point out that specimen 1 and specimen 2 probably may be genetically connected under certain conditions. Full certainty, however, is not at hand in the present case, any more than in other cases among the lichens. Culture experiments would probably settle the question.

DIPLOTOMMA

DIPLOTOMMA (Fw.) Körb.

Phylogeny. As mentioned elsewhere I consider it very likely that the genus *Diplotomma* is descended from the genus *Buellia.* To some extent these genera may be said to merge into one another so evenly that it would, perhaps, be most correct to unite them in one genus. And formerly the authors did so to a great extent. When, nevertheless, I separate *Diplotomma* from *Buellia,* it is because I have made it a principle in this work to gather into each genus all the species which are as homogeneous as possible as regards the structure of the spores and the specific qualities of the gonidia, in order to obtain the advantage of employing generic names comprising as homogeneous a collection of species as possible.

This principle cannot — as little as any other principle in systematic botany — be carried through to its last consequences, because every establishment of limits — specific as well as generic — represents artificial products of human thought, which we may be in need of, but which are not really justified on phylogenetic grounds.

Intermediate forms between *Diplotomma* and *Buellia* may easily be pointed out, e. g. *Buellia triphragmia* Nyl., which has partly 2-celled, partly 4-celled spores, so that it may with equal right be referred to either of the genera in question. In this work this species will be described under *Buellia.*

In the following it will be mentioned how the separate species and forms may be imagined to have developed from one another. I have only to emphasize that the genus comprises some extremely primitive lichens e. g. *D. betulinum* and *D. alboatrum*, growing on the bark of trees; from such forms the saxicolous forms may be supposed to have descended.

NATURAL HISTORY OF DANISH SPECIES OF DIPLOTOMMA

The **spore** is brown and when ripe sometimes 2-celled (see Fig. 242). Much more frequently, however, it is 3-celled or 4-celled, or rarely up to 6-celled, with the cells arranged in one series. On the other hand, longitudinal walls may sometimes occur, imparting to the spore a distinctly muriform shape. All these forms of spores may occur in the same apothecium or even in the same ascus. Their germination has not been observed.

Morphology. The thallus is crustaceous and provided with a margin, which is sometimes composed of radiating, somewhat indistinct colourless hyphæ, without gonidia (Fig. 301, 302). Gonidial algæ, which are gradually captured and embodied in the thallus, fall on to the surface of the margin (Fig. 302, to the left in the figure). Whether algæ lying on the substratum previously to the arrival of the hyphæ are capable of being embodied, has not been directly observed but must be considered as probable.

The thallus established by this union of the two components may either remain rather smooth, only provided with the roughness due to the substratum (Fig. 301), or it may become more coarsely granular (Fig. 314, 316, 317). From this form of the thallus, which occurs in corticolous species, there is a gradual transition to the more pronounced granulate-areolate thallus of the saxicolous species (Fig. 322).

How the cortical, gonidial, medullary, and rhizoidal layers are gradually differentiated is described in full detail under each separate species, to which the reader is referred.

The development of the **apothecia** is in part known in one of the species, viz. *D. alboatrum* (Fig. 308). In the case investigated was found a very young apothecium, entirely embedded in the thallus and in no way betraying its existence by any macroscopically recognizable sign; its was composed of a system of ascogenous, big-celled hyphæ, from which some few young and unripe asci were in the course of formation. Numerous small-celled, paraphysogenous hyphæ were intermingled among the ascogenous cells. The two systems of hyphæ constitute together the hypothecium, which is as yet quite colourless in the present state of development. Whether one (or more) carpogonia, or any trichogyne, originally occurred could not any longer be seen in the sections.

Densely interwoven paraphyses, already brown at the tips, occurred between the asci. The whole of this tissue comprising the hymenium and the hypothecium was surrounded by an exciple, composed of a distinctly limited calyx of hyphæ, placed below the hypothecium and rising from it upwards through the thallus; the apical cells of the hyphæ are brownish. There was no distinct stipes, and the calyx was as yet colourless, apart from its apical cells, but nevertheless it was distinctly separated from the surrounding tissue which contained gonidia. The stipes, which had not yet begun to develop, may by degrees become very much developed by intercalary divisions of the hyphæ of the calyx.

As seen in the figure (308) the whole of the cortex was still covered by the cortex.

The ripe apothecium has a well developed exciple. In *D. alboatrum* the stipes is big, whereas the sides of the calyx (the margin) are relatively more slender; in

D. betulinum the stipes is very short, whereas the calyx is well developed (Fig. 339, 340). During the development of the calyx it becomes entirely brown *(D. betulinum)*, or it may, even in the same individual, become either brown or colourless at the periphery. In the latter case the apothecium may take on a distinctly pseudo-lecanorine aspect (Fig. 322 and 327). The inner parts of the calyx and stipes are always brown.

The paraphyses are branched above, and their tips are brown. The asci are clavate, and their walls are usually rather thickened above. They contain 6-8 spores, the structure of which is described above.

Pycnidia were met with in *D. alboatrum* (Fig. 311, 312, 313). When ripe they are wide open, embedded in the thallus and provided with a slightly developed perithecium, which is not very distinctly separated from the surrounding tissues, and which merges smoothly into the richly branched, conidia-bearing hyphæ. The upper branches of the latter are capable of producing conidia from the apical cell as well as from the last cell but one (Fig. 313). The main part of the pycnidium is formed of colourless hyphæ except the ostiole, which is faintly brownish. The conidia are long, rod-shaped, straight or faintly curved.

Soredia are met with in *D. betulinum.* In this species relatively big soredia, which at first are slightly verrucose and covered with a greyish cortex, are formed here and there on the thallus. Later on the protecting cortex is broken by the growth of the soredia, and the soredia become visible as a greenish-yellowish powder, framed by the surrounding cortex. Still later the cortex is completely forced aside and becomes invisible like the evanescent margin of an apothecium, although it is always present, concealed by the soredia (Fig. 332, 333). The structure of the soredia is seen in Fig. 336.

Biological and **ecological** conditions will not be mentioned in detail at this point, as they will be described in full detail under each separate species.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

(Plate 109—110—111—112—113—114—115—116—117—118—119—120—121).

Specimen 1. On the periderm of *Tilia intermedia*. *Aalbæk* 1904. O. GALLØE.

The thallus is thin, continuous, very light, whitish. The form of its surface is almost entirely dominated by the roughness of the periderm. The margin is colourless, mycelial, and merges insensibly into the periderm. It is composed of hyphæ without gonidia and is loose in texture, with numerous intercellular spaces. The hyphæ partly spread on the surface of the periderm, partly make their way between the lamellæ of the periderm, but show no marked sign of attacking it chemically. The cells of the hyphæ are very short. At a little distance behind the margin the thallus becomes provided with gonidia (Fig. 302 and 304). This may, at any rate, happen by algæ falling on to the surface of the thallus and there being captured by the hyphæ (Fig. 302); on the other hand, it may presumably also happen by the hyphæ capturing algæ lying on the substratum previously to the moment when during their growth the hyphæ arrive at the place concerned. The captured gonidia divide and remain for some time, at any rate, gathered in rather distinct groups, of which each may be supposed to have originally arisen from one single alga. Later on the arrangement in groups disappears. On the extreme edge of the margin of the thallus no differentiation into different tissues has as yet taken place; it is not accomplished until otherwise the thallus is fully developed.

The thallus has a cortex, which is very thick and well developed. Its uppermost parts are cuticle-like, rather homogeneous, formed of the dead apical portions of the cortical cells. The deeper layers of the cortex is composed of living, short-celled hyphæ standing tolerably erect on the surface of the thallus and provided with rather big intercellular spaces. The hyphæ of the gonidial layer are of the same structure as the deeper layers of the cortex. The gonidia are 1-celled, cystococcoid. Haustoria do not occur. The medullary and rhizoidal layers are loosely built, with big intercellular spaces.

The apothecia arise apparently without any order, young and old being mixed together. It is, however, evident that young apothecia arise preferably in young portions of the thallus, i. e. partly along the margin of the thallus, and partly in such places where older portions of the thallus by the growth of the periderm of the substratum have been in part broken and renewed by regeneration. This fact is clearly seen in Fig. 301, where the older lamellæ of the periderm, which have not lately been exposed to bursting caused by tensions of growth in the substratum, are provided with the biggest and most developed apothecia, while the very young apothecia occur between these in regenerated portions of the thallus, between which even the substratum itself is visible in places, because it is still uncovered by the regeneration of the thallus.

In the present specimen I succeeded in finding very young stages in the development of the apothecia (Fig. 308). From my examination of the latter it appears that a branched ascogonium, formed of big, easily recognizable hyphæ and embedded in the deep layers of the thallus near the surface of the substratum, is differentiated at an early stage. The earlier stages of development of this ascogonium were not observed in my anatomical sections, and so it could not be shown whether a trichogyne existed at any moment. Among these ascogenous cells a tissue of numerous, small-celled hyphæ are found, which must be supposed to be identical with the original thalline medullary hyphæ. These two systems of hyphæ constitute the hypothecium, in which some quite young asci and paraphyses had already been formed in the case examined. Round this primordium a thin, quite distinctly developed, faintly brownish calyx of erect hyphæ had been developed, separating the hymenium and the hypothecium from the surrounding parts of the thallus which were provided with gonidia. Both the calyx and the paraphyses had faintly clavate apical hyphæ above, everywhere covered by the original thalline cuticle. The impression is conveyed that both the hyphæ of the calyx and of the paraphyses are ordinary thalline medullary hyphæ, the upper cells of which are coloured dark but yet for a while retain their cuticle-like dead apical portions, which will disappear later on. In the section figured (Fig. 308) there was not yet a distinct stipes, but a tissue sharply limiting the ascogonium from the periderm of the substratum is already formed. This tissue represents the bottom of the calyx. When later on it increases greatly in thickness and lifts the whole apothecium up above the level of the thallus, the stipes is thus differentiated and becomes well developed in the ripe apothecium.

The apothecia are slightly orbicular or a little irregular in outline. At first they are rather plane, black, with indistinct, light remnants of the thallus on their margin. Later on these remnants disappear, and the whole apothecium becomes convex and black.

In the fully developed apothecium the stipes is composed of bundles of parallel hyphæ, partly dark, partly more light-brown, mixed together without any visible order (Fig. 309). The stipes is continued above into a calyx, the sides of which are composed of erect hyphæ running upwards into the margin, on the surface of which they stand erect, the apical portions being somewhat clavate and swollen and of a brownish colour.

In the hypothecium is found a well developed, richly branched ascogonium (Fig. 310), the branches of which may often be followed for considerable distances in the preparations. The ascogenous cells are seen distinctly to vary somewhat in length and form. Besides, it may be observed that several asci are capable of arising in acropetal succession from the cells of one and the same hypha.

One phenomenon must be pointed out, because it *may* be of considerable importance for a future investigation of the development of the asci and therefore for the final interpretation of the phylogeny of the lichens and the *Ascomycetes:*

In several places I observed that cells belonging to different hyphæ apparently were anastomosed and in open connection with one another (see e. g. Fig. 310, the left figure marked with asterisks). This phenomenon is perhaps to be interpreted as indicating that a fertilisation is being accomplished between the cells concerned. If so, the phenomenon establishes an important phylogenetic connection between the *Zygomycetes* and the more primitive *Ascomycetes* together with *Pyronema*.

It must, however, be emphasized as being of the greatest importance that we should not at once allow our imagination to run riot and draw extreme conclusions from the observation in question. The smallest defect in the preparation or the smallest mistake in the examination may lead the investigator into a belief in phenomena, which should perhaps be interpreted in quite another way than the first examination seemed to justify. It must not be forgotten either that the ascogonia in question are embedded among numerous paraphysogenous hyphæ, which are very thin and even in thin sections form a confusion of crossing hyphæ, which make observation very difficult.

I take the opportunity of recommending future investigators, who may take up the old, but still unsettled question of the mode of development of the spore-sac for renewed and much-needed examination, to give their attention to the occurrence and interpretation of these anastomising cells. I myself consistently search for them in all individuals described in this work, but I have not set myself the special task of making inquiries into the question in preparations made solely for this purpose. Some such procedure will undoubtedly be necessary in order to settle the matter. Besides, the investigation will be difficult and require a long time.

The paraphyses are thin, their cells stretched. They are branched above, and their tips are slightly thickened. The asci are clavate, greatly constricted at the base; their walls are thickened above. They contain eight light-brown spores, provided with 3 or 5 transverse walls and, in rare cases, also a single longitudinal wall.

In the apothecium a non-crystallized brown pigment is desposited in the apical portions of the hyphæ of the calyx and the paraphyses and also in the central parts of the stipes and the calyx, whereas the peripheral parts of the calyx are colourless like the basal part of the paraphyses and the upper parts of the hypothecium.

In the present specimen a single pycnidium was observed at a short distance from the margin of the thallus. It was rather broad and wide-open. The perithecium is formed of hyphæ running in part concentric and forming a thin perithecium, from the inside of which hyphæ issue radiating towards the centre of the pycnidium. These hyphæ are short-celled, branched above, and cut off from the upper cells a long, thin and straight, or extremely slightly curved, conidium, the function of which is unknown in this as in all other cases.

Specimen 2, on bark, *Sorø.*

The thallus differs from specimen 1 in being of a pure whitish colour and in its unevenly verrucose and farinose surface. No distinct mycelial marginal hyphæ occur. Anatomically it agrees completely with specimen 1 in almost all details. It is, however, more verrucose, or perhaps more correctly, it should be designated as indistinctly areolate. The farinose aspect is caused by an anatomical peculiarity as shown in Fig. 319. From this figure it is evident that the cortex has a very uneven surface. Moreover, it is thinner and to a relatively greater extent composed of dead hyphæ than is the case in specimen 1. The cells, however, which are in direct contact with gonidia, are always living cells. The gonidial, medullary, and rhizoidal layers agree completely with specimen 1.

The apothecia arise without any visible order, young and old mixed together. Just before they break through the thallus, they are very easily recognized under a low power in the microscope, although they are pure white owing to covering fragments of the thallus. These fragments persist for a long time, partly on the margin, partly on the disc, as a more or less copious pruina, which by degrees becomes more and more scanty in proportion to the age of the apothecium. The outline of the apothecia is slightly orbicular, or, more frequently, somewhat irregularly angular, sometimes by mutual pressure. Originally they have a rather distinct, whitish-pruinose margin, which later on entirely disappears, and as a whole the apothecia become rather plane or very slightly convex. When they are fully developed, their size is considerably smaller than in specimen 1.

In structure the apothecia agree entirely with specimen 1, so a detailed description is not needed. Only must it be pointed out that there may be some difference in the distribution of colours, as seen in Fig. 315 and 316. From these it is evident that the sides of the calyx may be either quite colourless (Fig. 315) or coloured brown (Fig. 316).

Pycnidia were not observed.

As seen from the description specimen 1 and 2 differ somewhat in structure as regards the details mentioned above. Nevertheless they are here given the same name and would surely be so named by the majority of lichenologists. If numerous intermediate forms exist, which I myself have not found to be the case, it is possible that they may be referred to the same species in the sense of the word that they may issue from one another under certain fixed outer conditions of life. However, even if this should be the case, it would perhaps be better to give each of them its own name in order to point out the differences between them.

We are constantly faced with this question in lichenology and in botany as a whole: What purpose are we to pursue in giving a name? Are we to express by a name our ideas of, or more exactly our belief in, the connection of the individuals as belonging to one and the same 'species', or are we chiefly to take into account practical considerations and give different names to plants differing in aspect, even if we are convinced of their phylogenetic relationship? It is difficult to follow out one principle to its consequences, setting the other completely aside. So much the more important is it to follow out this principle in the description of plants: to keep the different individuals completely separated and not to make a common description of them. In making such a description we run the risk of establishing a kind of ideal individual, to which qualities are attributed which cannot perhaps occur at all in one single individual, or which may even prove irreconcilable for some physiological reason or other.

Specimen 3. On brick. *Kaas.*

The thallus has a margin growing out here and there into free, colourless, mycelial hyphæ, especially in places where the margin is in direct contact with grains of quartz (Fig. 322). Where such grains occur, there are frequently empty meshes in the thallus (Fig. 321) — a feature indicative of the fact that during its growth the thallus hesitated as long as possible before overgrowing these mineral grains, which as a whole are probably of no value for the nutrition of the plant. The fully developed parts of the thallus are whitish, indistinctly areolate or verrucose with confluent areoles. In several places of the margin of the thallus and of the inner margin round the grains of quartz which have not yet been overgrown, free algæ lie on the surface of the thallus (Fig. 322).

The cortex is chiefly composed of dead cells, formed by the gradual dying out of the apical parts of the living hyphæ in the deeper parts of the cortex. The surface of the cortex is very uneven, which imparts a farinose aspect to the thallus as a whole. Whitish, somewhat irregular, angular grains of a not closely examined substance, which judging from its position must be regarded mainly as a residual product, are deposited here and there among the dead cells.

The gonidial layer is loose in texture; its cells are rather short; there are numerous big intercellular spaces. The gonidia seem to be cystococcoid. Haustoria do not occur. The medullary and rhizoidal layers are very thick, formed of a loose hyphal tissue, in which the cells are somewhat longer or even much more stretched than in the gonidial layer, especially so in the parts of the thallus which are nearest to the substratum.

The apothecia are not arranged in any recognizable order on the thallus, young and old being mixed together. When the very young apothecia are on the point of breaking through the thallus, they have a thick, whitish margin and a darker disc, which is marbled with a white pruina standing out in dark relief. Later on they become markedly convex or more rarely plane, usually provided with a more or less whitish-pruinose disc. This disc is otherwise black, most often with a rather distinct, thick, white pseudo-lecanorine margin, the lecanorine aspect of which is caused by the presence of a colourless (white) cuticle on the edge of the calyx, really belonging to the proper margin of the apothecium itself (cp. Fig. 326).

In nearly all other respects the inner structure and colours of the apothecia agree entirely with specimen 2. Attention must, however, be drawn to the already mentioned pseudo-lecanorine margin, which is more distinct in specimen 3 than in specimen 2, and the structure of which is most easily understood by an examination of Fig. 326. From this figure it is evident that the white cuticle is formed by a transformation of some apical cells of the margin of the calyx, which is discoloured, while the cells lying a little deeper are brown. The fact that the dark cells figured have rounded walls only means that just these cells have not yet formed dead cuticular cells, whereas in other hyphæ it may be clearly seen how the uppermost cell or cells are colourless, dead and cuticular, while darker cells follow underneath. On the whole, this phenomenon is not unfrequently met with, especially in lichens where the thallus is provided with a dark cortex covered by a colourless cuticle.

Paraphyses and asci have the same structure as in specimen 2. In the present specimen, however, the spores are generally relatively a little broader and the number of longitudinal walls a little greater, so that the spores as a whole are more divided than in specimen 2.

Pycnidia were not observed.

The agreement between specimens 2 and 3 is quite obvious, even if, as shown above, small differences may be pointed out. It would be a very important and attractive task to find out whether such individuals as these, one growing on bark, the other on a rocky substratum, belong to the same species in the sense of the word that they may arise from one another under certain definite conditions of life. If such researches bore out our argument, they would be of the very greatest theoretical importance to a further experimental support of the doctrine of evolution. The researches might perhaps reveal certain general rules for the way in which crustaceous lichens of a primitive structure and growing on a more original substratum (bark of trees) change their habit when settling upon a less accustomed substratum (stone) — a process which has undoubtedly taken place in many cases during the phylogeny of the whole group of lichens.

DIPLOTOMMA BETULINUM

(Hepp.) Th. Fr.

(Plate 122—123—124—125—126—127).

On naked wood of *Juniperus*. Between *Ry Mølle* and *Himmelbjærget*.

The thallus is indistinct in most places and indistinctly bordered, grey. It is extremely primitive in structure, and in that respect it takes up a position which is as original as imaginable.

The margin of the thallus is dark in places, nearly black, and everywhere formed of small, cushion-shaped endoxyline grains. The marginal hyphæ make their way between the cells of the substratum and are covered by them; by degrees they capture any gonidial algæ they meet with on their way. This will be evident from an inspection of Fig. 335, where the marginal hyphæ themselves are seen covered in part by the periderm and on the point of capturing gonidia. Two of the latter are still placed outside the lichen, inasmuch as they have not yet been fully surrounded by hyphæ. In this case, where the periderm affords a sufficiently protecting cover over the hyphæ, the latter are very open and loose in structure and provided with big intercellular spaces, whereas a cortex is absent.

Gradually the covering periderm-cells peel off more or less completely, and the thallus becomes epixyline and gets quite a different structure. Where it has lately been laid bare, it is still mostly homoeomerous (Fig. 333), although provided with a thin, colourless cortex formed of living hyphæ. The cortex is followed by a gonidial layer of irregularly interwoven hyphæ with distinct intercellular spaces. The gonidia seem to be cystococçoid. Haustoria do not occur. The medullary-rhizoidal layer is thin and slightly developed and does not differ considerably from the gonidial layer.

Where it is more exposed to external influence, the thallus may have quite another structure (Fig. 336); the cortex is very thick and rather dense; its single cells are frequently somewhat indistinct, and many of them are distinctly living. The uppermost layer of cells is purely blackish-grey. On the other hand, the other tissues are not distinctly differentiated into separate tissues; there are numerous intercellular spaces between the hyphæ, the cells of which are rather short. No distinct signs were seen of the hyphæ influencing the substratum chemically.

The thallus is not entirely continuous, naked wood being visible in places between its different parts.

S o r a l i a arise in considerable numbers on the thallus. Their mode of development is seen in Fig. 330. From this figure it is evident how the soral at first appears as a low greyish cushion with a verrucose surface. Later on the cushion bursts in the centre, and the protecting cortex is forced aside by the yellow soredia breaking through. Nevertheless, there remains a persistent margin formed of a greyish cortical tissue round the soredia (Fig. 330 above to the right), and it may still be recognizable in big, old soralia. Each single soredium only consists of some few gonidia with surrounding hyphæ (Fig. 334).

The a p o t h e c i a are not arranged in any fixed order upon the thallus. At all ages they are rather regularly orbicular, with a thick margin, which is whole or faintly crenate and with a plane disc. They are black at all ages.

The s t i p e s is extremely slightly developed, the exciple being almost formed of the much developed calyx only. The bottom of the latter is composed of somewhat irregularly interwoven hyphæ, which at the base merge insensibly into the periderm and above continue partly into a very faintly brownish hypothecium, partly outwards to the sides into the margin, in which the hyphæ radiate in all directions towards the surface, on which they stand erect. The ascogenous hyphæ of the hypothecium are little conspicuous.

The p a r a p h y s e s are thin, branched above and with very faintly thickened tips. They are embedded in a thick hymenial gelatine. The a s c i are very short, their walls thickened above. They contain 6—8 spores, which are somewhat broad, brown, with 1—4 transverse walls and some few longitudinal walls (Fig. 340). There is no halo. The length is 14—24 μ.

The a s c i and the basal parts of the p a r a p h y s e s are colourless. The hypothecium is very faintly brownish, whereas the tips of the paraphyses together with the whole calyx is rather dark-brownish (Fig. 337).

P y c n i d i a were not observed.

This species is evidently a very primitive lichen and gives us some idea of the original structure of — perhaps — the plurality of the recent lichens when formerly they began their existence as newly lichenized fungi. I have no doubt that their prototypes very nearly had the same structure of the thallus and began their lichenization in this way, by capturing the algæ which were accidentally present on the substratum.

An examination of the structure of the soralia obviously suggests that they simply represent portions of the thallus in which, as it were, the lichen-symbiosis fails because the hyphæ are not capable of keeping hold of the gonidia in a symbiosis entirely dominated by the fungus, and for that reason the lichen becomes leprose.

The consideration by Reinke of the soral being the genuine means of propagation characteristic of the lichen-consortium is not supported by the presence of that organ in one of the most primitive of lichens. I for my part do not regard this opinion as probable either. This question, however, will be discussed in other places when we are faced with the soralia of other lichens. —

PLATES

PLATE 1.

LECANACTIS ABIETINA.

ACH.

Fig. 1. Thallus with apothecia and pycnidia of various ages. ($\times 26$).
Fig. 2. Vertical section of apothecium. ($\times 105$).

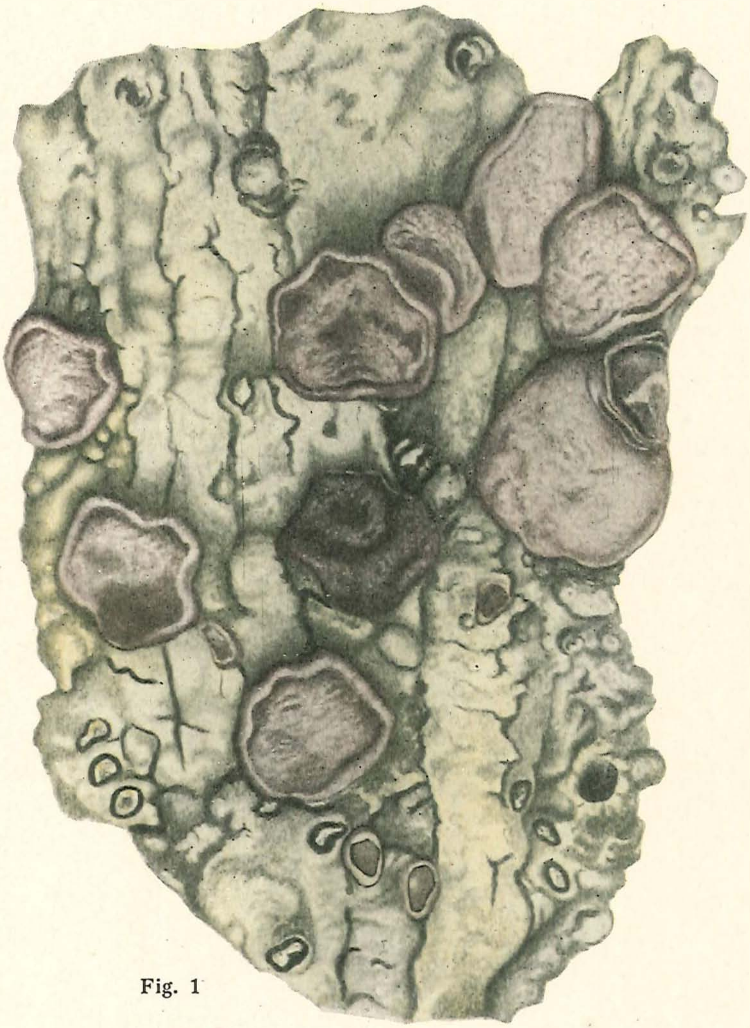


Fig. 1

Fig. 2

O. Galløe del.

LECANACTIS ABIETINA Ach.

PLATE 2.

LECANACTIS ABIETINA.

ACH.

Fig. 3. Thallus. Slightly developed cortex. Above to the left is seen a dead gonidium. (×840).

Fig. 4. Gonidia; in the middle two gonidia separated from each other. (×840).

Fig. 5. Two contiguous apothecia. (×105).

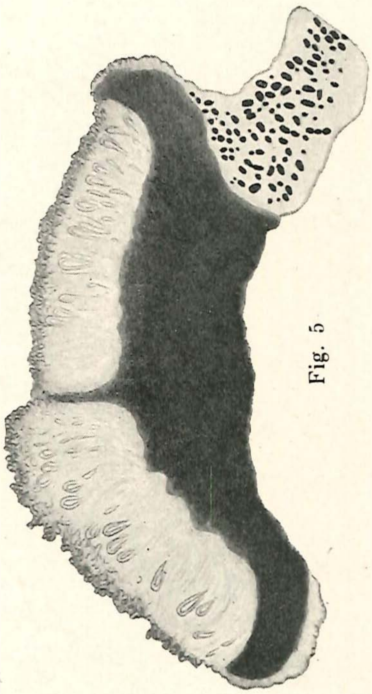


Fig. 5

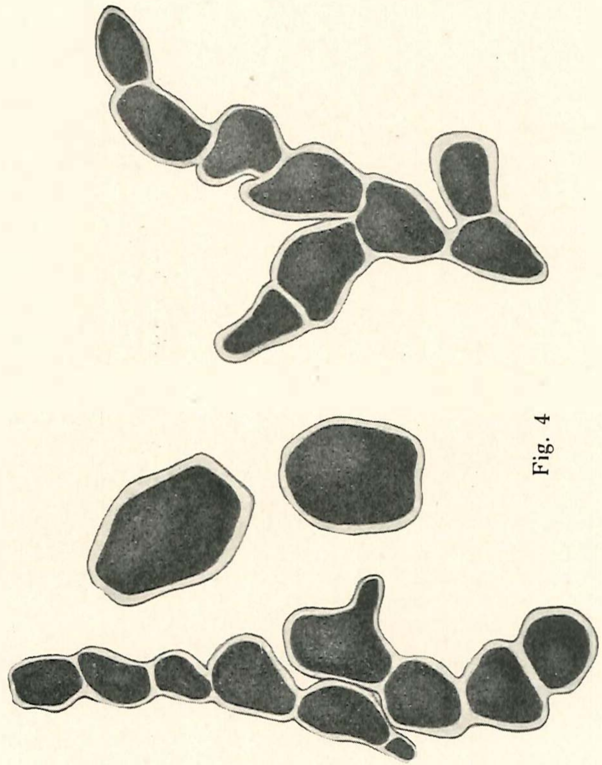


Fig. 4

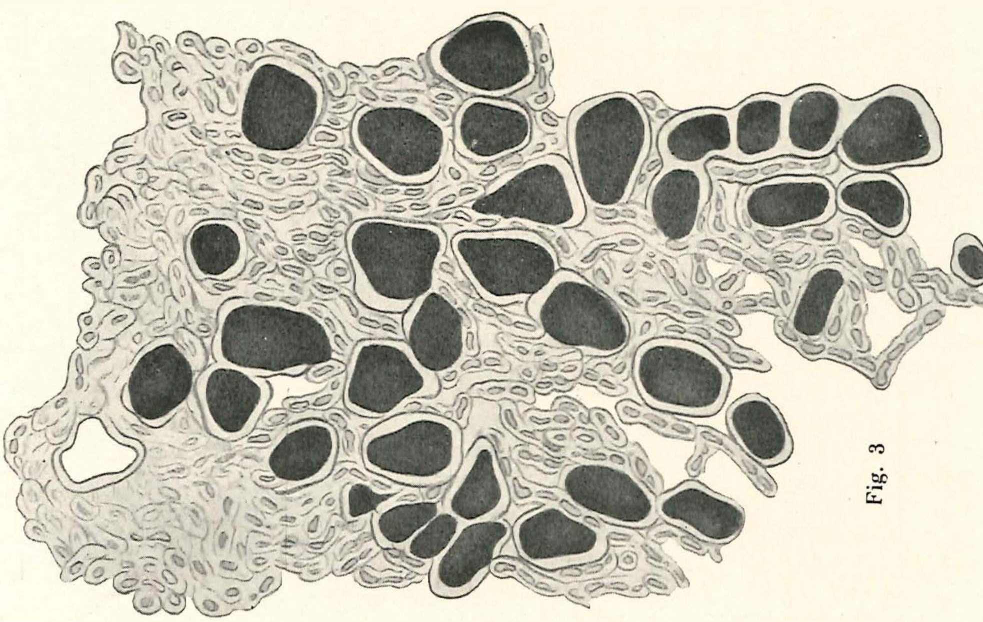


Fig. 3

O. Galløe del.

LECANACTIS ABIETINA Ach.

PLATE 3.

LECANACTIS ABIETINA.

ACH.

Fig. 6. Longitudinal section of stipes, calyx, and the bases of the paraphyses. The section shows stipes-calyx at full length; nothing is cut away. Note the gradual transition from the hyphæ of the calyx to the paraphyses. (×840).

Fig. 7. Horizontal section of hymenium, showing transverse section of paraphyses and asci. (×695).

Fig. 8. Margin of apothecium. Note the striking contrast between the inner dark calyx and the light hyphæ of the peripheral parts of the calyx; the light hyphæ impart a pruinose aspect to the margin of the apothecium. (×695).

Fig. 9. Four asci. (×840.)

PLATE 3.

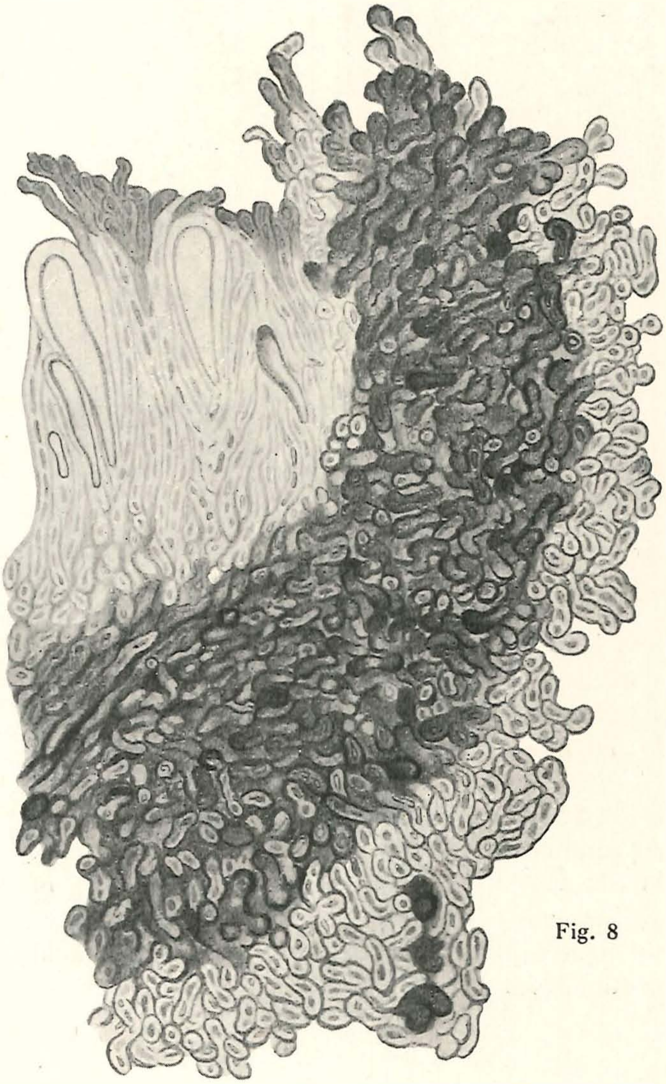


Fig. 8

Fig. 6

Fig. 7

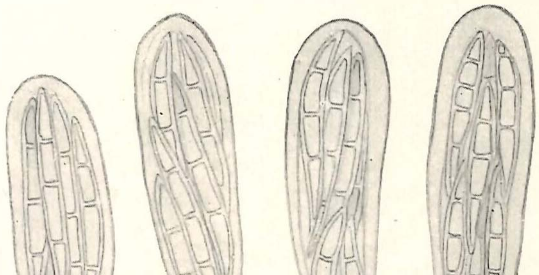


Fig. 9

O. Galløe del.

LECANACTIS ABIETINA ACH.

PLATE 4.

LECANACTIS ABIETINA.

ACH.

Fig. 10. Tips of the paraphyses, i. e. the epithecium. (×840).

Fig. 11. Surface-view of pycnidia. (×37).

Fig. 12. Vertical section of a pycnide, filled with conidia, which are somewhat conglutinated, so that they do not fall out of the pycnide by the cutting of the sections. (×157).

Fig. 13. Section through the perithecial wall, below bordering on the thallus, in which two gonidia are seen. The conidia-bearing hyphæ are colourless. (×840).

Fig. 14. Three groups of conidia-bearing hyphæ separated by the crushing of a pycnide and showing the mode of branching and the conidia. (×1500).

Fig. 15. Three conidia, each of them containing a series of small, sphæroidal bodies of unknown chemical composition. (×1500).

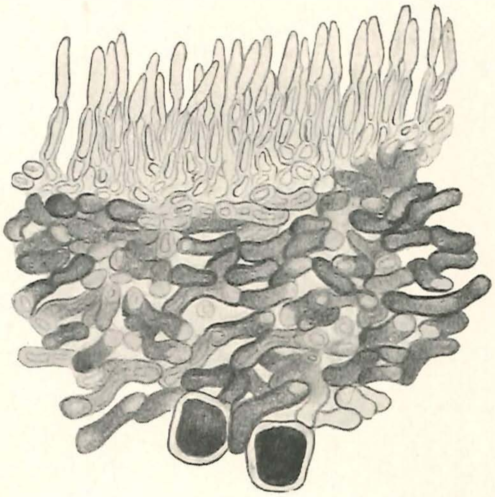


Fig. 13

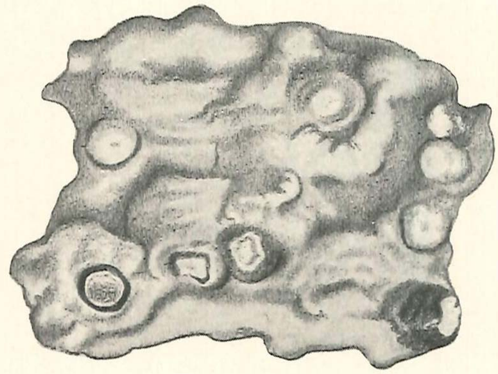


Fig. 11

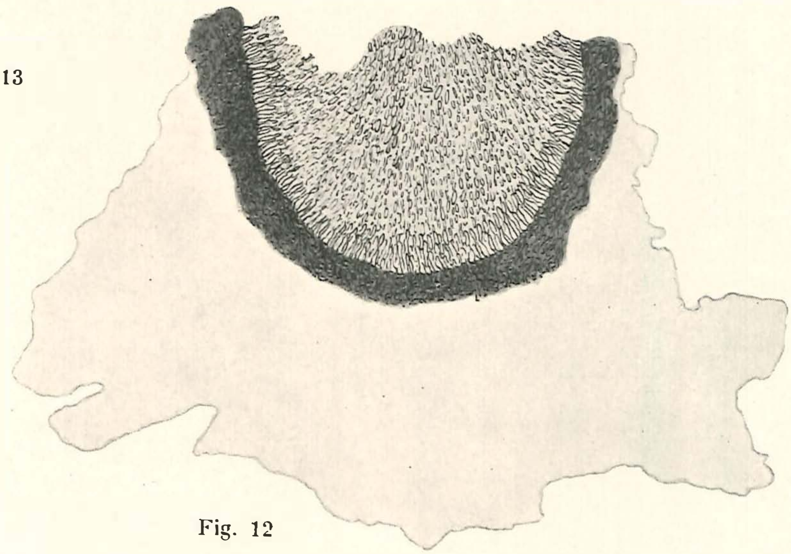


Fig. 12

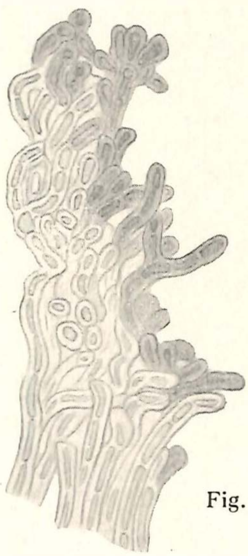


Fig. 10

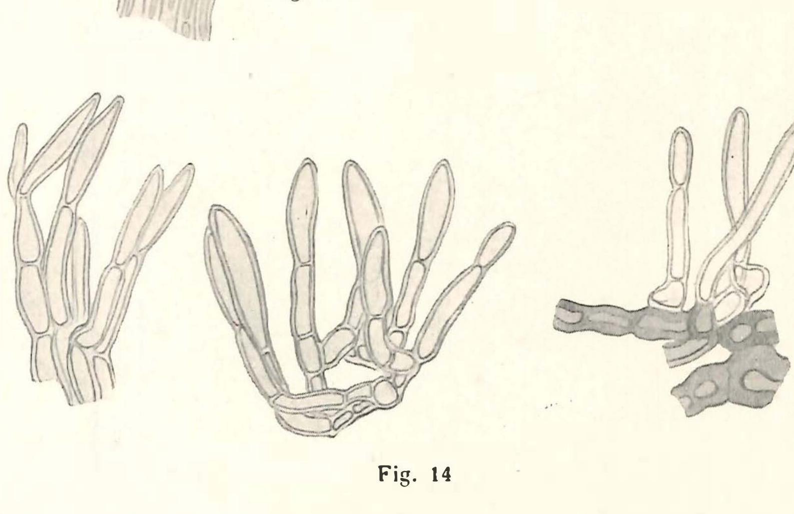


Fig. 14

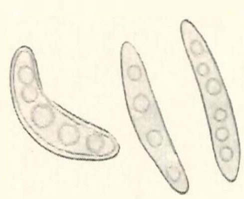


Fig. 15

O. Galløe del.

LECANACTIS ABIETINA Ach.

PLATE 5.

LECANACTIS AMYLACEA.

EHRH.

Fig. 16. Thallus with apothecia, of which some are entirely whitish-farinose and others brownish with a dark margin. (×35).

Fig. 17. Section of the homoeomerous thallus and two apothecia. (×105).

Fig. 18. Three confluent apothecia. (×105).

Fig. 19. Young apothecium on the point of breaking through the thallus. (×105).

Fig. 18

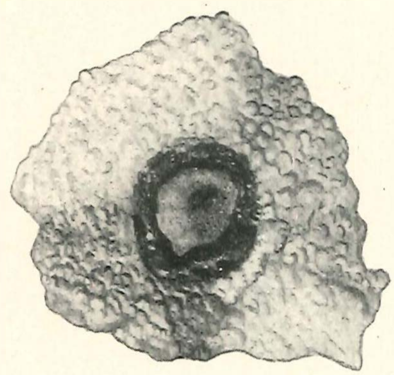


Fig. 19

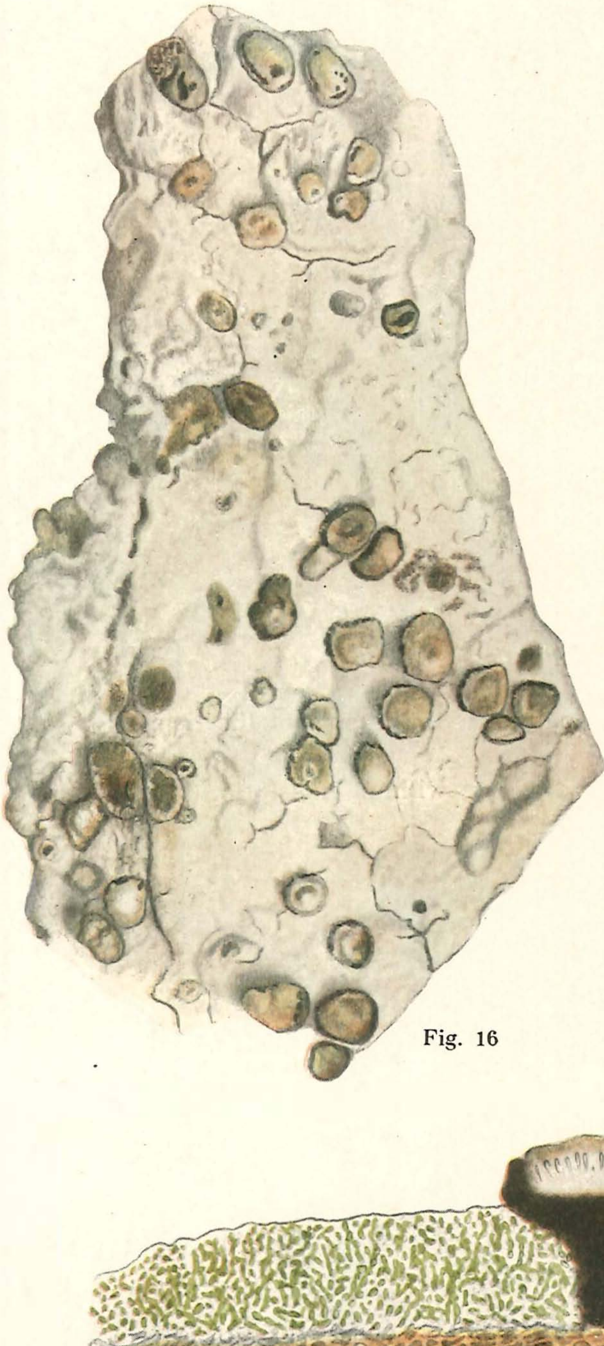


Fig. 16

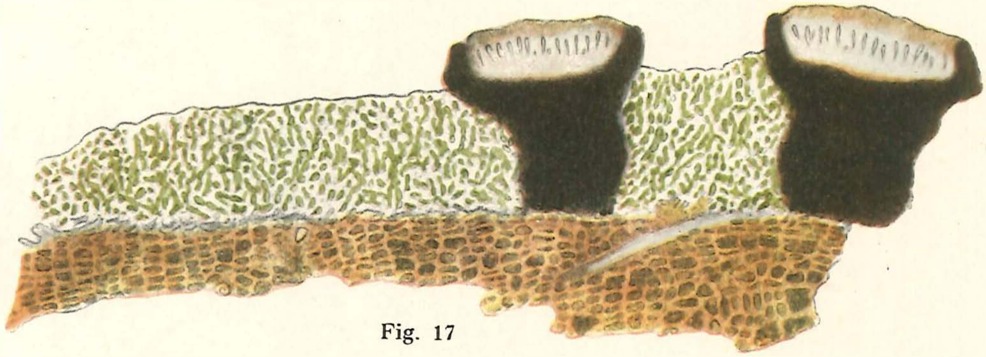


Fig. 17

O. Galløe del.

LECANACTIS AMYLACEA EHRH.

PLATE 6.

LECANACTIS AMYLACEA.

EHRH.

Fig. 20. Cells of the periderm of oak with the hyphæ of the lichen and with gonidia. (×840).

Fig. 21. Gonidia with surrounding hyphæ without haustoria. (×1185).

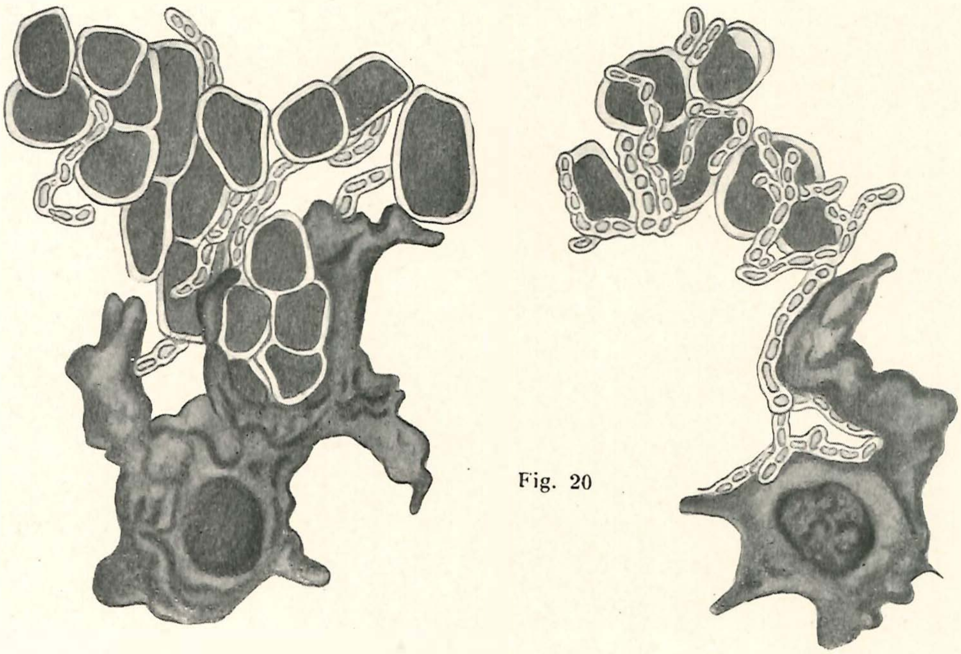


Fig. 20

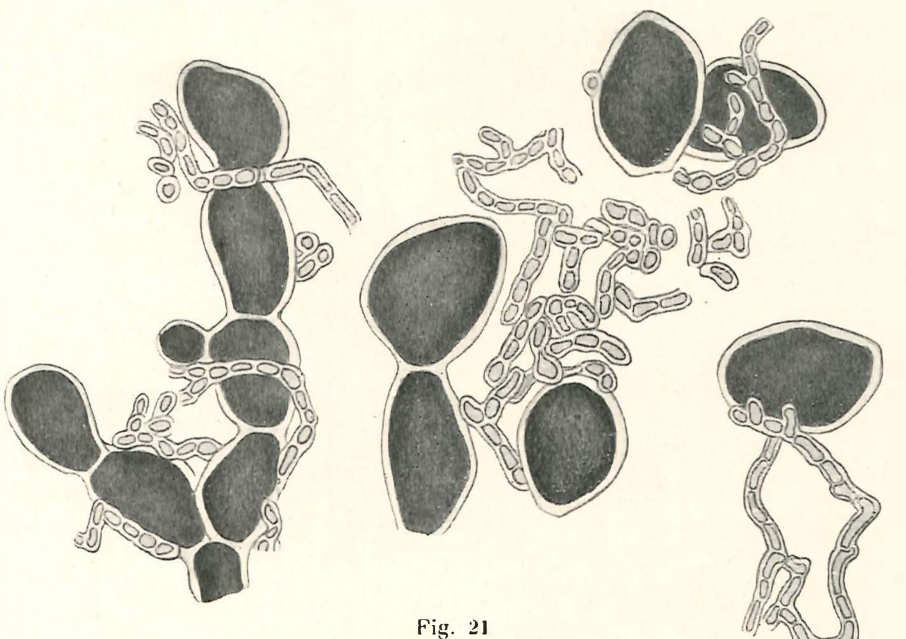


Fig. 21

O. Galløe del.

LECANACTIS AMYLACEA Ehrh.

PLATE 7.

LECANACTIS AMYLACEA.

EHRH.

Fig. 22. Margin of apothecium, showing among other things the faintly coloured hypothecium and its transition to the calyx, and the colourless apical hyphæ from the surface of the calyx and the epithecium; the apical hyphæ impart a farinose surface to the apothecium in spite of its inner dark colours. ($\times 695$).

Fig. 23. Horizontal section of the hymenium, showing the hymenial gelatine, and transverse section of asci and paraphyses. ($\times 840$).

Fig. 24. Two asci with ripe spores. ($\times 840$).

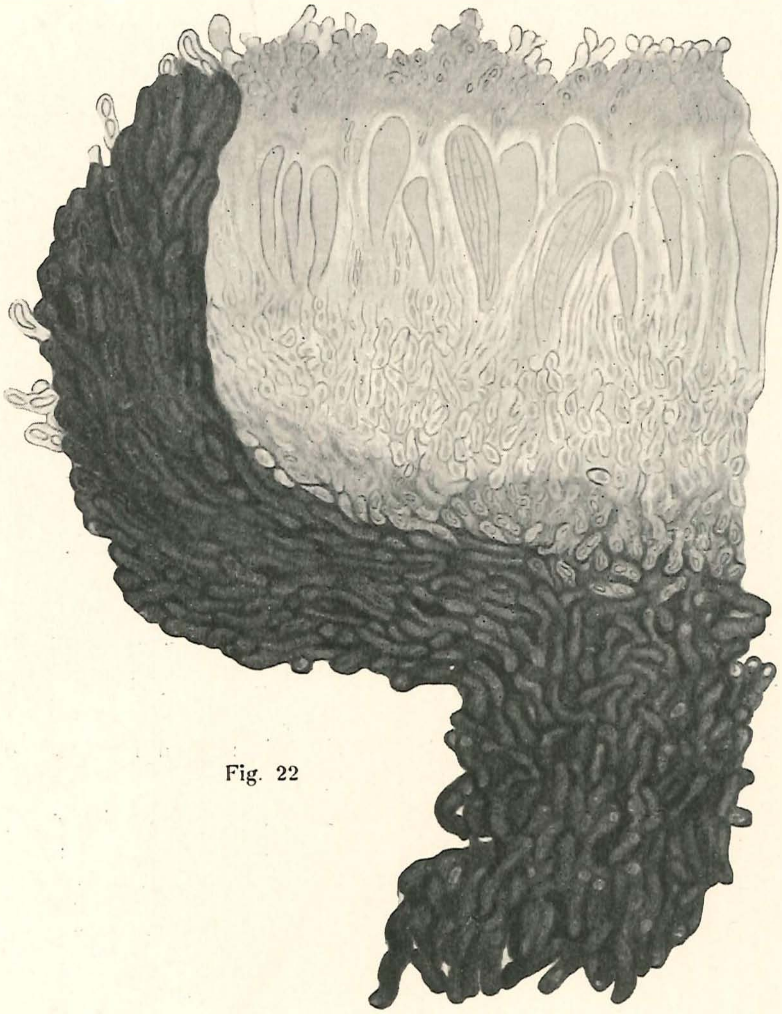


Fig. 22

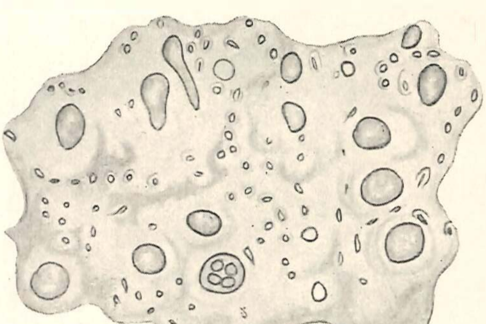


Fig. 23

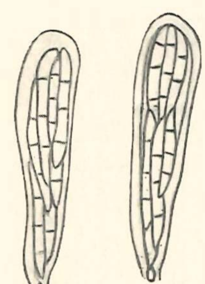


Fig. 24

O. Galløe del.

LECANACTIS AMYLACEA Ehrh.

PLATE 8.

ARTHRORHAPHIS FLAVOVIRESCENS.

DICKS.

Fig. 25. Thallus (yellow) and the naked substratum (brown). Above are seen two apothecia, apparently situate on the thallus but in reality issuing from "hypothallus". ($\times 35$).

Fig. 26. Section of thallus. Above to the right is seen a fragment of an apothecium, the remainder having been cut off. ($\times 140$).

Fig. 27. Two apothecia (in rather thick section), placed on the "hypothallus" between two cushions of thallus. ($\times 140$).

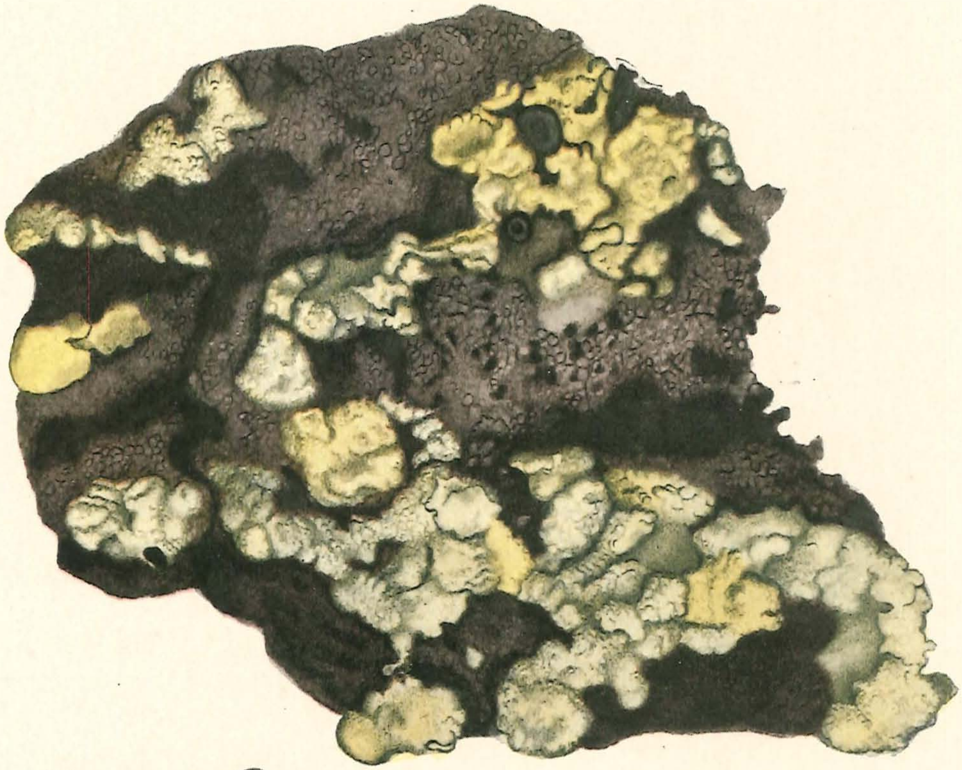


Fig. 25

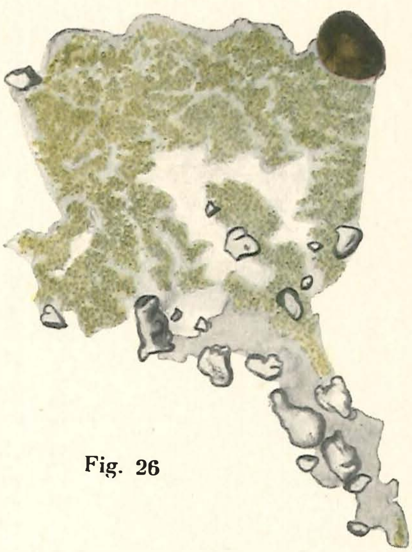


Fig. 26

Fig. 27

O. Galløe del.

ARTHRORHAPHIS FLAVOVIRESCENS Dicks.

PLATE 9.

ARTHRORHAPHIS FLAVOVIRESCENS.

DICKS.

Fig. 28. Thin section of apothecium. (×140).

Fig. 29. Group of apothecia on the "hypothallus", bordering on a cushion of the thallus. (×140).

Fig. 30. Two apothecia, apparently placed on the thallus; in reality they have arisen between the areoles. (×140).

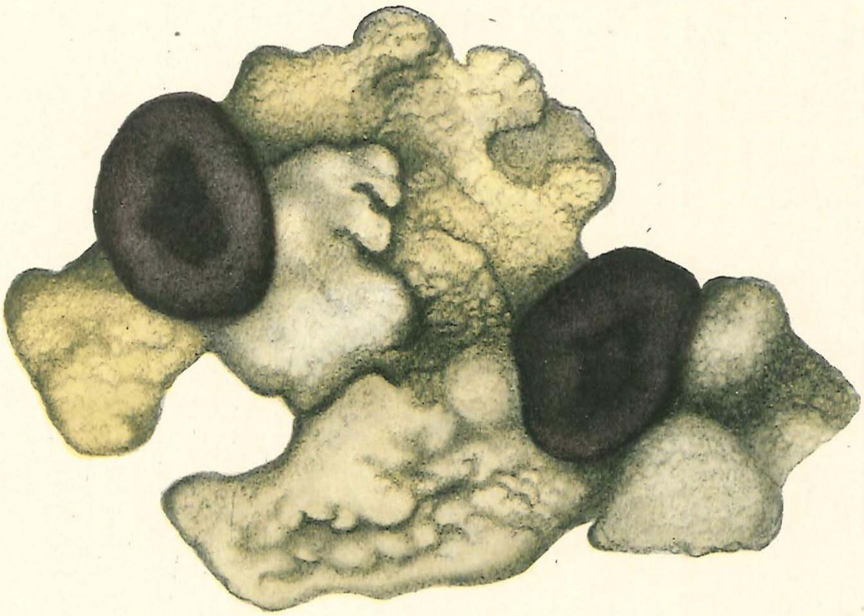


Fig. 30

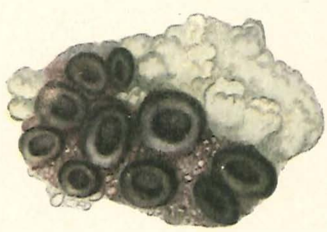


Fig. 29

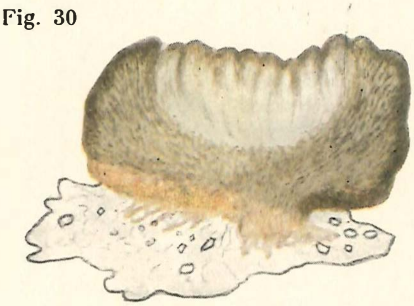


Fig. 28

O. Galløe del.

ARTHRORHAPHIS FLAVOVIRESCENS Dicks.

PLATE 10.

ARTHRORHAPHIS FLAVOVIRESCENS.

Dicks.

Fig. 31. Thallus, with cortex and gonidial layer. ($\times$ 840).

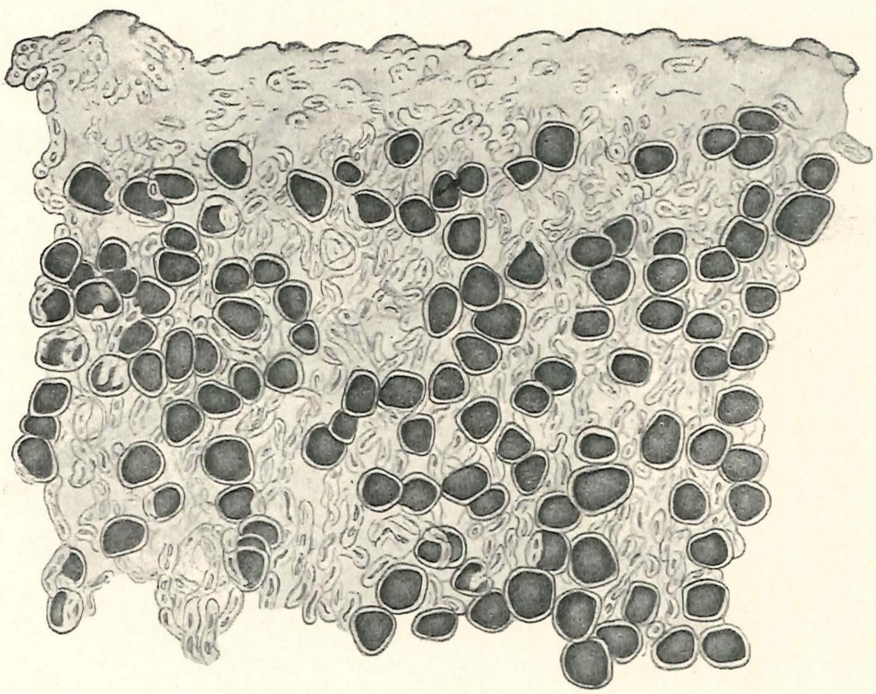


Fig. 31

O. Galløe del

ARTHRORHAPHIS FLAVOVIRESCENS Dicks.

PLATE 11.

ARTHRORHAPHIS FLAVOVIRESCENS.

DICKS.

Fig 32. Margin of apothecium. Below to the left an attached green alga *(Zygogonium)*. Note the numerous ascogenous cells and the erect paraphysogenous hyphæ of the hypothecium. (×840).

Fig. 33. One ripe and one unripe ascus, between which two spores. (×840). To the right two paraphyses, one branched and one unbranched. (×840).

Fig. 34. Rhizoidal hyphæ. (×1185).

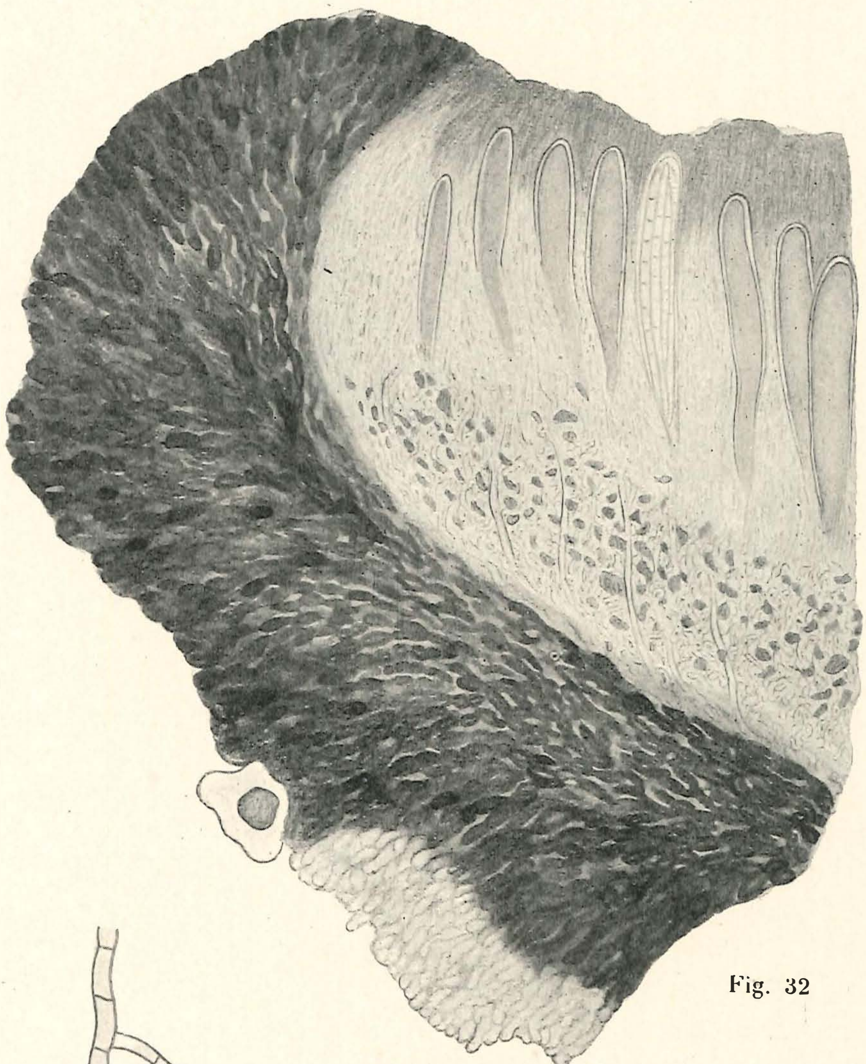


Fig. 32

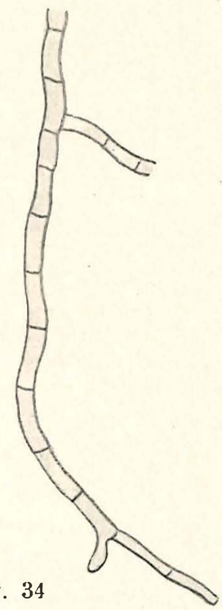


Fig. 34

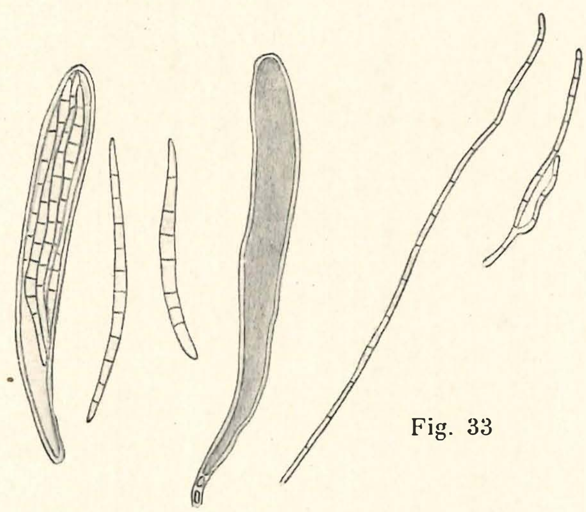


Fig. 33

O. *Galløe del.*

ARTHRORHAPHIS FLAVOVIRESCENS Dicks.

PLATE 12.

MICROPHIALE DILUTA.

PERS.

Fig. 35. Thallus on the periderm of *Pinus*. Apothecia at all ages. (×35).

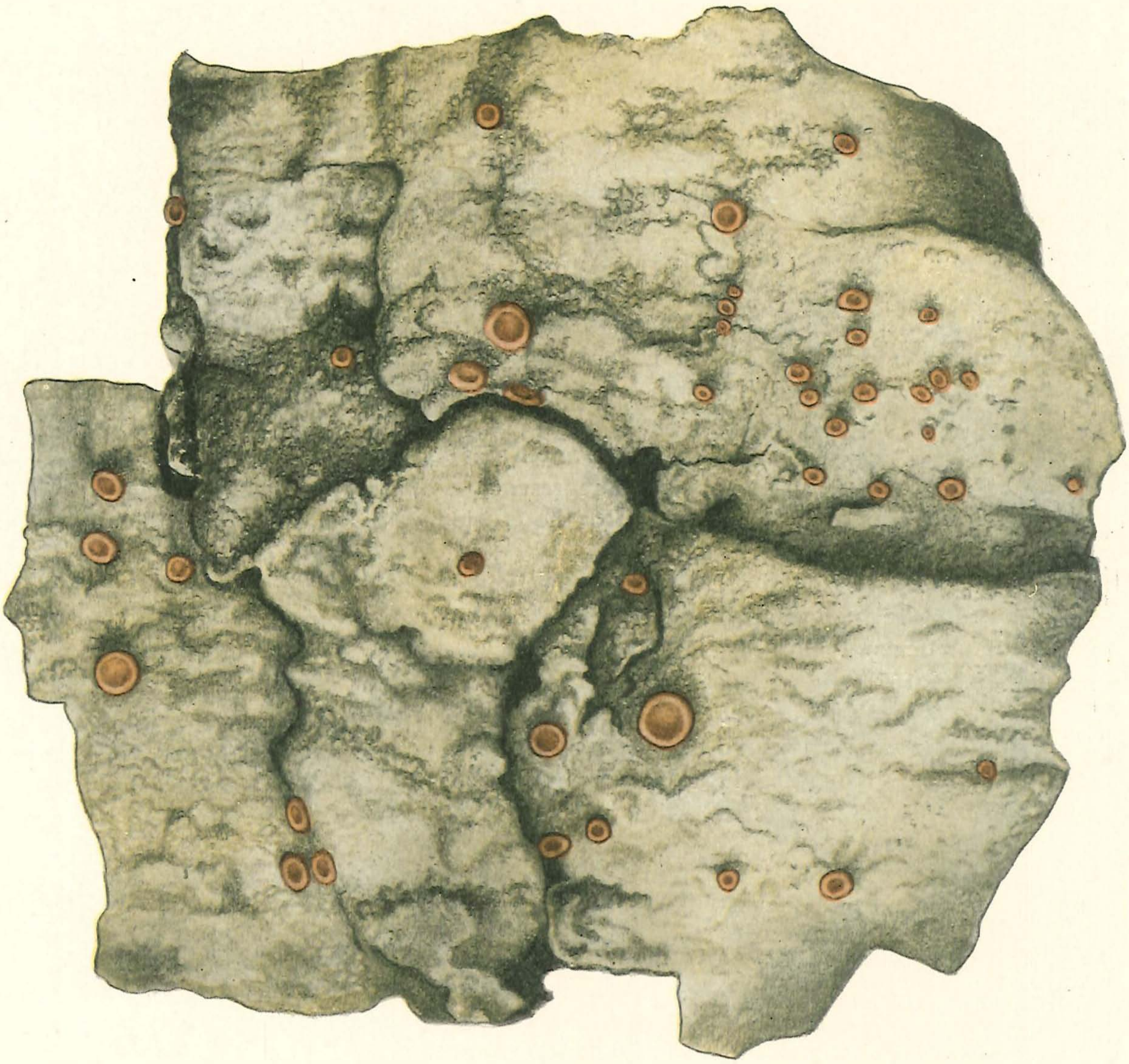


Fig. 35

O. Galløe del.

MICHROPHIALE DILUTA Pers.

PLATE 13.

MICROPHIALE DILUTA.

PERS.

Fig. 36. Above, section through the margin of the thallus; to the left is seen the colourless marginal mycelium. (×157). Below, section of a lamella of the periderm, covered on both sides by the thallus. (×105).

Fig. 37. Horizontal section of apothecium; the outer dark-shaded ring and the lighter ring inside it represent the calyx, in which are seen fairly numerous gonidia *(Chroolepus)*; accordingly, the apothecium is crypto-lecanorine. The remainder of the section, inside the calyx, represents the hymenium, in which transverse sections of asci may be noticed. On the outside of the calyx are two small portions of the thallus. (×157).

Fig. 38. Horizontal section of apothecium — as in Fig. 37 — but the section is cut on the borderline of hypothecium and hymenium, so that a small portion of the latter only appears. Most of the figure represents the crypto-lecanorine margin. (×157).

Fig. 39. Vertical section of apothecium with faintly convex disc and the crypto-lecanorine calyx. To the right in the apothecium the thallus is continued a little upwards alongside the calyx. (×157).

Fig. 40. Two apothecia with plane discs. (×157).

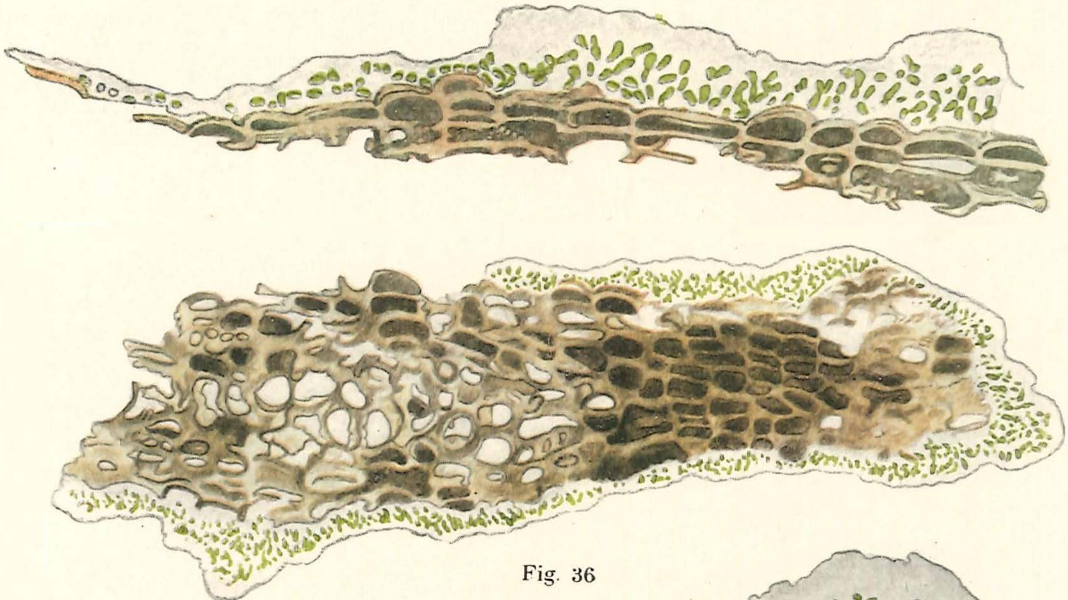


Fig. 36

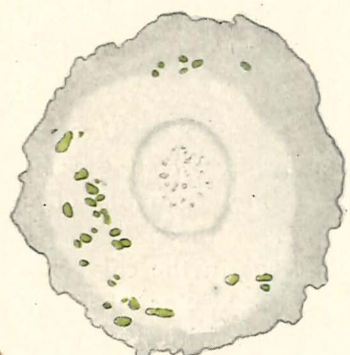


Fig. 37

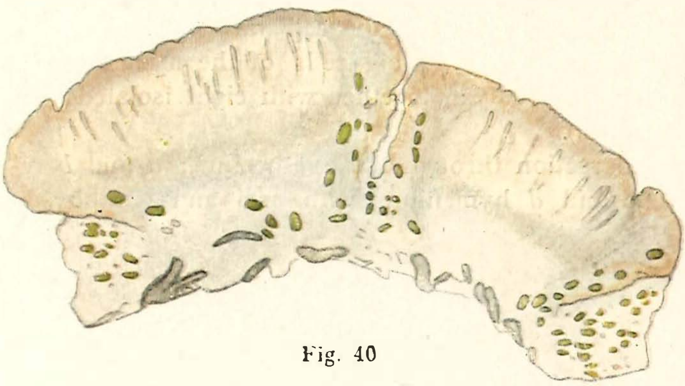


Fig. 40

Fig. 39

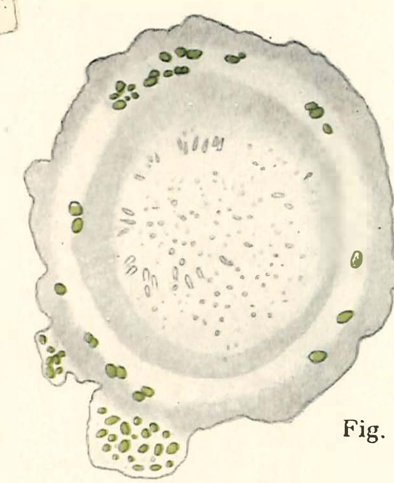


Fig. 38

O *Galløe del.*

MICROPHIALE DILUTA Pers.

PLATE 14.

MICROPHIALE DILUTA.

PERS.

Fig. 41. Section through margin of apothecium, from the base of stipes to epithecium. Below to the left are seen fragments of the cell walls of the substratum, possibly remnants of moss-leaves. Note the big cells of the hyphæ of the stipes and of the peripheral parts of the calyx, together with eight isolated cells of *Chroolepus* in the calyx itself. (×840).

Fig. 42. Sector of a horizontal section through the apothecium; *a* and *b* represent calyx with two gonidia; *c* and *d* hymenium with asci and paraphyses. (×840).

Fig. 41

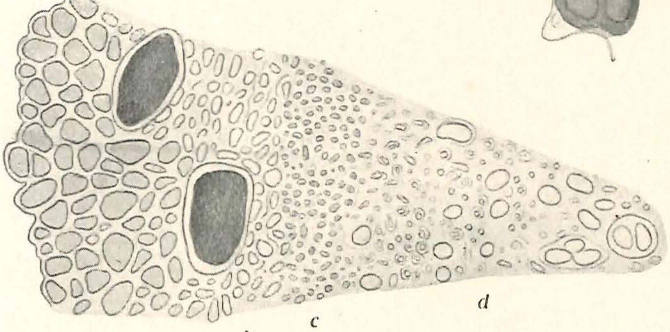


Fig. 42

O. Galløe del.

MICROPHIALE DILUTA Pers.

PLATE 15.

MICROPHIALE DILUTA.

PERS.

Fig. 43. Vertical section of thallus, with *Chroolepus*-gonidia and periderm-cells of the substratum plant. ($\times 840$).

Fig. 44. Surface-view of three pycnidia on the thallus. ($\times 105$). Below to the left five conidia. ($\times 840$).

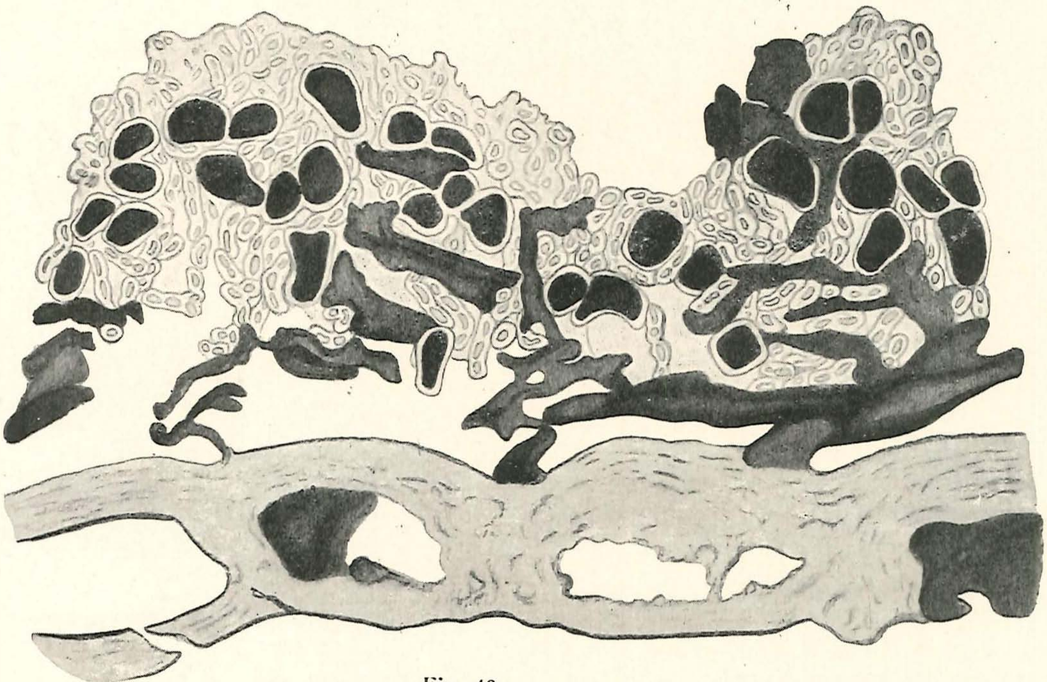


Fig. 43

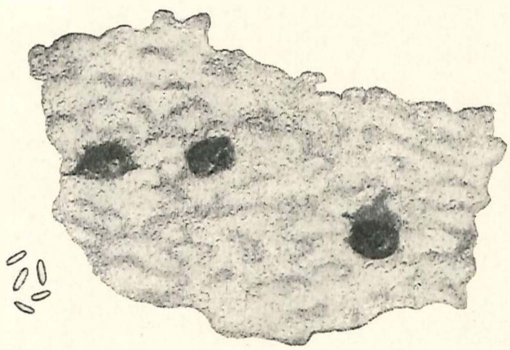


Fig. 44

O. Galløe del.

MICROPHIALE DILUTA Pers.

PLATE 16.

MICROPHIALE DILUTA.

PERS.

Fig. 45. Pycnide in vertical section. Above, the perithecial wall is dark. The ostiole is not yet visible. The majority of the conidia have fallen out by the cutting of the section. Otherwise, they are at first conglutinated to a compact mass. Whether later on they dry up and are blown away by the wind or washed away by the rain is unknown. (×840).

Fig. 46. Conidia bearing hyphæ; the two hyphæ below to the left have anastomosed. In one of the conidia a nucleus can be seen. (×1500).

Fig. 47. To the left and in the middle, asci with spores. To the right a portion of the hymenium with paraphyses and unripe asci. (×840).

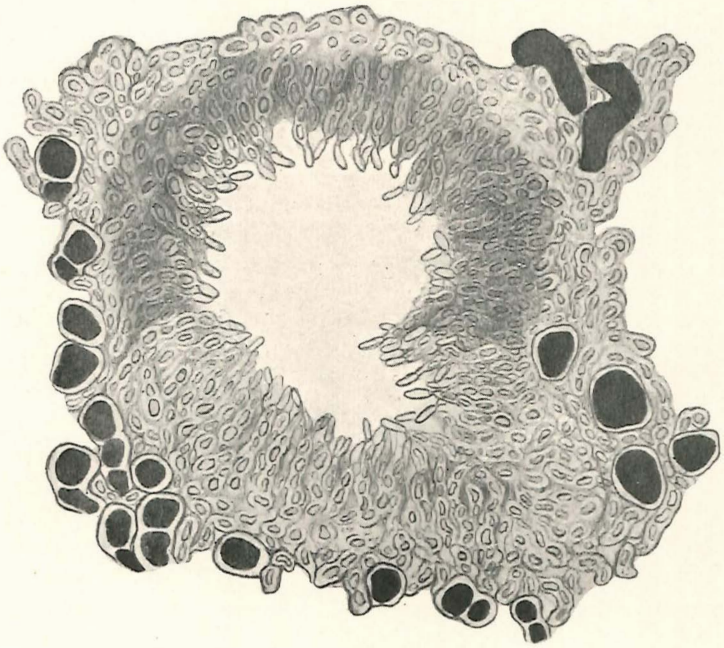


Fig: 45

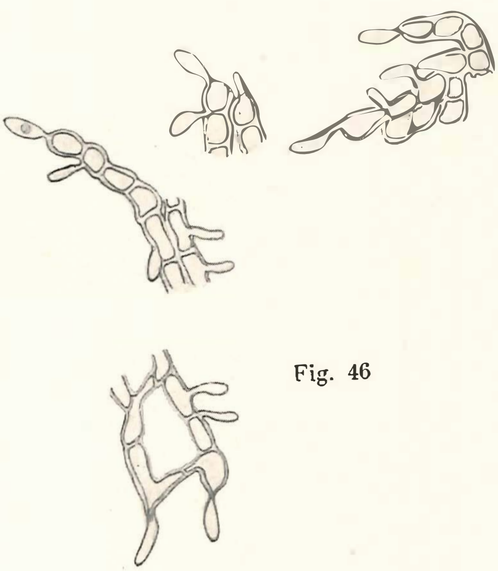


Fig. 46

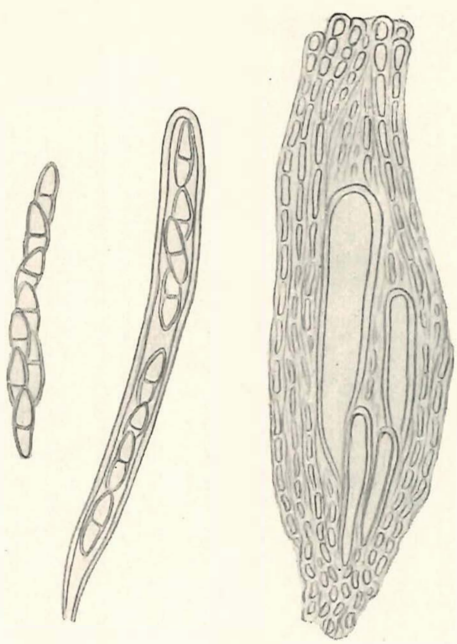


Fig. 47

O. Galløe del.

MICROPHIALE DILUTA Pers.

PLATE 17.

PACHYPHIALE CARNEOLA.

ACH.

Fig. 48. Thallus with apothecia of all ages. A dead apothecium is seen at *a*. ($\times$35).

Fig. 49. Thallus on the periderm, with an apothecium. ($\times$140).

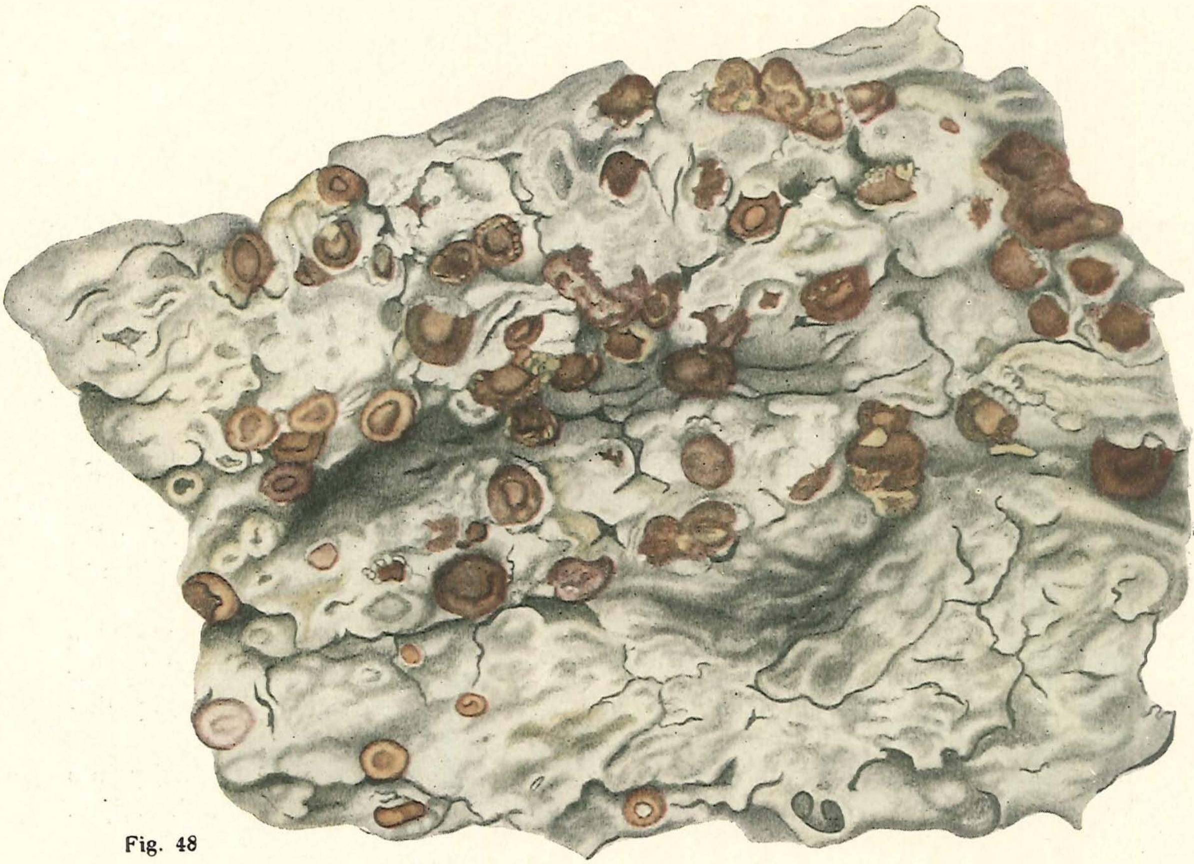


Fig. 48

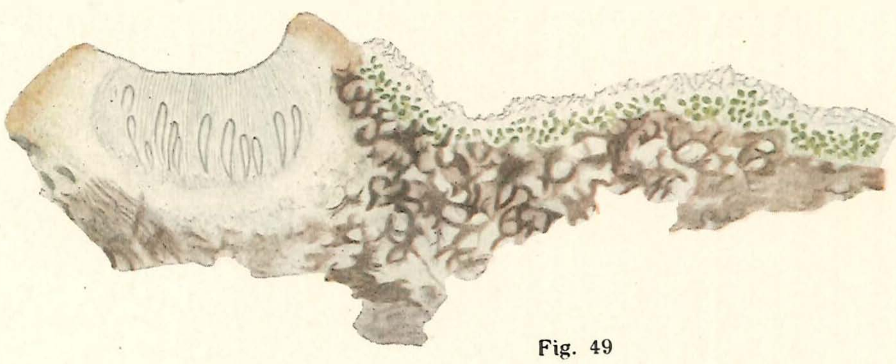


Fig. 49

O. *Galløe del.*

PACHYPHIALE CARNEOLA Ach.

PLATE 18.

PACHYPHIALE CARNEOLA.

ACH.

Fig. 50. Horizontal section through an apothecium, with gonidia in calyx, and also transverse section of asci. (×105).

Fig. 51. Six gonidia from the section shown in Fig. 50. They are embedded in the hyphæ of the calyx, which are seen in transverse section. (×840).

Fig. 52. Horizontal section of the same apothecium as shown in Fig. 50; the section is at a somewhat higher level in the apothecium, where the hymenium is broader. Gonidia are wanting. (×105).

Fig. 53. Above to the right a young apothecium is on the point of breaking through the thallus. Only the disc is visible, while the margin is covered by the thallus. To the left a dead and empty apothecium. To the right a young apothecium with remnants of thallus on the margin. (×105).

Fig. 54. Vertical section of an apothecium. Below, it merges gradually into the substratum, the remnants of which are mixed with the hyphæ of the stipes. (×157).

Fig. 55. Dead apothecium (compare Fig. 53). The hymenium is wanting; only the calyx remains; it is partly dark owing to intercellular air. In the calyx a number of gonidia (the black spots). (×157).

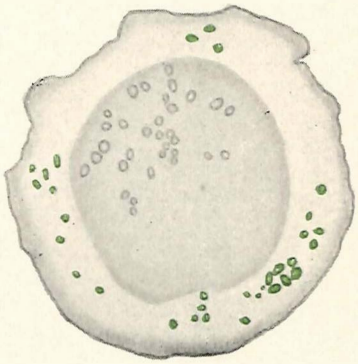


Fig. 50

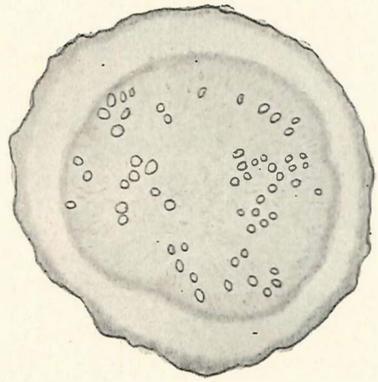


Fig. 52

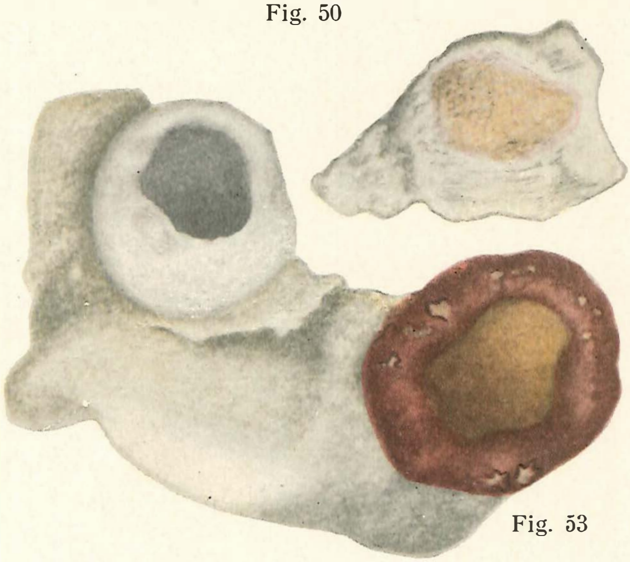


Fig. 53

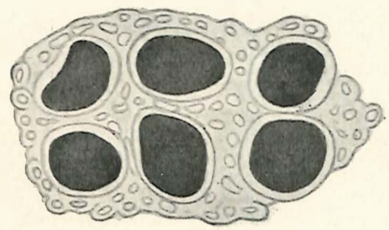


Fig. 51

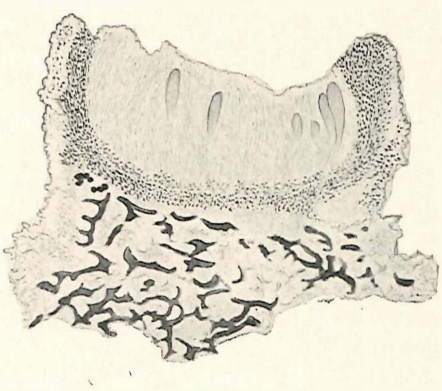


Fig. 54

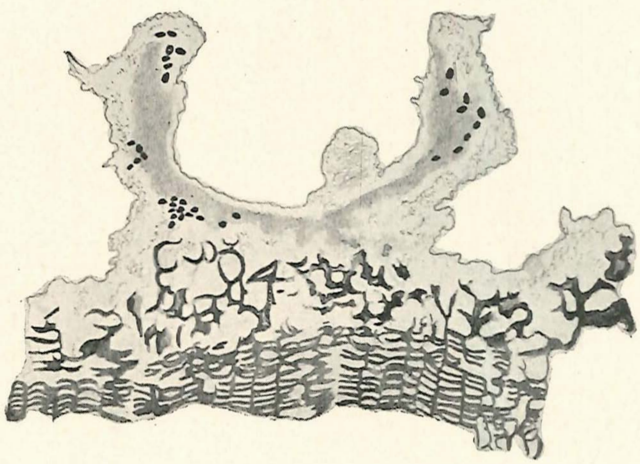


Fig. 55

O. Galløe del.

PACHYPHIALE CARNEOLA ACH.

PLATE 19.

PACHYPHIALE CARNEOLA.

ACH.

Fig. 56. Margin of apothecium. Below, a fragment of the periderm of the substratum, and also (to the left) gonidia in the calyx. Note how the paraphyses arise along the whole inside of the calyx. In the hymenium dark hyphæ of a presumably parasitic fungus. ($\times 840$).

Fig. 57. Section of hymenium (with two asci), the hypothecium (with distinct ascogenous hyphæ), and also calyx-stipes containing below fragments of the substratum. To the right of the section two ripe spores. The section is taken through the central parts of the apothecium. ($\times 840$).

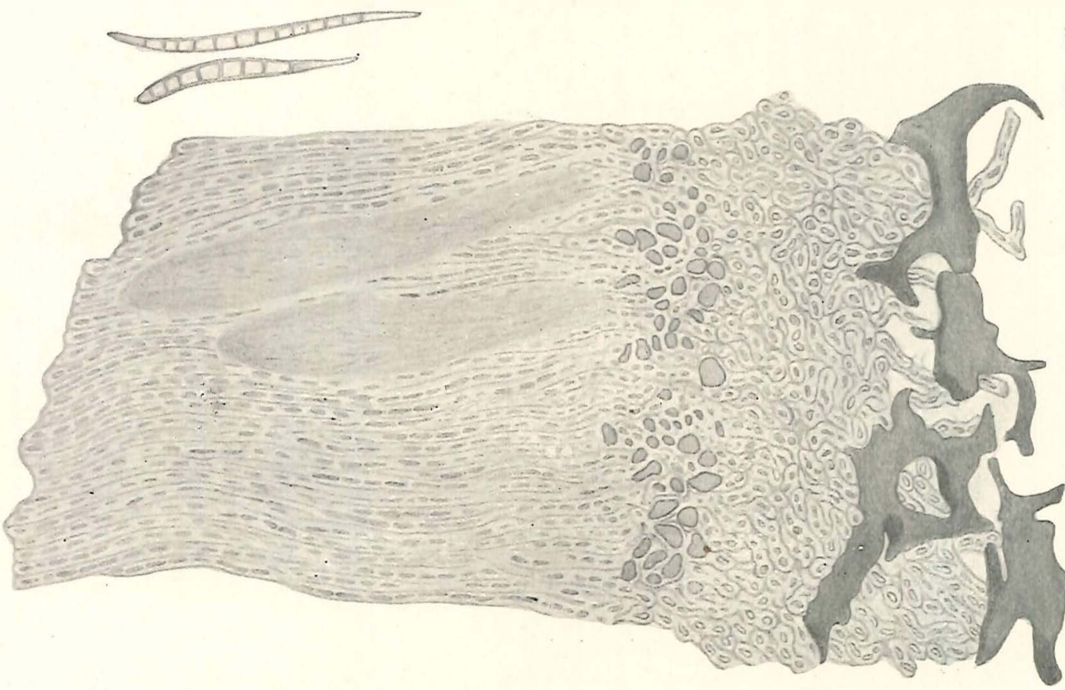


Fig. 57

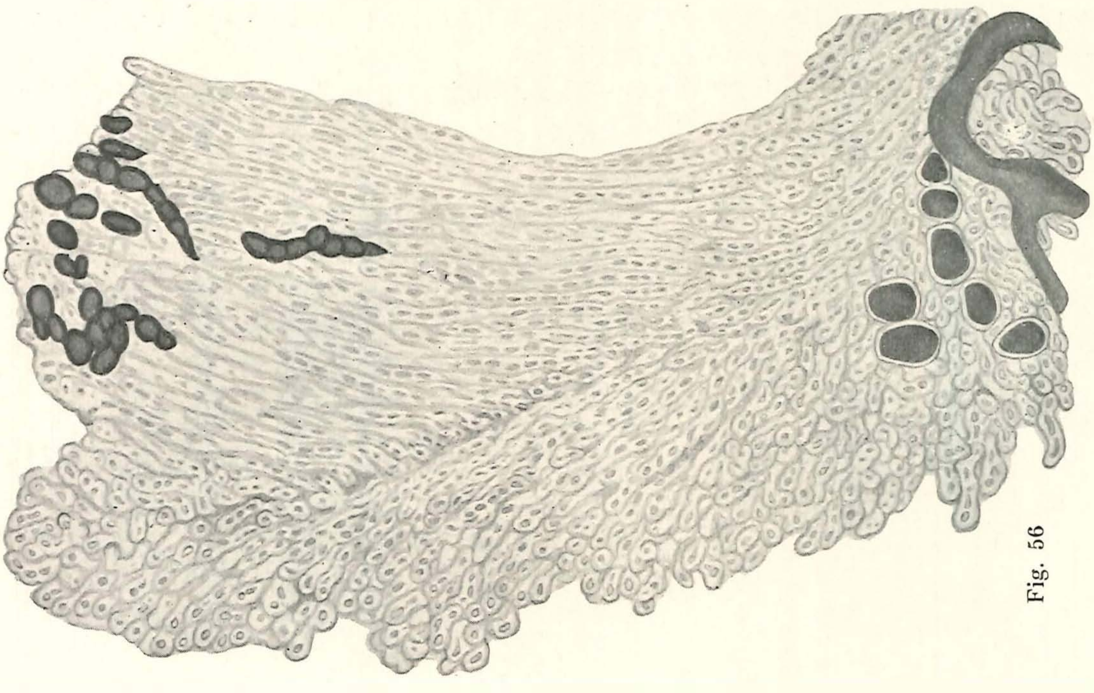


Fig. 56

O. Galløe del.

PACHYPHIALE CARNEOLA Ach.

PLATE 20.

PACHYPHIALE CARNEOLA.

ACH.

Fig. 58. Ripe ascus with spores. (×840).

Fig. 59. Portion of a horizontal section through the hymenium and the margin. Above *a* the peripheral cells of the margin containing the yellow pigment. Between *a* and *b* the more faintly coloured or entirely colourless part of the calyx. Between *b* and *c* the hymenium, with paraphyses and asci, in which the spores are seen in transverse section. (×840).

Fig. 60. Section of the thallus, with chroolepoid gonidia and fragments of the thallus. (×840).

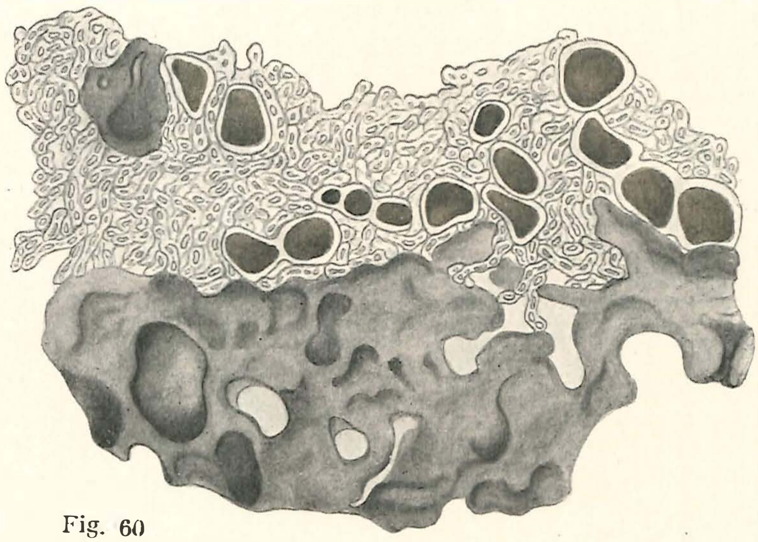


Fig. 60

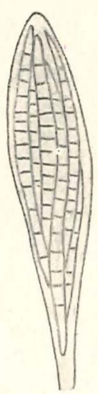


Fig. 58

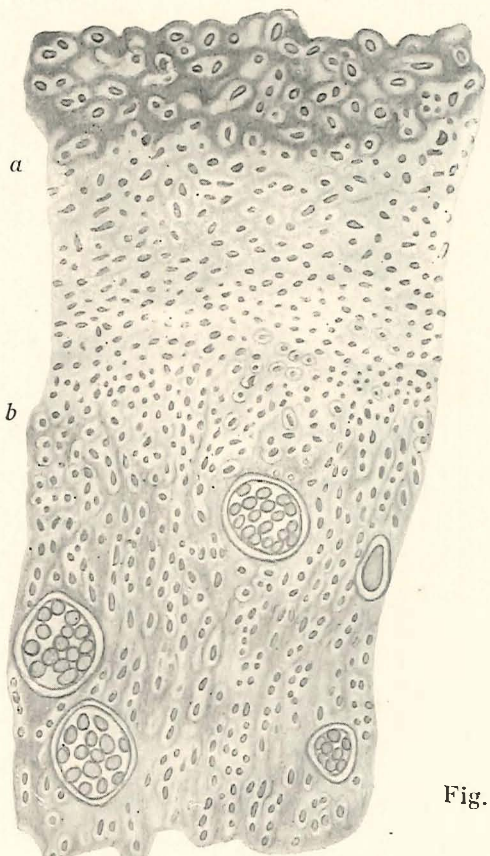


Fig. 59

O. Galløe del.

PACHYPHIALE CARNEOLA Ach.

PLATE 21.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

Fig. 61. Thallus with apothecia. ($\times 35$).
Fig. 62. Two apothecia, markedly urceolate in shape. ($\times 140$).

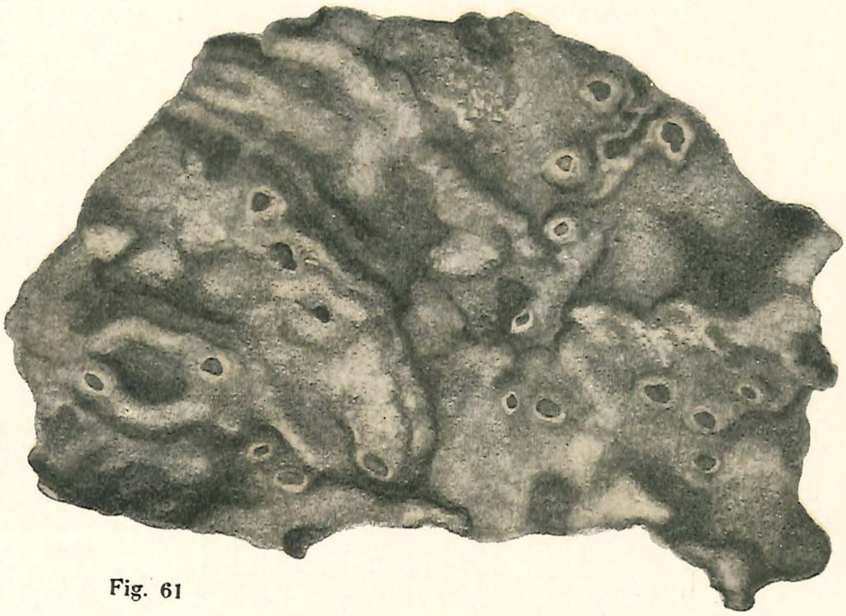


Fig. 61

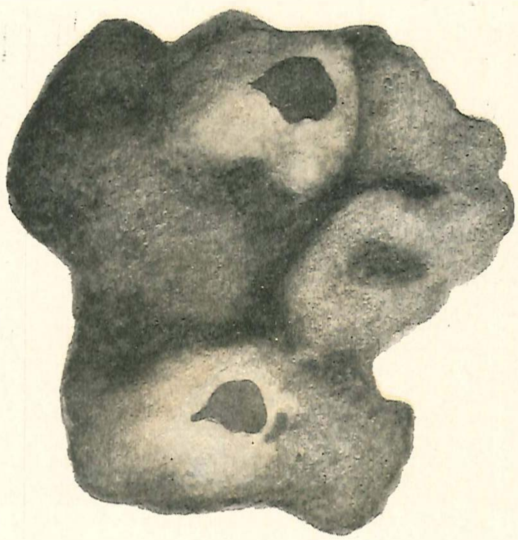


Fig. 62

O. Galløe del. BRYOPHAGUS GLOEOCAPSA NITSCHKE.

PLATE 22.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

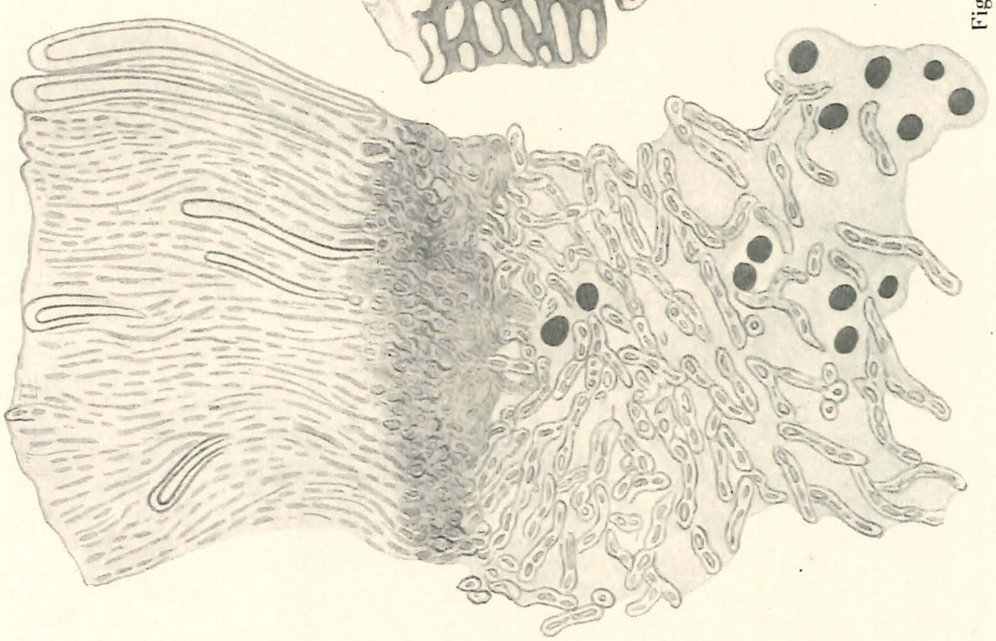
Fig. 63. Section of thallus and apothecium. To the left a fragment of a moss-leaf embedded in the thallus. The latter is markedly gelatinous. The gonidia (*Chroococcaceæ*) are artificially stained red for the sake of clearness (while the exciple of the apothecium is shown in its natural yellow colour). In the gelatine are scattered hyphæ spreading like a cobweb. (×157).

Fig. 64. Section of hymenium, hypothecium, and calyx, below merging insensibly into the hyphæ of the thallus. Among the hyphæ some cells of *Cyanophyceæ* are seen, the gelatine of which fills up the intercellular spaces between the hyphæ. (×840).

PLATE 22.

Fig. 63

Fig. 64



O. *Galløe del.*

BRYOPHAGUS GLOEOCAPSA NITSCHKE.

PLATE 23.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

Fig. 65. Portion of a horizontal section of the apothecium. Between *a* and *b* the peripheral part of the calyx (the margin), in which the hyphæ in part run concentrically round the apothecium. Between *b* and *c* the interior part of the calyx, in which the hyphæ are cut in transverse section. The rest of the section represents the hymenium with transverse section of paraphyses in the hymenial gelatine and transverse section of asci, one of which contains ripe spores. (×840).

Fig. 66. Vertical section through the margin of the apothecium and the adjacent parts of the thallus. (×840).

Fig. 67. Horizontal section of apothecium with surrounding thallus. Note the periclinal hyphæ in the periphery of the calyx. (×105).

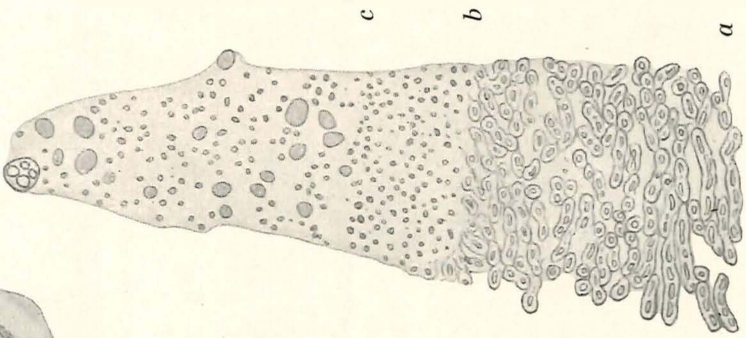


Fig. 65

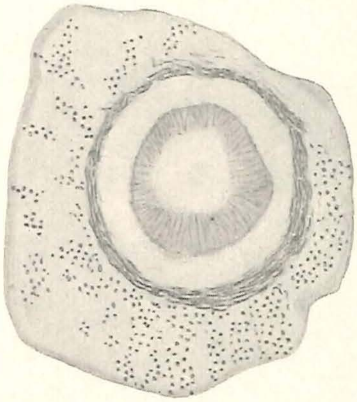


Fig. 67

Fig. 66

O. Galløe del.

BRYOPHAGUS GLOEOCAPSA NITSCHKE.

PLATE 24.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

Fig. 68. Ascus with spores, and paraphyses. (×840).

Fig. 69. Ripe spores. (×840).

Fig. 70. Vertical section of the surface of the thallus. At *a*, *b* and *c* particles of minerals, fallen as dust on the thallus. In addition, the gonidia are seen as dark spots, densely crowded below in the section. The hyphæ branch in the gelatine of the gonidia. (×840).

Fig. 71. Another portion of the thallus, in which the gonidia are considerably bigger. (×840).

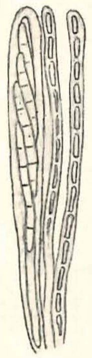


Fig. 68

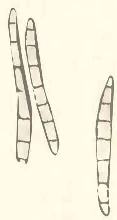


Fig. 69

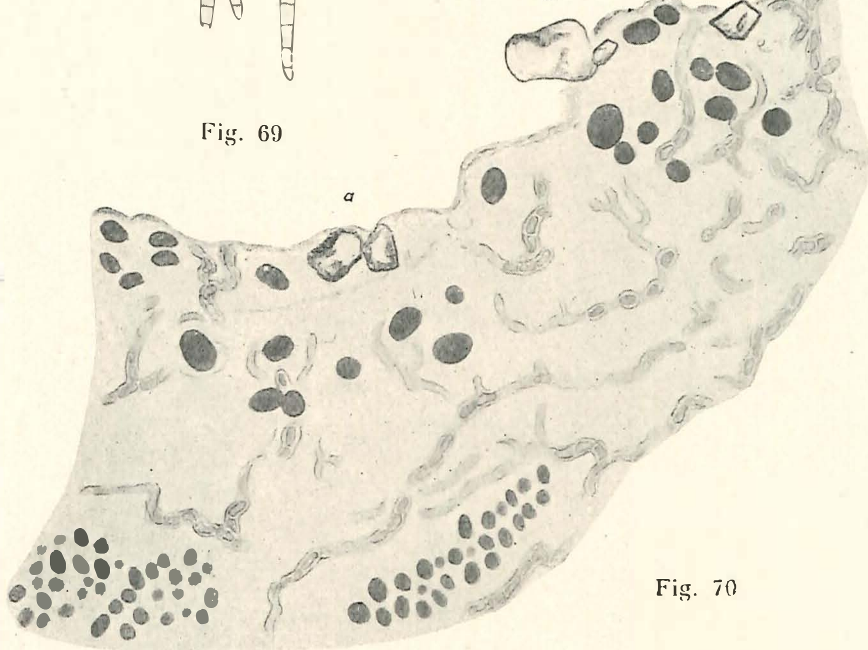


Fig. 70

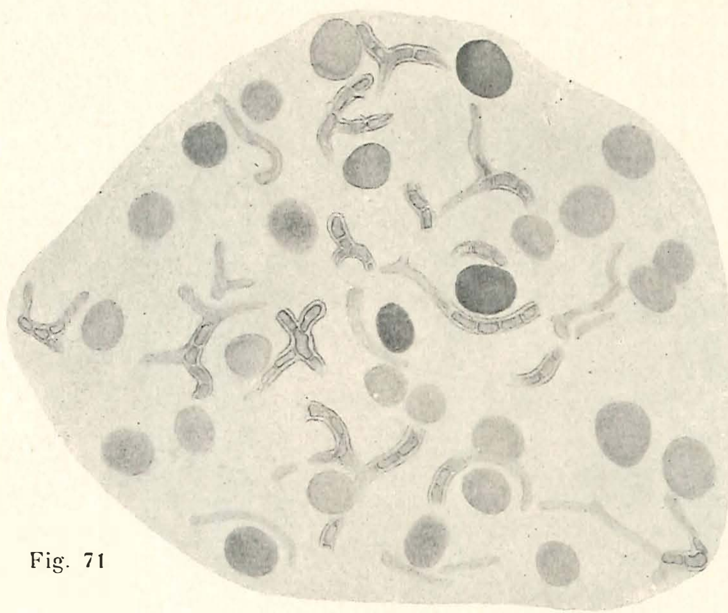


Fig. 71

O. Galløe del.

BRYOPHAGUS GLOEOCAPSA NITSCHKE.

PLATE 25.

BRYOPHAGUS GLOEOCAPSA.

NITSCHKE.

Fig. 72. A single isolated group of gonidia. (×840).

Fig. 73. Three different types of *Cyanophyceæ* observed in the thallus. The central one is very common; the two others are much rarer (×1185).

Fig. 74. Portion of the thallus, in which the walls of the gonidia are distinctly stratified. (×840).

Fig. 75. Peculiarly shaped hyphæ, of which one shows intercalary divisions. (×840).

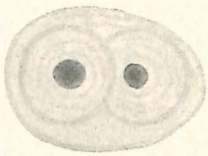


Fig. 72

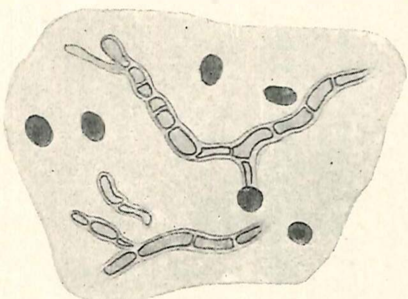


Fig. 75

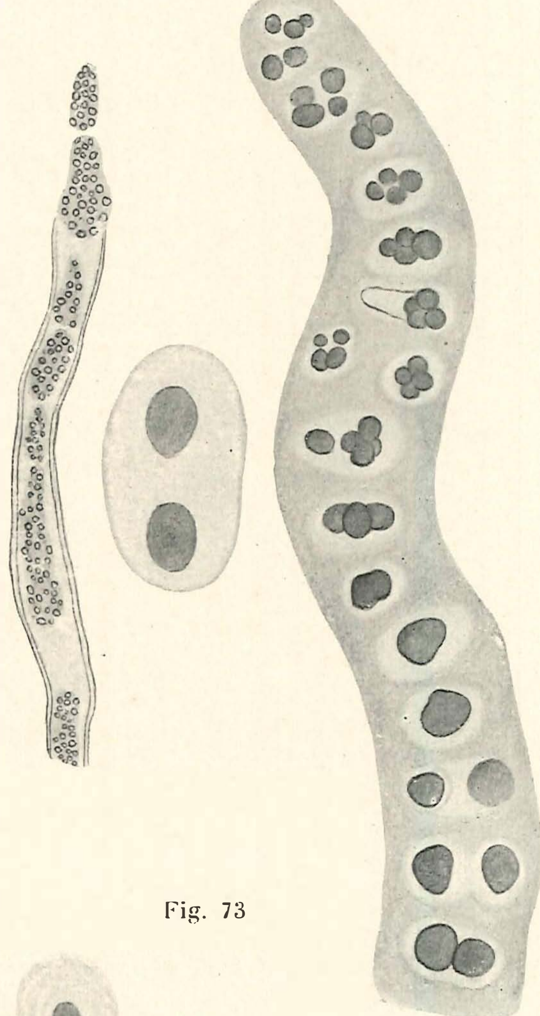
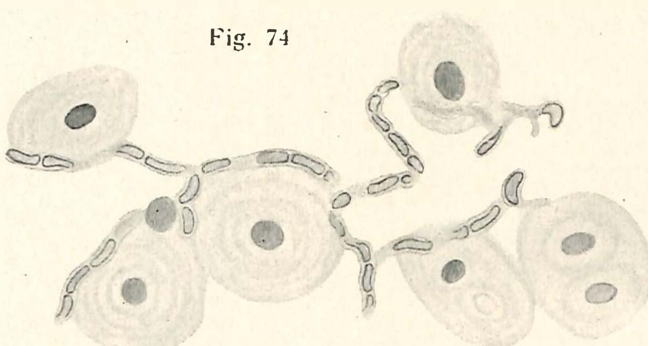


Fig. 73

Fig. 74



O Galløe del.

BRYOPHAGUS GLOEOCAPSA NITSCHKE.

PLATE 26.

BIATORELLA MORIFORMIS.
ACH.

Fig. 76. Thallus with apothecia, on oak-wood. ($\times 35$).

Fig. 76

O. Galløe del.

BIATORELLA MORIFORMIS ACH.

PLATE 27.

BIATORELLA MORIFORMIS.

ACH.

Fig. 77. Vertical section of apothecium and thallus. (×140).

Fig. 78. Horizontal section of thallus, cut parallel with the substratum. Most of the thallus is removed, but the remaining portion shows how the thallus is composed of granules with groups of gonidia. The outlines of the cells and pith-rays of the substratum are indistinguishable owing to their being partly lined with the hyphæ of the lichen. (×140).

Fig. 79. Transverse section of the oak-wood (in which the pith-rays and big vessels are discerned); the thallus of *Biatorella* is seen on its surface. The curved, thick lines on the surface of the thallus represent parts of the wood. (×140).

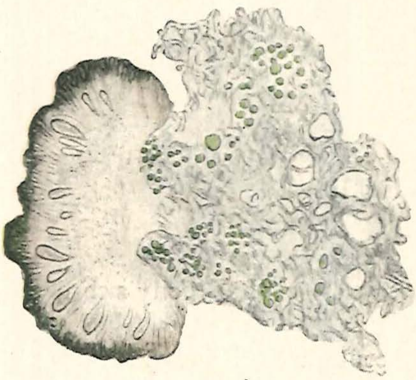


Fig 77

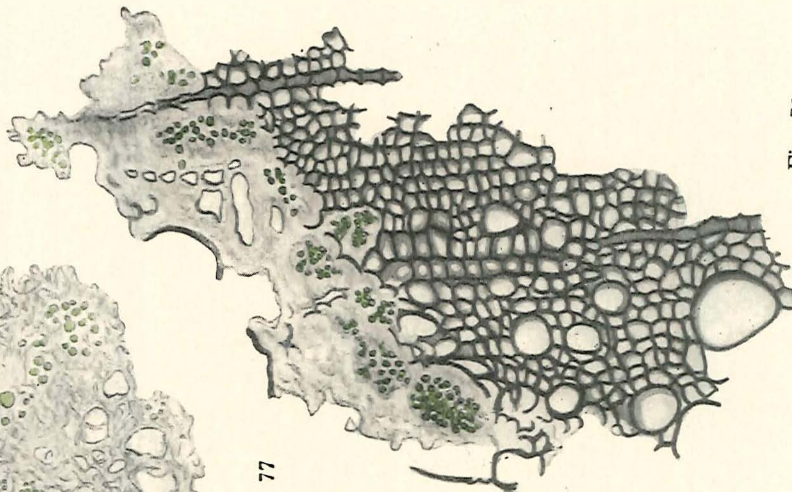


Fig. 79

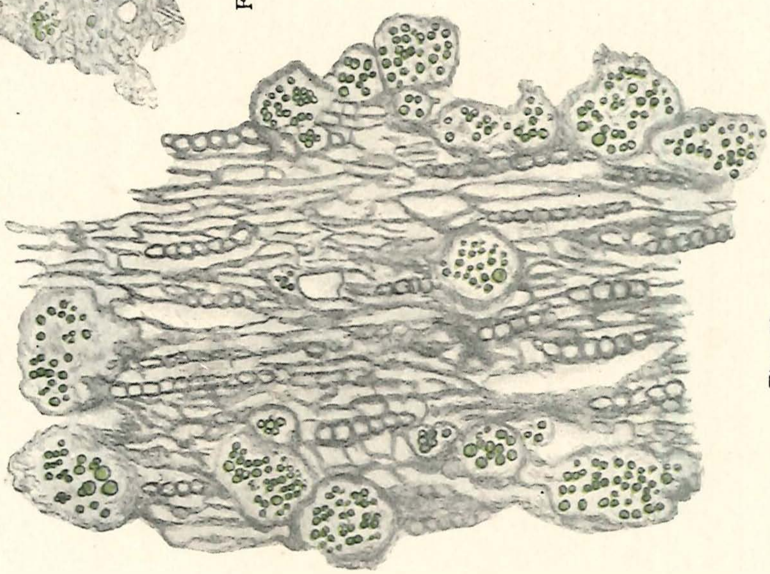


Fig. 78

O. Galløe del.

BIATORELLA MORIFORMIS Ach.

PLATE 28.

BIATORELLA MORIFORMIS.

Ach.

Fig. 80. Rhizoidal hyphæ in the interior of the cells of the woody substratum. (×840).

Fig. 81. Margin of the apothecium with adjacent thallus, in which four gonidia. (×840).

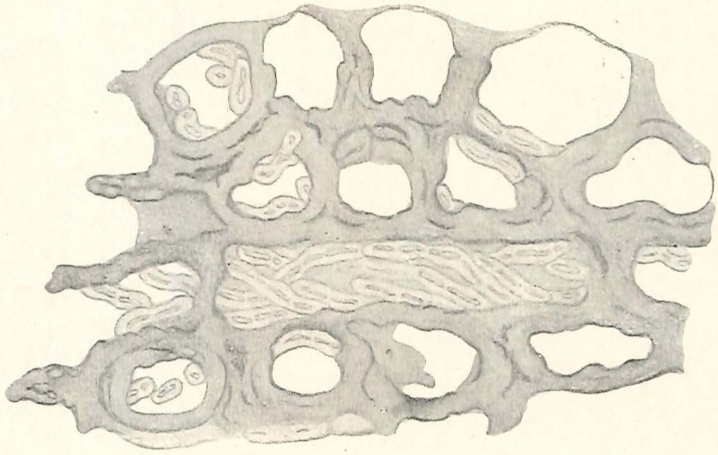


Fig. 80

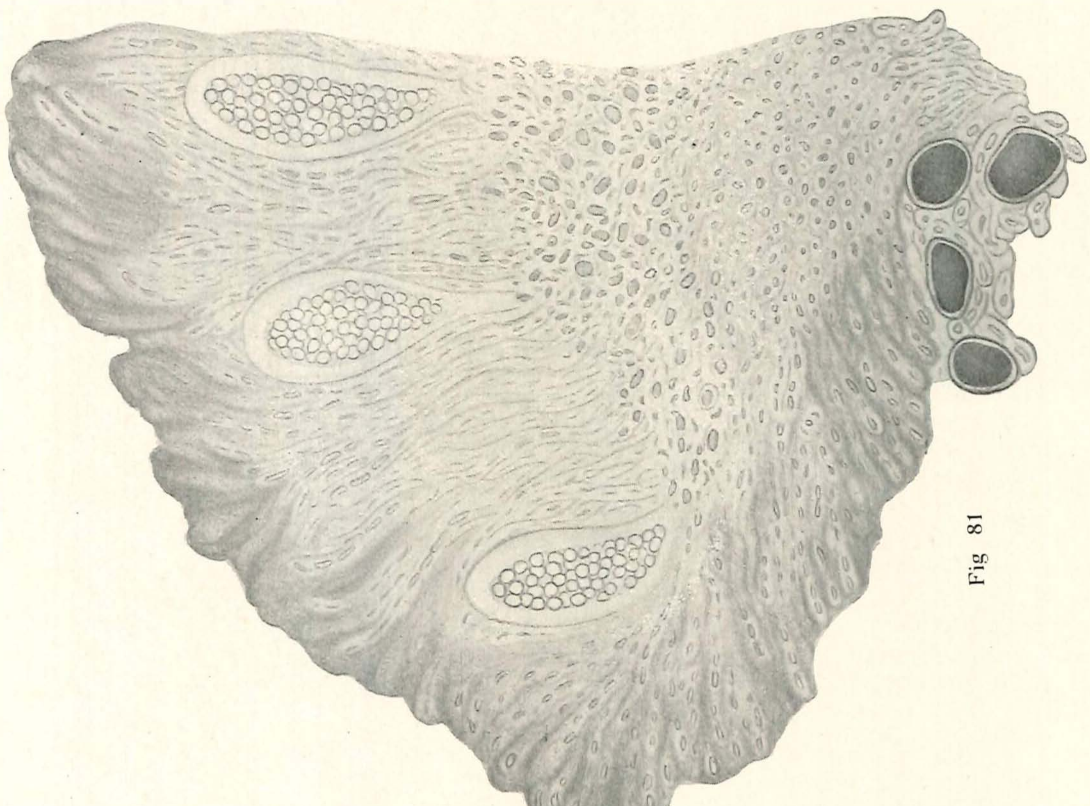


Fig 81

O. Galløe del.

BIATORELLA MORIFORMIS Ach.

PLATE 29.

BIATORELLA MORIFORMIS.

ACH.

Fig. 82. Horizontal section of the hymenium, with well developed hymenial gelatine, in which numerous paraphyses and also unripe and ripe asci are seen. (×840).

Fig. 83. Horizontal section of the thallus, with hyphæ and groups of gonidia. (×840).

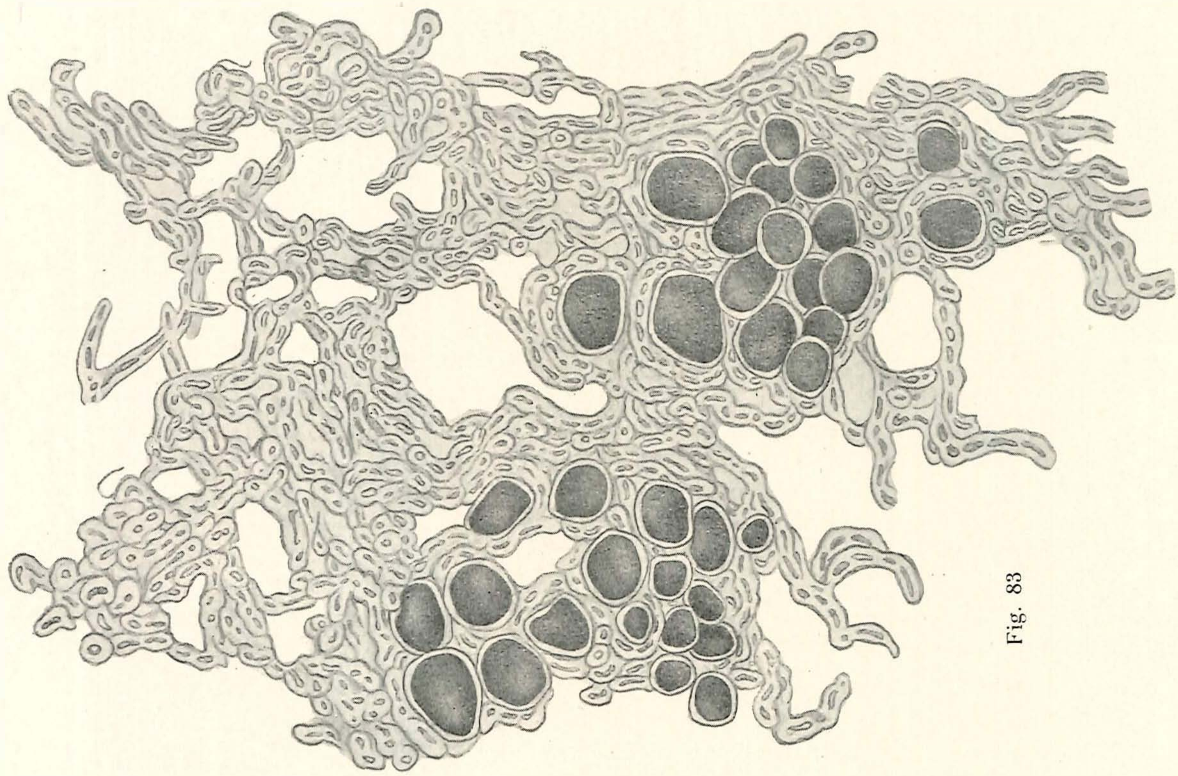


Fig. 83

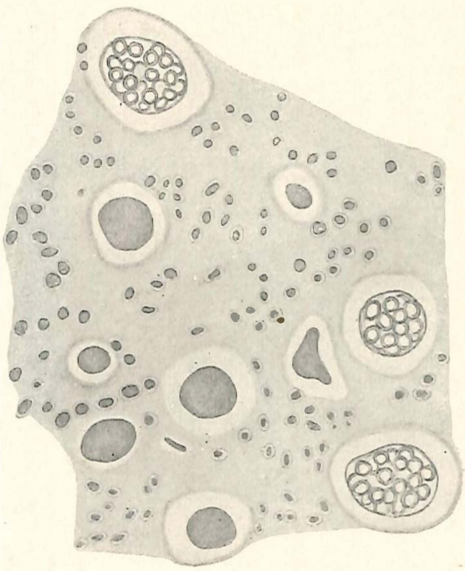


Fig. 82

O. Galløe del.

BIATORELLA MORIFORMIS Ach.

PLATE 30.

BIATORELLA (SARCOGYNE) PRUINOSA.

Sm.

Fig. 84. Thallus with apothecia. Above to the right and below to the left radiating, mycelial, marginal hyphæ. The thallus borders on an indeterminable sterile thallus of another crustaceous lichen. The struggle for space on the substratum has already begun where the two thalli are in direct contact with one another. The result of the competition cannot be seen at the present stage. (×35).

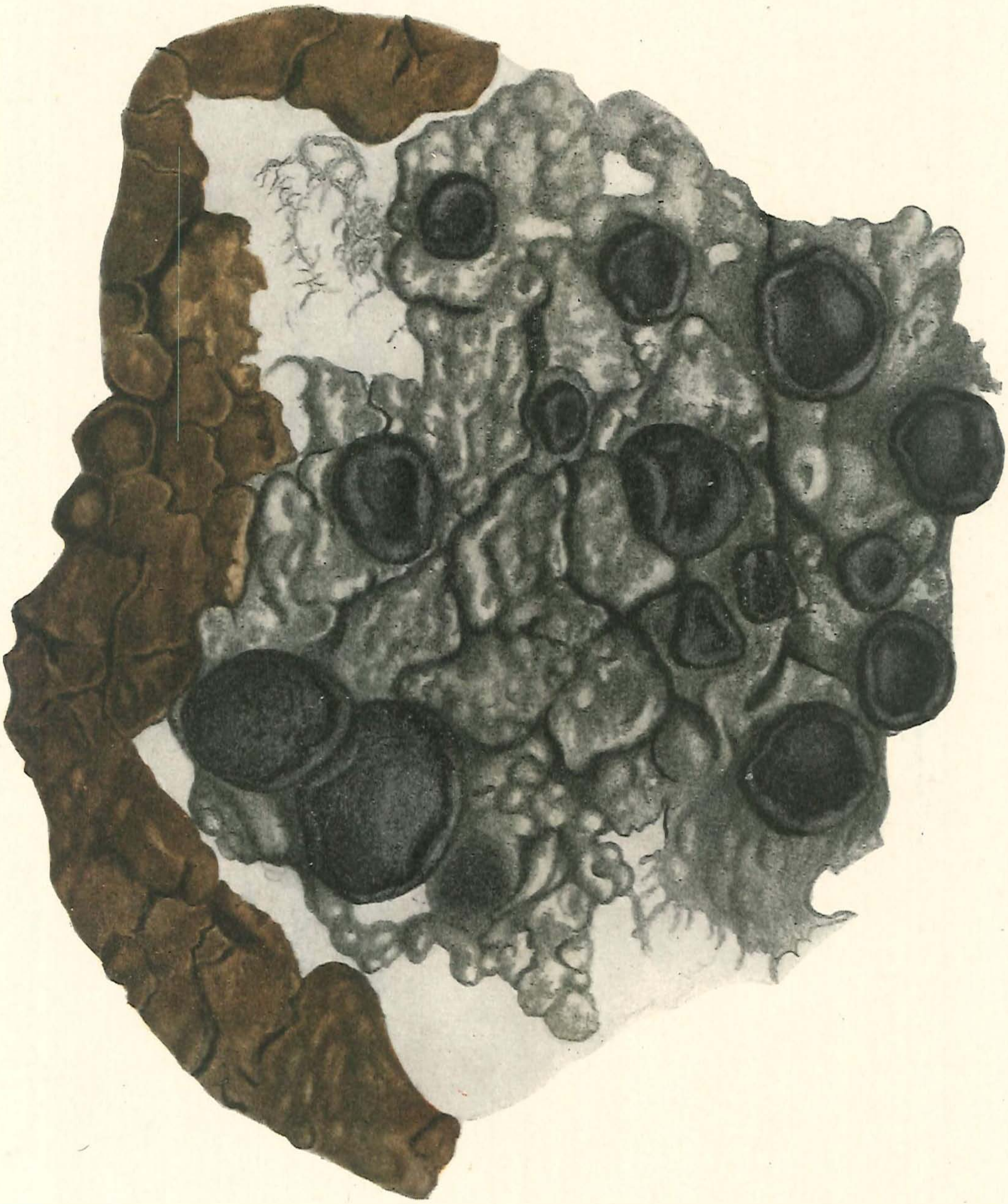


Fig. 84

O. Galløe del.

BIATORELLA (SARCOGYNE) PRUINOSA SM.

PLATE 31.

BIATORELLA (SARCOGYNE) PRUINOSA.

Sm.

Fig. 85. Section of two apothecia, both cut axially through the stipes. No gonidia occur below the apothecia, but considerable quantities of lime are found right up under the apothecia. (×105).

Fig. 86. Portion of areole; the natural surface of the side of the areole is to the right. Above to the right, on the margin of the areole, some brown foreign bodies are embedded in the cortex; below the latter a grain of lime-stone. Some single grains of lime-stone are likewise found under the gonidia. (×840).

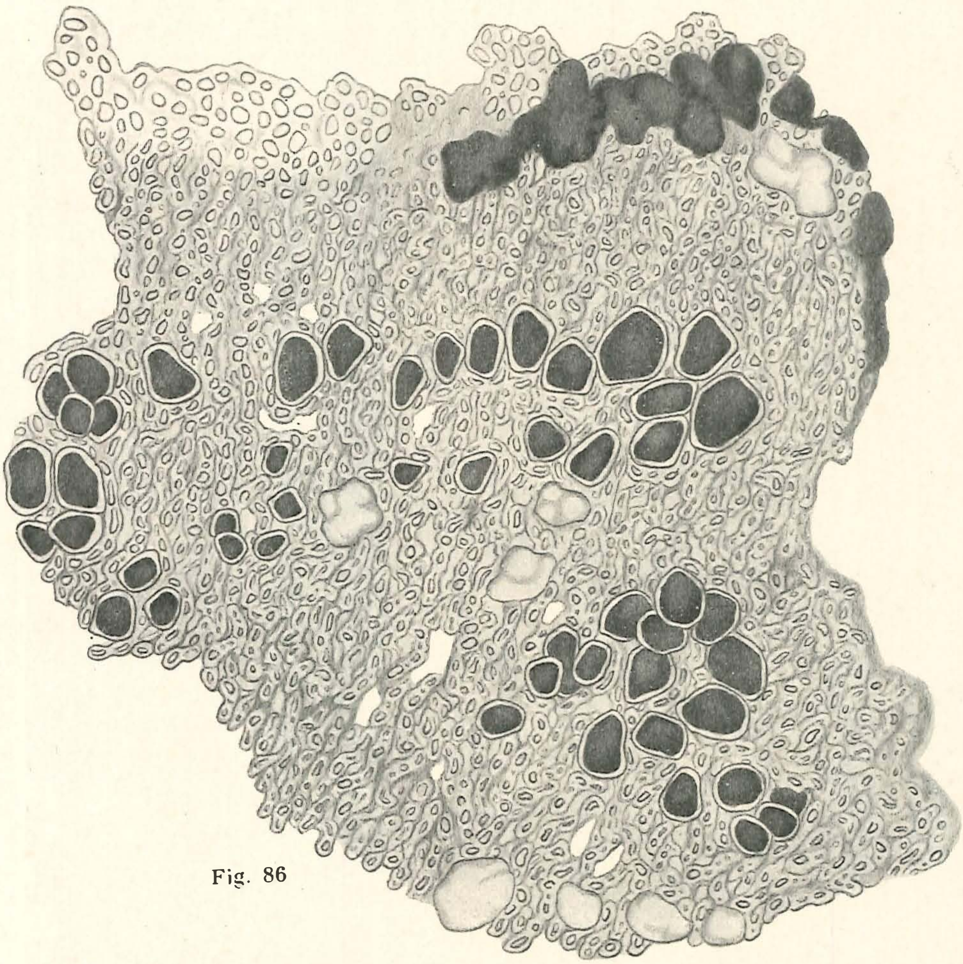


Fig. 86

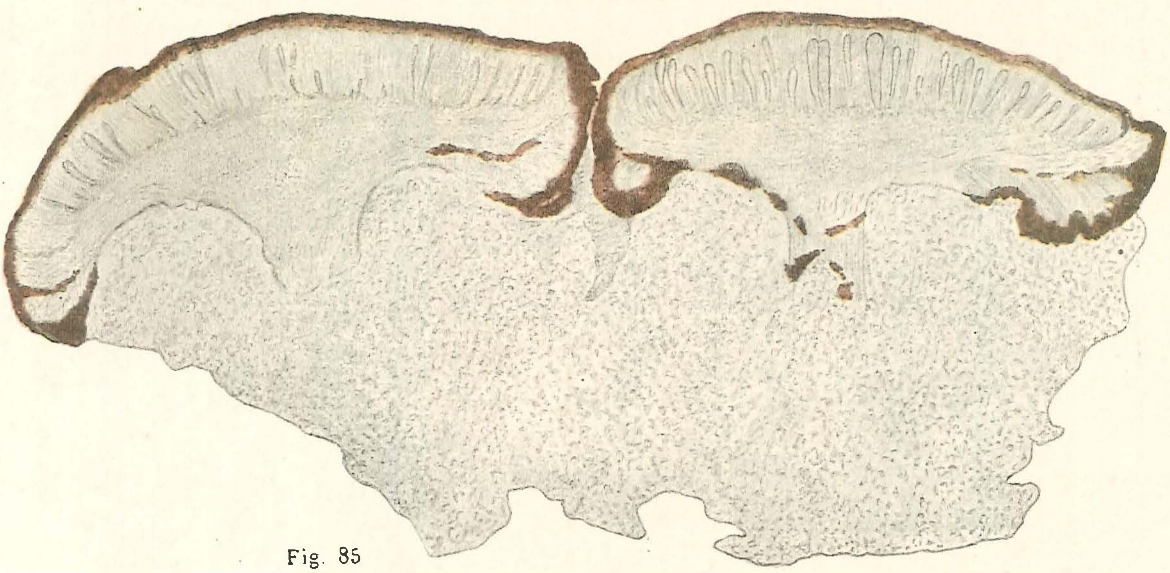


Fig. 85

O. Galløe del.

BIATORELLA (SARCOGYNE) PRUINOSA Sm.

PLATE 32.

BIATORELLA (SARCOGYNE) PRUINOSA.

Sm.

Fig. 87. Section of thallus and extra axial section of the apothecium (stipes is absent in the section). The grey zone below in the section represents grains of lime-stone, embedded in the medullary layer. ($\times 105$).

Fig. 88. Rhizoidal tissue, endolithic in the substratum. All the meshes of the tissue were filled with lime-stone, dissoluble in HNO_3. The hyphæ are partly small-celled, partly big-celled ('sphæroidal cells'). Above in the picture a group of gonidia. ($\times 840$).

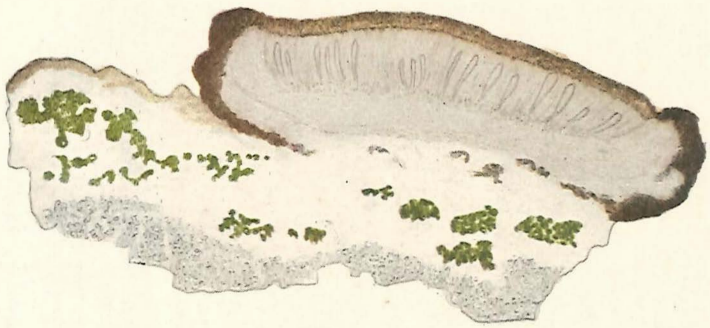


Fig 87

Fig. 88

O. Galløe del.

BIATORELLA (SARCOGYNE) PRUINOSA SM.

PLATE 33.

BIATORELLA (SARCOGYNE) PRUINOSA.

SM.

Fig. 89. Margin of the apothecium. The white masses in the calyx are limestone. ($\times$840).

Fig. 90. Portion of hymenium with two ripe asci and one unripe one. Below these the hypothecium with distinct cell-lumina. To the right four ripe spores. ($\times$840).

Fig. 91. To the left, portion of calyx, the apical cells of which are coloured dark (brown) from a pigment deposited in the periphery of the walls of the hyphæ. To the right, analogous bigger hyphæ from the inferior part of calyx, near the surface of the thallus. ($\times$840).

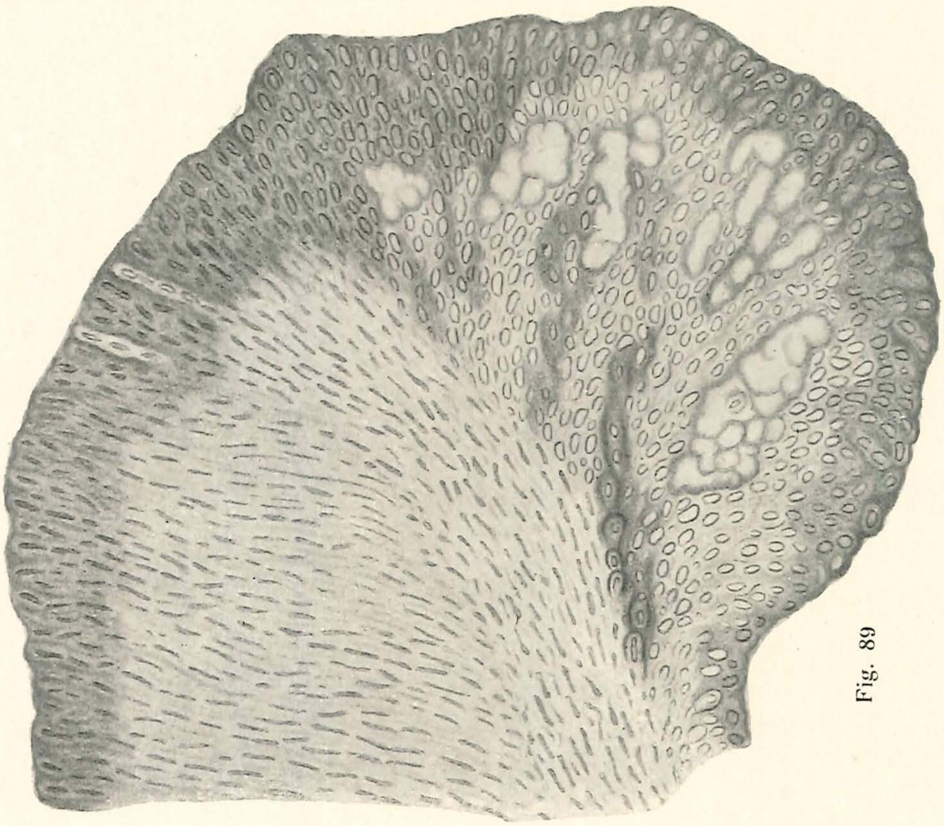


Fig. 89

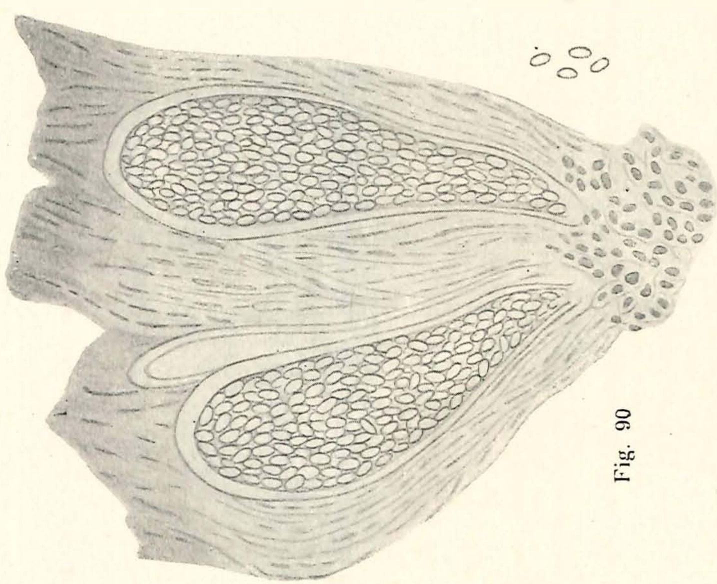


Fig. 90

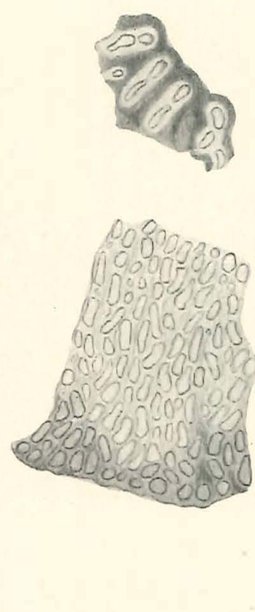


Fig. 91

O. *Galløe* del.

BIATORELLA (SARCOGYNE) PRUINOSA SM.

PLATE 34.

BIATORELLA (SARCOGYNE) SIMPLEX.

BR. & ROSTR.

Fig. 92. Thallus with apothecia of all ages. The naked substratum is seen between the areoles. (×35).

Fig. 93. Group of apothecia. (×35).

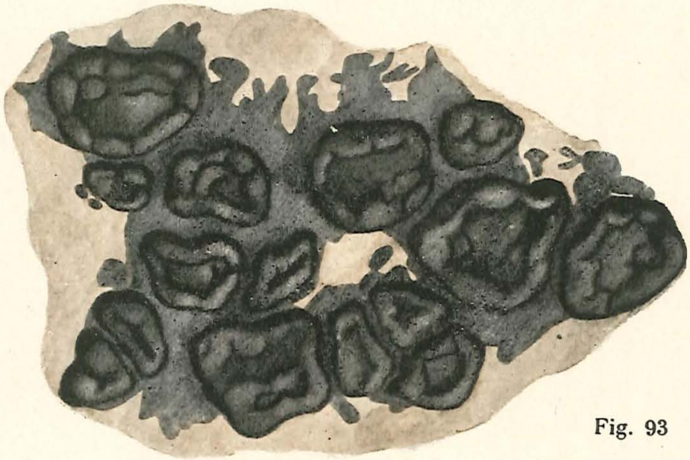


Fig. 93

Fig. 92

O. Galløe del.

BIATORELLA (SARCOGYNE) SIMPLEX Br. & Rostr.

PLATE 35.

BIATORELLA (SARCOGYNE) SIMPLEX.

BR. & ROSTR.

Fig. 94. Young apothecium with surrounding thallus. (×105).

Fig. 95. Areole from the thallus. To the rigth in the figure it borders on another areole. (×840).

Fig. 96. Apothecium and thallus. (×105).

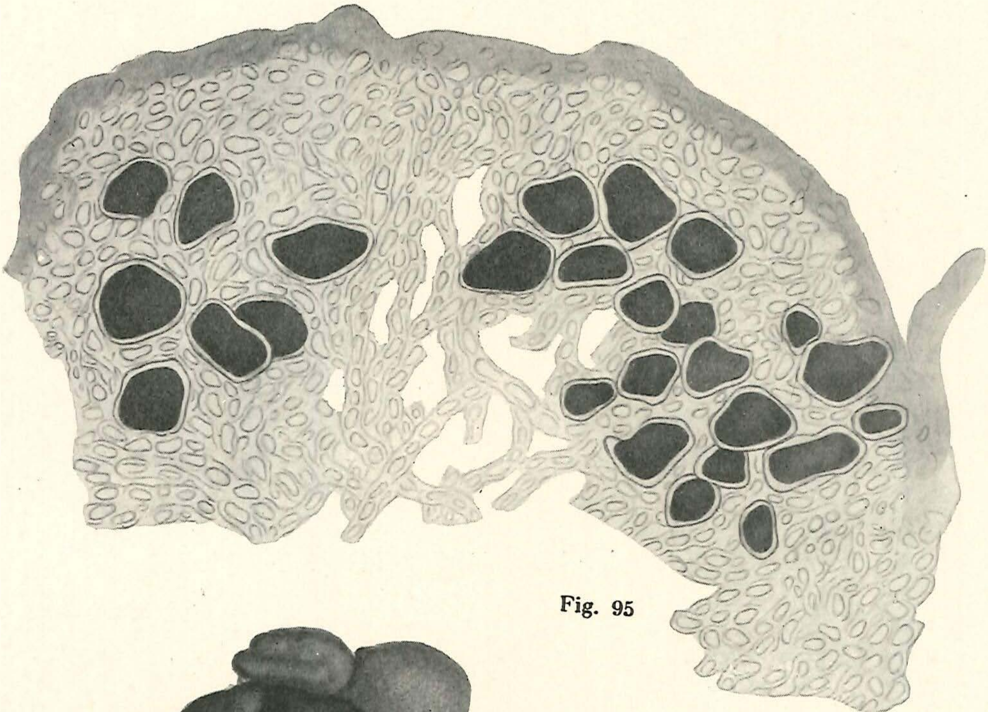


Fig. 95

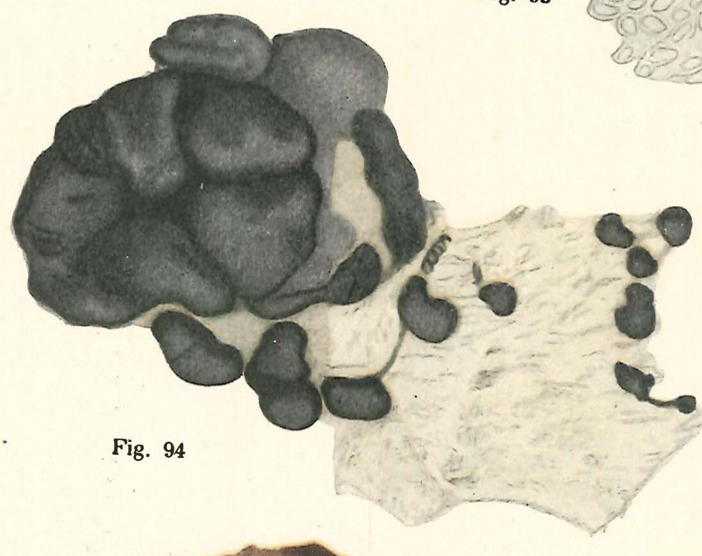


Fig. 94

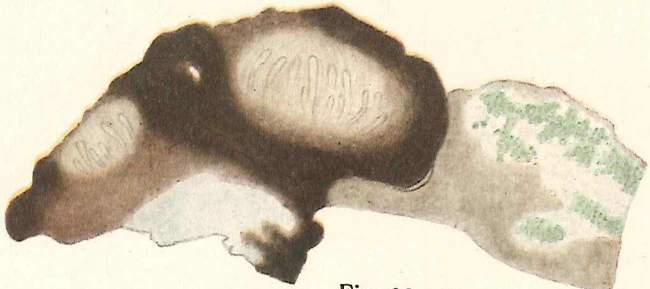


Fig. 96

O. Galløe del.

BIATORELLA (SARCOGYNE) SIMPLEX Br. & Rostr.

PLATE 36.

BIATORELLA (SARCOGYNE) SIMPLEX.

BR. & ROSTR.

Fig. 97. Section of apothecium. Between the two parts of the hymenium a brownish tissue, viz. a bend of the calyx projecting towards the centre of the apothecium, thus dividing the hymenium into two parts. Stipes is partly cut away at the base. (×105).

Fig. 98. Apothecium with almost entire stipes. Here also, the hymenium is divided into several parts. (×105).

Fig. 99. Margin of apothecium. Calyx is somewhat different in structure in the interior parts next to the hypothecium, and in the more peripheral parts (below to the left in the figure). To the right an ascus and isolated spores. (×840).

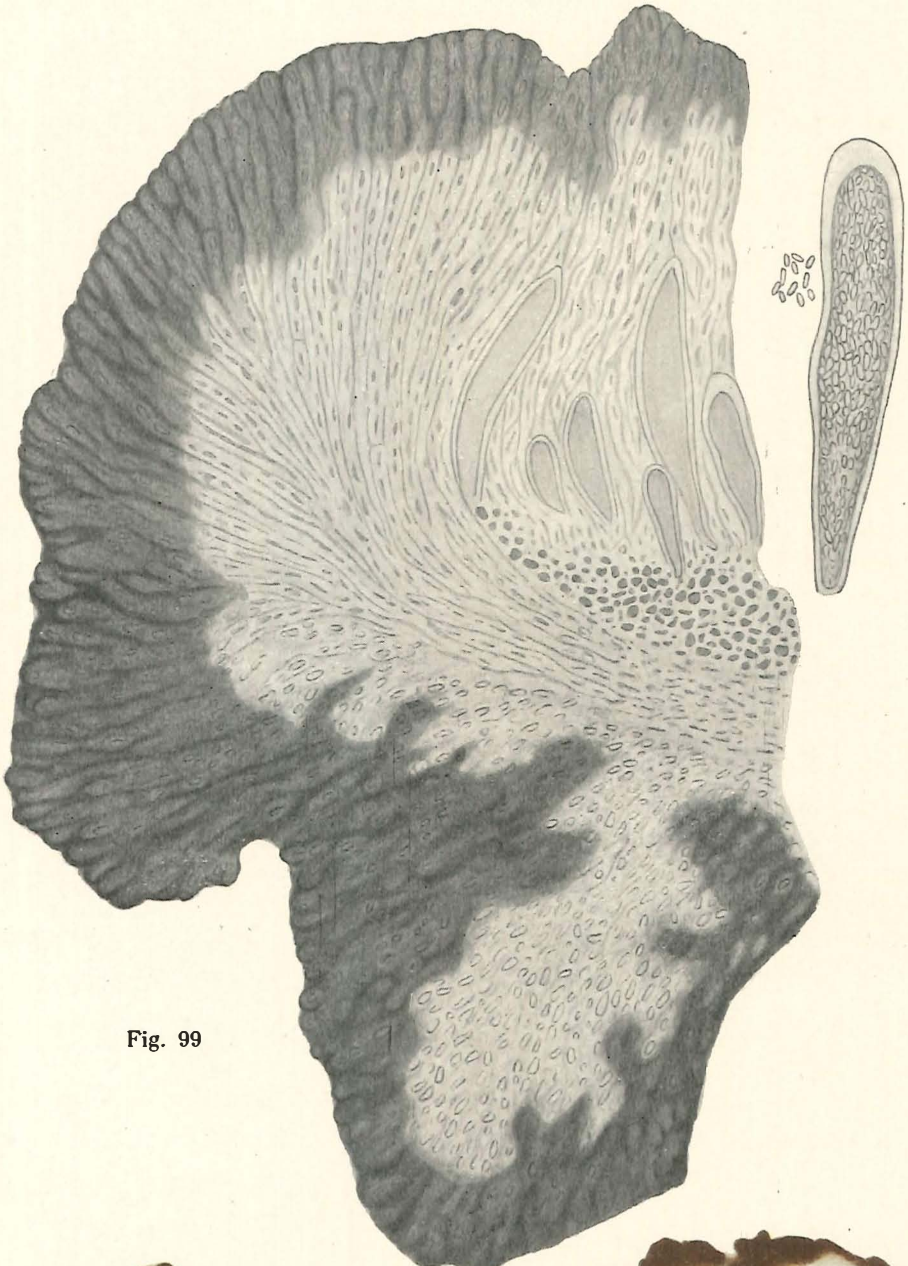


Fig. 99

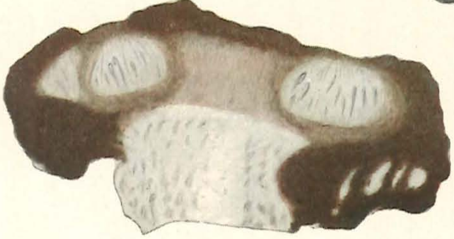


Fig. 97

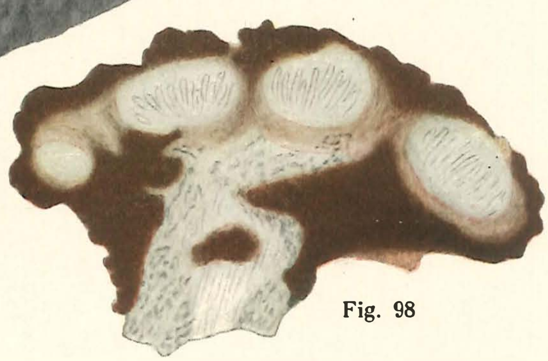


Fig. 98

O. *Galløe del.*

BIATORELLA (SARCOGYNE) SIMPLEX Br. & Rostr.

PLATE 37.

BIATORELLA (SARCOGYNE) SIMPLEX.

Br. & Rostr.

Fig. 100. Parallel hyphæ from the stipes. Between them narrow intercellular spaces. (×1120).

Fig. 101. Apical hyphæ from the margin. The pigment is deposited in the peripheral parts of the walls of the hyphæ. (×1120).

Fig. 102. Paraphyses. (×1120).

Fig. 103. Gonidia and hyphæ from the gonidial layer. (×1120).

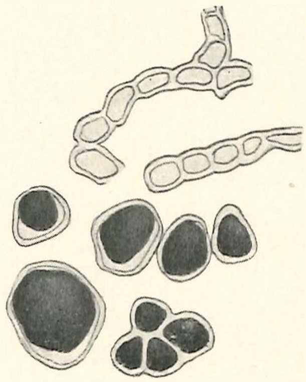


Fig. 103

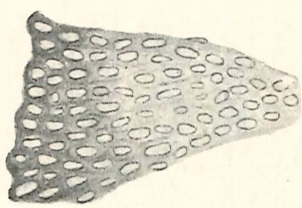


Fig. 101

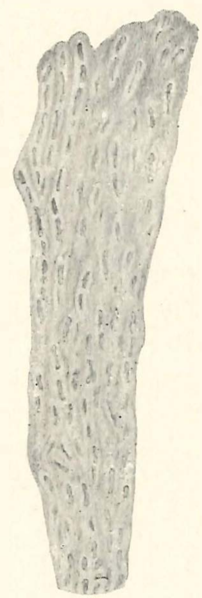


Fig. 102

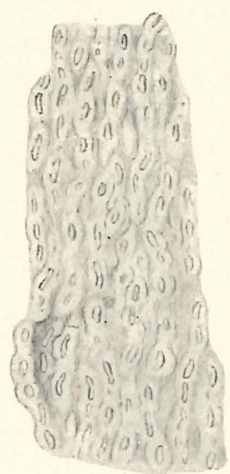


Fig. 100

O. Galløe del.

BIATORELLA (SARCOGYNE) SIMPLEX Br. & Rostr.

PLATE 38.

BIATORELLA (SARCOGYNE) CLAVUS.
Dc.

Fig. 104. Apothecia, growing among moss. ($\times 22$).

Fig 104

O. Galløe del. BIATORELLA (SARCOGYNE) CLAVUS Dc.

PLATE 39.

BIATORELLA (SARCOGYNE) CLAVUS.

Dc.

Fig. 105. Vertical section of apothecium. The two dark portions in the hymenium represent bends from the margin. (×37).

Fig. 106. Vertical section of apothecium, with well-preserved stipes. Note the dark, peripheral tissues in stipes and calyx, figured separately in Fig. 107. The dark spots above in the calyx represent groups of crystals (vide Fig. 109). The direction of growth of the hyphæ in stipes-calyx is indicated in the figure. The hypothecium and the hymenium are faintly yellowish. (×37).

Fig. 107. Portion of stipes in longitudinal section. To the left the parallel, longitudinal hyphæ (colourless), forming outwards towards the surface a cortex of horizontal, dark, blackish-brown hyphæ, the pigment of which is deposited in the outer layers of the cell-walls. Above to the right, such a hypha in transverse section. The margin of the calyx is everywhere composed of hyphæ of this type. (×840).

Fig. 108. To the left a ripe ascus. In the centre, above a transverse section of ascus with surrounding paraphyses, below an unripe ascus. To the right, portion of the hymenium with paraphyses, the tips of which are transformed into a colourless cuticle. (×840).

Fig. 109. Group of crystals among hyphæ of the calyx. (×840).

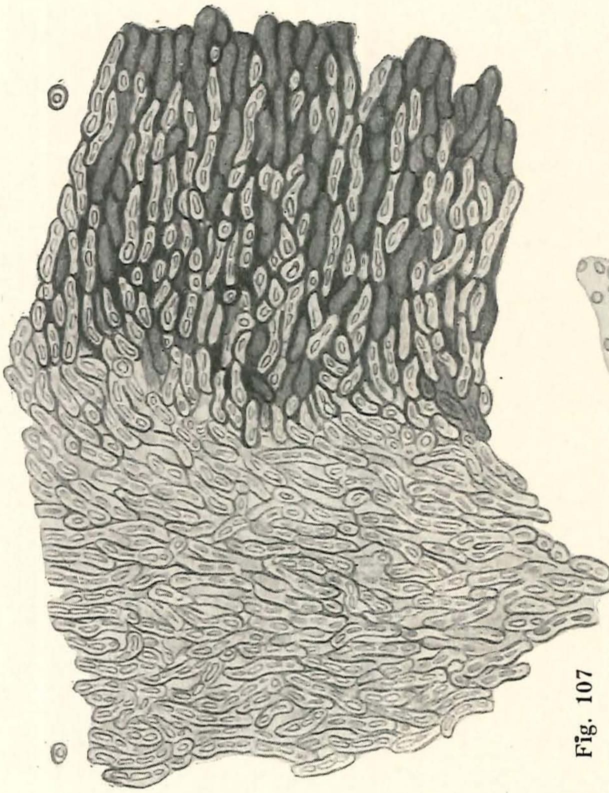


Fig. 107

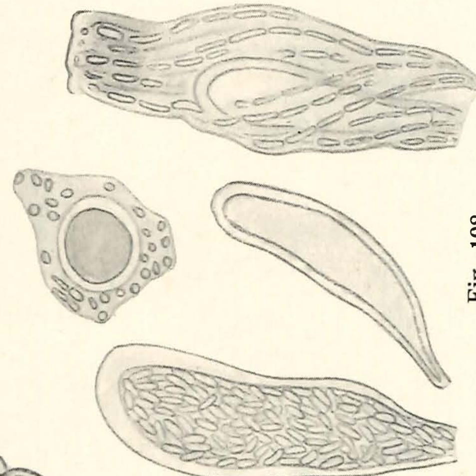


Fig. 108

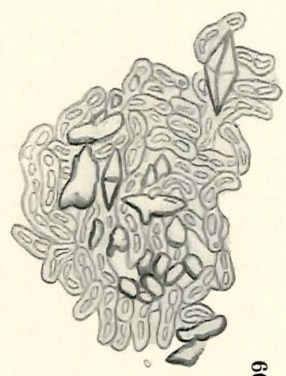


Fig. 109

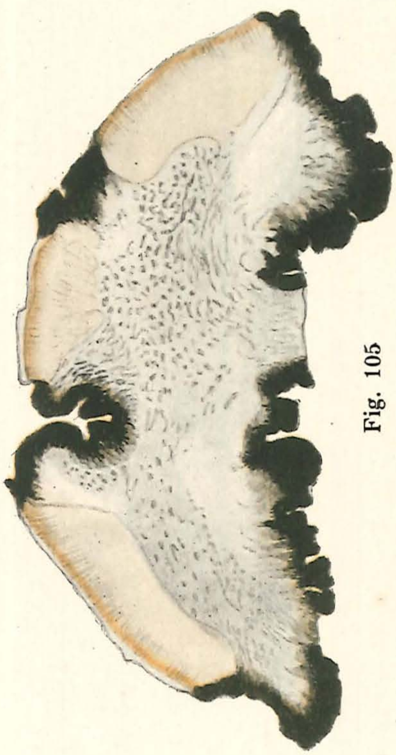


Fig. 105

Fig. 106

O. Galløe del.

BIATORELLA (SARCOGYNE) CLAVUS Dc.

PLATE 40.

MYCOBLASTUS SANGUINARIUS.

L.

Fig. 110. Margin of the thallus, mycelial at the edge, with radiating hyphæ (on the woody substratum), but otherwise composed of confluent areoles. Eight young apothecia. ($\times 11$).

Fig. 111. Rather old portion of the thallus, with old apothecia, partly overgrown by the thallus. ($\times 11$).

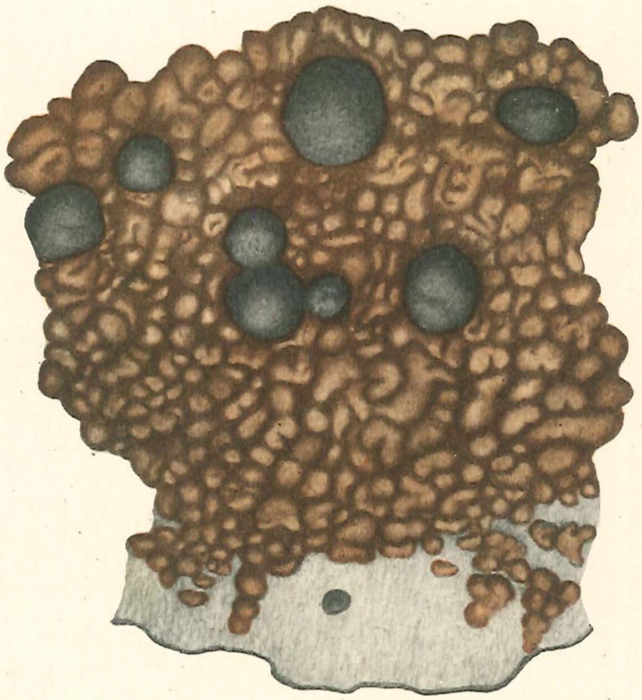


Fig. 110

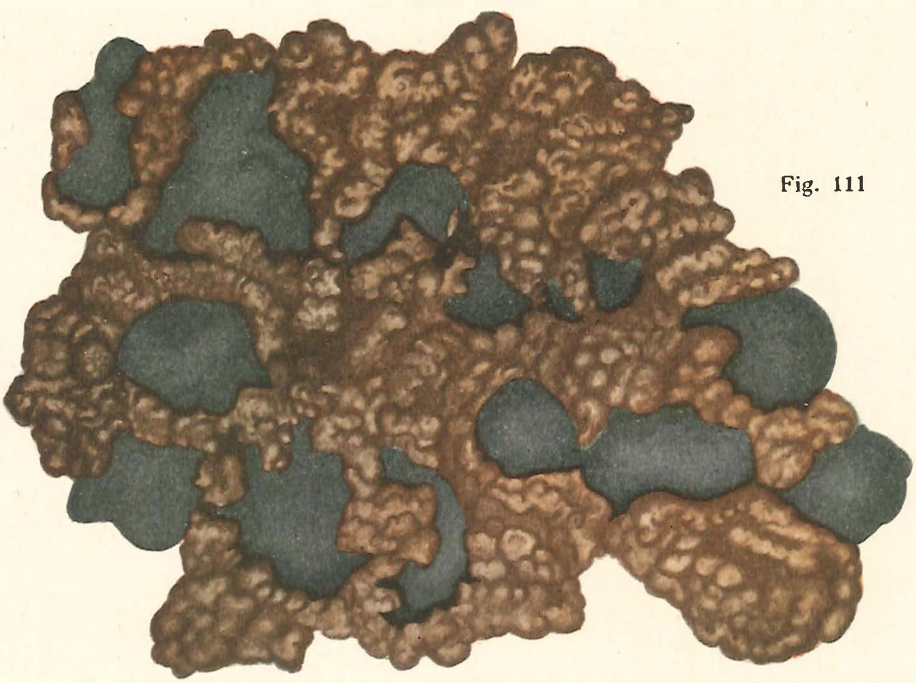


Fig. 111

O. Galløe del.

MYCOBLASTUS SANGUINARIUS L.

PLATE 41.

MYCOBLASTUS SANGUINARIUS.

L.

Fig. 112. Two confluent areoles; the left one has a partly blood-coloured medulla; the right one bears an apothecium with yellow calyx, partly blood-coloured stipes and grey hymenium. (×105).

Fig. 113. Thallus, composed of confluent, partly overlapping areoles; some of the overshaded ones are without gonidia. Above, an old apothecium with a big (blood-coloured) spot below the calyx. (×45).

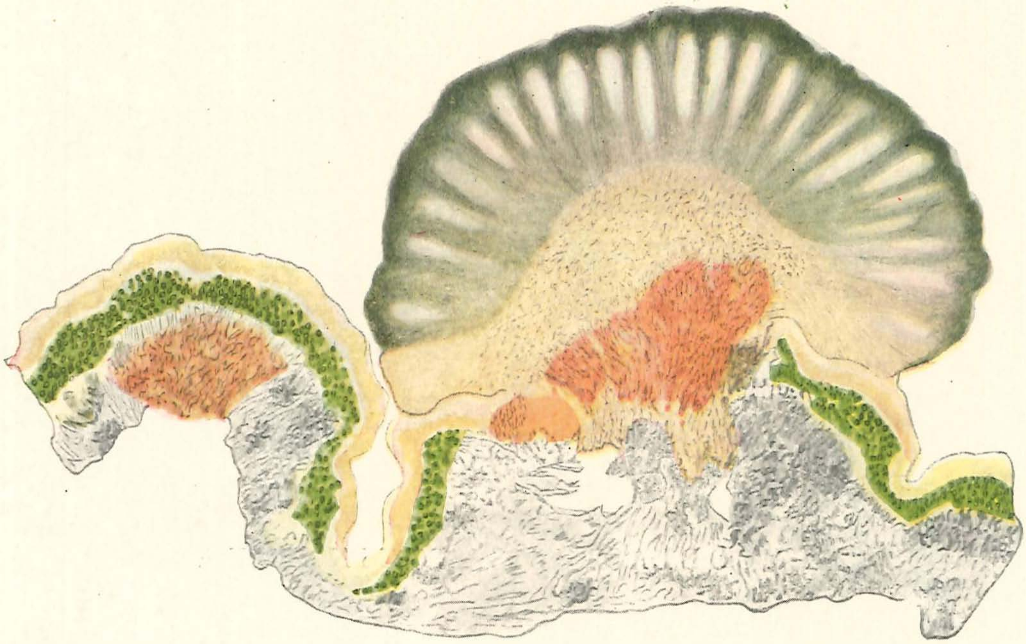


Fig. 112

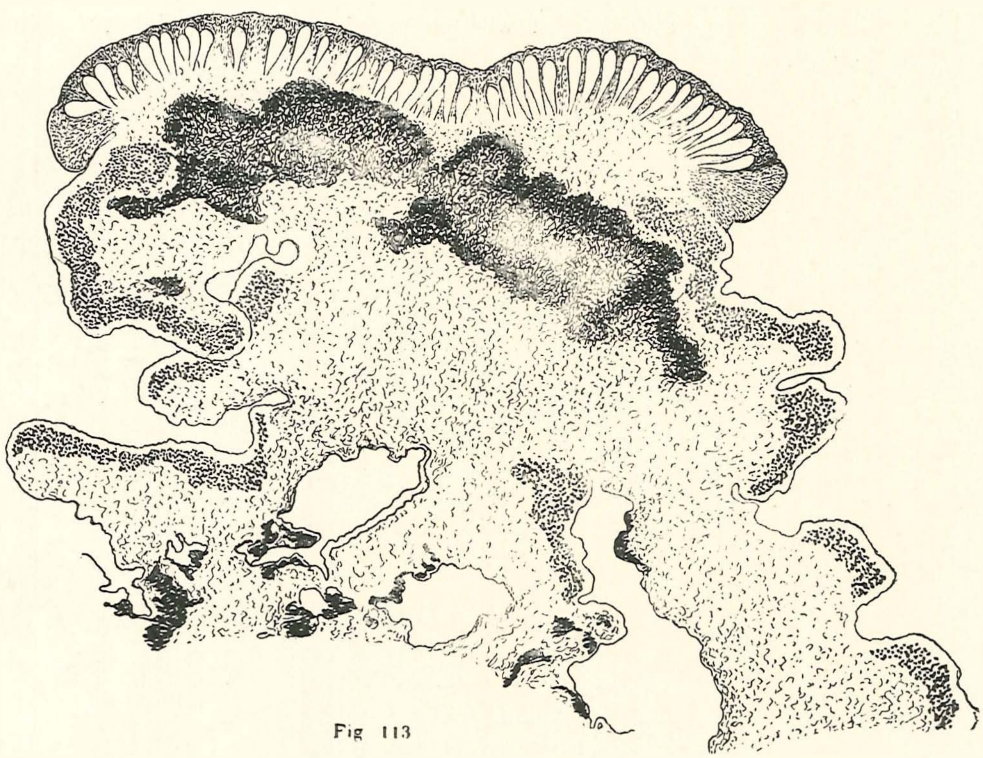


Fig 113

O. Galløe del.

MYCOBLASTUS SANGUINARIUS L.

PLATE 42.

MYCOBLASTUS SANGUINARIUS.
L.

Fig. 114. Cortex and gonidial layer. (×450).

Fig. 115. Hyphæ from the medullary layer. (×1185).

Fig. 116. Margin of apothecium with adjacent thallus. In the hymenium an ascus with a young spore. (×695).

Fig. 117. The boundary between the hyphæ of the stipes (above in the Fig.) and the medullary layer (the long-celled hyphæ below in the Fig.). (×840.)

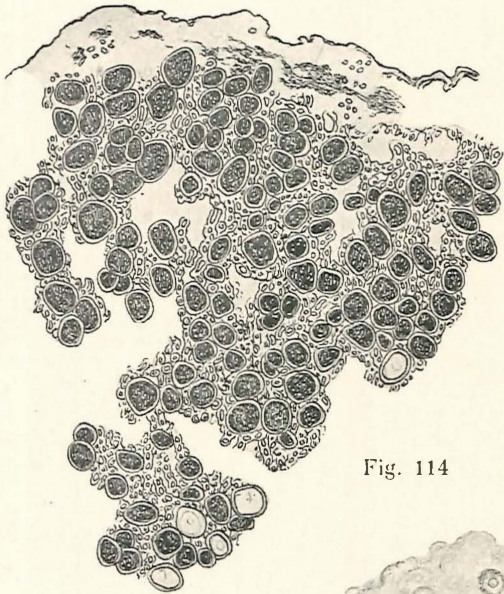


Fig. 114

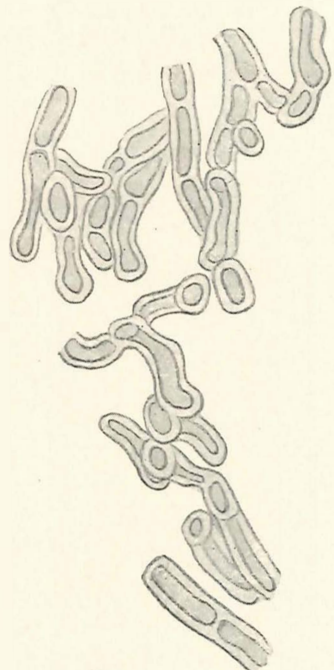


Fig. 115

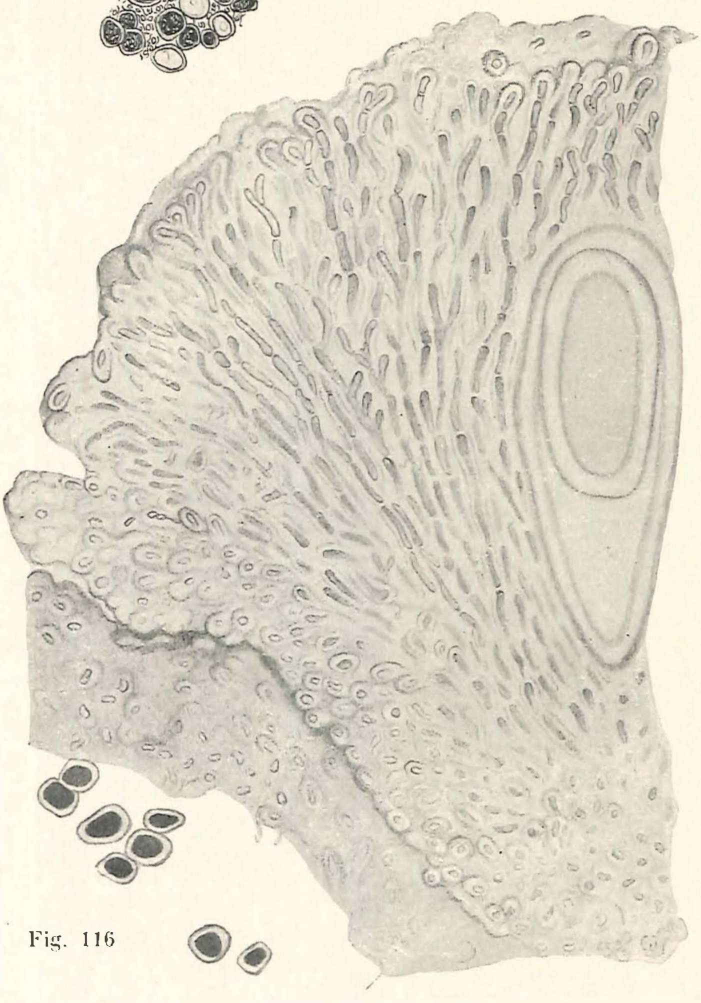


Fig. 116

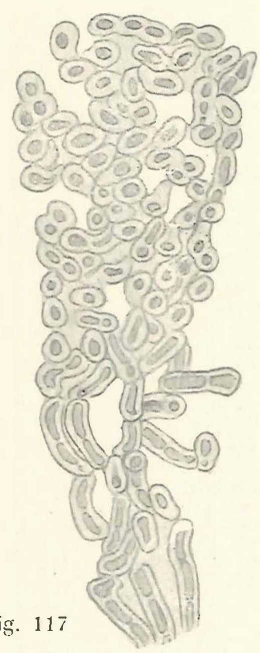


Fig. 117

O. *Galløe del.*

MYCOBLASTUS SANGUINARIUS L.

PLATE 43.

MYCOBLASTUS SANGUINARIUS.
L.

Fig. 118. Hymenium with an ascus, in which a spore is seen. ($\times$695).

Fig. 119. Ascogonium and young asci. ($\times$840).

Fig. 120. Horizontal section of hymenium, with an ascus, paraphyses, and hymenial gelatine. ($\times$840).

Fig. 121. Surface view of paraphyses. The grey colour (which is sometimes more bluish-green, sometimes more yellowish-green, and which seems to be a colour composed of blue and yellow) is chiefly deposited in the hymenial gelatine and in the outer layers of the walls of the paraphyses. ($\times$840).

Fig. 122. Young spore, the wall of which is still 1-layered. ($\times$840).

Fig. 123. Ripe spore. The inner layers of the cell-wall are provided with pores for the germination of the hyphæ. ($\times$840).

PLATE 43.

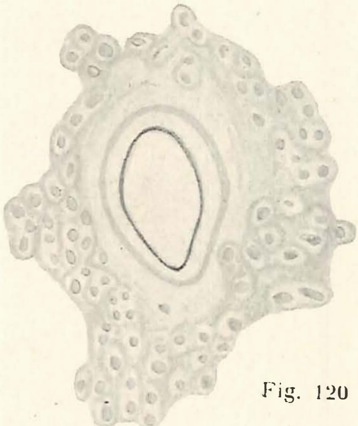


Fig. 120

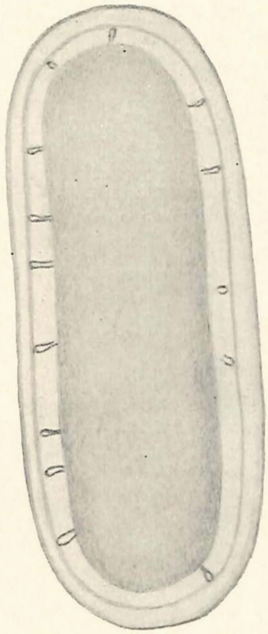
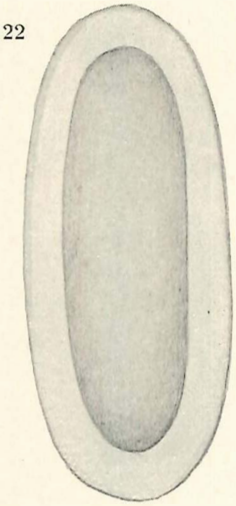


Fig. 123

Fig. 122



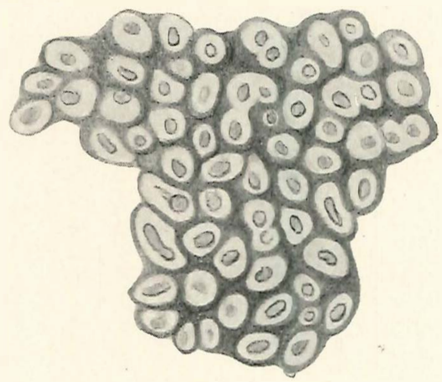


Fig. 121

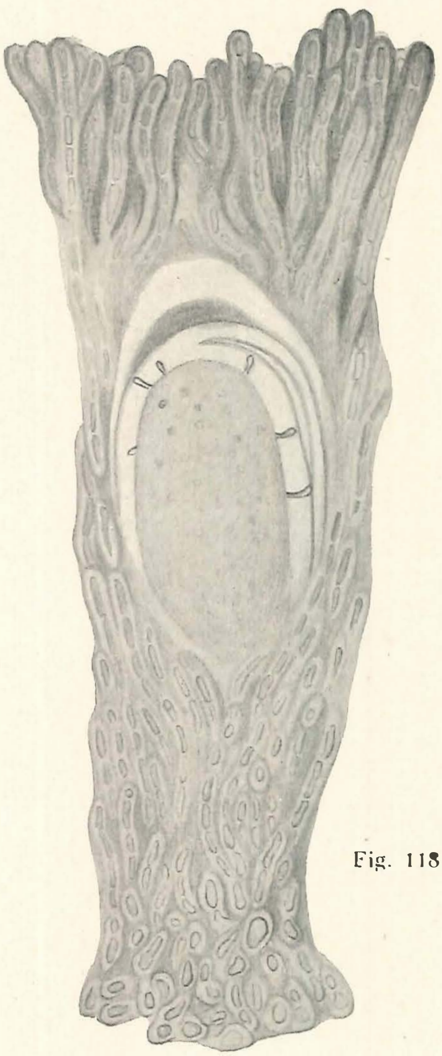


Fig. 118

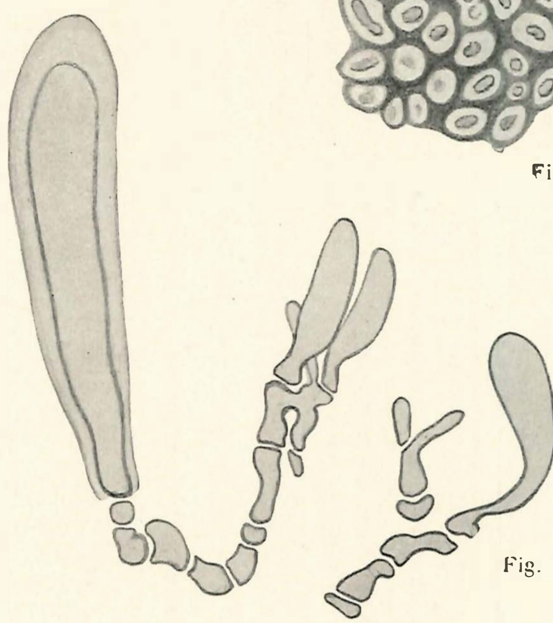


Fig. 119

O. Galløe del.

MYCOBLASTUS SANGUINARIUS L.

PLATE 44.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 1.

Fig. 124. Thallus with apothecia of all ages; above, it borders on a *Lecanora subfusca;* the borderline is black. ($\times 5^1/_2$).

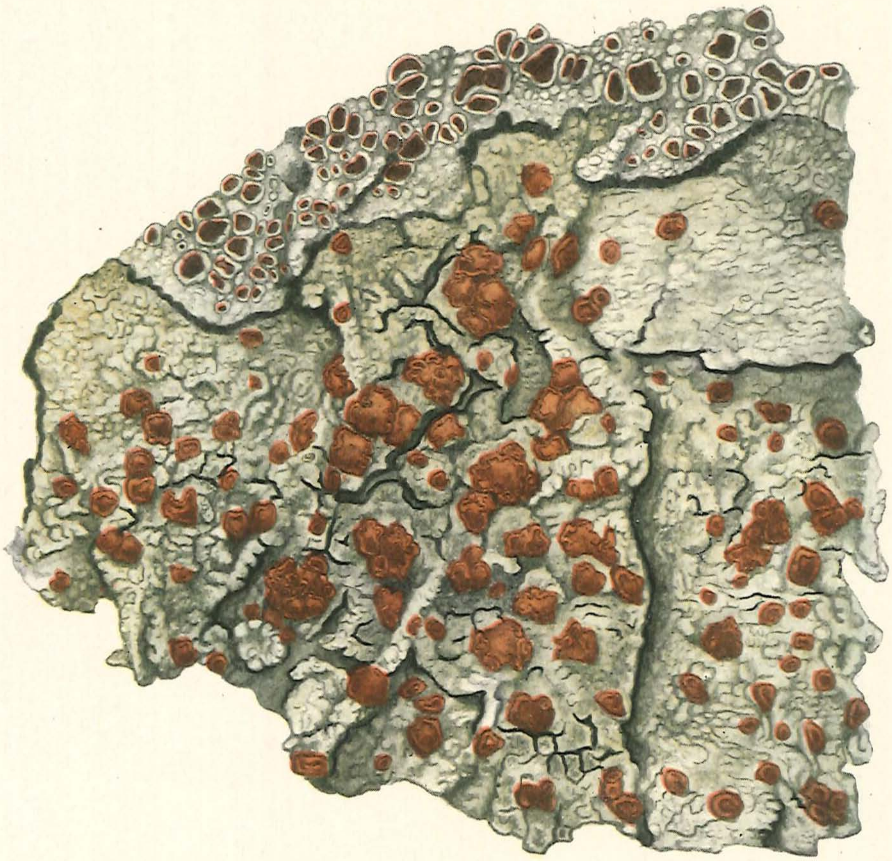


Fig. 124

O. Galløe del.

BLASTENIA FERRUGINEA Huds.
(Specimen 1)

PLATE 45.

BLASTENIA FERRUGINEA.

Huds.

Specimen 1.

Fig. 125 Above to the left a very young apothecium (×90). To the right, thallus with young and older apothecia. (×22).

Fig. 126. Section of apothecium, showing asci and ascogonia, artificially stained red, — and also some few gonidia in the calyx; accordingly, the apothecium is crypto-lecanorine. (×105).

Fig. 127. Apothecium and thallus in vertical section. Note the gonidia in the calyx, which is crypto-lecanorine. Stipes reaches right down to the surface of the substratum. (×105).

PLATE 45.

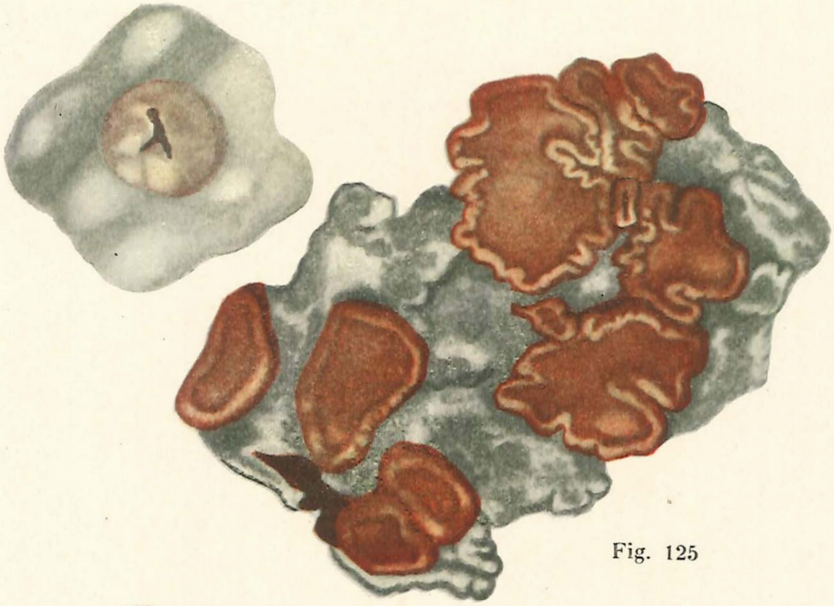


Fig. 125

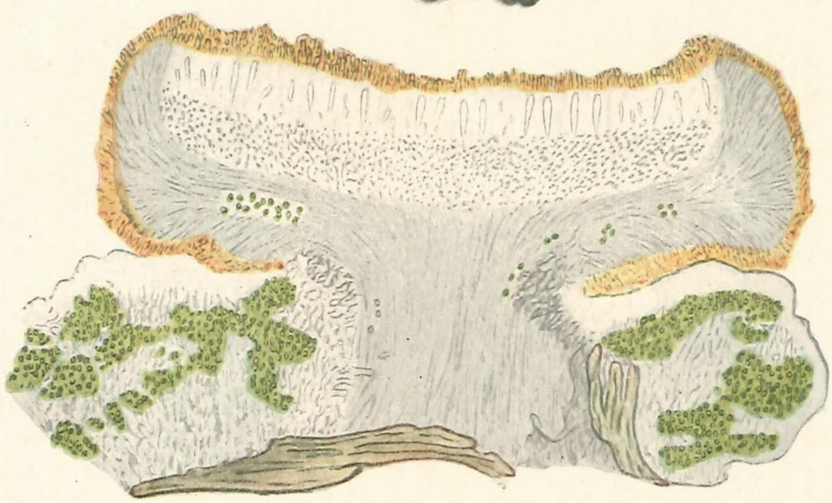


Fig. 127

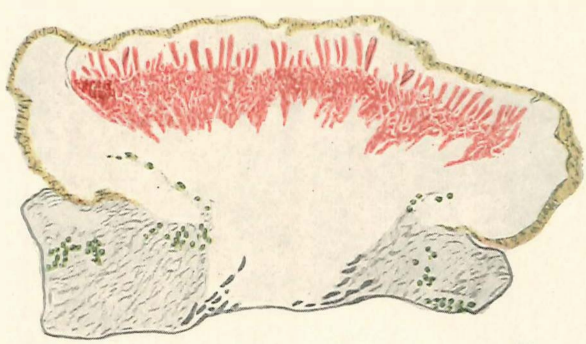


Fig. 126

O. *Galløe del.*

BLASTENIA FERRUGENIA HUDS
(Specimen 1)

PLATE 46.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 1.

Fig. 128. Primordium of an apothecium. The red-stained hyphæ represent three ascogonia, of which the central one is nearly complete and provided with a trichogyne; the two others were partly removed by the cutting. Among the ascogonia the future paraphyses. Round this primordium of ascogonia and paraphysogeneous hyphæ a calyx is formed, in which some few gonidia are embedded; (compare Fig. 126 and Fig. 127). Outside the calyx the gonidial layer. The whole primordium of the apothecium is embedded between two lamellæ of the periderm, like the other parts of this portion of the thallus, which accordingly is in part endophloeodic. The cortex is seen on the uppermost lamella of the periderm. Below in the section part of the periderm, which is highly susceptible to staining in places that are in direct contact with the thallus. Regarding the interpretation of this phenomenon see the text. (× 695).

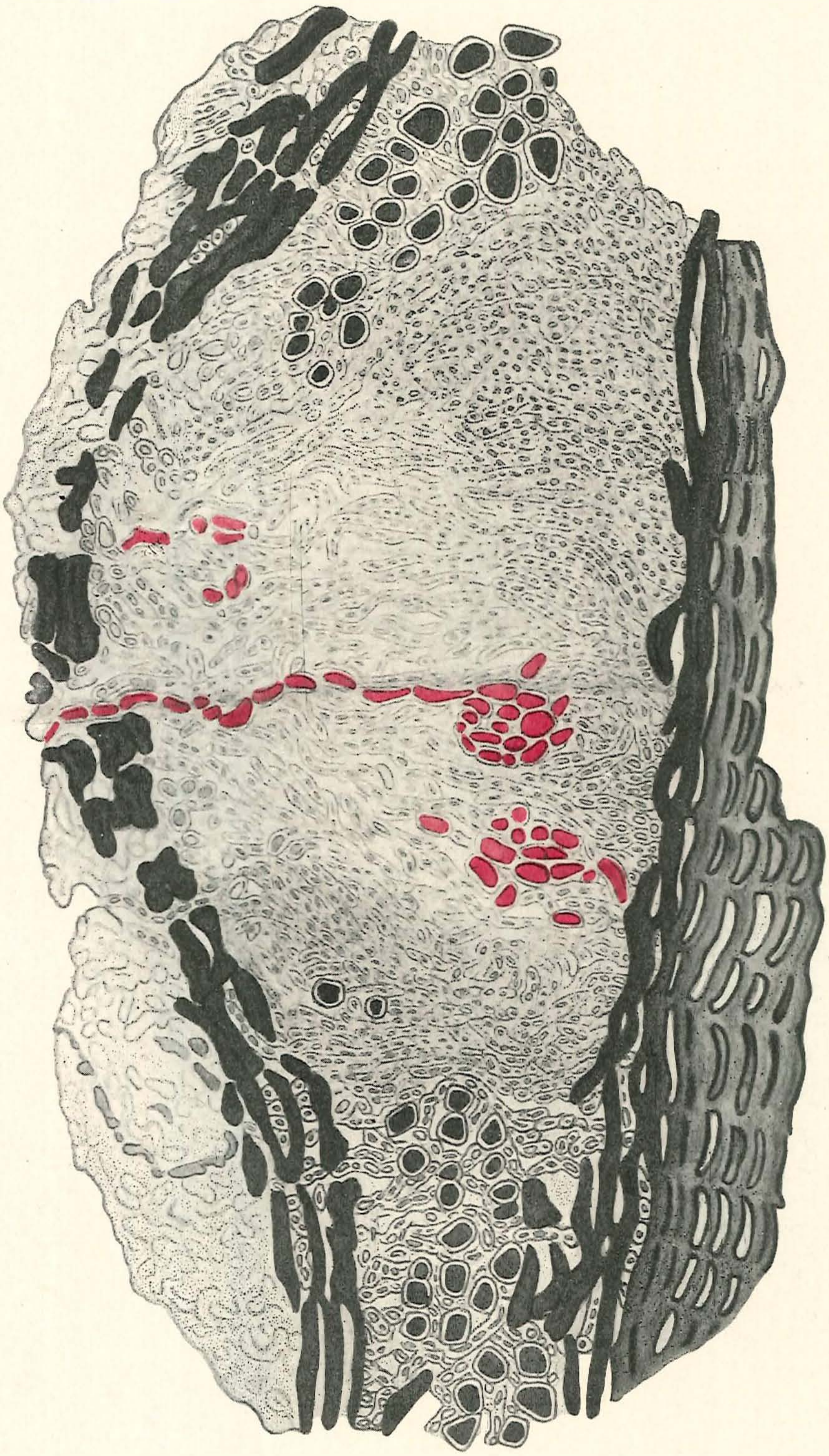


Fig. 128

O. Galløe del.

BLASTENIA FERRUGINEA HUDS.
(Specimen 1)

PLATE 47.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 1.

Fig. 129. Margin of apothecium. The peripheral parts of the calyx and also the tips of the paraphyses are yellow (shaded dark in the figure). In the hypothecium very distinct ascogenous hyphæ (compare Fig. 126). (×695).

Fig. 130. Above, four spores of different types; two of them without isthmus, one of them 1-celled and one with a broad isthmus. Below to the left an ascus with normal spores; in the middle a paraphysis with (yellow) granules of pigment on the cell-wall; to the right an ascus with young, still 1-celled spores. (×840).

Fig. 131. To the left apical cells of the hyphæ of the calyx with granules of pigment. (×840). To the right two young asci and ascogenous hyphæ. (×1185).

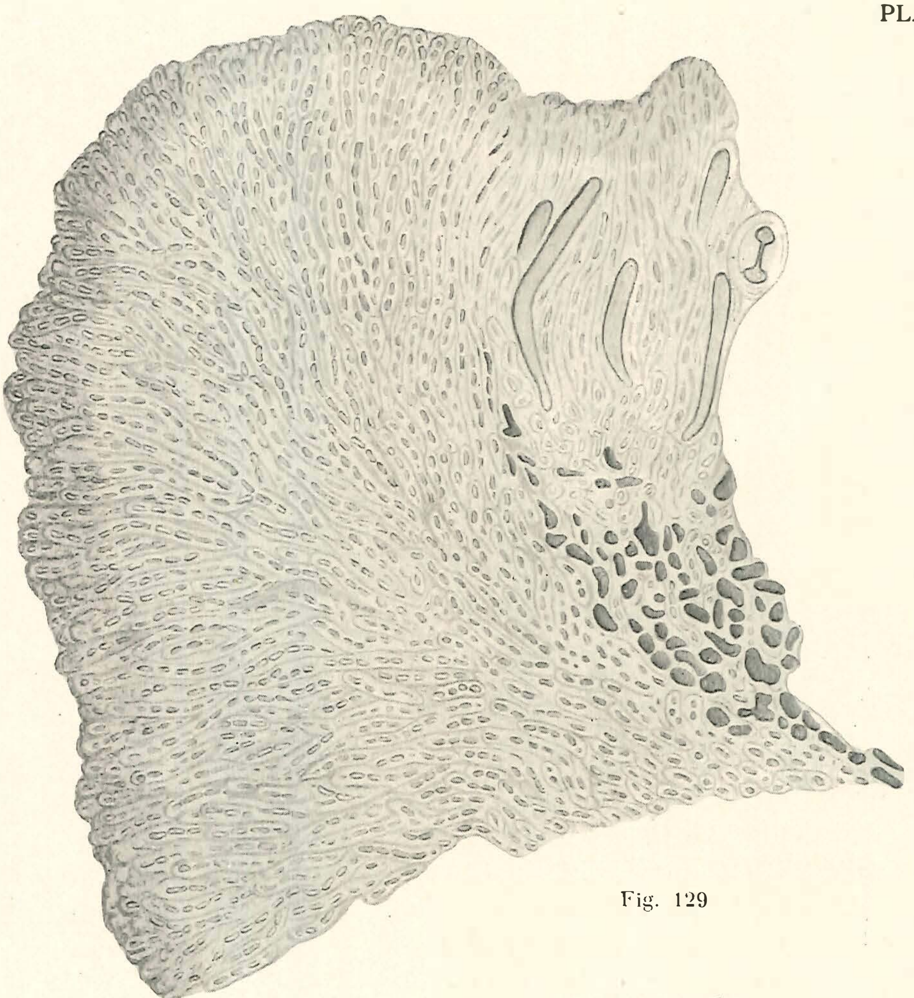
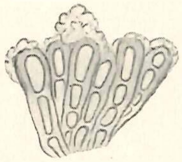


Fig. 129



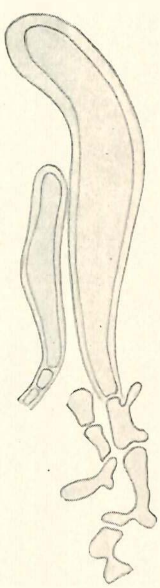


Fig. 131

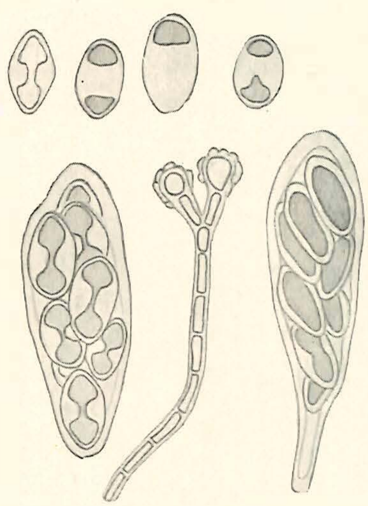


Fig. 130

O. Galløe del.

BLASTENIA FERRUGINEA Huds.
(Specimen 1)

PLATE 48.

BLASTENIA FERRUGINEA.

Huds.

Specimen 1.

Fig. 132. Vertical section of thallus. On the cortex particles of dust. Below in the section the cells of the periderm. (×695).

Fig. 133. Section of cortex, in which some living cells (to the right, shaded dark); below, some small remnants of the cells of the periderm. Below in the section the hyphæ and the gonidia of the gonidial layer. (×1185).

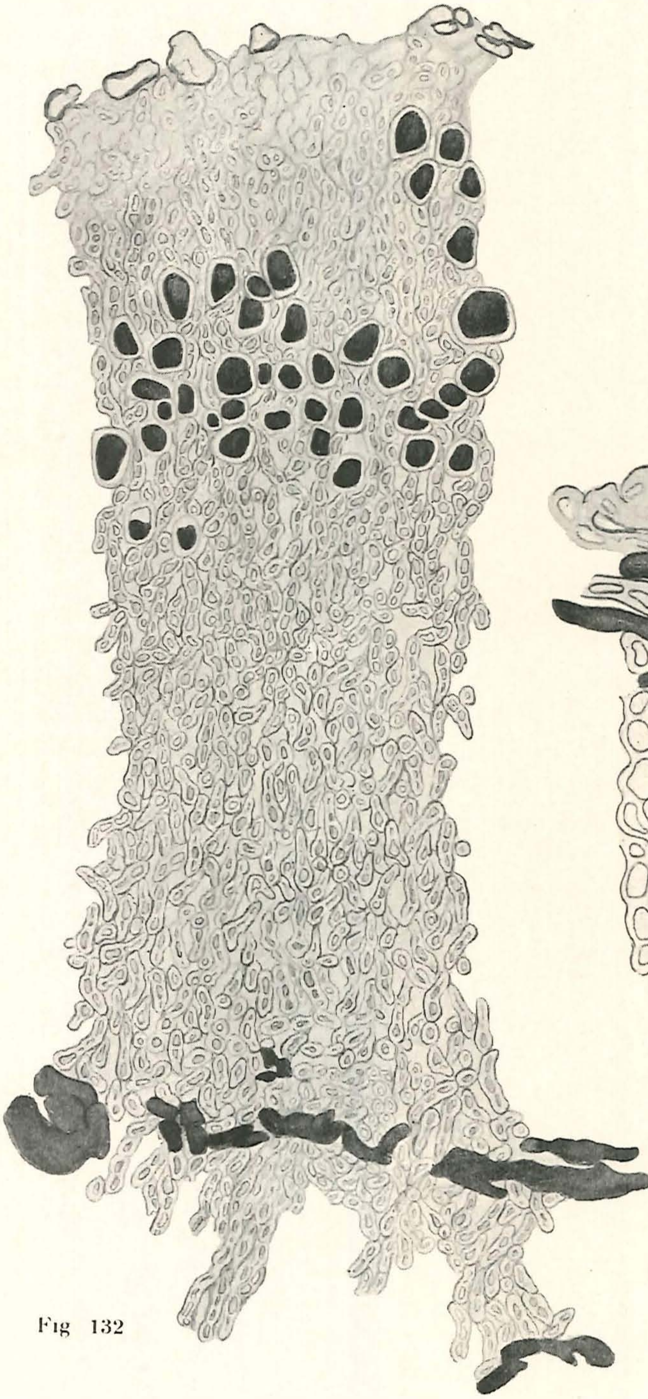


Fig 132

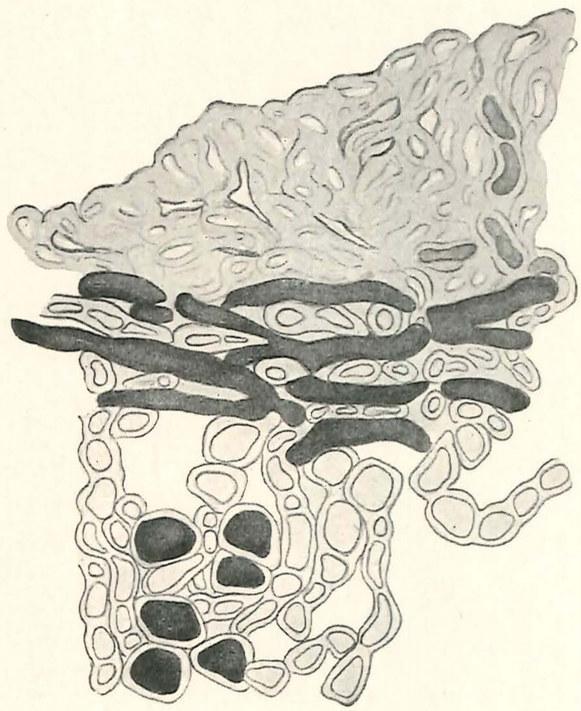


Fig. 133

O. Galløe del.

BLASTENIA FERRUGINEA HUDS.
(Specimen 1)

PLATE 49.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 2.

Fig. 134. Thallus with apothecia of all ages; some of them are on the point of breaking through the thallus and still partly covered by it. In several places the grains of quartz of the substratum (the whitish portions in the figure) are seen to be incompletely covered by black hyphæ creeping in over them from the thallus. Below to the right in the figure this phenomenon is particularly distinct. ($\times 35$).

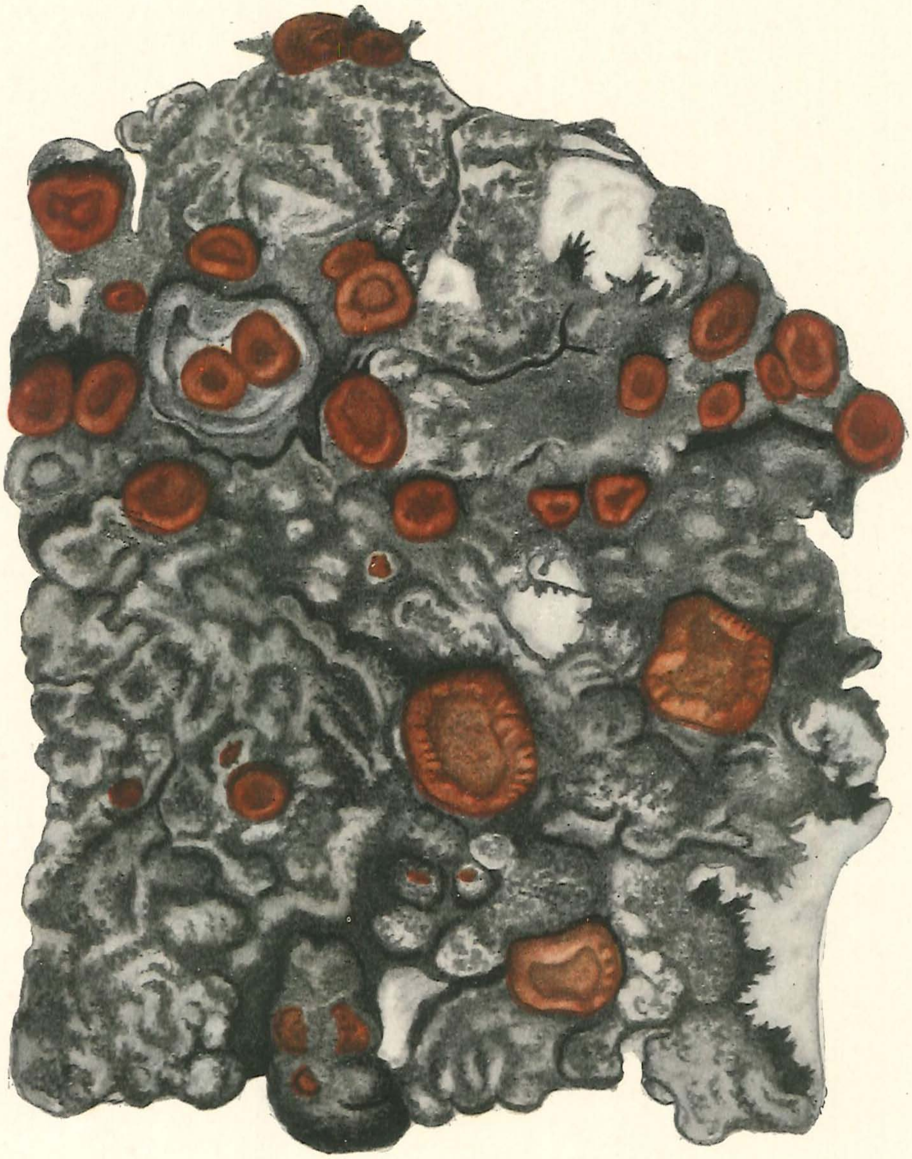


Fig. 134

O. Galløe del.

BLASTENIA FERRUGINEA Huds.
(Specimen 2)

PLATE 50.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 2.

Fig. 135. Quite young apothecium breaking through the thallus; the thick margin is partly grey from protecting portions of the thallus. (×90).

Fig. 136. Rather old apothecium, with reddish-ochraceous margin and dark-brown disc. (×37).

Fig. 137. Convex, old apothecium, without a margin, dark-brown. (×37).

Fig. 138. Young apothecium, with stipes and crypto-lecanorine margin; note the light colour in calyx and paraphyses. (×105).

Fig. 139. Rather old apothecium. The section is a little extra-axial, so stipes is less distinct. Note the crypto-lecanorine margin and the dark-brown colour in the coloured portions of the apothecium. (×105).

PLATE 50.

Fig. 135

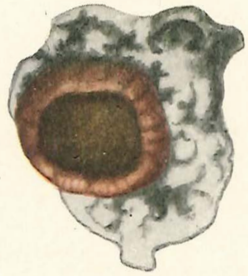


Fig. 136

Fig. 137

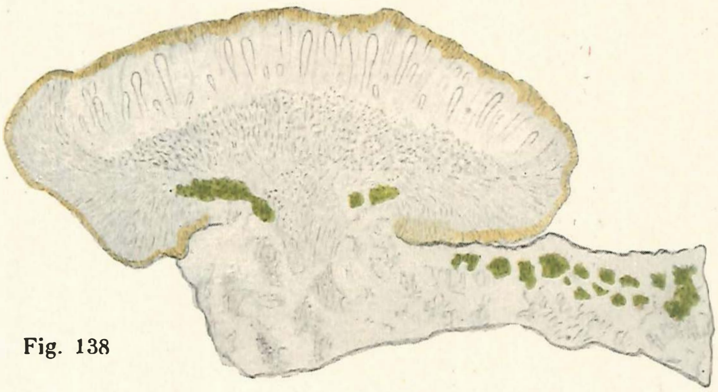


Fig. 138

Fig. 139

O. Galløe del.

BLASTENIA FERRUGINEA Huds.
(Specimen 2)

PLATE 51.

BLASTENIA FERRUGINEA.

Huds.

Specimen 2.

Fig. 140. Thallus. In the cortex the difference between living, colourless parts without a cuticle (to the left) and dark parts with dead, colourless cuticle (to the right) is distinctly seen. Below in the section two grains of minerals. (×695).

Fig. 141. Margin of apothecium. In the hypothecium distinct ascogenous hyphæ. (×695).

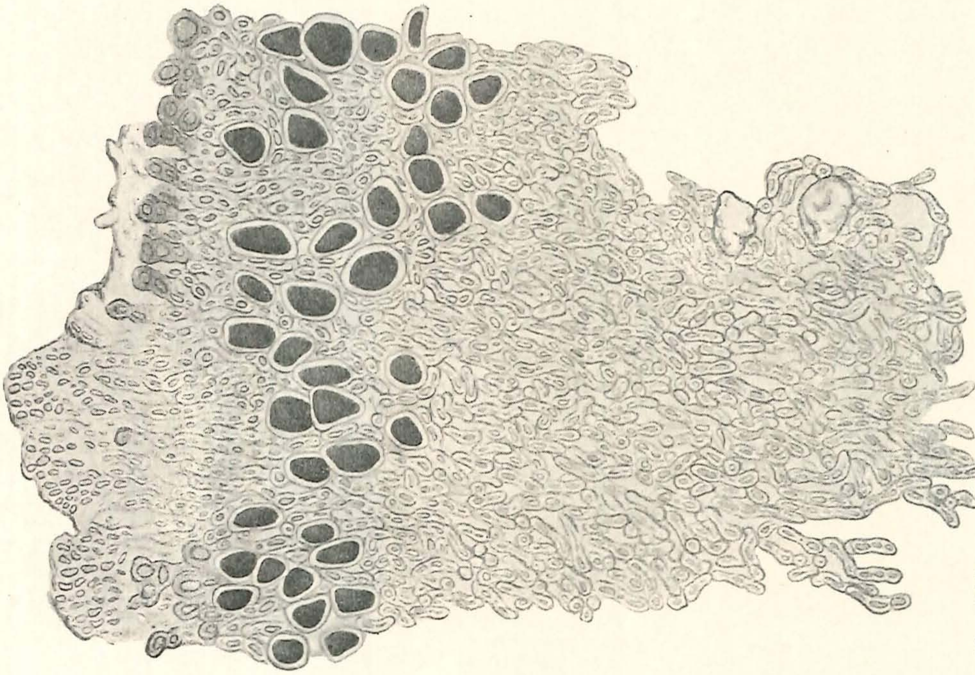


Fig. 140

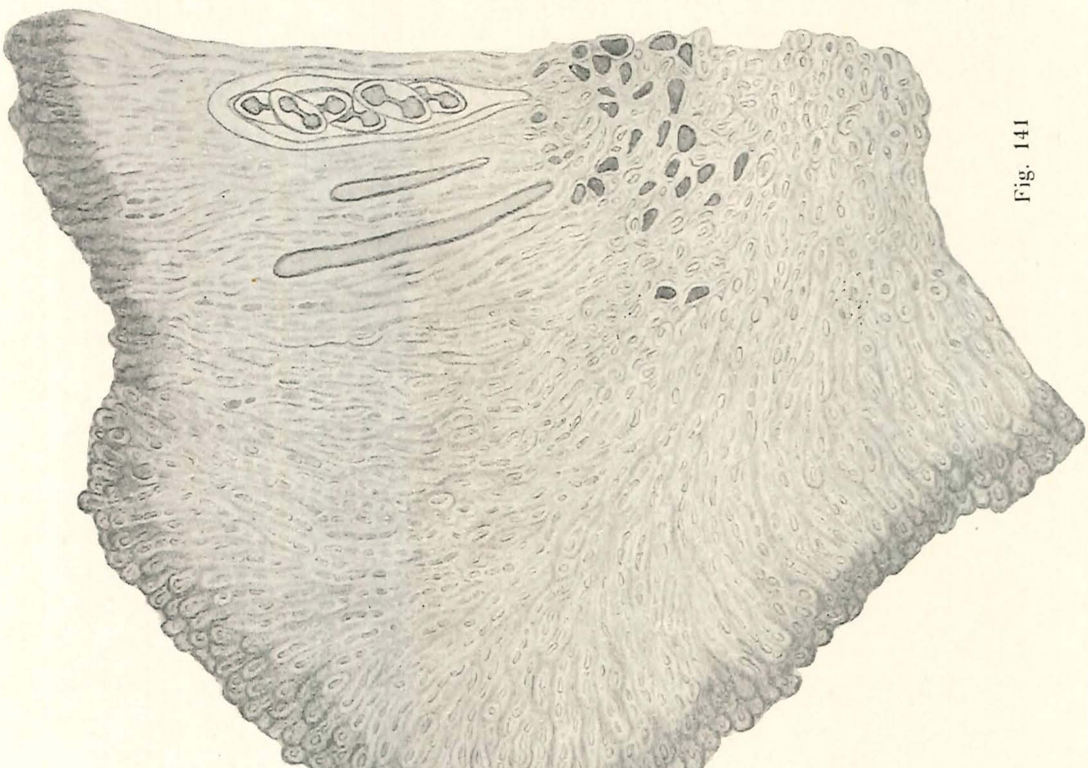


Fig. 141

O. Galløe del.

BLASTENIA FERRUGINEA Huds.
(Specimen 2)

PLATE 52.

BLASTENIA FERRUGINEA.

HUDS.

Specimen 2.

Fig. 142. To the left and the right in the figure two asci with ripe spores; in the left one a spore without isthmus. In the centre paraphyses with granules of pigment, and also a young ascus. (×840.)

Fig. 143. Above, apical parts of hyphæ from the calyx; the cell-wall itself is here coloured yellow. Below, similar hyphæ; here the pigment is deposited both in the cell-wall itself and as granules on the surface of the cell-wall. (×840).

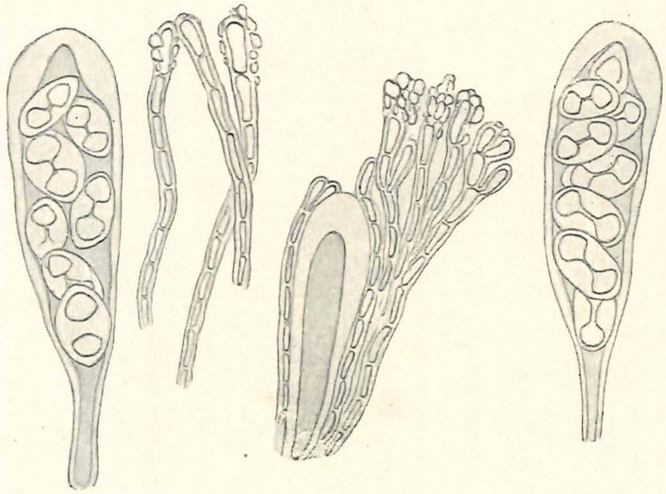


Fig. 142

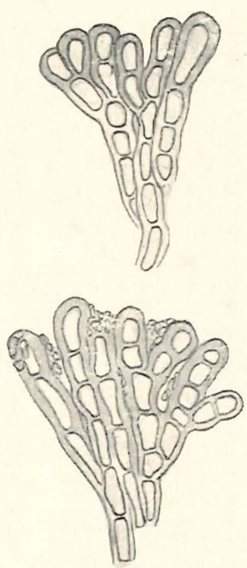


Fig. 143

O. *Galløe del.*

BLASTENIA FERRUGINEA Huds.
(Specimen 2)

PLATE 53.

CATOCARPON APPLANATUM.

(Fr.) Th. Fr.

Specimen 1.

Fig. 144. Thallus with apothecia of all ages. Above to the left it partly borders on a sterile thallus of a crustaceous lichen, to the right it ends free on the substratum and has there a radiating, black margin; just behind the latter the youngest areoles are seen. Part of the old areoles are whitish from air found between the cells of the cortex. Below in the thallus two small thalli of a sterile, crustaceous lichen; most likely they are doomed to death in this place. ($\times$26).

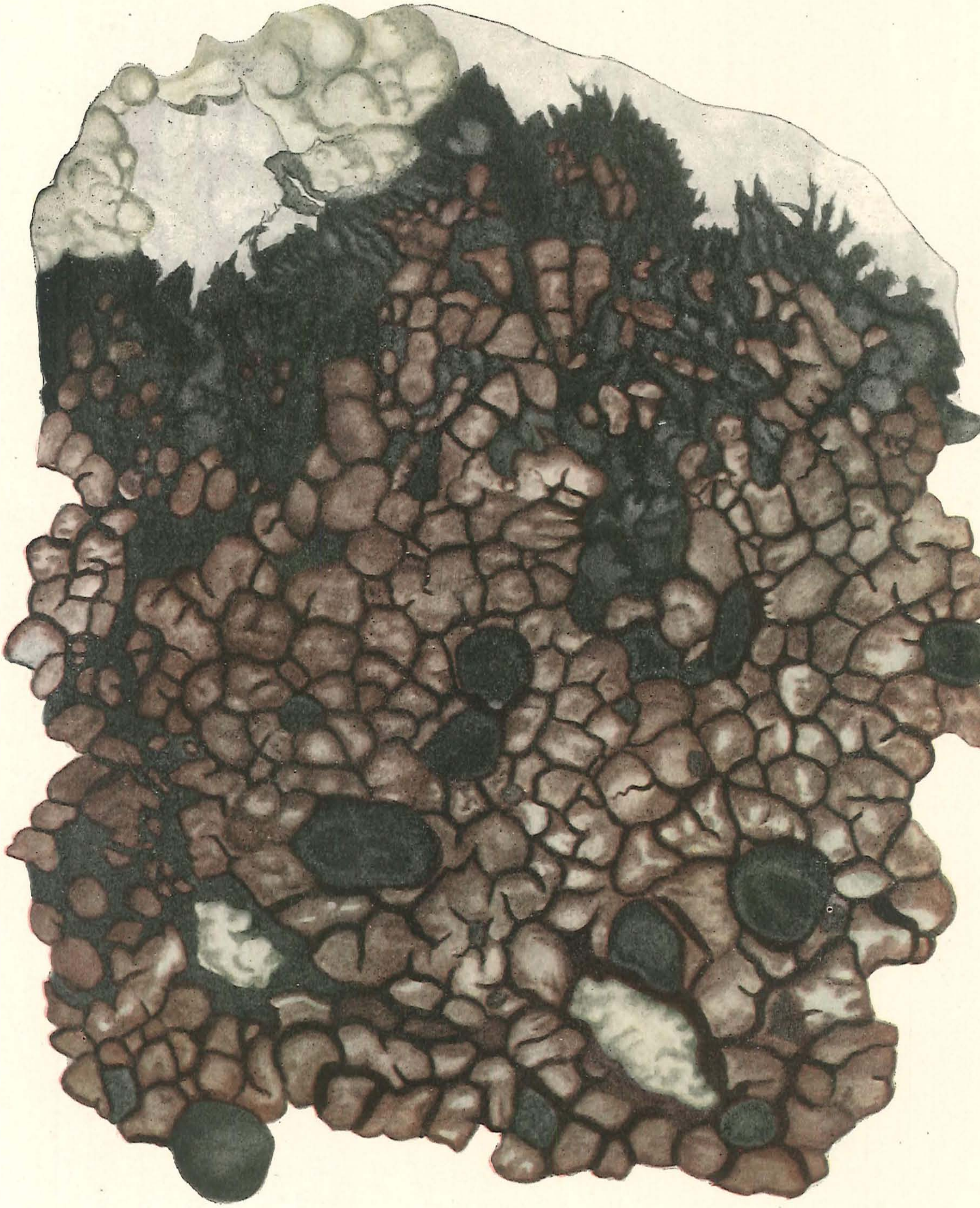


Fig. 144

O. Galløe del.

CATOCARPON APPLANATUM (FR.) TH. FR.
(Specimen 1).

PLATE 54.

CATOCARPON APPLANATUM.

(Fr.) Th. Fr.

Specimen 1.

Fig. 145. Areole. To the left it ends free, to the right it is continued into "hypothallus", i. e. inter-areolar thallus. Fig. 158 is a magnified picture of this right side of the present areole. (× 105).

Fig. 146. Thick section of an apothecium, in which the details as to the distribution of the colours are but little visible. (× 105).

Fig. 147. Thin section of an apothecium, showing the distribution of the colours more distinctly. (× 105).

Fig. 148. Old, brown areoles. Between these the inter-areolar, black and thin thallus ("hypothallus"), on which still black, young areoles, which will later become brown, and also three young apothecia are seen. (× 105).

Fig. 149. Three spores from the same apothecium. (× 840).

Fig. 150. Above, two tips of paraphyses. Below, two asci and parts of the hypothecium, which is nearly colourless (very faintly brownisb). In the hypothecium the rather big ascogenous cells and the smaller paraphysogenous cells are seen. (× 840).

Fig. 151. Four spores from another apothecium than that in Fig. 149. (× 840).

PLATE 54.

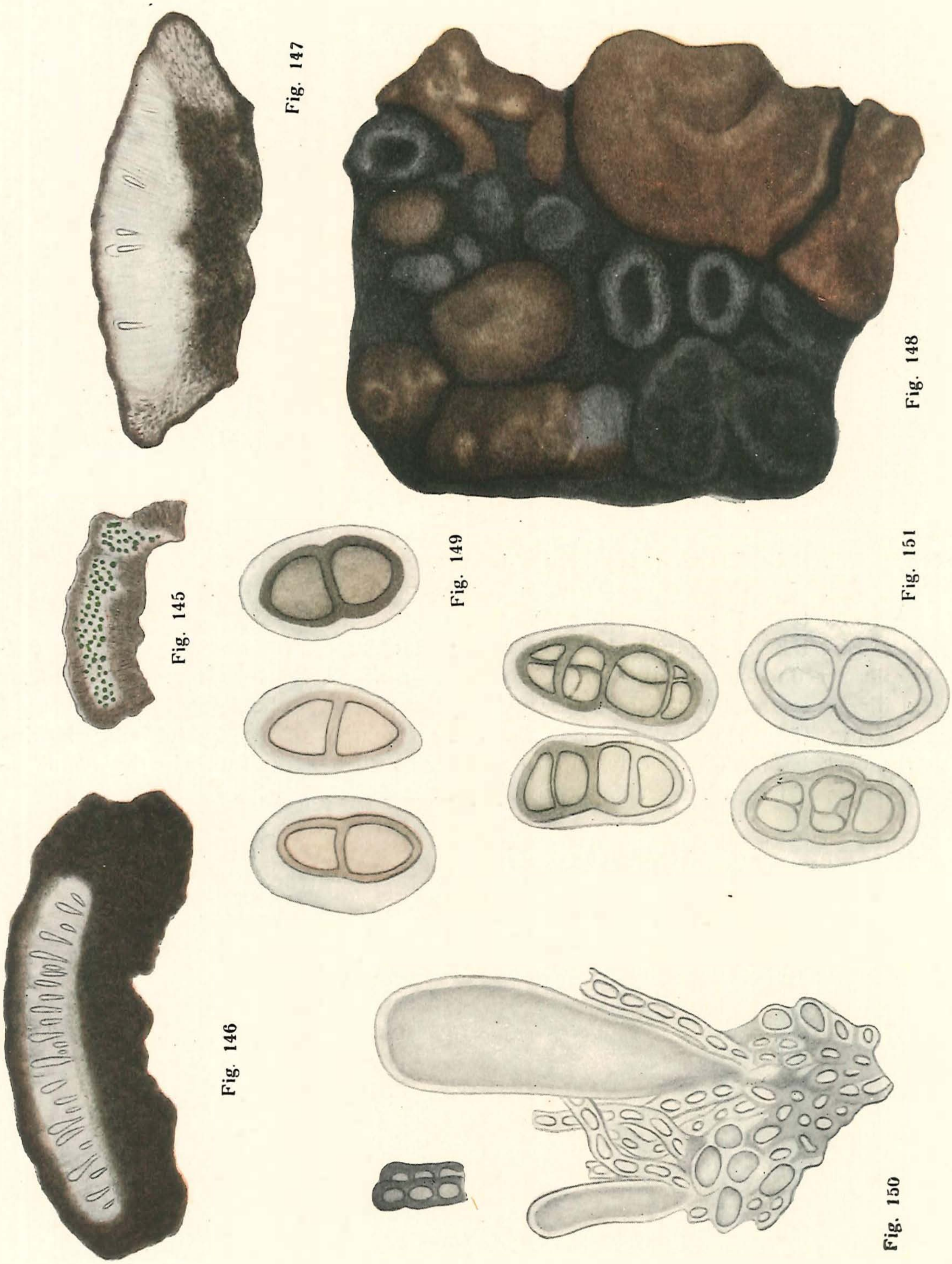


Fig. 145 Fig. 146 Fig. 147 Fig. 148 Fig. 149 Fig. 150 Fig. 151

O. Galløe del.

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 1)

PLATE 55.

CATOCARPON APPLANATUM.

(FR.) TH. FR.

Specimen 1.

Fig. 152. Three spores from a third apothecium. ($\times$840).

Fig. 153. Three spores from a fourth apothecium. ($\times$840).

Fig. 154. Paraphyses. ($\times$840).

Fig. 155. Longitudinal section of a part of stipes. The outer layers of the cell-walls are dark-brown; their inner layers are nearly colourless. Fig. 150 represents a direct continuation of the upper part of the present section. ($\times$840).

Fig. 156. Horizontal section through the margin of the apothecium, showing the dark hyphæ of the calyx and also the colourless hymenium with hymenial gelatine, and transverse section of paraphyses and asci. ($\times$840).

PLATE 55.

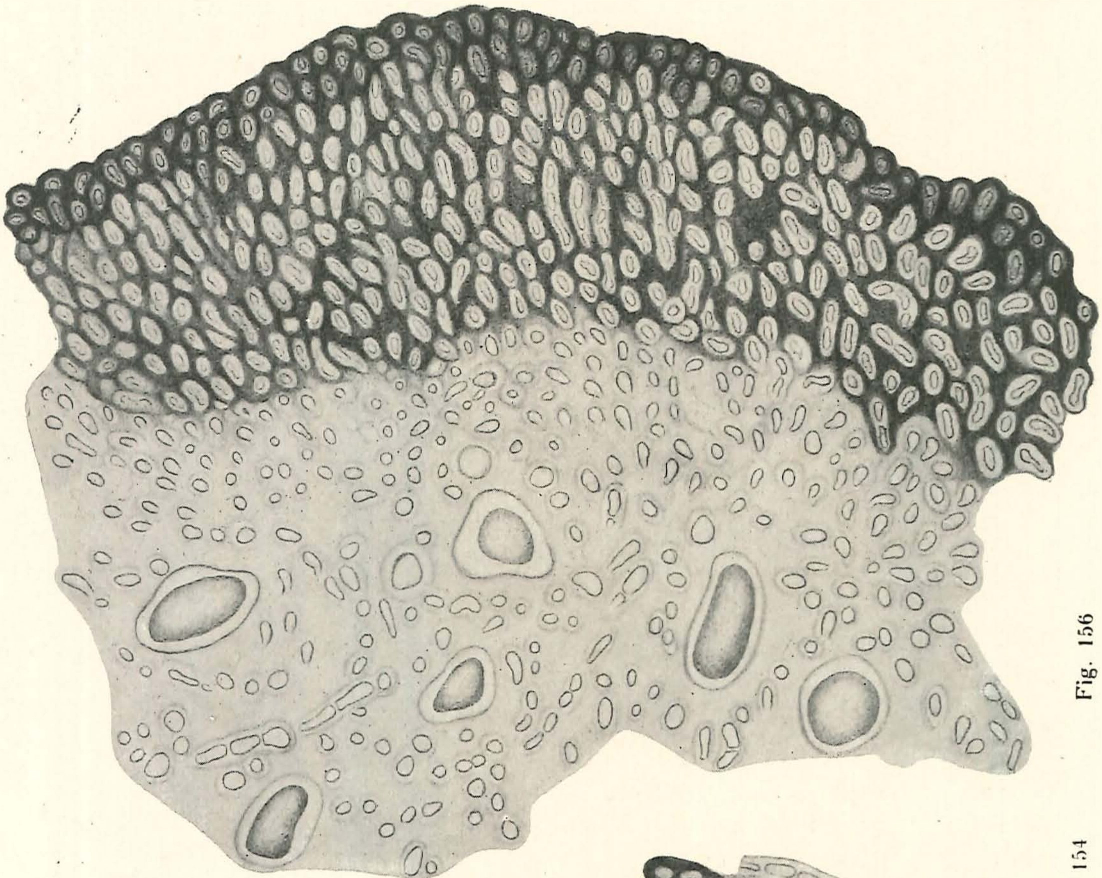


Fig. 156

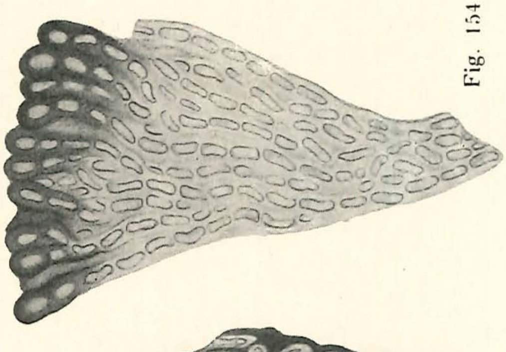


Fig. 154

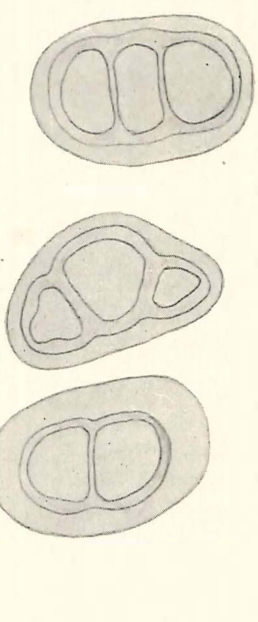


Fig. 153

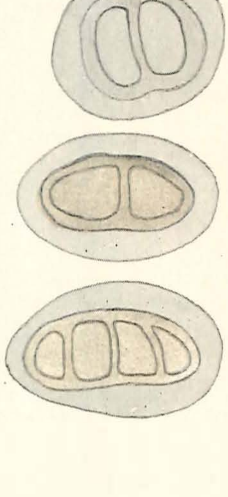


Fig. 152

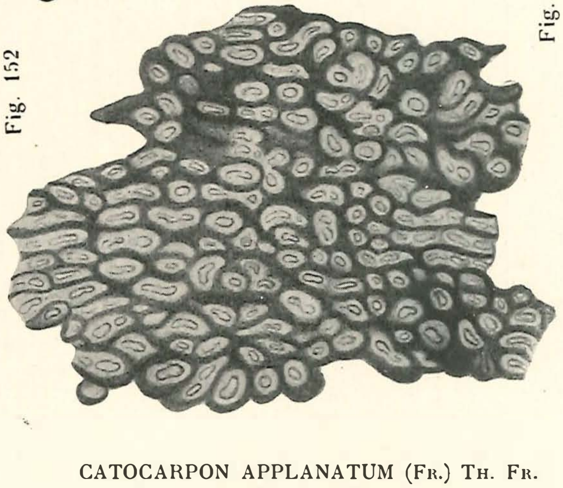


Fig. 155

O. Galløe del.

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 1).

PLATE 56.

CATOCARPON APPLANATUM.

(Fr.) Th. Fr.

Specimen 1.

Fig. 157. Vertical section of margin of apothecium. (×840).

Fig. 158. Margin of an areole, to the right continuing into an inter-areolar, dark thallus (hypothallus). (×840).

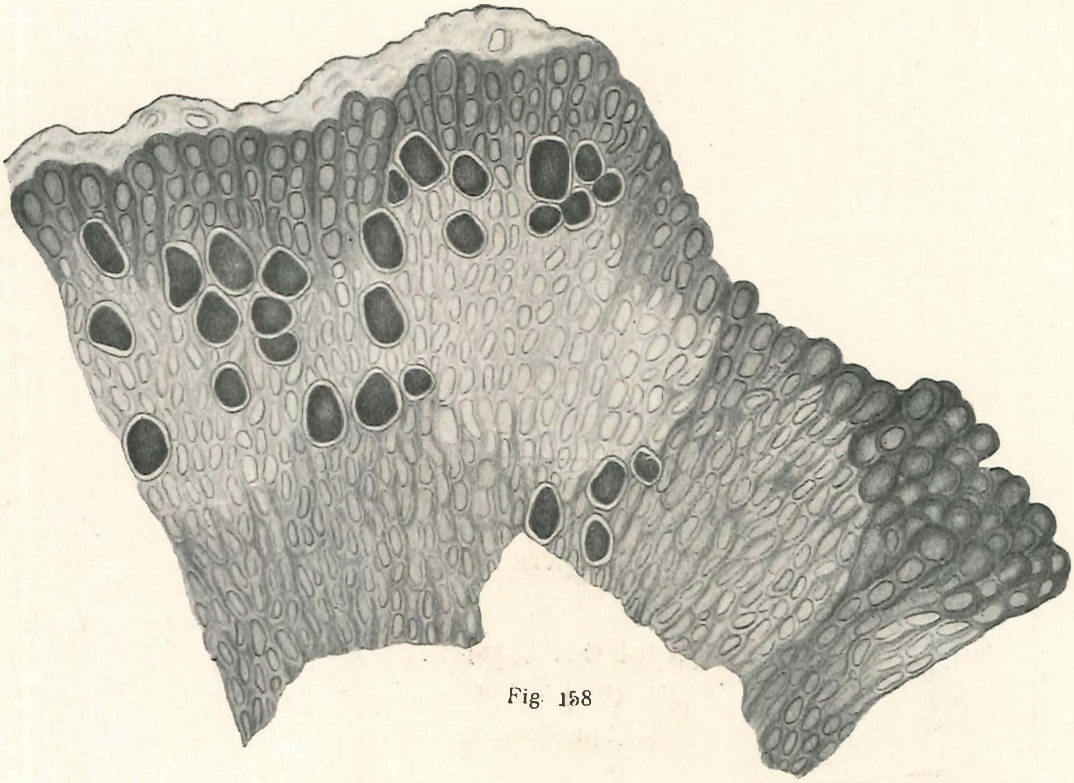


Fig. 158

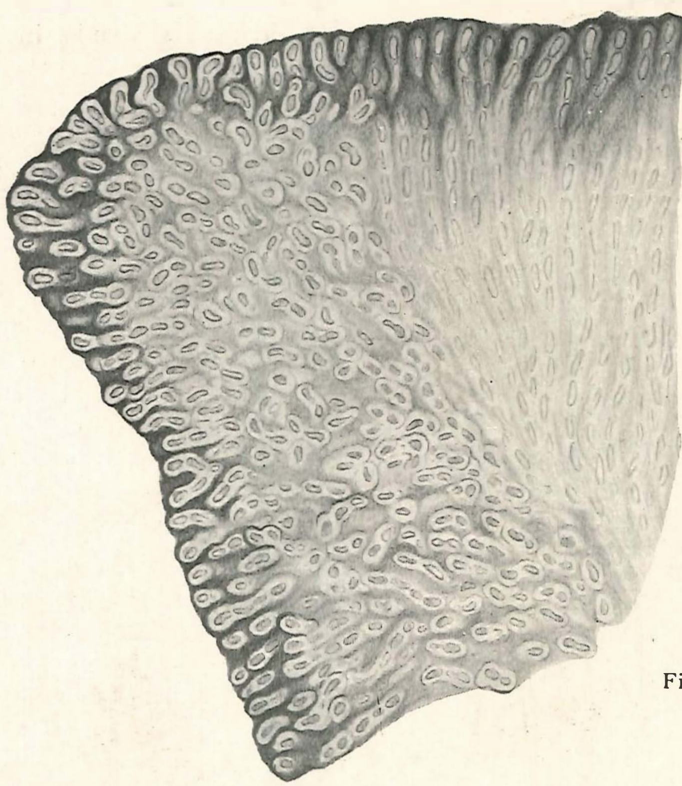


Fig. 157

O. Galløe del.

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 1)

PLATE 57.

CATOCARPON APPLANATUM.

(FR.) TH. FR.

Specimen 2.

Fig. 159. Thallus with apothecia of all ages. To the left and the right the black margin of the thallus. A strip of inter-areolar thallus is visible in the central parts of the thallus. (×26).

PLATE 57.

Fig. 159

O. Galløe del.

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 2).

PLATE 58.

CATOCARPON APPLANATUM.

(FR.) TH. FR.

Specimen 2.

Fig. 160. To the left in the section the brown, inter-areolar thallus; to the right an areole, the interior of which is unusually light; note the cuticle on the surface of the areole. The lower surface of the section is quite smooth, because the lichen has been growing on the smooth surface of a stone; the basal parts of the medullary layer and also the cortex are brownish. (×157).

Fig. 161. Young apothecium, still partly embedded in 'hypothallus', which is very distinct in the left side of the section. (×157).

Fig. 162. Rather old, fully developed apothecium, with two neighbouring areoles. (×157).

Fig. 163. Three brownish spores. (×840).

Fig. 164. Areole. The cuticle is seen above. To the right in the section the natural margin of the areole. Below to the right two grains of quartz, embedded among the hyphæ. (×695).

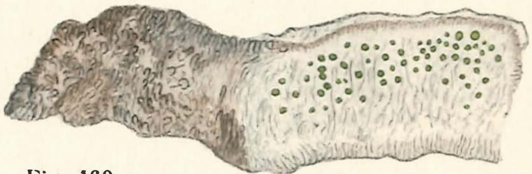


Fig. 160

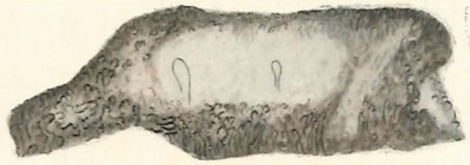


Fig. 161

Fig. 162

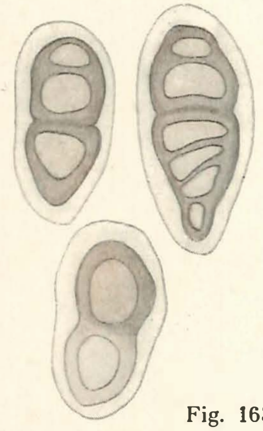


Fig. 163

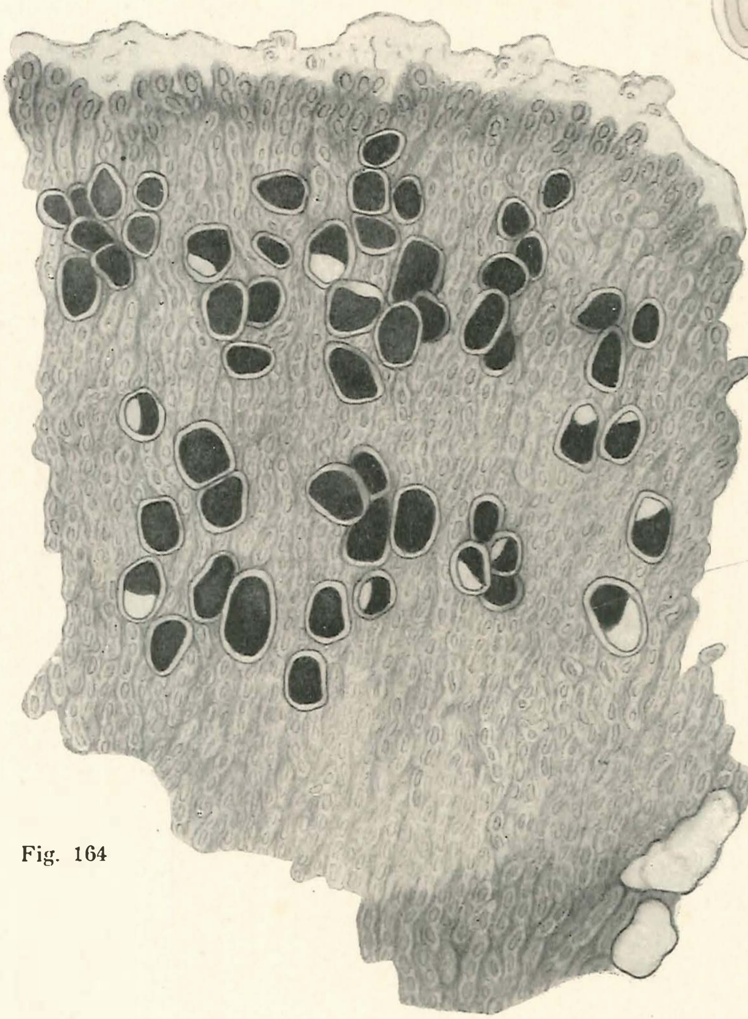


Fig. 164

CATOCARPON APPLANATUM (FR.) TH. FR.
(Specimen 2)

PLATE 59.

CATOCARPON APPLANATUM.

(FR.) TH. FR.

Specimen 2.

Fig. 165. To the left above, two brown cortical hyphæ. To the right, gonidia. Below, the smooth, basal part of an areole, which is smooth on the lower surface and without rhizoids (comp. Fig. 160). (×840).

Fig. 166. To the left a cortical hypha from an areole; the left branch of the hypha ends in two brown, living cells. Its right branch ends above in a dead cell, transformed into a constituent of the cuticle. (×1185). To the right in the figure hyphæ from the gonidial layer. (×1185).

Fig. 167. Margin of apothecium, bordering on an areole. (×840).

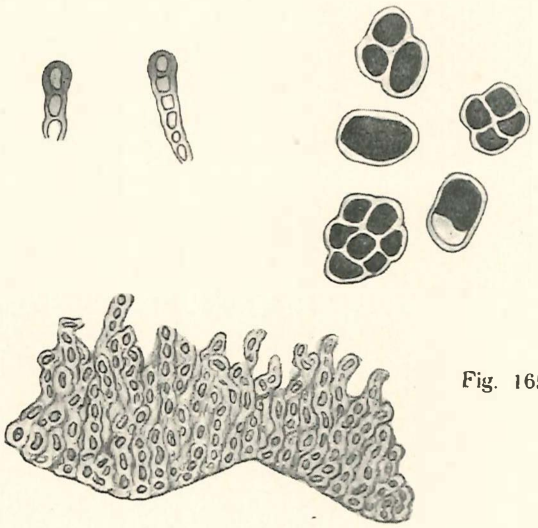


Fig. 165

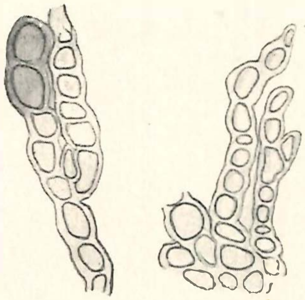


Fig. 166

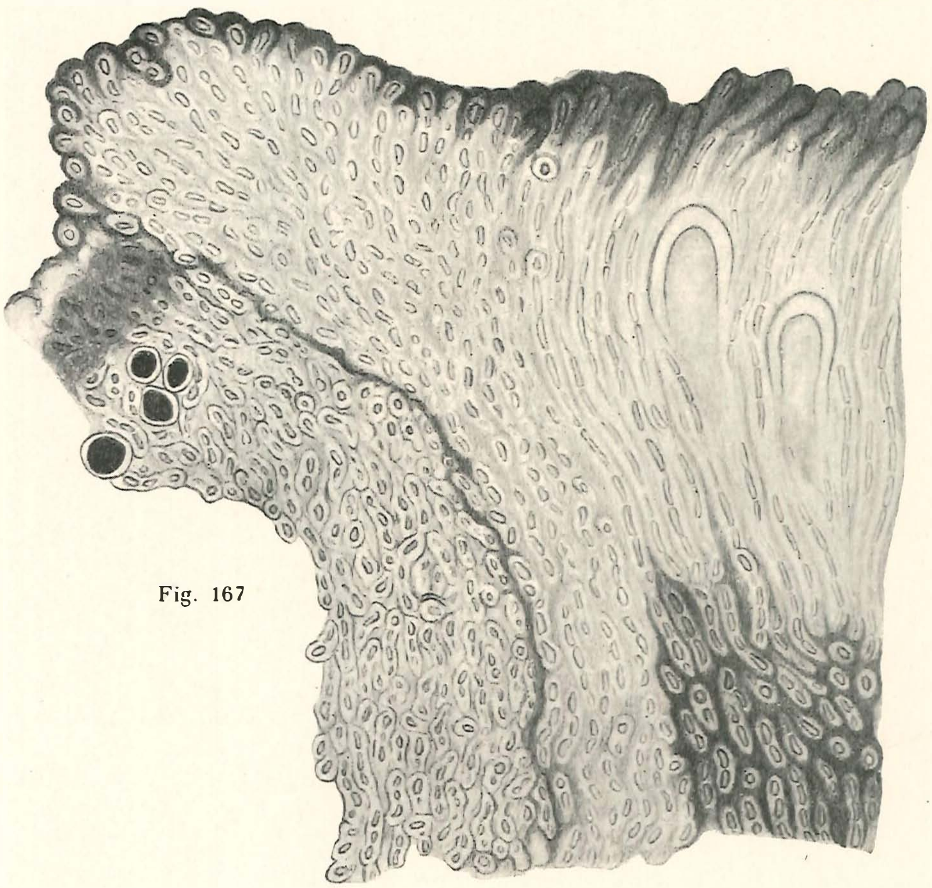


Fig. 167

O. *Galløe del.*

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 2)

PLATE 60.

CATOCARPON APPLANATUM.

(Fr.) Th. Fr.

Specimen 2.

Fig. 168. To the left an ascus with light brownish-grey spores. To the right an ascus, in which there are three quite colourless, still undivided spores, and also two spores, of which one half is colourless, the other half brownish coloured. Right above in the ascus a ripe spore, apparently germinating. (×840).

Fig. 169. Young ascus. (×840).

Fig. 170. Young ascus with surrounding paraphyses. (×840).

Fig. 171. Vertical section of stipes (with brown hyphæ) bordering on calyx-bypothecium, the hyphæ of which are faintly brownish coloured. (×840).

Fig. 172. Four spores, of the most common, colourless type. (×840).

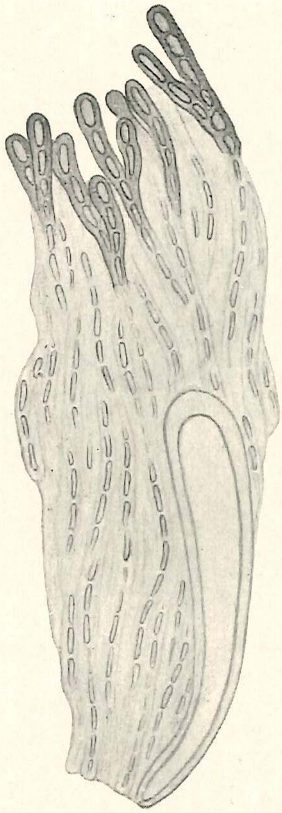


Fig 170

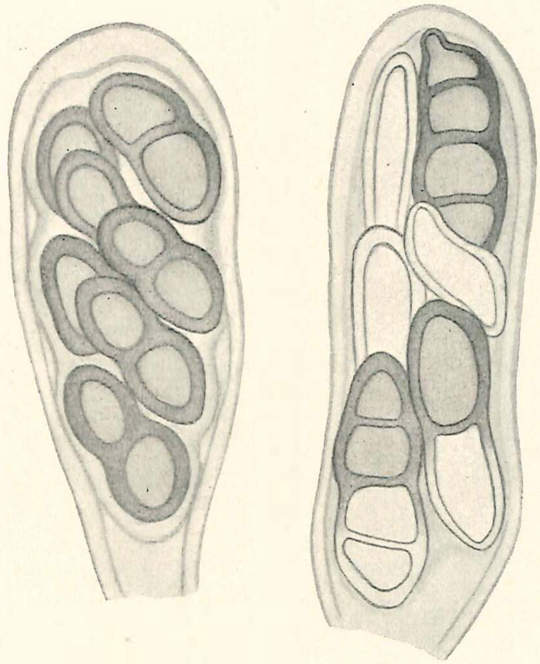


Fig. 168

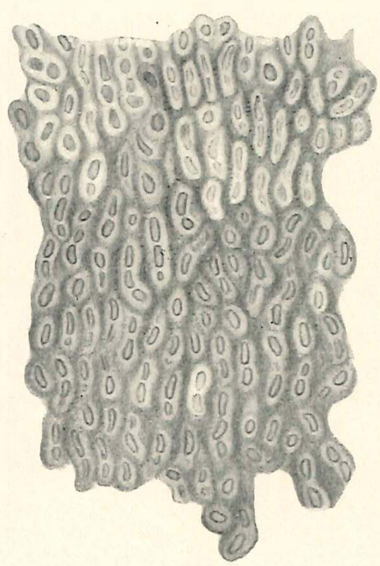


Fig. 171

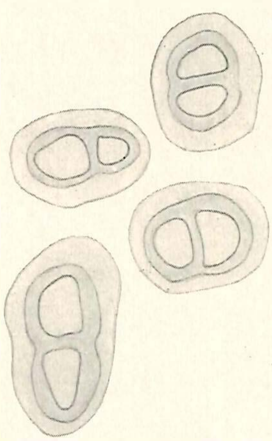


Fig. 172

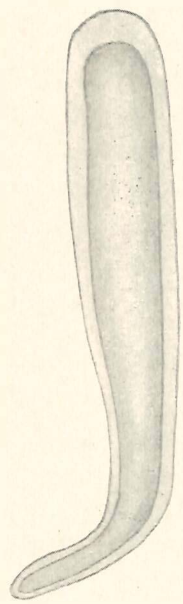


Fig. 169

O. Galløe del.

CATOCARPON APPLANATUM (Fr.) Th. Fr.
(Specimen 2)

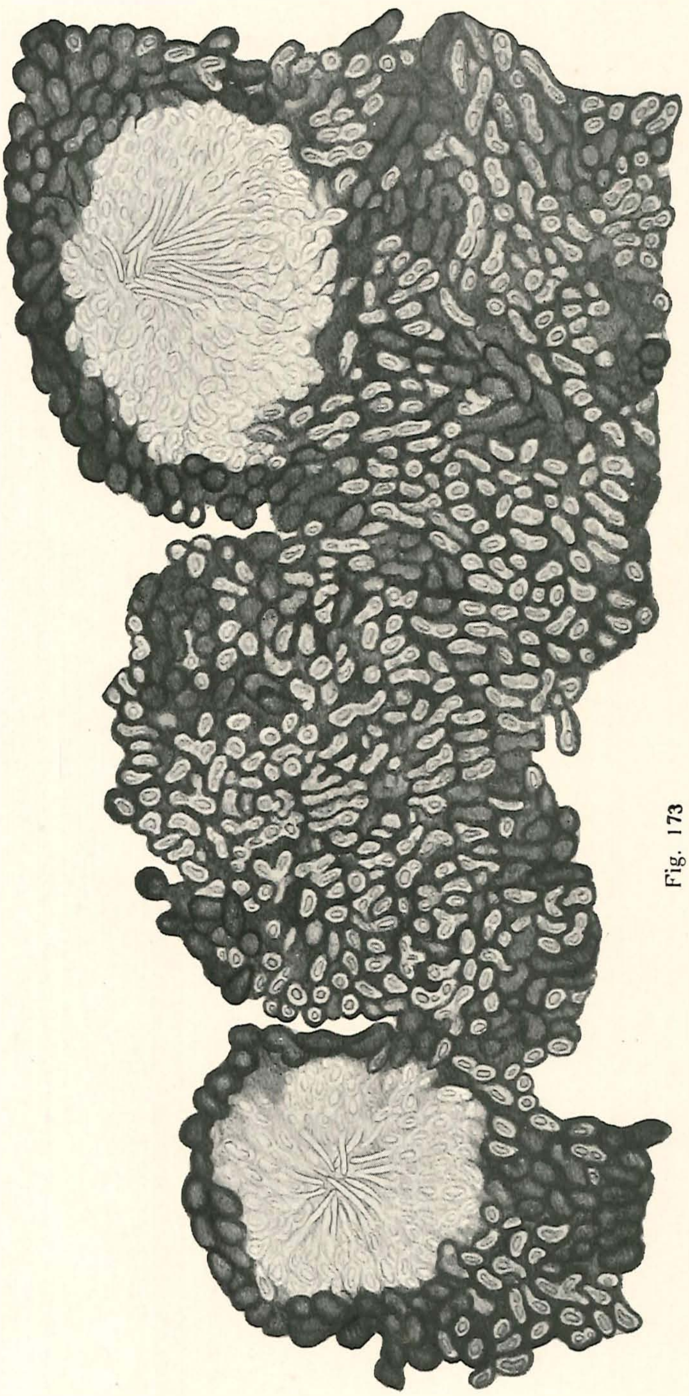
PLATE 61.

CATOCARPON APPLANATUM.

(FR.) TH. FR.

Specimen 2.

Fig. 173. Vertical section of three young, still black areoles near the margin of the thallus. Two of them contain each a pycnide, the conidia-bearing hyphæ of which radiate towards the centre of the pycnide, where they cut off long, rod-like conidia. (×695).



O. Galløe del.

CATOCARPON APPLANATUM (FR.) TH. FR.
(Specimen 2)

PLATE 62.

CATOCARPON BADIOATRUM.

FLK.

Fig. 174. Thallus with apothecia of all ages. Above to the right a broad, black strip of inter-areolar tissue ('hypothallus'). (×22).

Fig. 174

O. Galløe del.

CATOCARPON BADIOATRUM Flk.

PLATE 63.

CATOCARPON BADIOATRUM.

FLK.

Fig. 175. Apothecium and adjacent thallus with partly brown cortical and medullary layers. This section does not show any distinct limit between the areole and the apothecium, as the areole is not corticated where it touches the calyx. Perhaps this fact may be interpreted as a proof that the apothecium has arisen in the areole and not directly from 'hypothallus'. This interpretation, however, is not absolutely convincing (compare the text). (×105).

Fig. 176. To the left a group of spores from one and the same ascus. The epispores are still confluent; they do not separate until later when the spores are shed. To the right two spores from another ascus; the lower one of them seems on the point of germinating though still lying in the ascus. Below these some colourless spores of a type much rarer in this specimen. (×840).

Fig. 177. Portion of an areole, on the upper side of which there is a colourless cuticle, absent on its vertical sides. In a single place the brown cortical hyphæ are breaking through the cuticle. To the left in the figure the natural vertical surface of the areole, without a cuticle. Below in the section the brown medullary layer. (×695).

Fig. 175

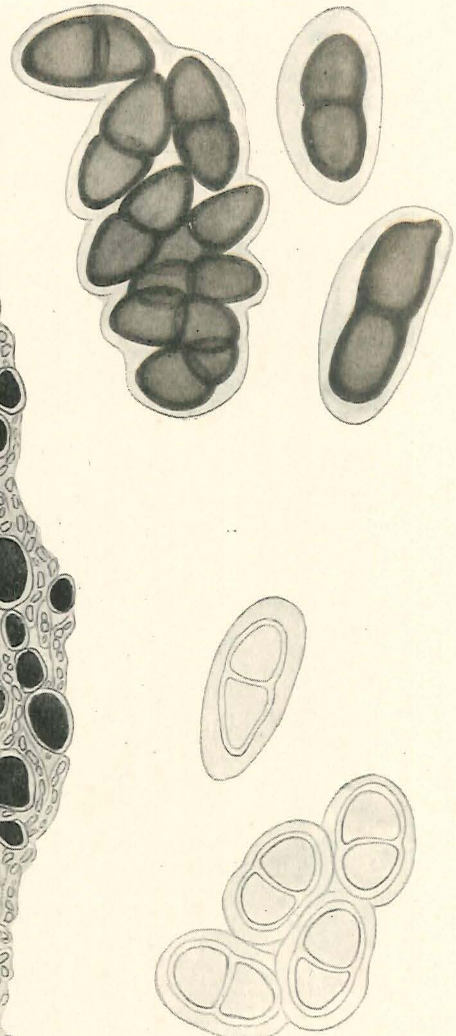


Fig. 176

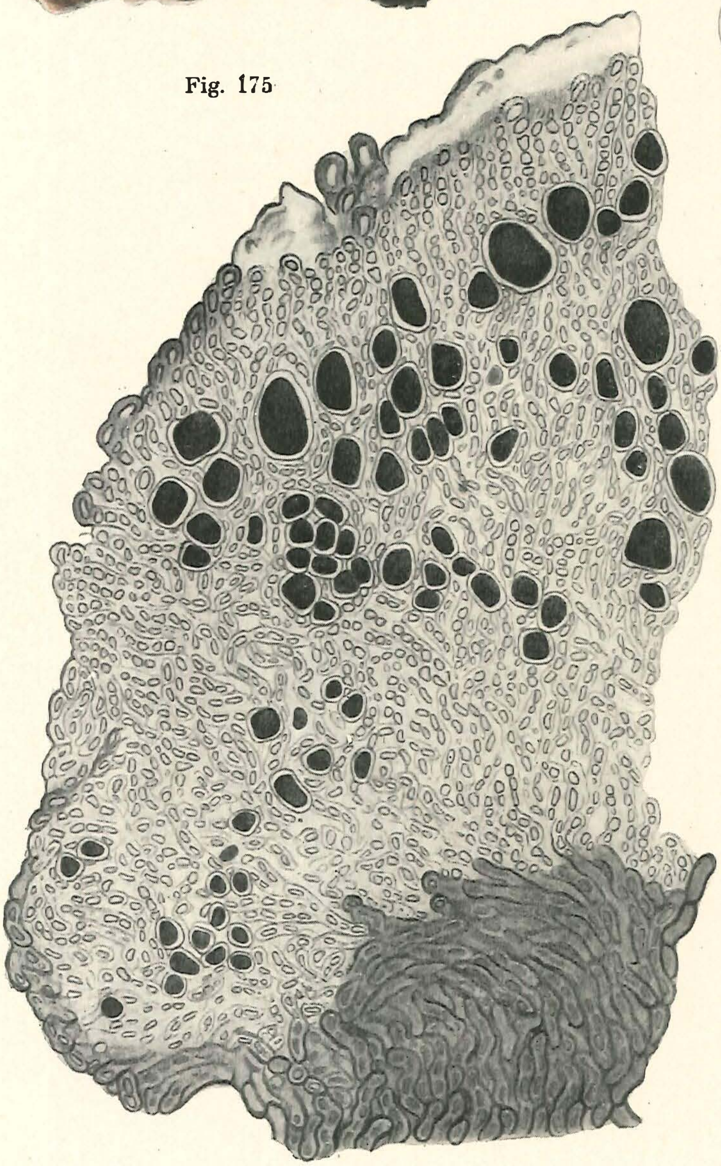


Fig. 177

O. Galløc del.

CATOCARPON BADIOATRUM FLK.

PLATE 64.

CATOCARPON BADIOATRUM.

FLK.

Fig. 178. Margin of apothecium. Below to the left parts of the stipes of the calyx and hypothecium. ($\times 695$).

Fig. 178

O. Galløe del.

CATOCARPON BADIOATRUM FLK.

PLATE 65.

RHIZOCARPON CALCAREUM.

WEIS.

Fig. 179. Fragment of thallus on a decayed, red brick. Alongside the margin (above in the figure) the concentric arrangement of the apothecia can be seen. Lower down in the thallus this order has disappeared (vide the text). To the right in the figure the specimen is broken. ($\times 5$).

Fig. 180. Section of thallus, with thick cortex and medullary layer, and also two apothecia, the surface of which only rises a little above the level of the thallus. Note the well developed stipes. ($\times 105$).

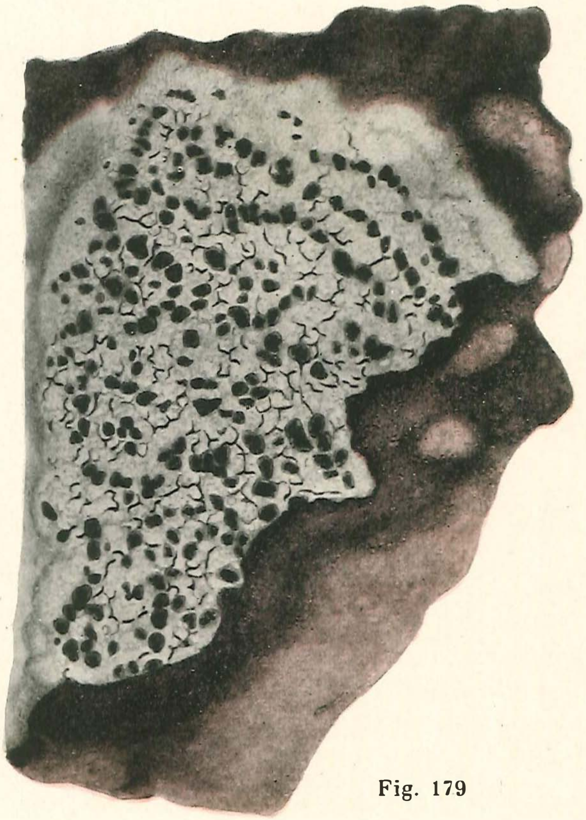


Fig. 179

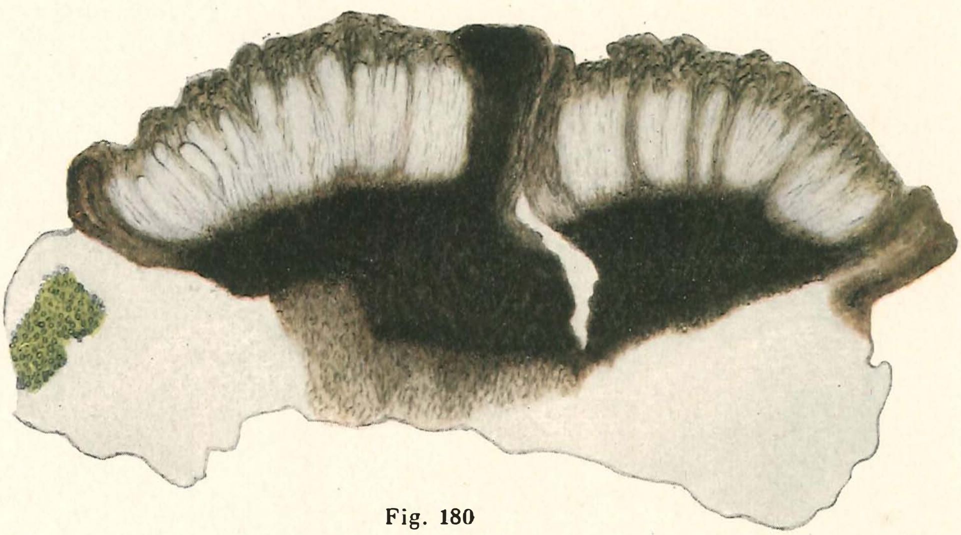


Fig. 180

O. Galløe del.

RHIZOCARPON CALCAREUM WEIS.

PLATE 66.

RHIZOCARPON CALCAREUM.

WEIS.

Fig. 181. Thallus. Surface-view. Note the light, greyish margins of apothecia. Thallus has numerous cracks and fissures (×22).

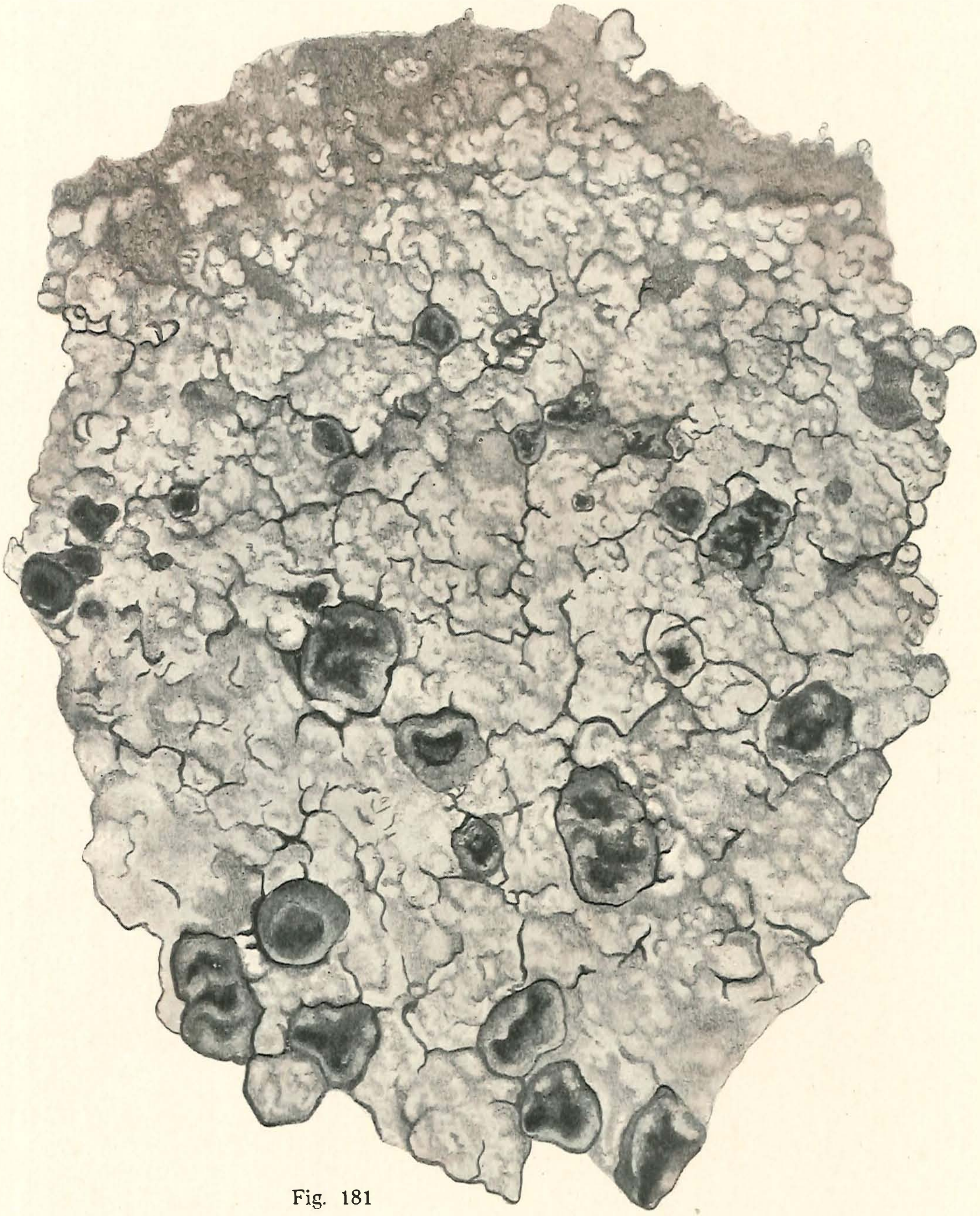


Fig. 181

O. Galløe del.

RHIZOCARPON CALCAREUM WEIS.

PLATE 67.

RHIZOCARPON CALCAREUM.

WEIS.

Fig. 182. Vertical section of thallus. Cortex is thick. Only the upper part of the medullary layer is figured; otherwise the medulla is very thick (vide Fig. 180). To the left in the figure the natural surface of thallus, bordering on a crack in the thallus; a thin but distinct cortex occurs in this place showing that the cracks of the cortex are not caused by the drying-up of the thallus but represent a primitive areolation. Note (as mentioned in the text) tbe light grains in cortex and medullary layer. (×695).

Fig. 183. Margin of apothecium, bordering on the thallus (to the left in the figure). Below to the right the section shows the upper part of calyx (dark), above which the colourless hypothecium with distinct ascogenous hyphæ, and also portions of three asci. In the right one of the latter some of the spores are seen lying transversely in the ascus, so that they are seen in transverse section (or better, from an end). The paraphyses are here dark at the tips, but their uppermost parts are cuticle-like and colourless. To the left of the hymenium the calyx with thickened margin, the upper part of which is likewise covered by a light, somewhat cuticle-like cortex (for further particulars see the text). To the left of the calyx the adjacent parts of the thallus. The limit between calyx and thallus may sometimes be more indistinct in other apothecia than shown here, as the hyphæ of the calyx may be lighter than the present ones. (×695).

Fig. 184. Ascus (somewhat broad from the pressure of the cover-glass upon the preparation), with ripe, colourless spores. (×840).

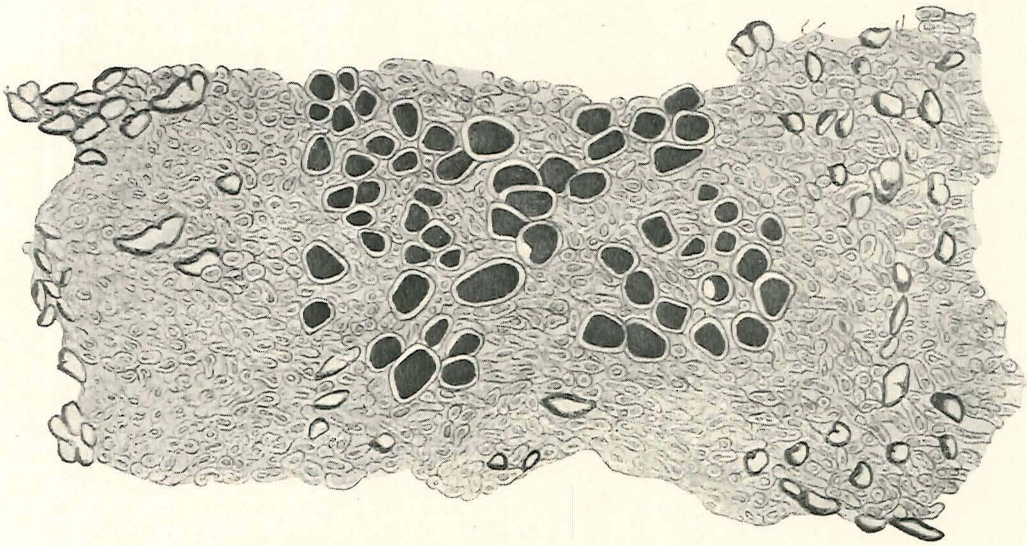


Fig. 182

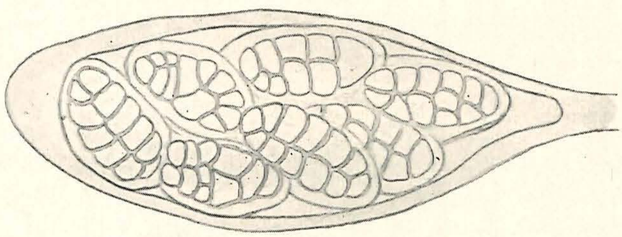


Fig. 184

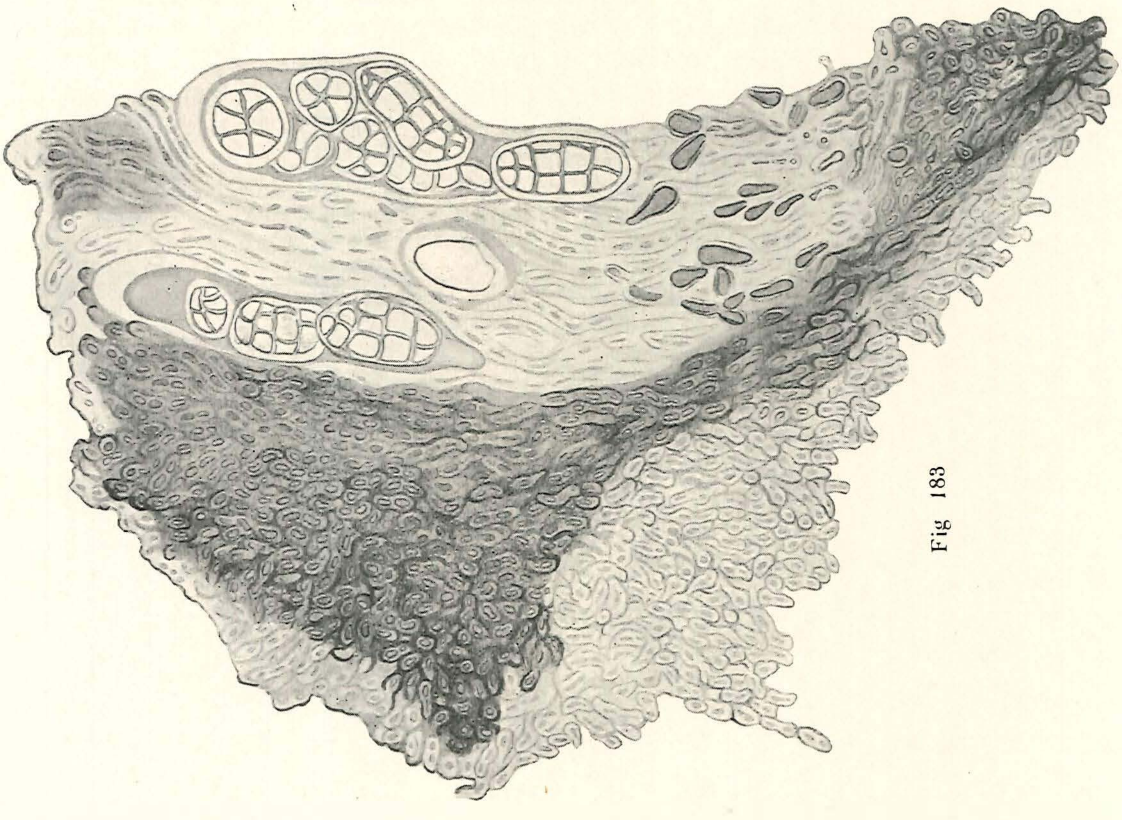


Fig 183

O. Galløe del.

RHIZOCARPON CALCAREUM Weis.

PLATE 68.

RHIZOCARPON REDUCTUM.

Th. Fr.

Fig. 185. To the left three specimens, in part separated by a dark margin. Two of them have grown together along their margin (for further details vide the text). To the right a single, isolated individual. ($\times 5^1/_2$).

Fig. 186. Longitudinal section through the margin of the thallus; the mycelial margin is seen to the left in the section. Three newly formed areoles (with green gonidia) occur in the figure. ($\times 157$).

Fig. 187. This figure is an enlarged picture of the central areole of Fig. 186. A group of newly divided gonidia are seen, surrounded by dark hyphæ ('hypothallus'); below these the hyphæ are colourless. ($\times 1185$).

Fig. 185

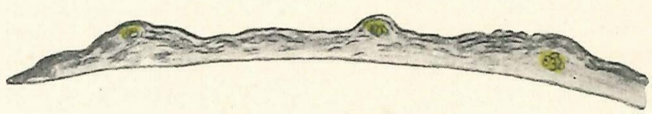


Fig. 186

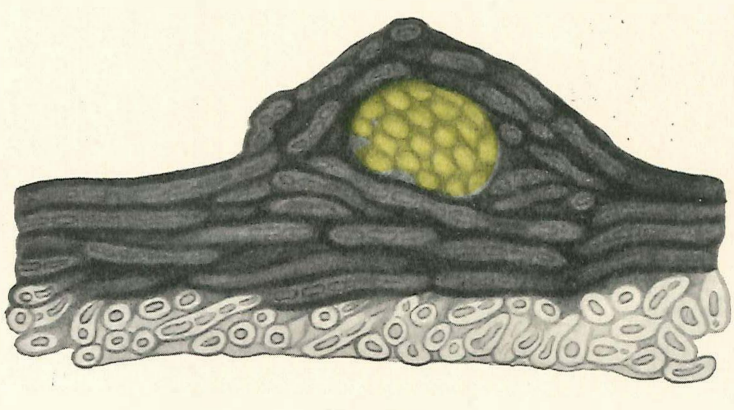


Fig. 187

O. Galløe del.

RHIZOCARPON REDUCTUM TH. FR.

PLATE 69.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 188. Thallus with mycelial margin and young areoles together with fully developed areoles; also apothecia of all ages. (×26).

Fig. 188

O. Galløe del.

RHIZOCARPON REDUCTUM TH. FR.

PLATE 70.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 189. Two young, fully developed, coherent areoles, not far from the margin of the thallus (situated to the right in the Fig.), and also a portion of an apothecium. In the youngest (right) areole the medullary hyphæ are still young and horizontal; in the other areole they are on the point of becoming erect. (×157).

Fig. 190. Above, a rather young areole; below, an older areole with its natural, vertical surfaces. The medullary-gonidial layer is brownish. (×157).

Fig. 191. Above, the apices of three marginal hyphæ. Below to the left some faintly coloured, brownish, mycelial marginal hyphæ, to the right some blackish-brown ones. (×840).

Fig. 192. Portion of a horizontal section of an areole. Above, the cortical hyphæ cut across (they stand erect in the areole). Farther down, the gonidial layer, the walls of which are brownish here. (×840).

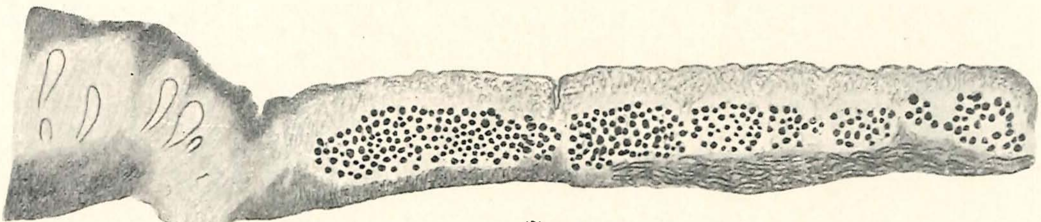


Fig. 189

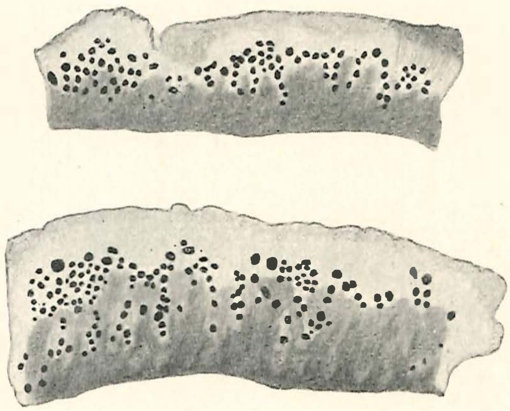


Fig. 190

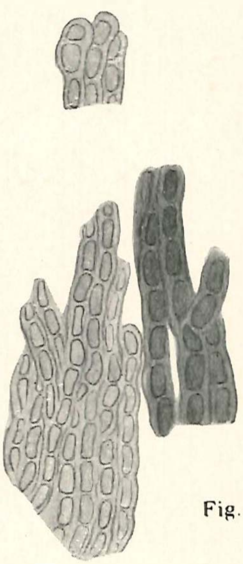


Fig. 191

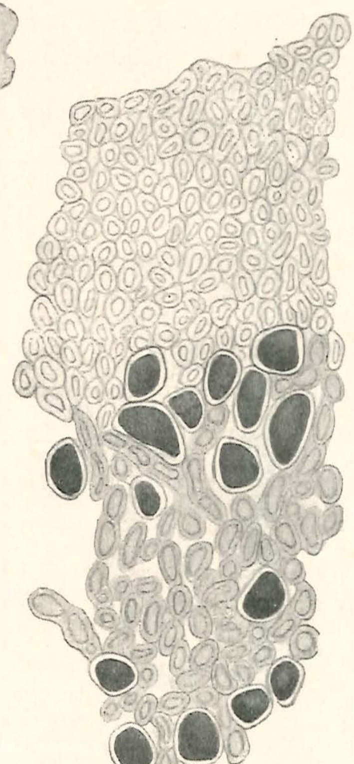


Fig. 192

O. Galløe del.

RHIZOCARPON REDUCTUM TH. FR.

PLATE 71.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 193. Section of apothecium, showing the peculiar distribution of the colours in the calyx and also the difference between dark and light paraphyses. To the left of the apothecium an areole with brown medulla and corticate on the side nearest the apothecium. (×157).

Fig. 194. Margin of an areole, showing the occurrence of cortex on the vertical sides, and also a brownish medulla. (×840).

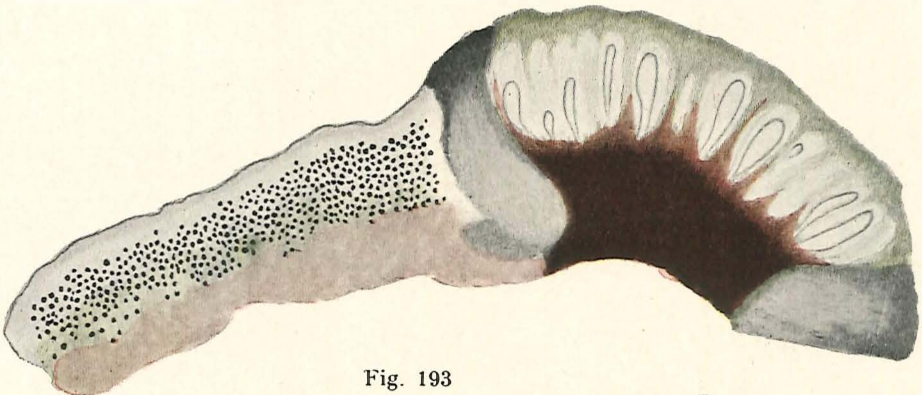


Fig. 193

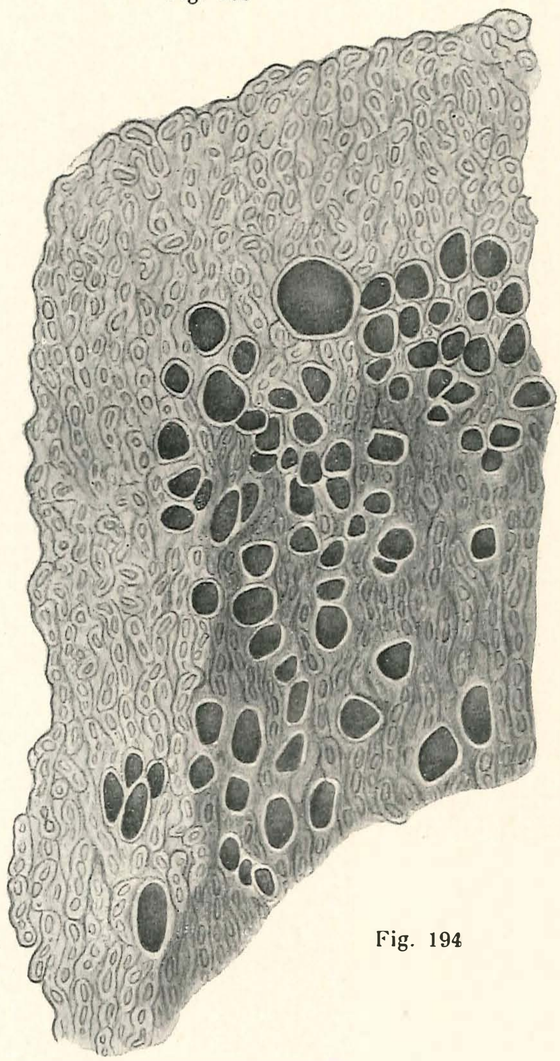


Fig. 194

O. Galløe del.

RHIZOCARPON REDUCTUM TH. FR.

PLATE 72.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 195. Margin of apothecium. The hyphæ above in the calyx are dark; there is, however, a thin, colourless layer of hyphæ covering part of the margin and imparting to the latter a macroscopically lighter colour than that of the disc (cp. Fig. 188). The lower parts of the calyx (below to the left) are considerably lighter (cp. Fig. 193). (×840).

Fig. 195

O Galløe del.

RHIZOCARPON REDUCTUM TH. FR.

PLATE 73.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 196. Portion of the hymenium. To the left the paraphyses are light with copious hymenial gelatine. To the right they are grouped closely together, with very scanty gelatine. Above, a thin, colourless, cuticle-like tissue is formed by the tips of the paraphyses. The dark paraphyses issue from dark hyphæ in stipes-hypothecium. (×840).

Fig. 197. Horizontal section of the hymenium. Below a group of dark paraphyses, above a group of light ones (cp. Fig. 196). Several asci are see across. (×840).

Fig. 196

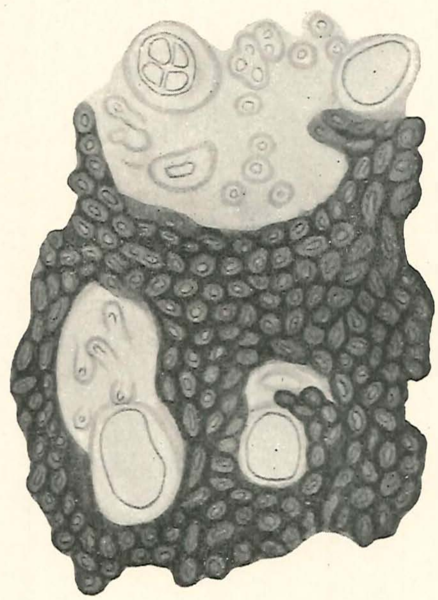


Fig. 197

O. *Galløe del*

RHIZOCARPON REDUCTUM TH. FR.

PLATE 74.

RHIZOCARPON REDUCTUM.

TH. FR.

Fig. 198. Tips of paraphyses; in this case there is no cuticle as in Fig. 196. (×840).

Fig. 199. Group of spores from one ascus. (×840).

Fig. 200. Ascus with spores. (×840).

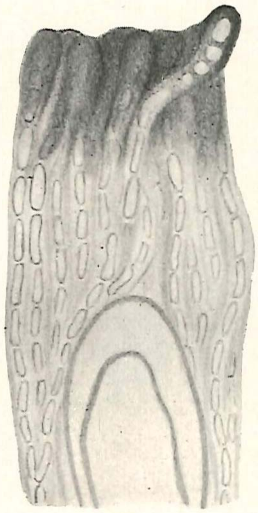


Fig. 198

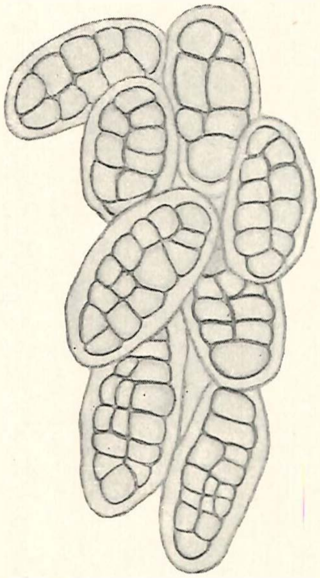


Fig. 199

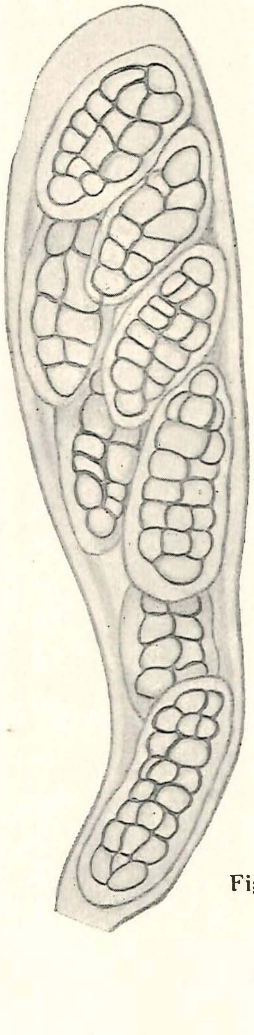


Fig. 200

O. *Galløe del.*

RHIZOCARPON REDUCTUM TH. FR.

PLATE 75.

RHIZOCARPON OBSCURATUM.
(ACH.) KÖRB.

Fig. 201. Thallus with apothecia of all ages. (×26).

Fig. 201

O. Galløe del.

RHIZOCARPON OBSCURATUM (ACH) KÖRB.

PLATE 76.

RHIZOCARPON OBSCURATUM.

(ACH.) KÖRB.

Fig. 202. Two young apothecia, grown together. (×105).

Fig. 203. Apothecium and neighbouring areoles. (×105).

Fig. 204. Four young apothecia. Two of them were evidently formed in one areole. On the areoles traces of the grey colour of the margin of the thallus. (×105).

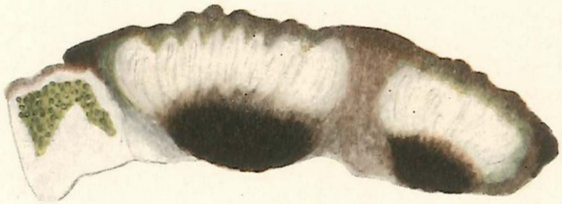


Fig 202

Fig. 203

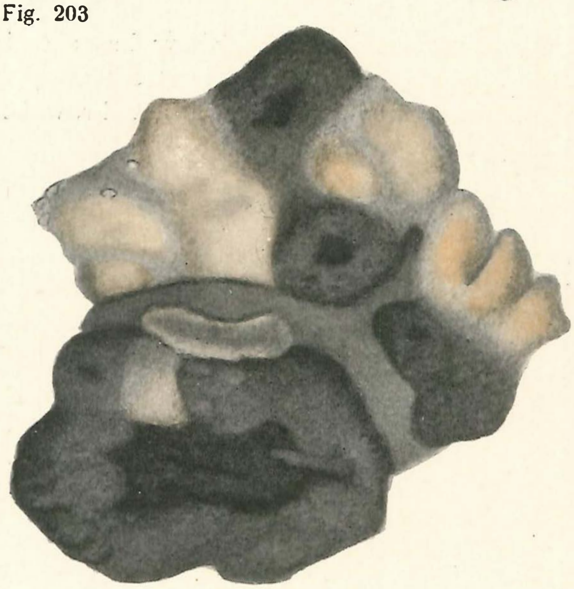


Fig. 204

O. Galløe del.

RHIZOCARPON OBSCURATUM (Ach.) Körb.

PLATE 77.

RHIZOCARPON OBSCURATUM.

(ACH.) KÖRB.

Fig. 205. About $^2/_3$ of an areole, which above has a cuticle and below this distinct (brown) cortical hyphæ. At *a* the areole is cut away from its basal connection with the neighbouring areole. Some darker, brownish hyphæ may be discerned in the medullary layer. ($\times$695).

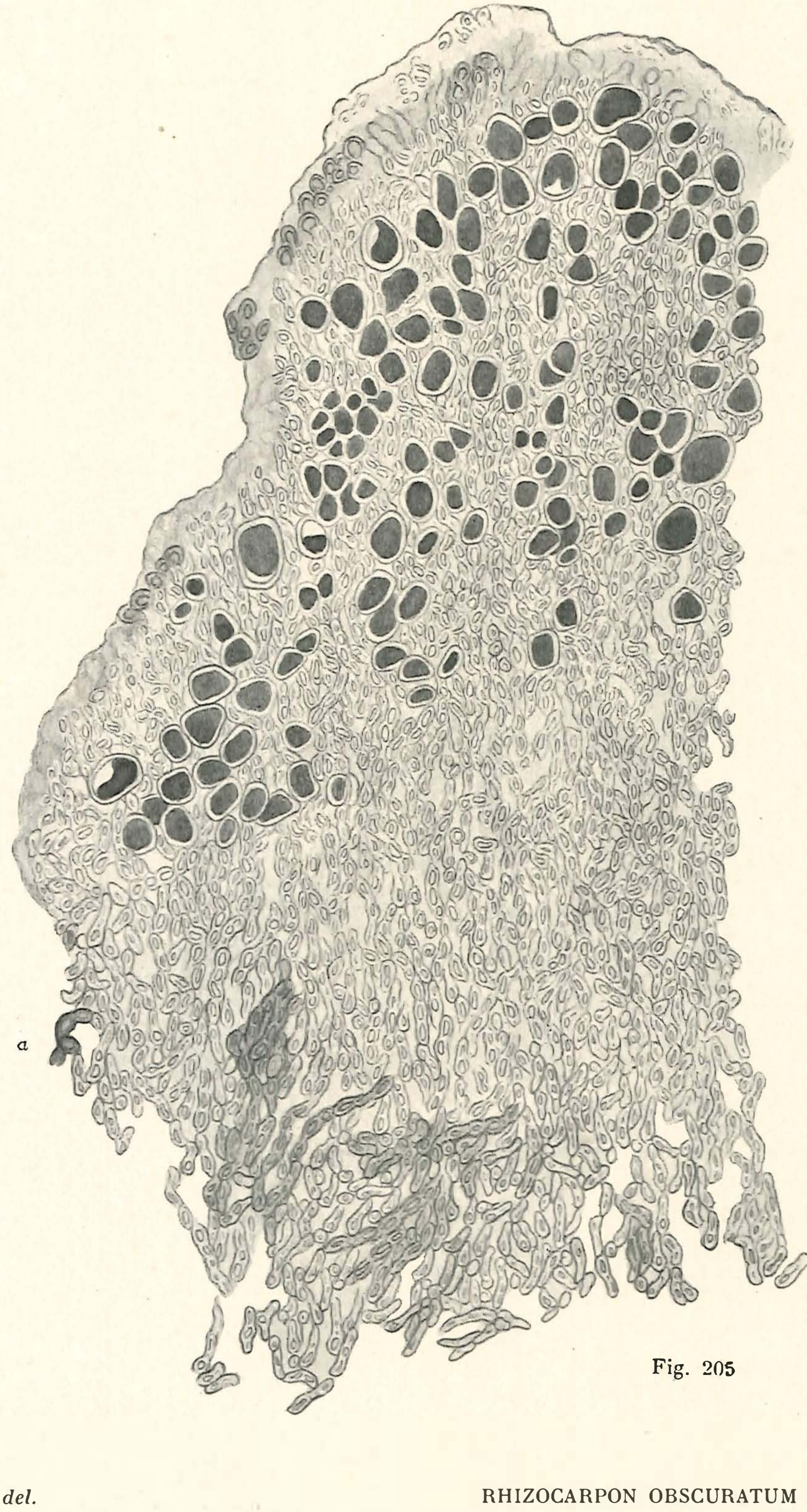


Fig. 205

O. Galløe del.

RHIZOCARPON OBSCURATUM (Ach.) Körb.

PLATE 78.

RHIZOCARPON OBSCURATUM.

(ACH.) KÖRB.

Fig. 206. Portion of the margin of the thallus. The centre of the thallus is to the left of the section. Note the colourless hyphæ in the future gonidial layer between the dark, blackish-brown basal hyphæ and the cortical hyphæ. A gonidial alga, which has fallen on to the surface of the thallus, has been captured at the extreme right of the margin. This is the first irrefutable observation of this phenomenon, the existence of which has hitherto been only surmised but scarcely ever proved with any certainty. Below in the section two grains of minerals from the substratum. Below the main figure is shown a branched hypha from the margin of the thallus; it is colourless, with blackish-brown apices. (×840).

Fig. 207. Margin of apothecium, bordering on the thallus. The apothecium has clearly arisen in an areole; otherwise there would be a distinct boundary and possibly an interstice too between the apothecium and the areole. Note in the margin of the apothecium the faintly coloured, erect hyphæ of the calyx, with dark apices above. In the thallus the dark cortical hyphæ. (×840).

Above in the figure are seen the apices of some hyphæ from the margin; on them a cuticle of remnants of dead hyphæ, probably formed of the uppermost dead and discoloured cells of the dark hyphæ themselves. (×1185).

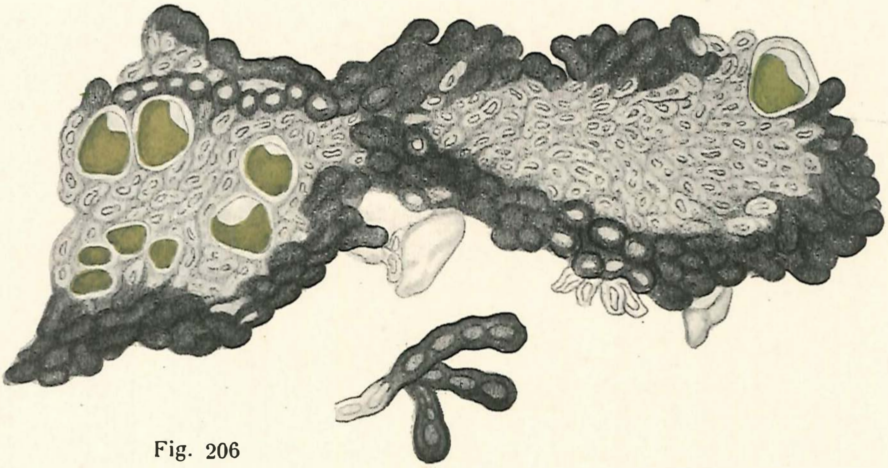


Fig. 206

Fig. 207

O. *Galløe del.*

RHIZOCARPON OBSCURATUM (ACH.) KÖRB.

PLATE 79.

RHIZOCARPON OBSCURATUM.

(ACH.) KÖRB.

Fig. 208. Portion of apothecium. The lower surface of the section rests immediately on the surface of the substratum (omitted in the figure) and is smooth and even, without rhizoids. The lower parts of the hyphæ of the stipes are brown; higher up, in the calyx and the hypothecium, they become partly brown, partly colourless. Above in the section three distinct asci may be discerned, cut obliquely across. Some bigger ascogenous cells may be discerned in the hypothecium. (×840).

Fig. 209. Portion of the hymenium with unripe asci. (×840).

Fig. 210. Above, a group of spores from one and the same ascus. Below to the left an ascus with spores, nearly all of them lying across in the ascus and therefore seen from one end, the arrangement of the longitudinal walls thus becoming distinct. To the right an ascus, in which at least three spores, which have only transverse but no longitudinal walls. (×840).

Fig. 211. Three isolated spores, the epispore of which is somewhat irregularly corroded. To the right in the figure a spore seen from one end. (×840).

Fig. 208

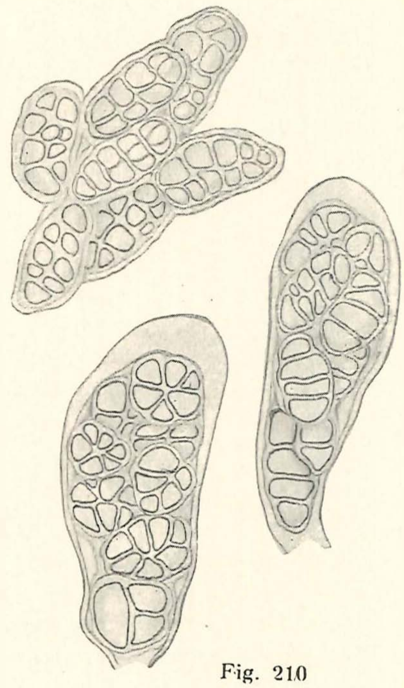
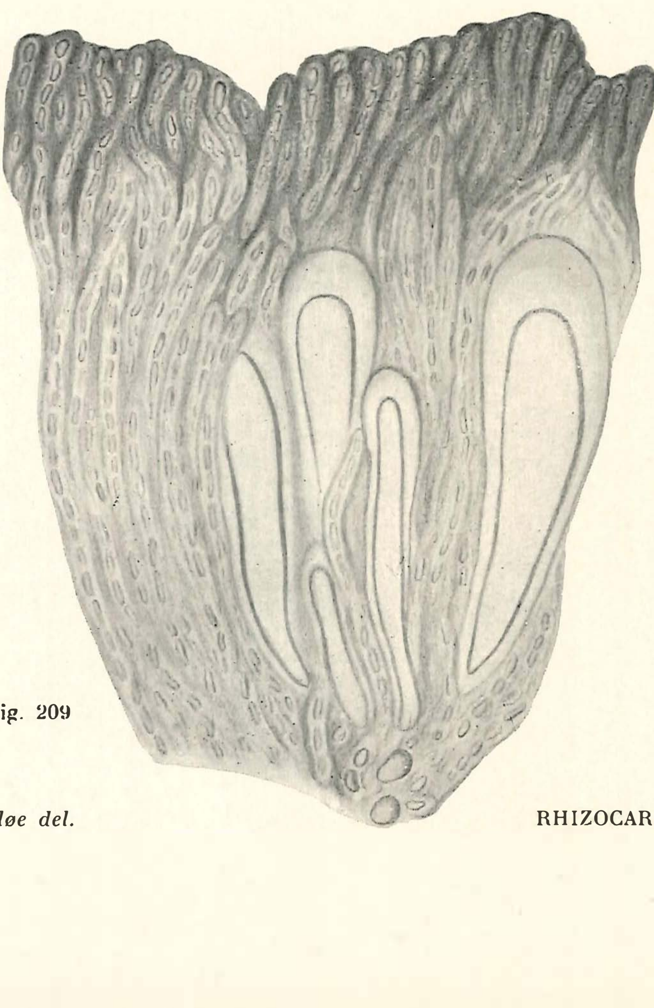


Fig. 210



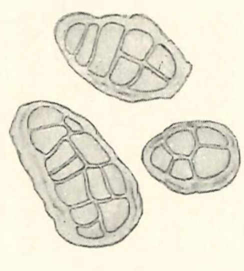


Fig. 211

Fig. 209

O. Galløe del.

RHIZOCARPON OBSCURATUM (Ach.) Körb.

PLATE 80.

RHIZOCARPON DISTINCTUM.

TH. FR.

Fig. 212. Thallus with apothecia of all ages. In the black margin of the thallus and in the inter-areolar thallus several empty meshes. Above in the figure the thallus of *Lecanora sordida*, which has in part grown over the *Rhizocarpon*, and above to the right has reached an apothecium and an old areole. This fact proves that the *Rhizocarpon* has really been grown over, as an apothecium cannot be formed on the extreme edge of the thallus. ($\times$26).

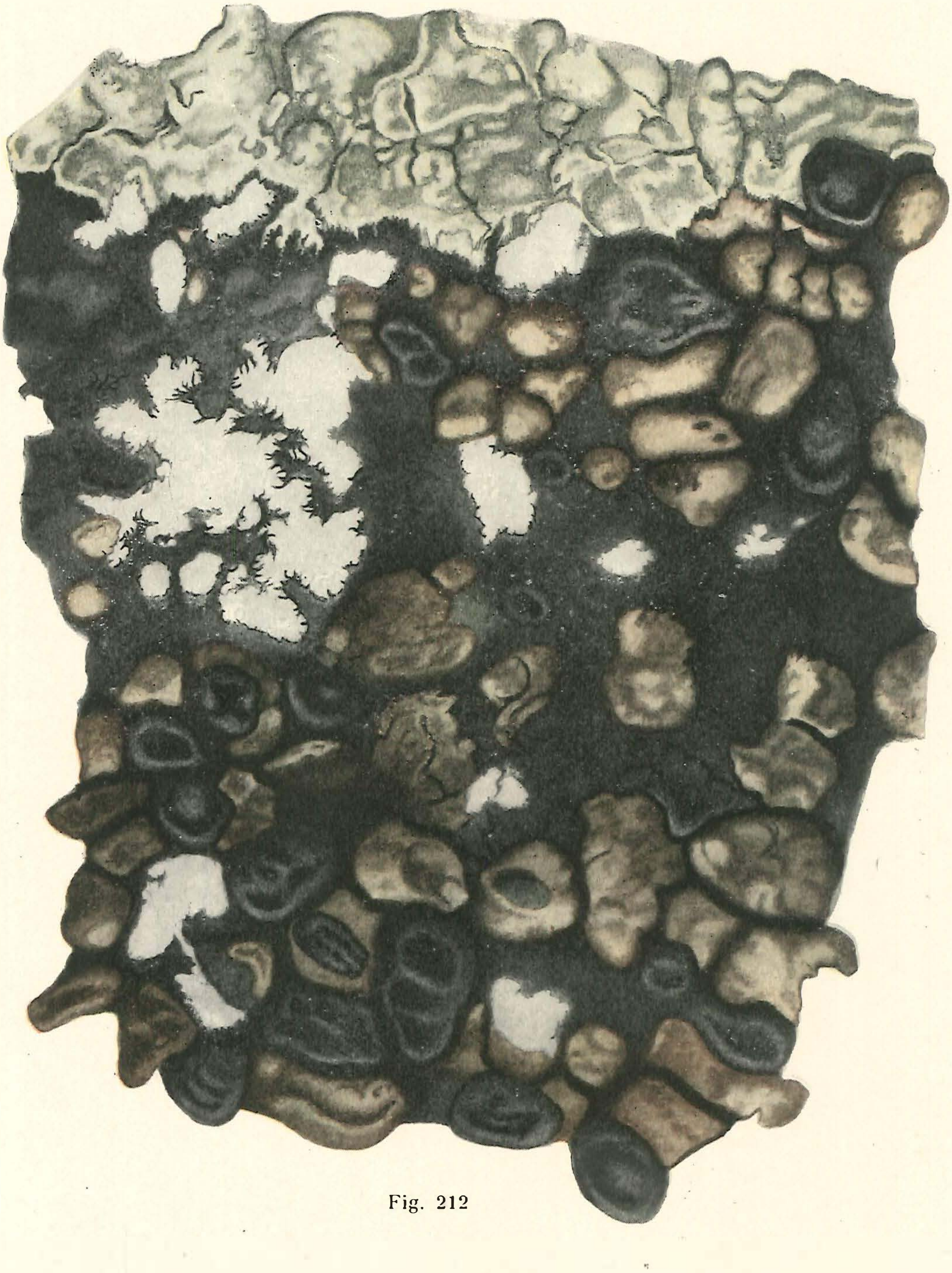


Fig. 212

O. Galløe del.

RHIZOCARPON DISTINCTUM TH. FR.

PLATE 81.

RHIZOCARPON DISTINCTUM.

TH. FR.

Fig. 213. Apothecium with adjacent areole. (×105).

Fig. 214. Portion of an areole. Note the thick cuticle on the surface of the areole. (×695).

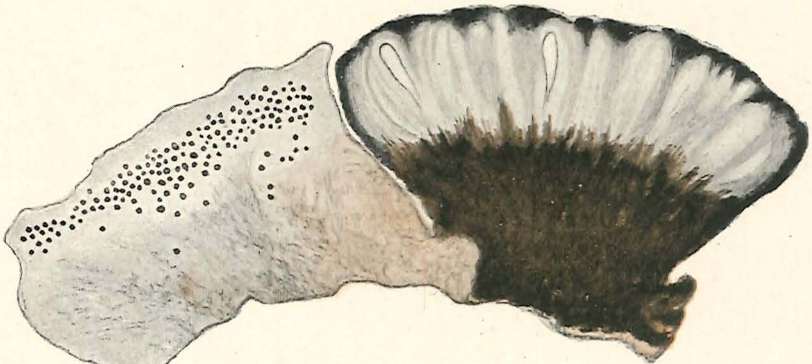


Fig. 213

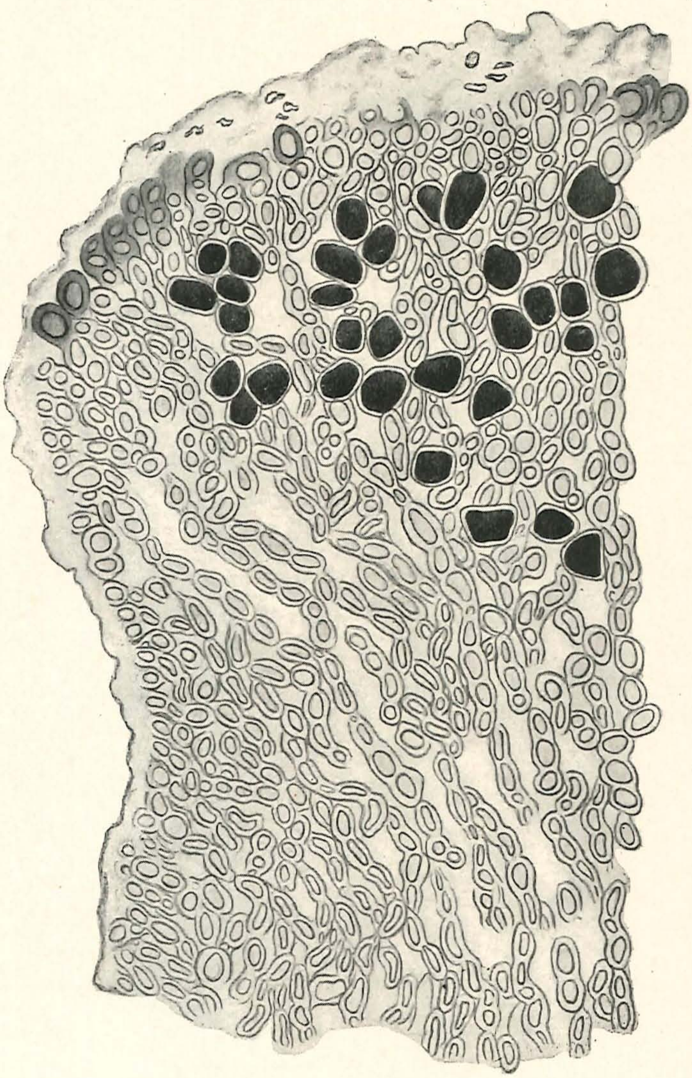


Fig. 214

O. Galløe del.

RHIZOCARPON DISTINCTUM TH. FR.

PLATE 82.

RHIZOCARPON DISTINCTUM.

TH. FR.

Fig. 215. The section shows how the cuticle is composed of the upper ends of the cortical hyphæ, which latter stand erect. Four gonidia. (×1185).

Fig. 216. Above to the left three gonidia isolated from the black margin of the thallus. The black tissue is the marginal mycelium. (×840).

Fig. 217. The gonidial layer. (×1185).

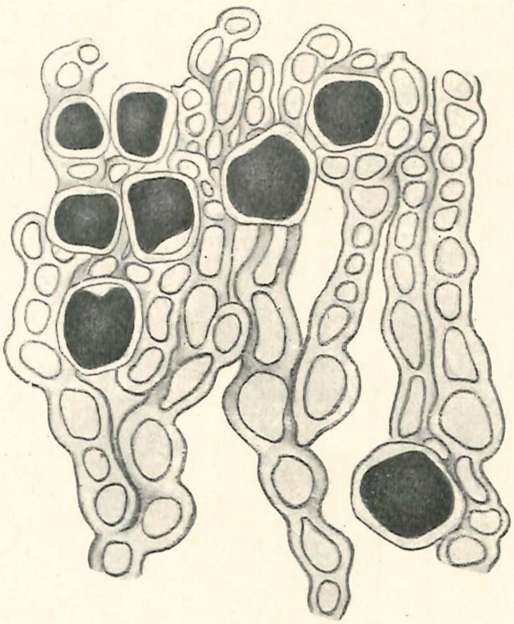


Fig. 217

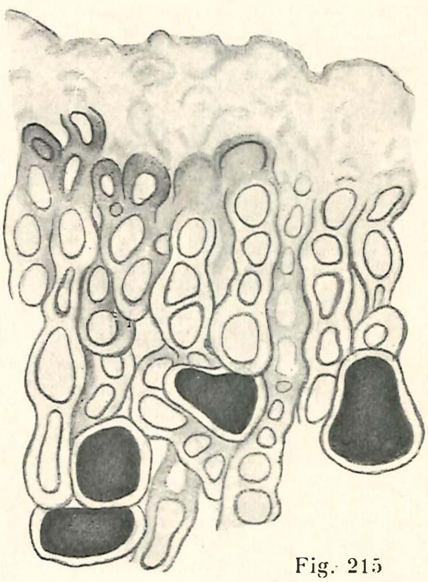


Fig. 215

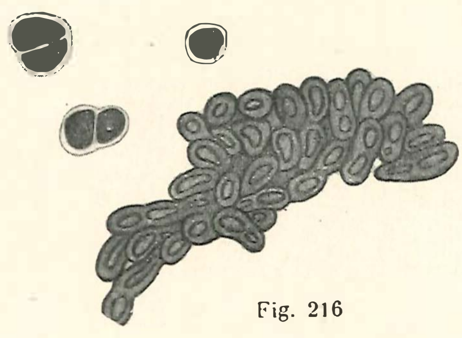


Fig. 216

O. Galløe del.

RHIZOCARPON DISTINCTUM Th. Fr.

PLATE 83.

RHIZOCARPON DISTINCTUM.

TH. FR.

Fig. 218. The medullary layer. (×1185).

Fig. 219. Two asci with spores. Note that some of the spores are exclusively provided with transverse walls but lack longitudinal walls. The ascus to the right has been squeezed somewhat flat by pressure of the cover-glass. (×840).

Fig. 220. The boundary between the hymenium and hypothecium-calyx. The hyphæ are brown; where they are cut across, the pigment is seen to be exclusively deposited in the outer layers of the cell-walls. The strikingly big cells are ascogenous cells. (×840).

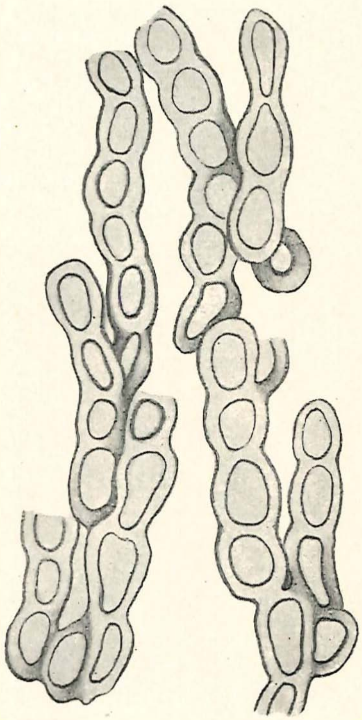


Fig. 218

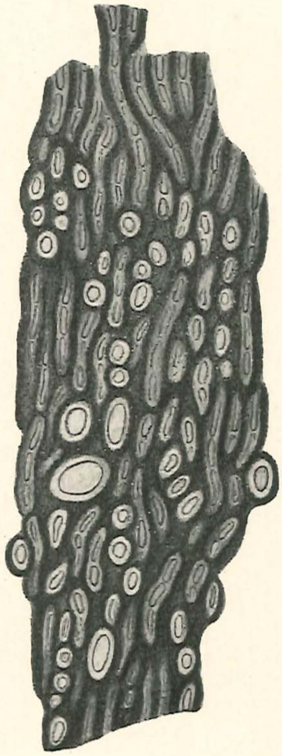


Fig. 220

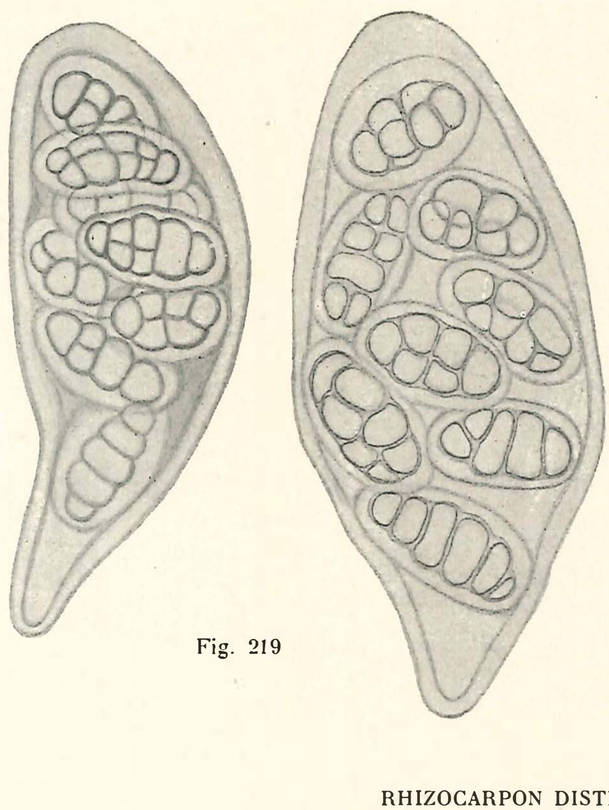


Fig. 219

O. Galløe del.

RHIZOCARPON DISTINCTUM Th. Fr.

PLATE 84.

RHIZOCARPON DISTINCTUM.

TH. FR.

Fig. 221. Margin of apothecium; the hymenium is omitted. It is seen how the colour is distributed in the hyphæ, the apices of which are black. Below to the left some apical hyphæ of that kind cut across. Even here the layers of the inner walls of the hyphæ are colourless. ($\times$840).

Fig. 222. Paraphyses with hymenial gelatine. The hypothecium is seen below. ($\times$840).

Fig. 221

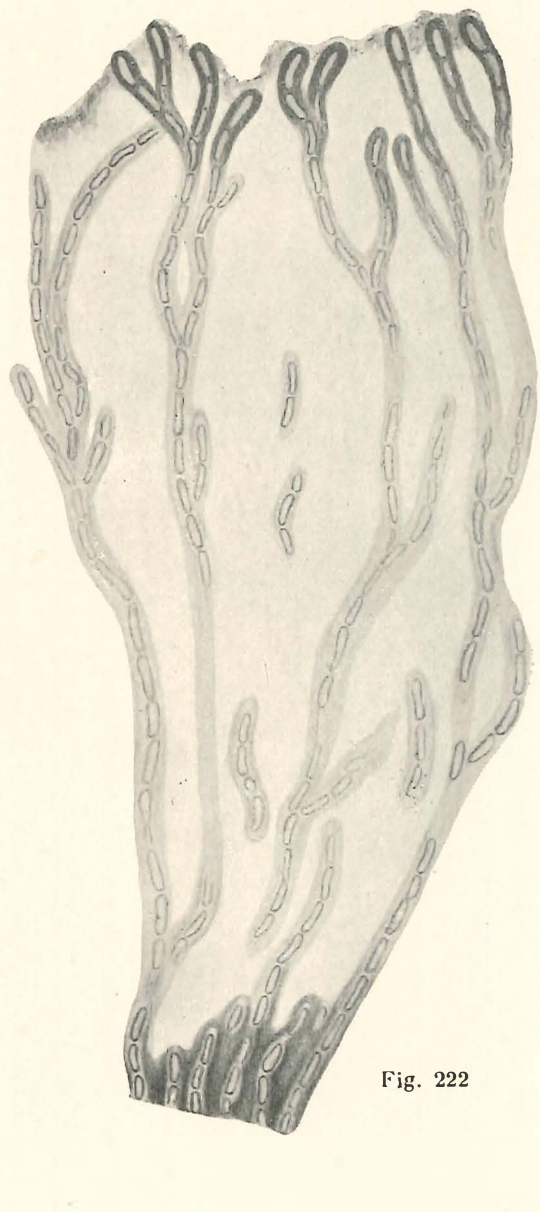


Fig. 222

O. Galløe del.

RHIZOCARPON DISTINCTUM TH. FR.

PLATE 85.

RHIZOCARPON DANICUM.

O. GALLØE. NOV. SP.

Fig. 223. Thallus (on flint), and apothecia of all ages. For further morphological particulars *vide* the text. (×22).

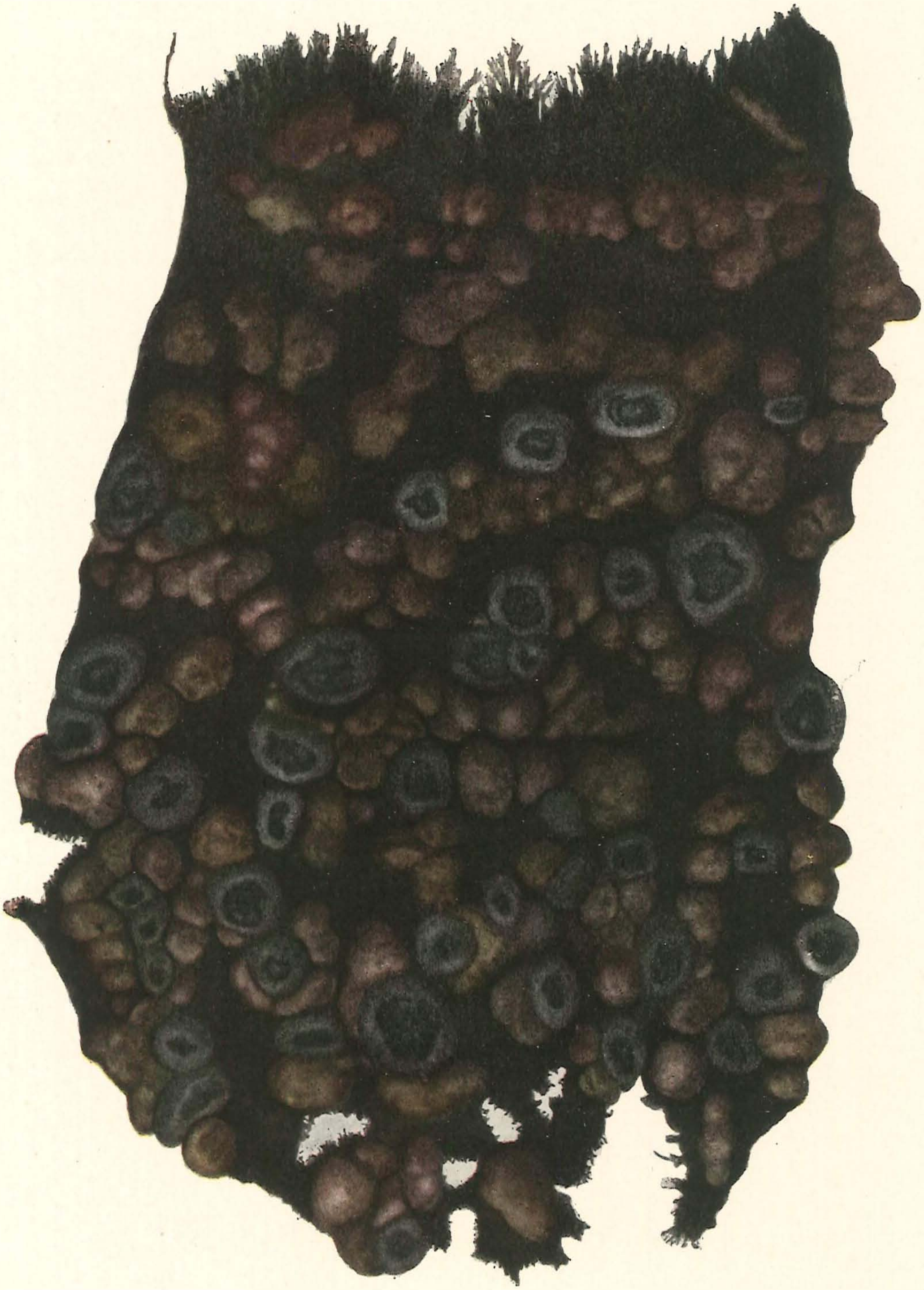


Fig. 223

O. Galløe del.

RHIZOCARPON DANICUM O. GALLØE. NOV. SP.

PLATE 86.

RHIZOCARPON DANICUM.

O. GALLØE. NOV. SP.

Fig. 224. Areole and two confluent apothecia, resting immediately on the substratum (omitted in the figure). (×157).

Fig. 225. Areole with cuticle, cortical and gonidial layers. The medullary layer is omitted. (×840).

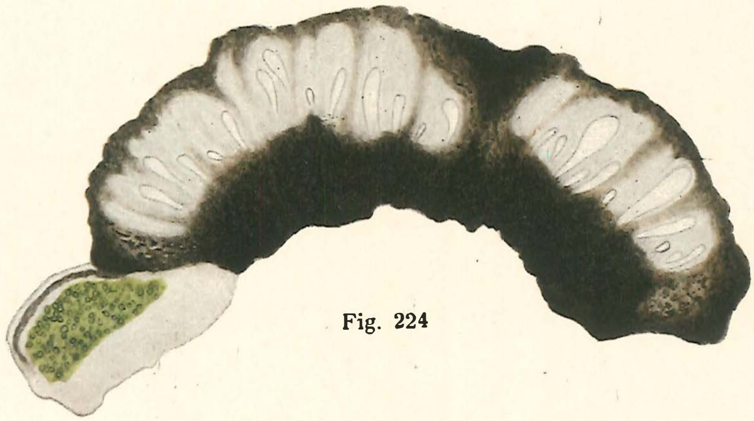


Fig. 224

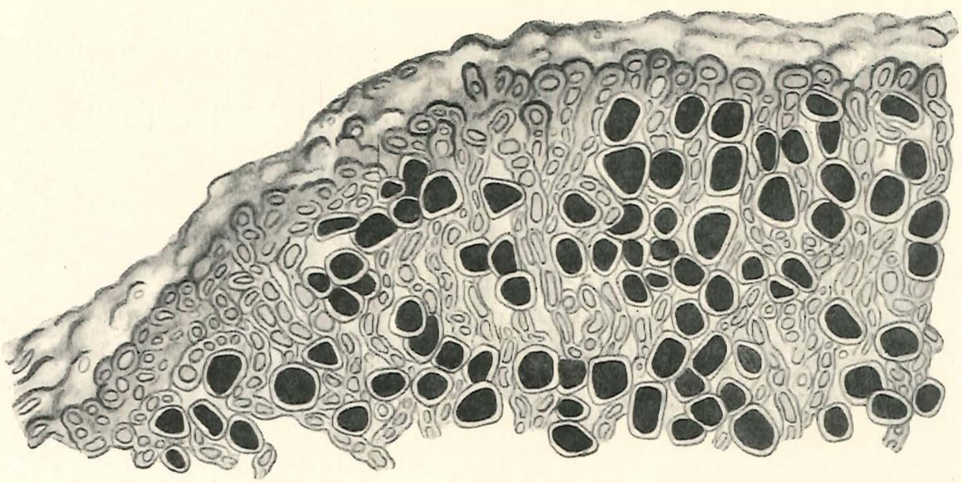


Fig. 225

O. Galløe del.

RHIZOCARPON DANICUM O. GALLØE. NOV. SP.

PLATE 87.

RHIZOCARPON DANICUM.

O. GALLØE. NOV. SP.

Fig. 226. Margin of apothecium. In the hymenium several very young and small asci. (×695).

Fig. 227. To the left, spores of different types. To the right, paraphyses with hymenial gelatine. (×840).

Fig. 228. Ascus with spores. (×840).

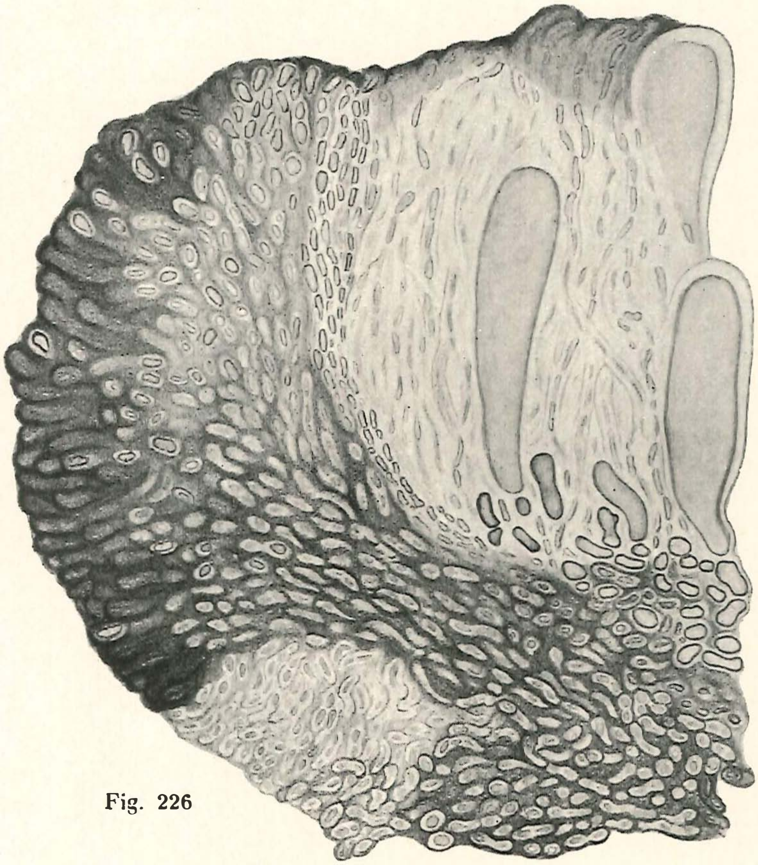


Fig. 226

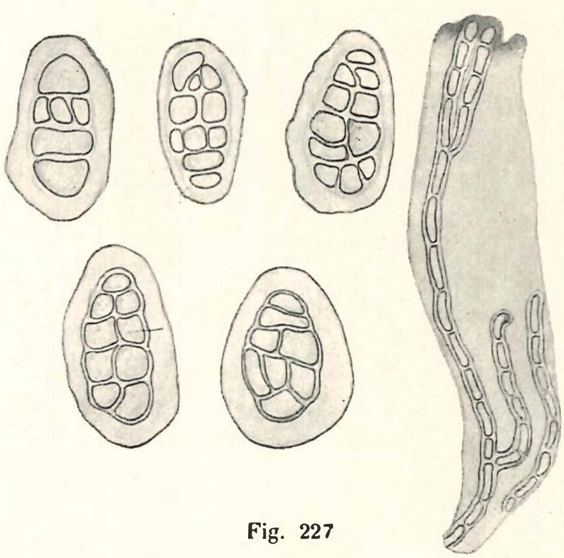


Fig. 227

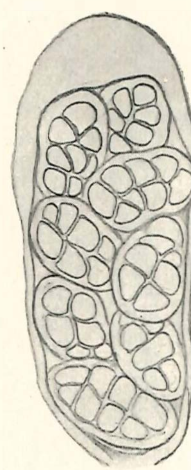


Fig. 228

O. Galløe del.

RHIZOCARPON DANICUM O. GALLØE. NOV. SP.

PLATE 88.

RHIZOCARPON GRANDE.

(FLK.) ARN.

Fig. 229. Thallus on sand-blown flint; in several places it is somewhat reticulate, i. e. it has not yet completely covered the substratum, but in these places the 'inner margins' grow from all sides inwards over the substratum. Apothecia of all ages. ($\times$35).

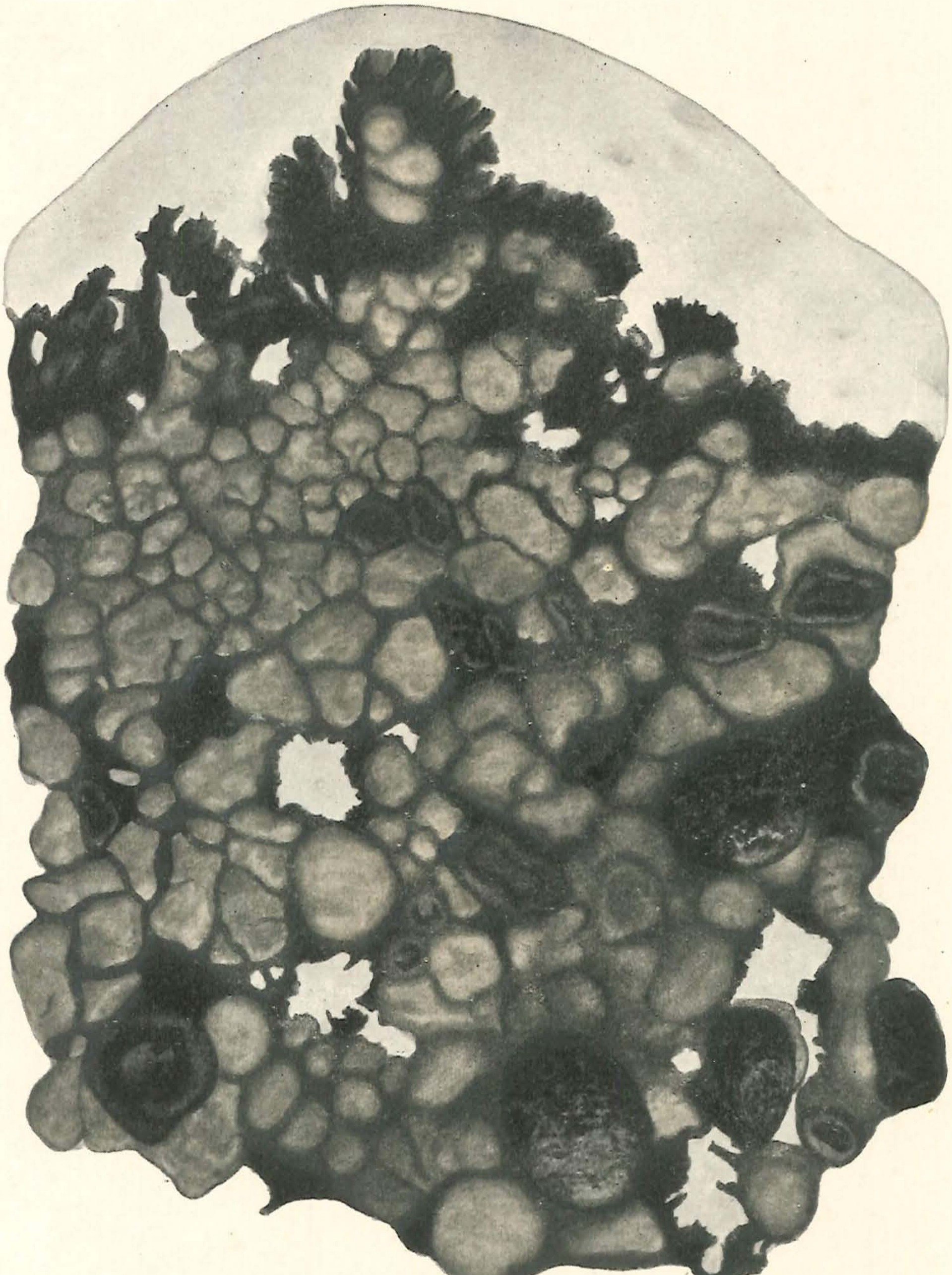


Fig. 229

O. *Galløe del.*

RHIZOCARPON GRANDE (Flk.) Arn.

PLATE 89.

RHIZOCARPON GRANDE.

(FLK.) ARN.

Fig. 230. Two areoles, with brownish cortex. The gonidia are not continued from one areole to the other. Below, the thallus has been separated from the substratum, but is about to establish a new connection with it (for further particulars, *vide* the text). (×157).

Fig. 231. Apothecium with adjacent areole. The very lowest hyphæ in the stipes are colourless. Note the dark, brownish bundles of paraphyses among the colourless ones. (×105).

Fig. 232. Rather old, ripe spores. (×840).

Fig. 233. Spore of a peculiar appearance, with dark, slightly undulating walls. Several asci were observed, in which all the spores were of that kind. (×840).

Fig. 234. Areole, in which the basal parts of the medulla are slightly brownish. (×157).

Fig. 235. A very young areole on the margin of the thallus. The dark, marginal hyphæ form a cortex over the gonidial layer. The margin of the thallus is to the left in the figure. (×157).

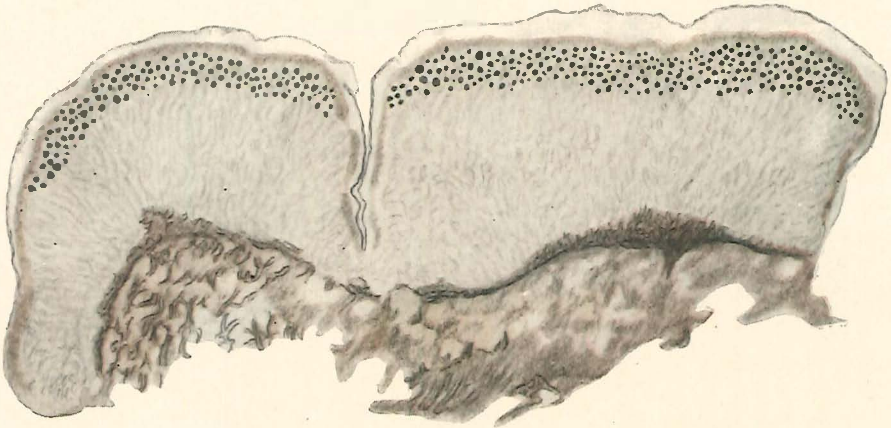


Fig. 230

Fig. 231

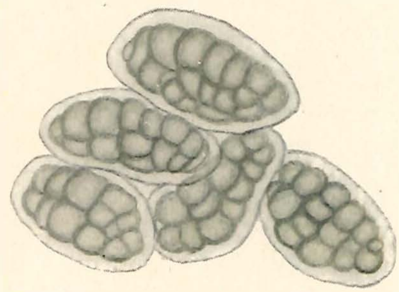


Fig. 232

Fig 233

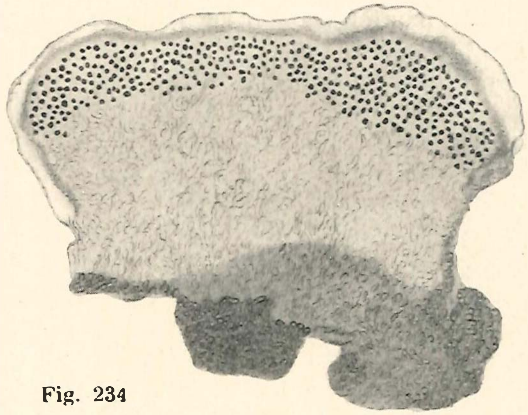


Fig. 234

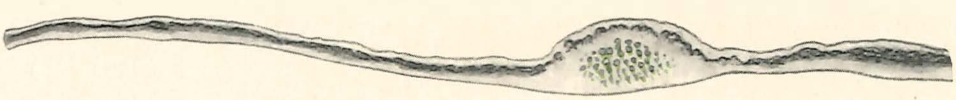


Fig. 235

O. Galløe del.

RHIZOCARPON GRANDE (FLK.) ARN.

PLATE 90.

RHIZOCARPON GRANDE.

(Flk.) Arn.

Fig. 236. Young areole. Below in the section the light hyphæ lie flat on the sandblown stony substratum. To the right a group of hyphæ penetrate into a cavity of the substratum. To the left of the areole the narrow line represents the surface of the neighbouring areole. (×840).

Fig. 237. Margin of a fully developed areole, standing somewhat isolated on the thallus and so having a cuticle on the vertical surface too and also gonidia extending downwards on the side of the areole. (×90).

Fig. 238. Horizontal section of gonidial layer with groups of cystococcoid and pleurococcoid gonidia. (×1185).

Fig. 239. Horizontal section of medullary layer. (×1185).

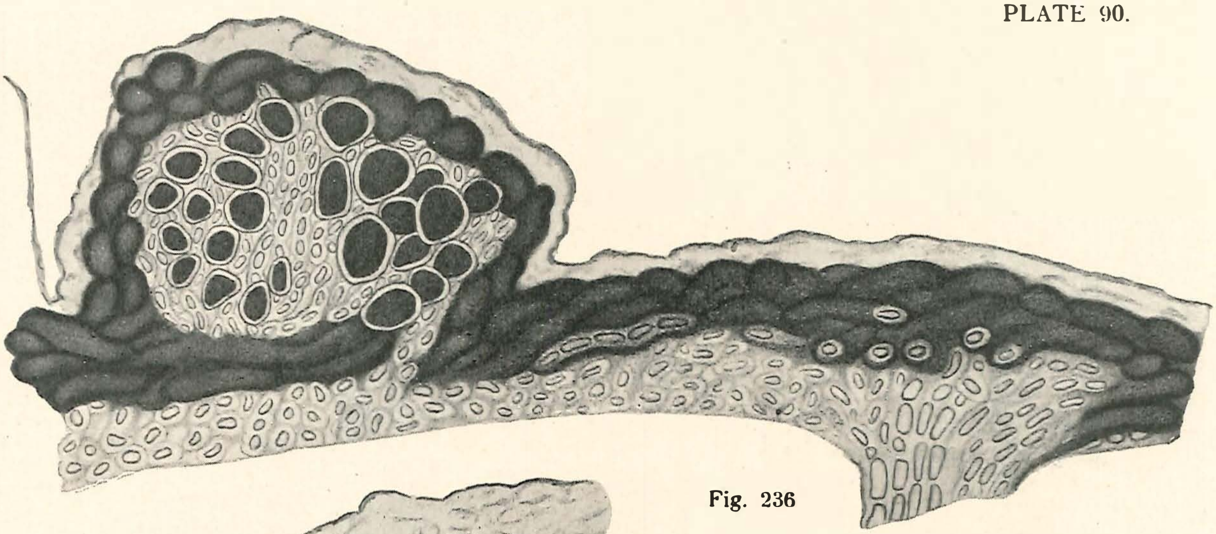


Fig. 236

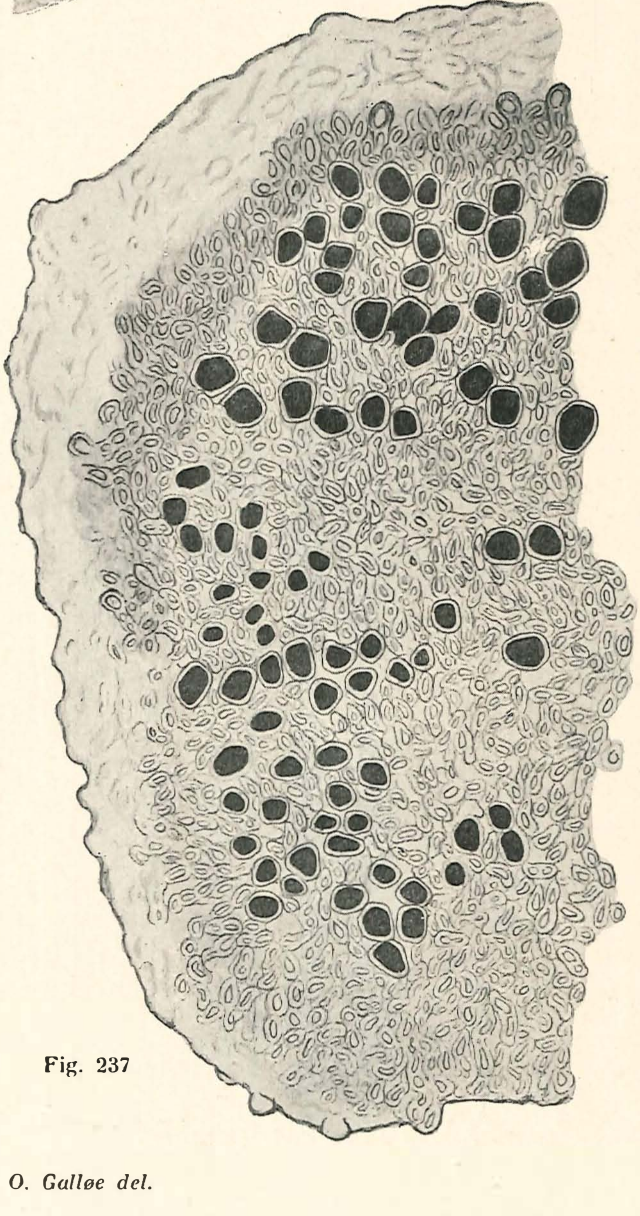


Fig. 237

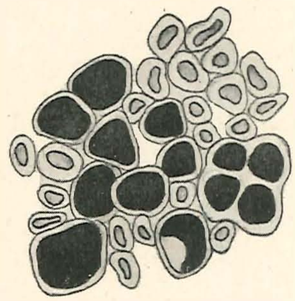


Fig. 238

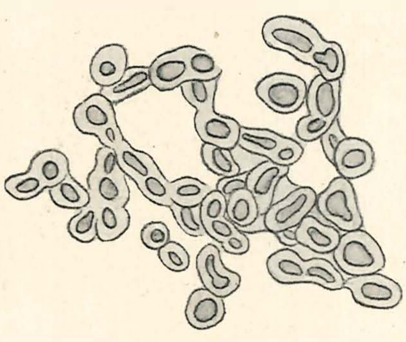


Fig. 239

O. *Galløe del.*

RHIZOCARPON GRANDE (FLK.) ARN.

PLATE 91.

RHIZOCARPON GRANDE.

(FLK.) ARN

Fig. 240. Margin of apothecium. ($\times 840$).

Fig. 241. Horizontal section of the upper part of the hypothecium, the walls of which are brown. ($\times 1185$).

Fig. 242. Cross-section of dark, black hyphæ from the margin of the apothecium. ($\times 1185$).

Fig. 243. To the left an ascus, the spores of which have a thin halo. To the right, ejaculated spores with swollen epispore. ($\times 840$).

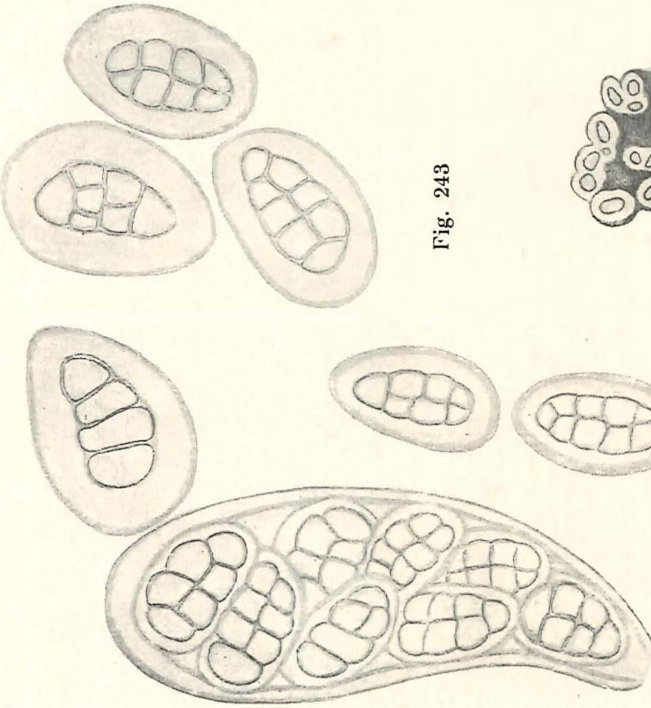


Fig. 243

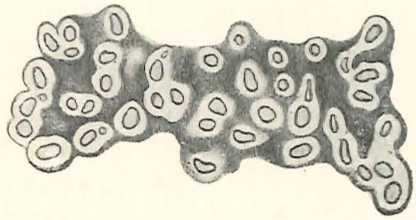


Fig. 242

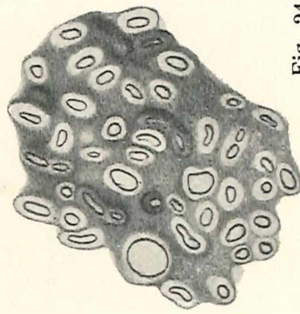


Fig. 241

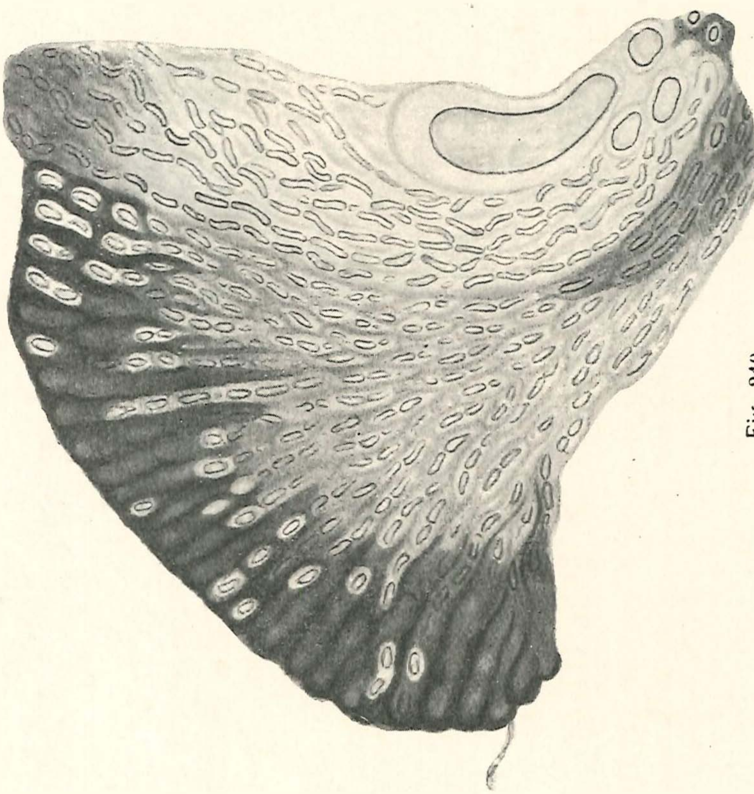


Fig. 240

O. Galløe del.

RHIZOCARPON GRANDE (FLK.) ARN.

PLATE 92.

RHIZOCARPON GRANDE.

(Flk.) Arn.

Fig. 244. Hymenium. To the right, dark paraphyses; to the left, light ones. Ascogenous cells are seen in the hypothecium. (×840).

Fig. 245. Isolated spores of different types. (×840).

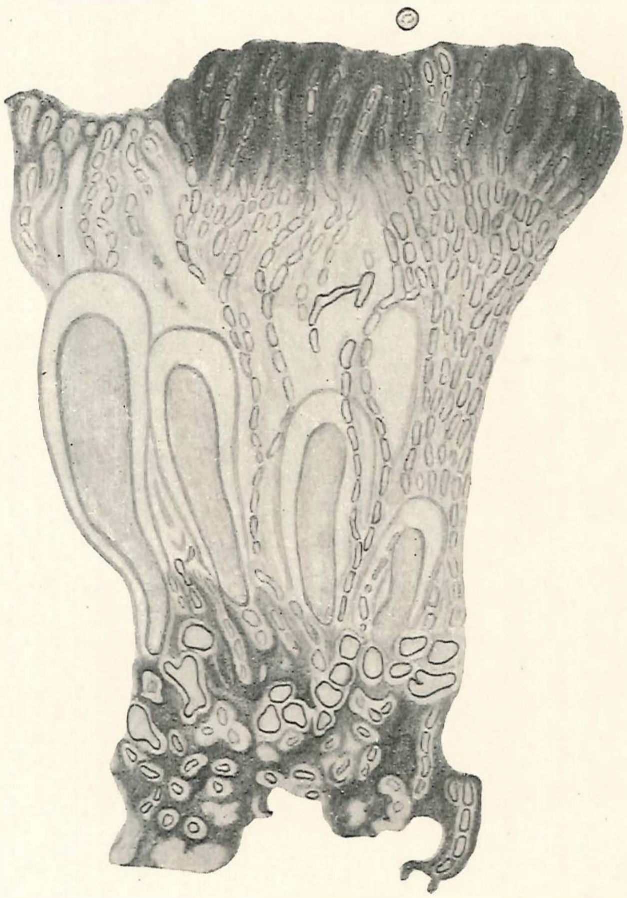


Fig. 244

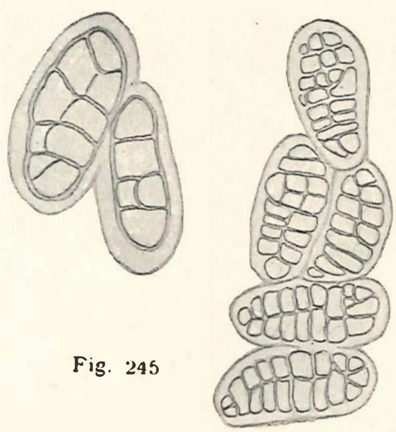


Fig. 245

O. Galløe del.

RHIZOCARPON GRANDE (Flk.) Arn.

PLATE 93.

RHIZOCARPON GRANDE.

(FLK.) ARN.

Fig. 246. Horizontal section of hymenium, with dark and light paraphyses, and also with turgescent and emptied (compressed) asci. ($\times 840$).

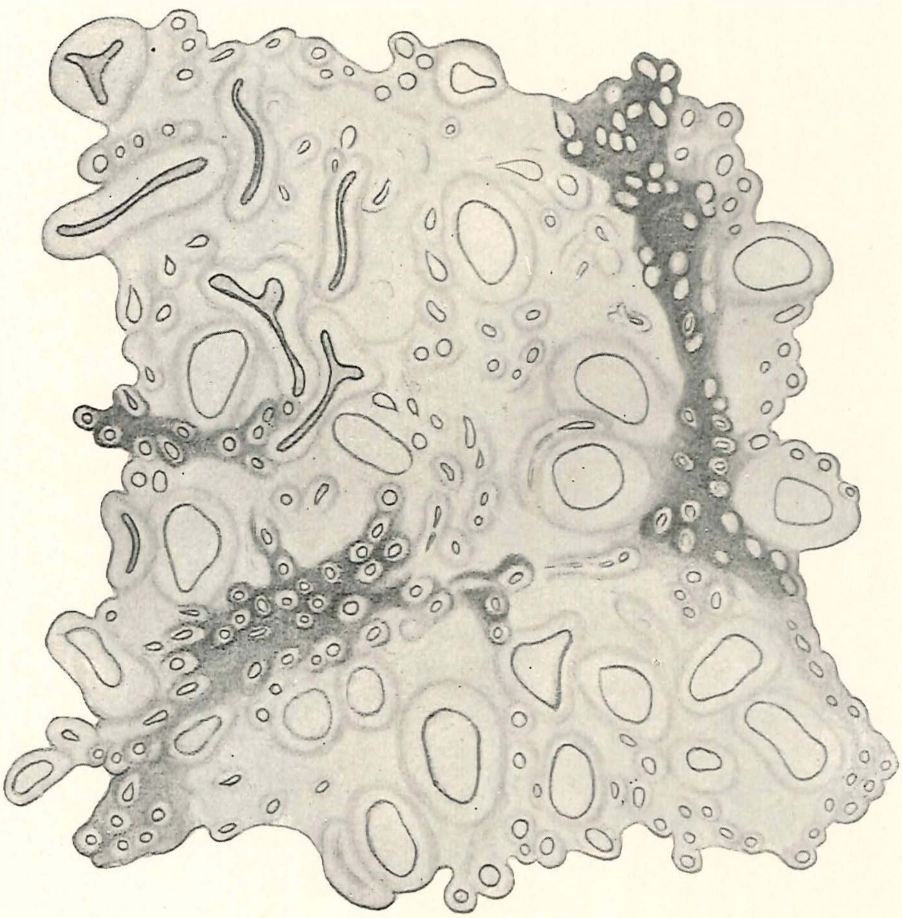


Fig. 246

O. Galløe del.

RHIZOCARPON GRANDE (FLK.) ARN.

PLATE 94.

RHIZOCARPON OEDERI.

(WEB.) KÖRB.

Fig. 247. The black, somewhat uneven margin of the thallus on the substratum. The rust-coloured, youngest areoles and also, below to the right, two young apothecia. (×26).

Fig. 247

O. Galløe del.

RHIZOCARPON OEDERI (WEB.) KÖRB.

PLATE 95.

RHIZOCARPON OEDERI.

(WEB.) KÖRB.

Fig. 248. Rather old, central parts of the thallus, with confluent areoles and apothecia of all ages. (×26).

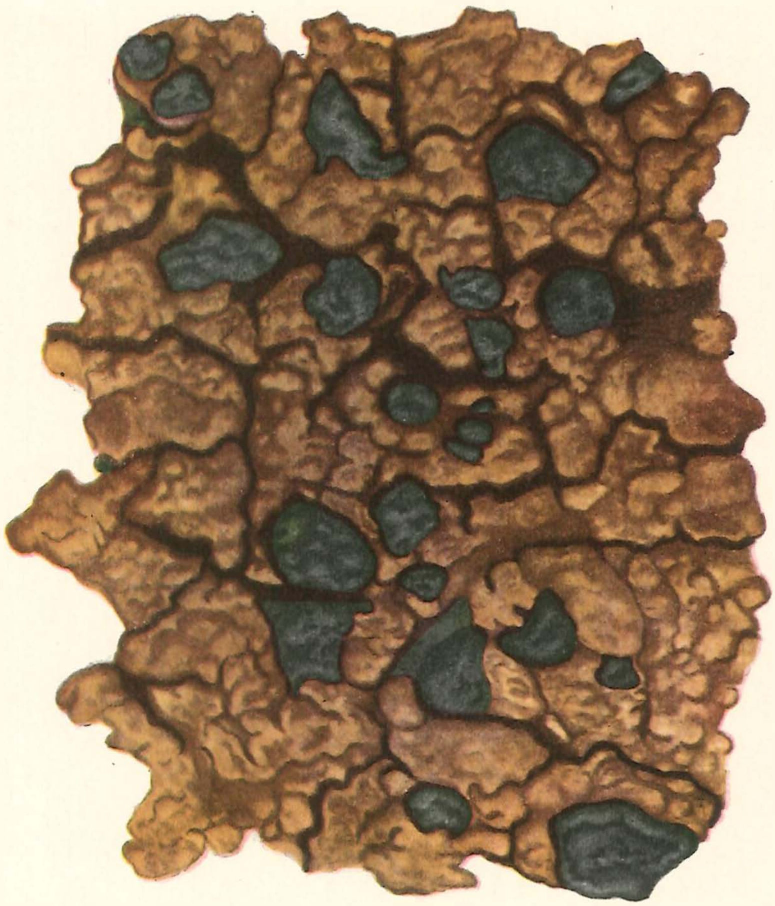


Fig. 248

O Galløe del.

RHIZOCARPON OEDERI (WEB.) KÖRB.

PLATE 96.

RHIZOCARPON OEDERI.

(WEB.) KÖRB.

Fig. 249. Margin of an areole. Note the rust-coloured excretion on the cortex and partly also in the medulla below the gonidial layer, where the yellow substance but very rarely occurs. Below in the medulla, at the surface of the substratum, the hyphæ of the medullary layer are darker, brown. (×840).

Fig. 250. Cortex and parts of the gonidial layer. To the left in the section most of the gonidia are gathered in a little group (×1185).

Fig. 251. Apothecium between relatively high areoles. Note the dark bundles of paraphyses in the hymenium; they arise by the direct extension of the hyphæ of the stipes into the hymenium. (×105).

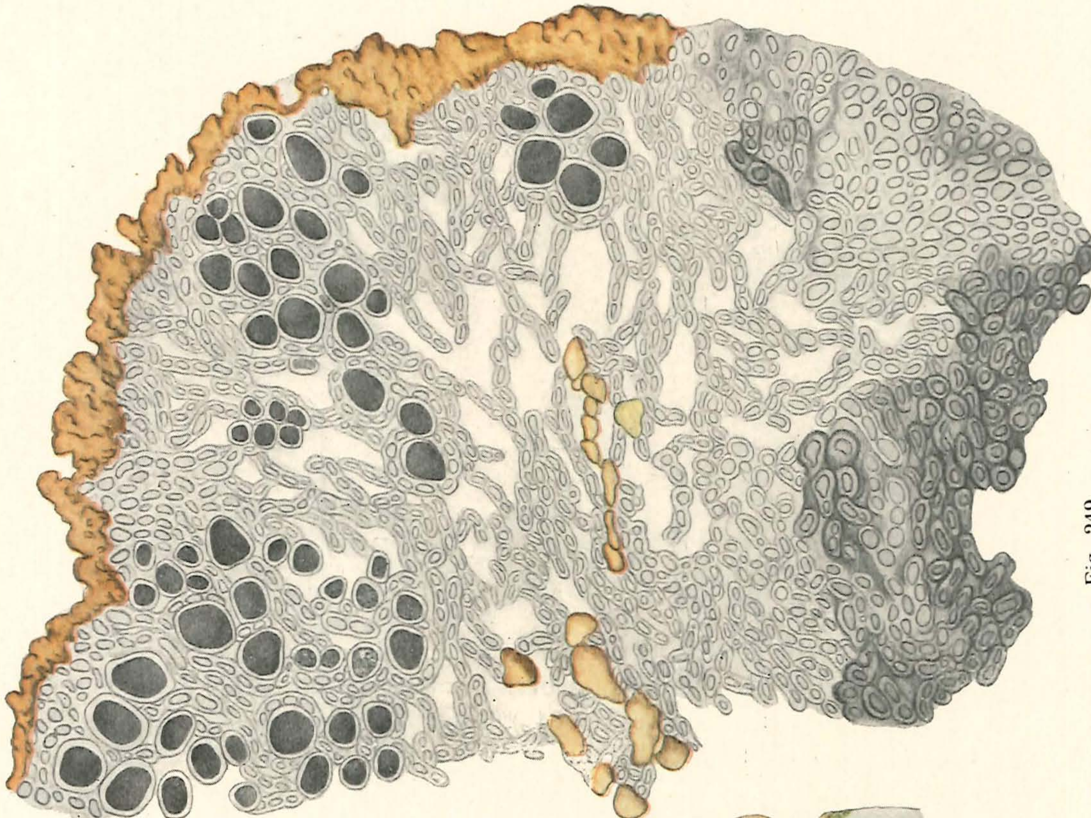


Fig. 249

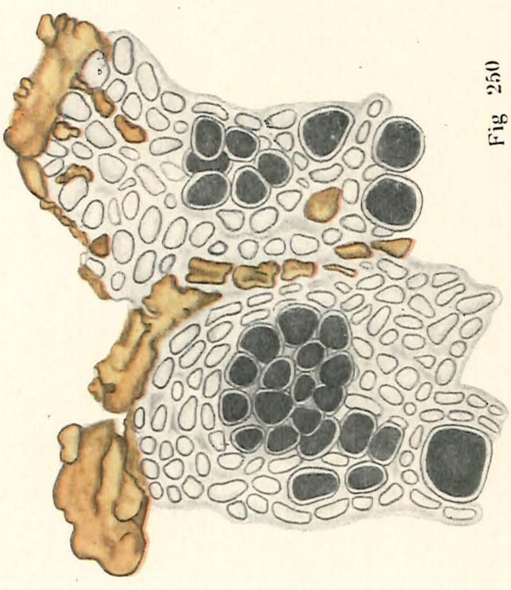


Fig. 250

Fig. 251

O. *Galløe del.*

RHIZOCARPON OEDERI (WEB.) KÖRB.

PLATE 97.

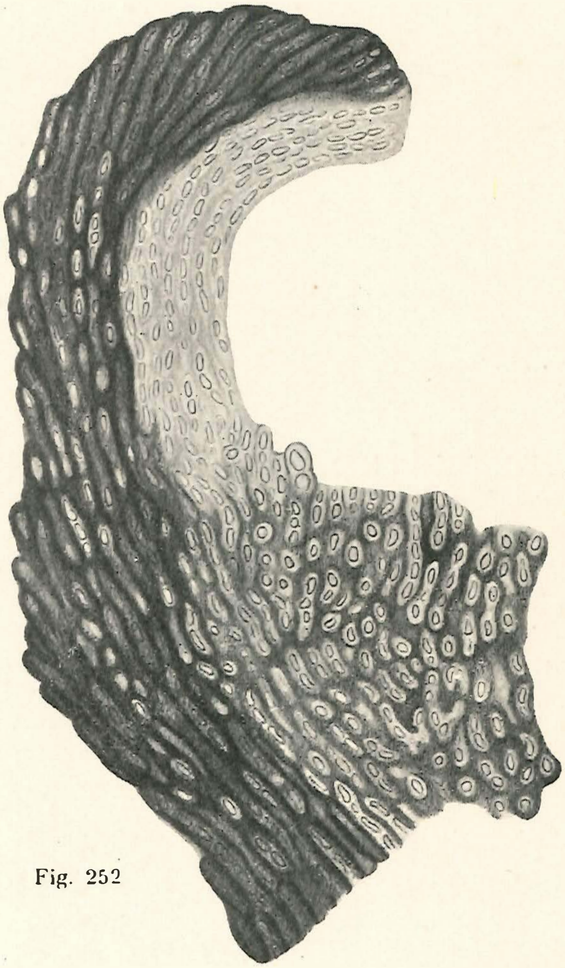
RHIZOCARPON OEDERI.

(WEB.) KÖRB.

Fig. 252. Margin of apothecium. The hymenium is completely removed; only the calyx is shown; the peripheral parts of the latter are dark, the interior parts nearest the hymenium are colourless. ($\times$ 840).

Fig. 253. Horizontal section of the hymenium. Above in the section dark, densely crowded paraphyses with faintly developed hymenial gelatine. The rest of the paraphyses are colourless. Several asci are seen cut across. ($\times$ 840).

Fig. 254. Group of dark, densely crowded paraphyses, below merging insensibly into the hypothecium, in which are seen some cells, a little bigger and possibly ascogenous. ($\times$ 840).



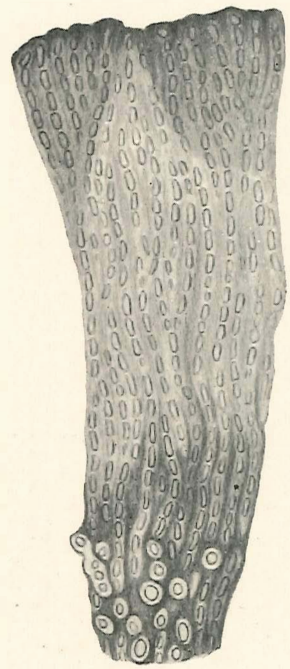


Fig. 254

Fig. 252

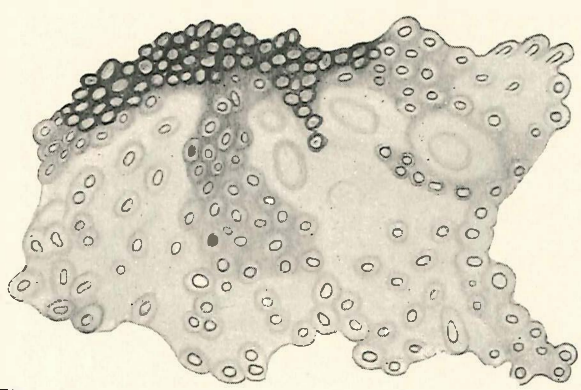


Fig. 253

O. *Galløe* del.

RHIZOCARPON OEDERI (WEB.) KÖRB.

PLATE 98.

RHIZOCARPON OEDERI.

(WEB.) KÖRB.

Fig. 255. Group of light paraphyses, with copious hymenial gelatine. Below they merge insensibly into the hypothecium. (×840).

Fig. 256. Above, a series of gonidia with thick walls. Below, a group of quite another type, apparently cystococcoid. (×840).

Fig. 257. A ripe ascus with spores, three quite young asci, and also numerous colourless, ascogenous hyphæ from the hypothecium. The tips of the paraphyses are removed in the section (×840).

Fig. 258. An isolated, ripe spore. (×840).

Fig. 259. Ascogenous cells, embedded in a common gelatine. (×840).

Fig. 260. Ripe ascus. (×840).

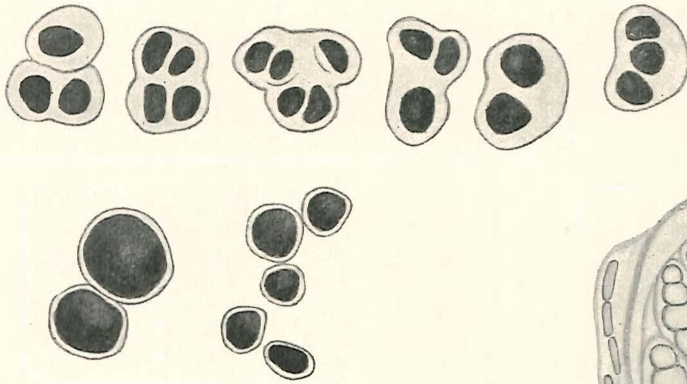


Fig. 256

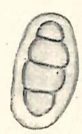


Fig. 258

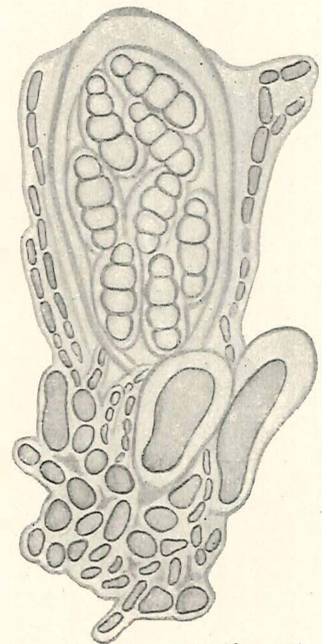


Fig. 257

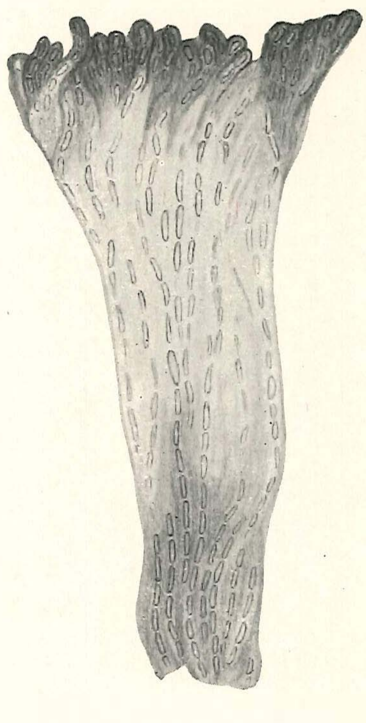


Fig. 255

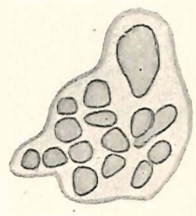


Fig. 259

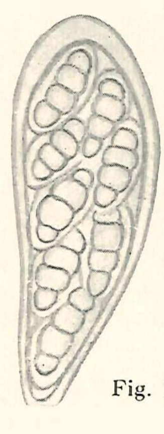


Fig. 260

O. Galløe del.

RHIZOCARPON OEDERI (WEB.) KÖRB.

PLATE 99.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 261. Thallus on the substratum, a red tile. Above, the margin of a foreign, whitish crustaceous lichen. The formation of the areoles on the margin of the thallus is very easily seen. Note the partly yellowish shade on the young apothecia (for further details *vide* the text). ($\times 22$).

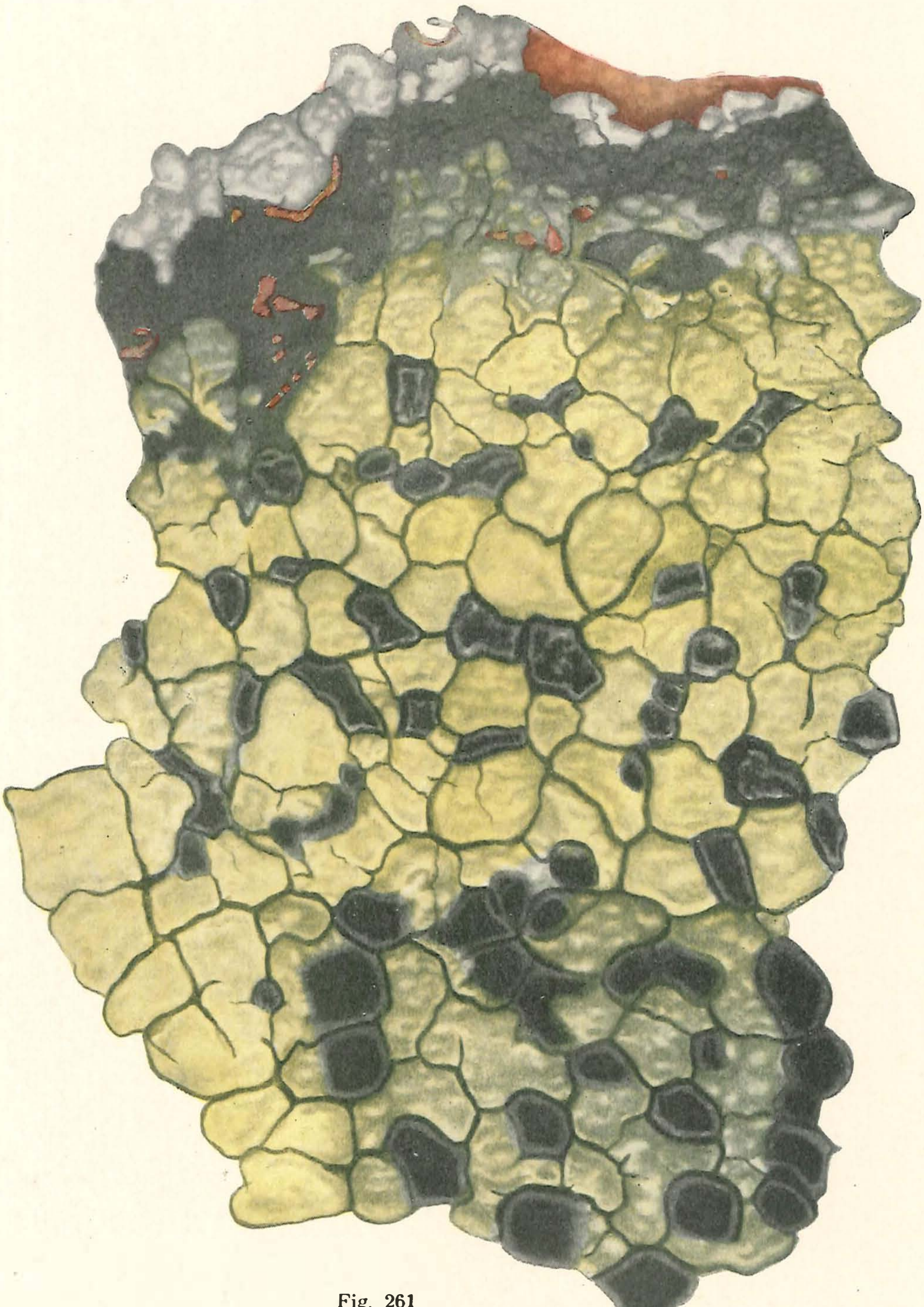


Fig. 261

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1).

PLATE 100.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 262. Margin of the thallus (to the left in the Fig.). Two gonidial algæ are on the point of being captured on the surface of the tissue. The red colour represents the substratum. (×840).

Fig. 263. Young areole, near the black margin of the thallus. A colourless gonidial layer has been formed between the dark basal hyphæ and the still dark cortical hyphæ. (×157)

Fig. 264. An areole, a little older than the one shown in Fig. 263. The cortex has here become yellow. (×157).

Fig. 265. Apothecium on the margin of an areole. Both the free side of the apothecium (to the left) and the side embedded in the areole (to the right) are formed of brown hyphæ (*vide* Fig. 276). (×105).

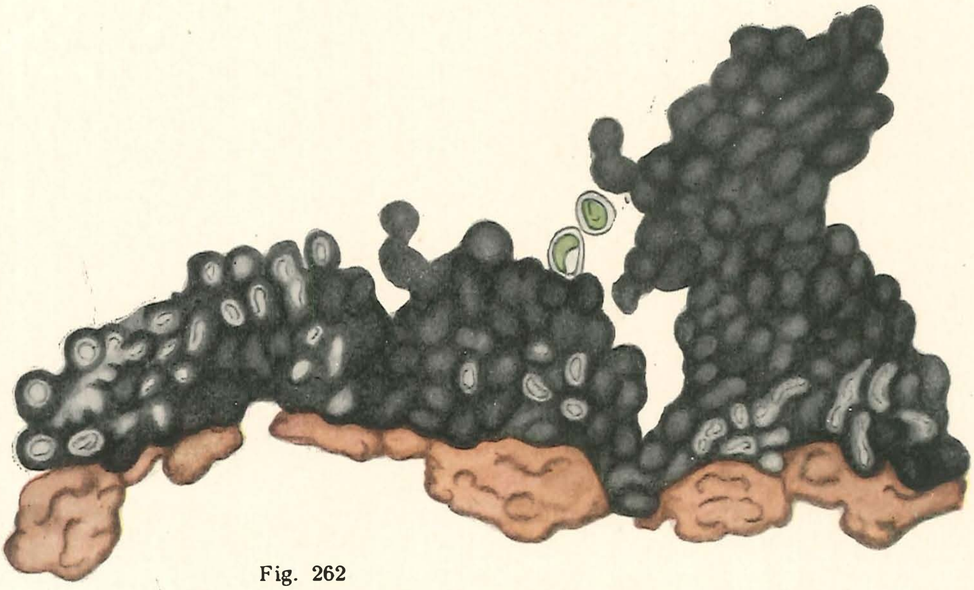


Fig. 262

Fig. 263

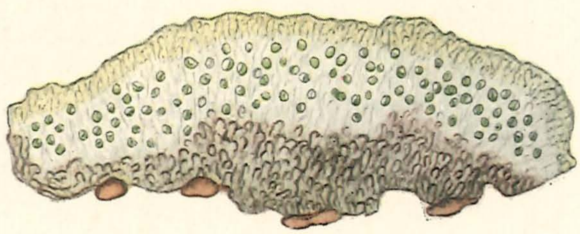


Fig. 264

Fig. 265

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1)

PLATE 101.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 266. Apothecium in the margin of an areole. The exposed side of the areole (to the left) has a calyx formed of partly brown, partly yellow hyphæ of the same type as shown in Fig. 275. The part of the calyx embedded in the areole (to the right) has the same structure as shown in Fig. 276. (×105).

Fig. 267. Apothecium from the inter-areolar thallus; the calyx is everywhere here of the same type as in Fig. 275. (×105).

Fig. 268. A fully developed areole. The hyphæ of the gonidial layer are colourless. (×105).

Fig. 269. Horizontal section of cortex; the hyphæ are here cut across; there are intercellular spaces between them. (×840).

Fig. 270. An isolated, yellow hypha from cortex; its top cell is intact. (×840).

Fig. 271. Horizontal section of the gonidial layer. The hyphæ are cut across; there are numerous intercellular spaces between them. (×840).

Fig. 272. To the left three gonidia of a pleurococcoid aspect. To the right an isolated hypha from the gonidial layer. (×840).

Fig. 273 Horizontal section through the margin of the calyx and the adjacent hymenium, in which paraphyses and a transverse section of an ascus with a spore. The calyx consists externally of blackish-brown hyphæ, internally of yellow ones (cp. Fig. 275 and 267). (×840).

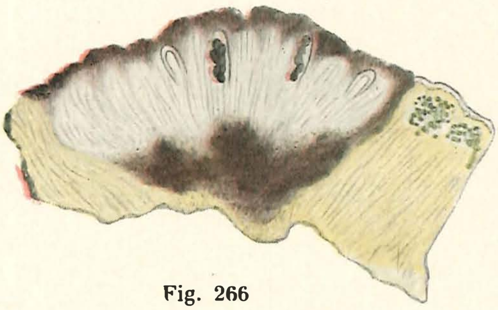


Fig. 266

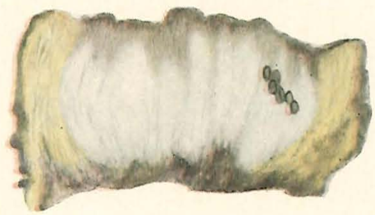


Fig. 267

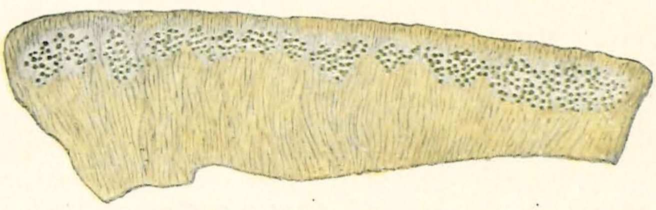


Fig. 268

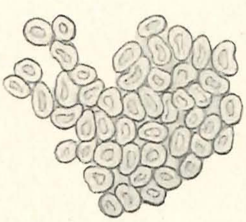


Fig. 269

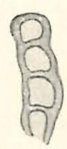


Fig. 270

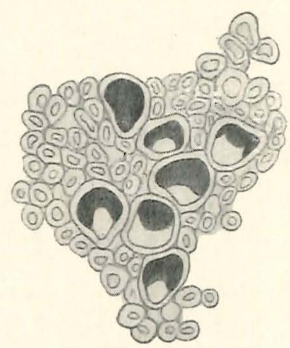


Fig. 271

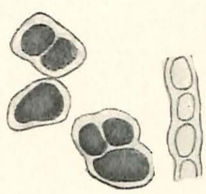


Fig. 272

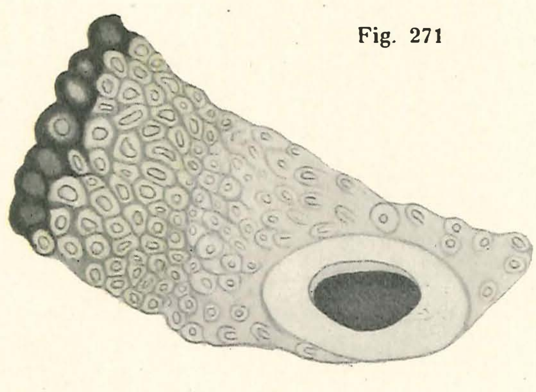


Fig. 273

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1)

PLATE 102.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 274. Portion of an areole, the natural surface of which is seen to the right. There is a colourless cuticle without distinct cell boundaries above on the horizontal surface of the areole, whereas the vertical surface (to the right) is without such a cuticle. (×840).

Fig. 275. Margin of apothecium. The interior parts of calyx are formed of yellow hyphæ, whereas the outer, peripheral hyphæ are dark. The same colour, too, is found right above, where calyx ends in the margin. In a single place, however, some few yellow hyphæ, which are remain yellow to the very tips, are seen placed among the dark ones. Where this condition is common (in young apothecia), it influences the colour of the margin, which is changed into a marbled effect of yellow and black (cp. 261). (×840).

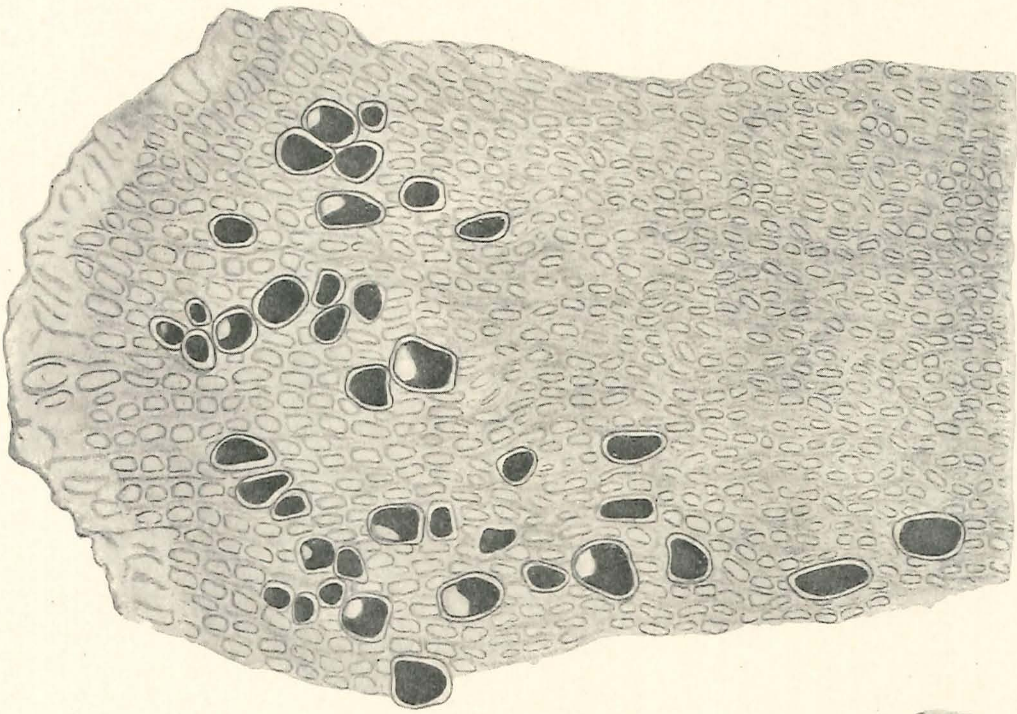


Fig. 274

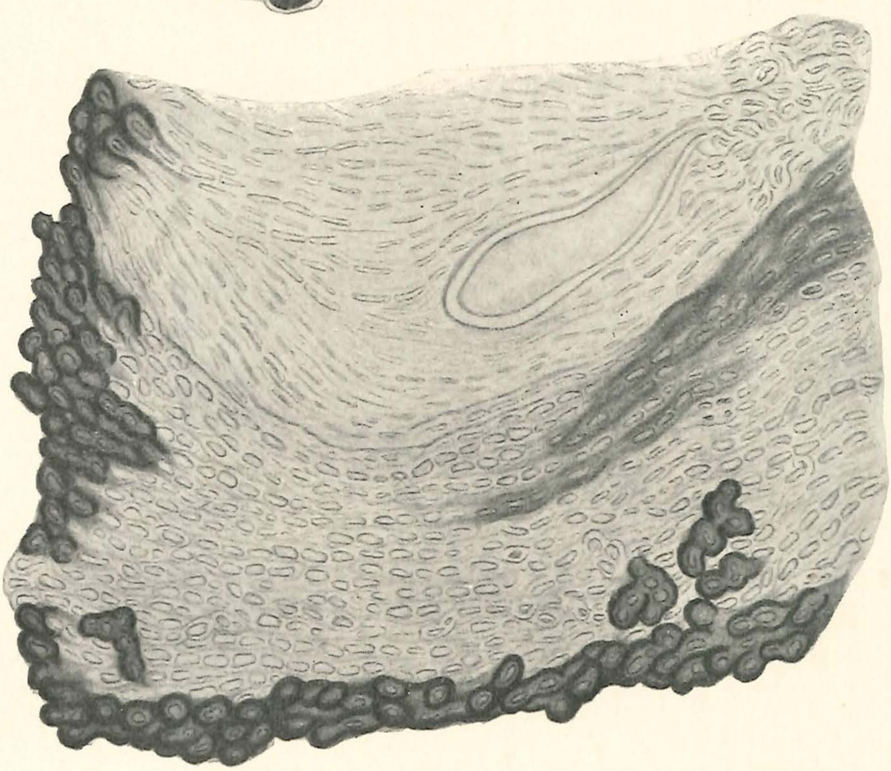


Fig. 275

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1)

PLATE 103.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 276. Margin of apothecium. Calyx is here quite dark, corresponding to Fig. 265. The light, colourless (not yellow) hyphæ are paraphyses. (×840).

Fig. 277. Longitudinal section of stipes, below bordering immediately on the substratum (omitted in the Fig.), above merging grandually into the colourless hypothecium. (×840).

Fig. 278. Hymenium and hypothecium with ascogenous cells and young asci. (×840).

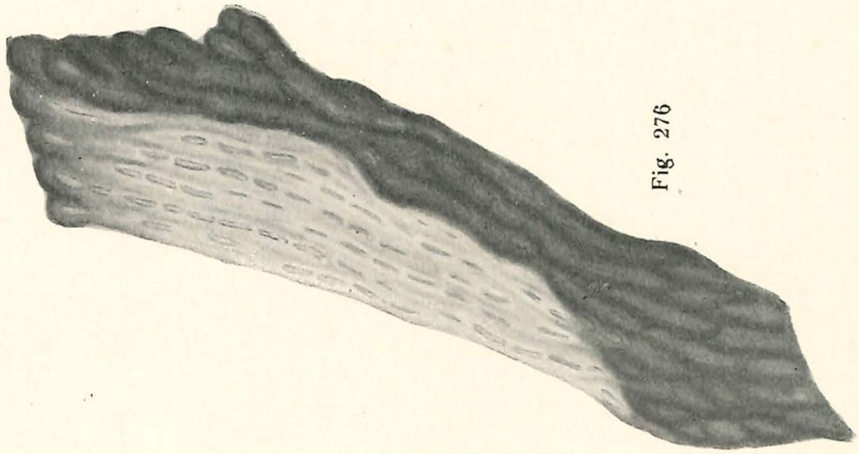


Fig. 276

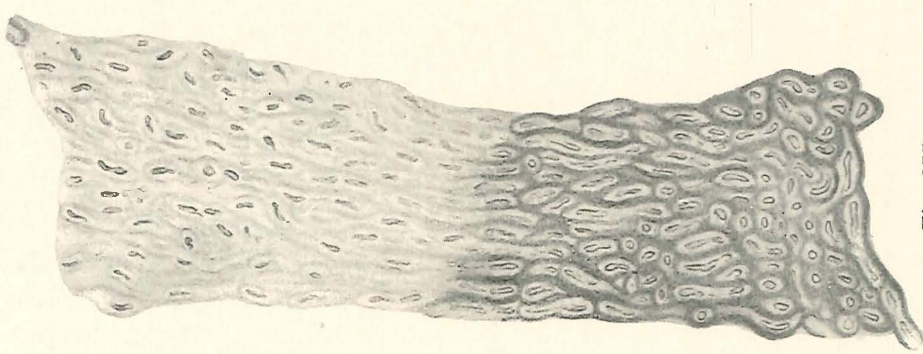


Fig. 277

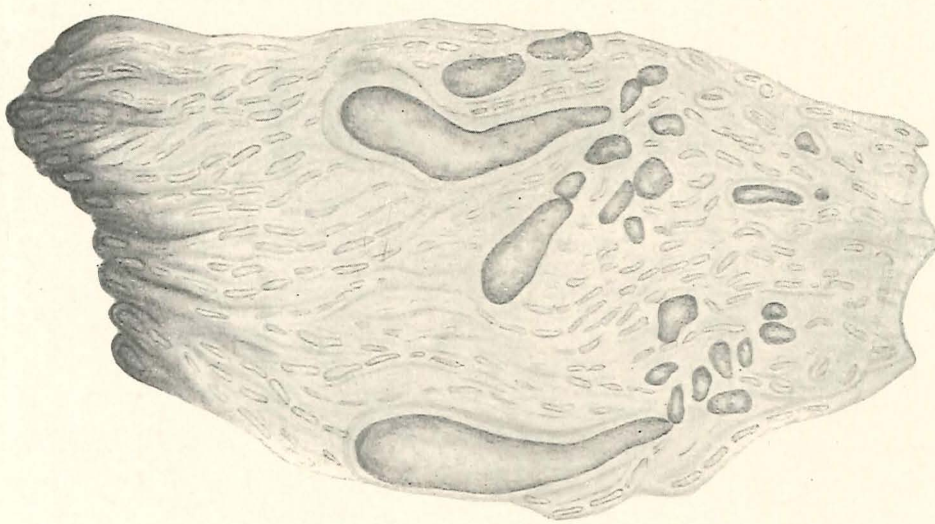


Fig. 278

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.

PLATE 104.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 1.

Fig. 279. Paraphyses and hymenial gelatine. The greyish-black colour is deposited in the outer wall-layers of the paraphyses and in the gelatine. (×840).

Fig. 280. Ripe, dark, somewhat brownish spore. (×840).

Fig. 281. Upper part of ascus with partly young spores. (×840).

Fig. 282. Four ripe spores, which are purely greyish-black, not brownish. (×840).

Fig. 283. Two young spores, still only 2-celled. (×840).

Fig. 284. Ripe spore, seen from one end. (×840).

Fig. 285. Upper part of an ascus, with young, still undivided spores. (×840).

Fig. 286. Horizontal section of the hymenium, with three asci and paraphyses in the hymenial gelatine. (×840).

Fig. 280

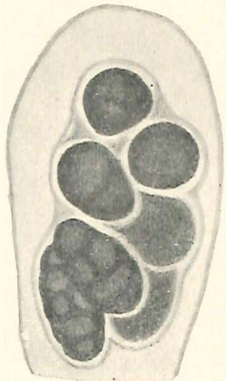


Fig. 281

Fig. 279

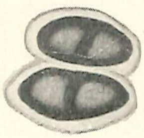


Fig. 283

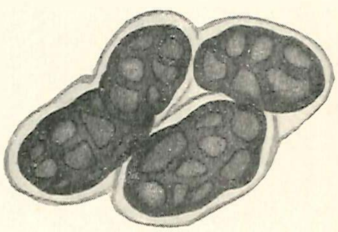


Fig. 282

Fig. 284

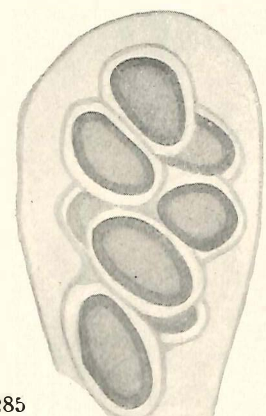


Fig. 285

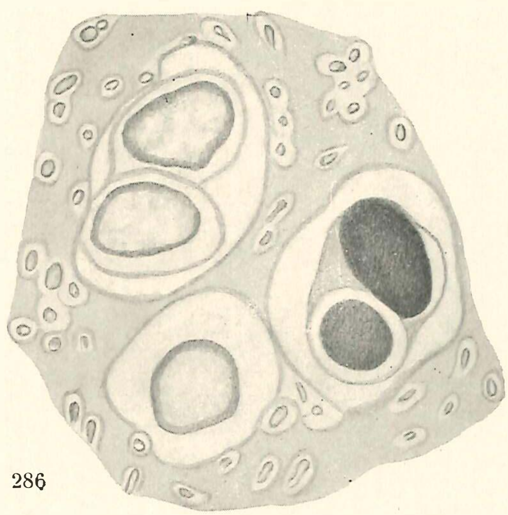


Fig. 286

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1)

PLATE 105.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 2.

Fig. 287. Thallus with apothecia of all ages. The margin of the thallus is partly reticulate. ($\times 26$).

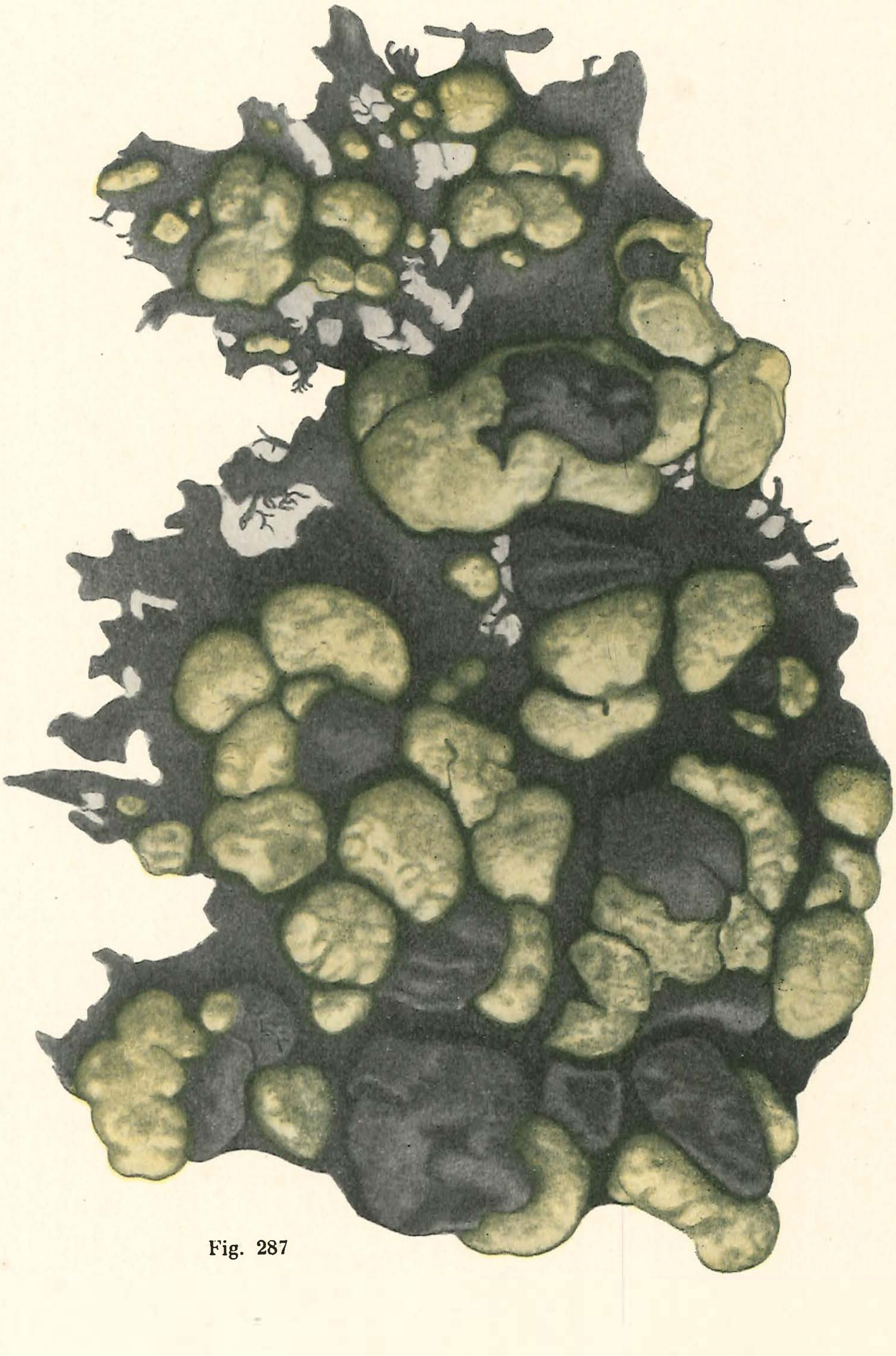


Fig. 287

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 2)

PLATE 106.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 2.

Fig. 288. Apothecium and areole. They issue from a common basal tissue, but otherwise they are distinct from one another, there being a deep furrow between them. The areole is covered with a cortex, but has no gonidia, on the side nearest the apothecium. Note the brown colour in all the tissues of the apothecium. A thinner section than the one figured here would of course have presented all the colours lighter. ($\times 90$).

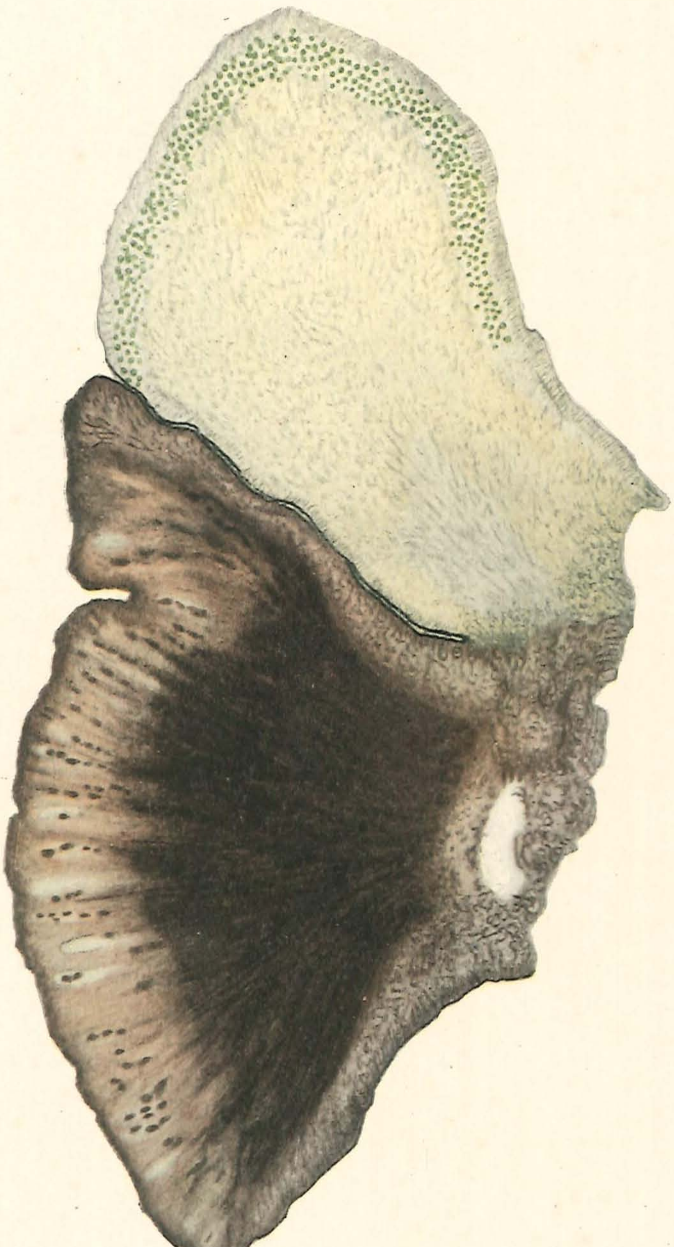


Fig. 288

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 2)

PLATE 107.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 2.

Fig. 289. Margin of the apothecium. Below, the inter-areolar tissue, directly continuing into stipes and calyx. In the latter all the peripheral hyphæ are dark, whereas the interior hyphæ are partly dark, partly considerably lighter, all of them brown however. (×157).

Fig. 290. Cortex from the vertical side of an areole. The hyphæ stand erect on the surface (to the right in the section), thereby differing from the conditions in specimen 1 (Fig. 274). The yellow pigment is deposited as minute granules on the surfaces of the hyphæ. (×840).

Fig. 291. Cortex and gonidial layer. The hyphæ are all colourless here. (×840).

Fig. 292. Colourless hyphæ from the medullary layer, with big inter-cellular spaces. (×840).

Fig. 293. Hyphæ from the hypothecium, partly dark hyphæ partly lighter ones, both kinds continuing upwards into dark and light paraphyses respectively. (×840).

Fig. 294. Paraphyses, which are greyish-black above; further down they are more brown from a non-crystallized pigment, in places deposited in the transverse walls too. (×840).

Fig. 289

Fig. 290

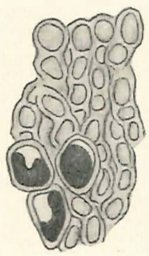


Fig. 291

Fig. 293

Fig. 294

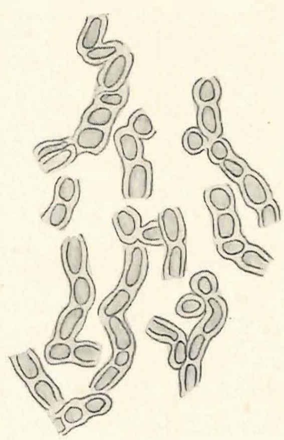


Fig. 292

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 2)

PLATE 108.

RHIZOCARPON GEOGRAPHICUM.

(L.) D. C.

Specimen 2.

Fig. 295. Horizontal section of the hymenium, with asci, light-brown paraphyses and hymenial gelatine. ($\times$840).

Fig. 296. Horizontal section of the hymenium, with darker, brown paraphyses. ($\times$840).

Fig. 297. Margin of apothecium in horizontal section. The walls are dark brown in the apical cells; the remaining parts are more light brown. ($\times$840).

Fig. 298. Ascus with rather young spores, not yet fully divided. ($\times$840).

Fig. 299. Ascus cut across, with three spores seen from the end. ($\times$840).

Fig. 300. Two ripe spores, so dark that their cellular spaces cannot be seen. ($\times$840).

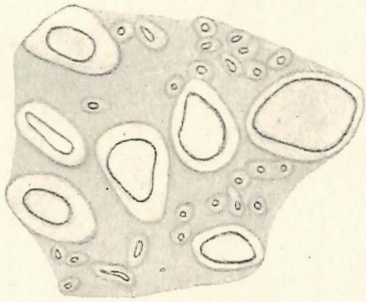


Fig. 295

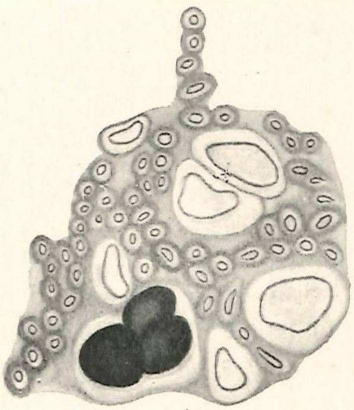


Fig. 296

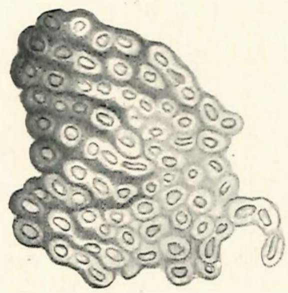


Fig. 297

Fig. 298

Fig. 299

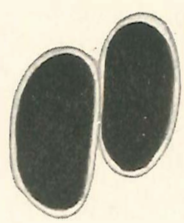


Fig. 300

O. Galløe del.

RHIZOCARPON GEOGRAPHICUM (L.) D. C.
(Specimen 1)

PLATE 109.

DIPLOTOMMA ALBOATRUM.

(Hoffm.) Th. Fr.

Specimen 1.

Fig. 301. Thallus with apothecia of all ages. Below to the right the naked substratum. Above to the left two young apothecia, on the margins of which remnants of the thallus are still left. The other small black spots in the figure represent still embedded apothecia. (×26).

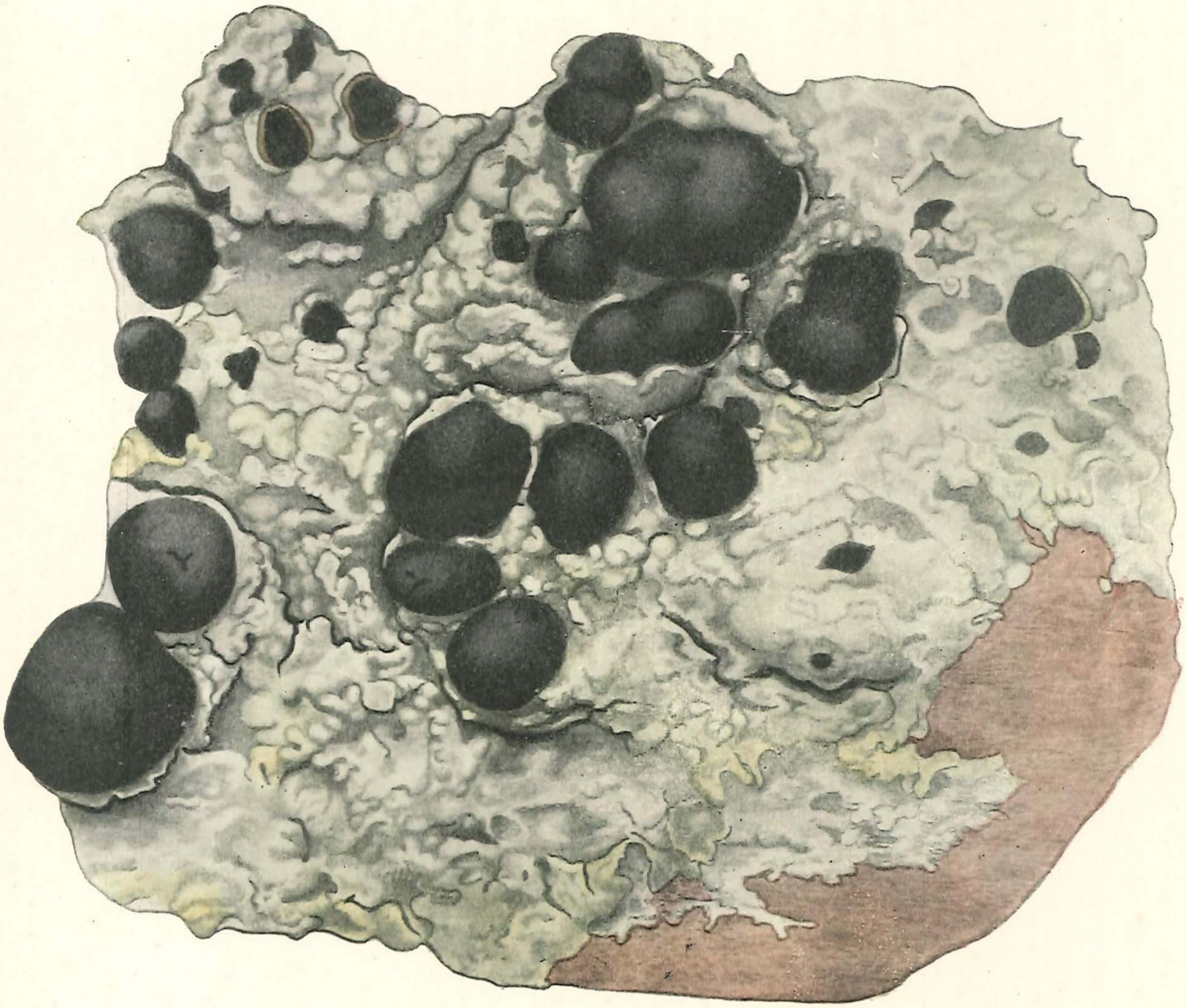


Fig. 301

O. Galløe del.

DIPLOTOMMA ALBOATRUM (Hoffm.) Th. Fr.
(Specimen 1)

PLATE 110.

DIPLOTOMMA ALBOATRUM.

(Hoffm.) Th. Fr.

Specimen 1.

Fig. 302. Thallus on periderm. To the left in the figure the margin of the thallus, which is chiefly mycelial. On its surface free gonidia. (×157).

Fig. 303. To the left an apothecium with thallus. (×105).

To the right three spores. (×840).

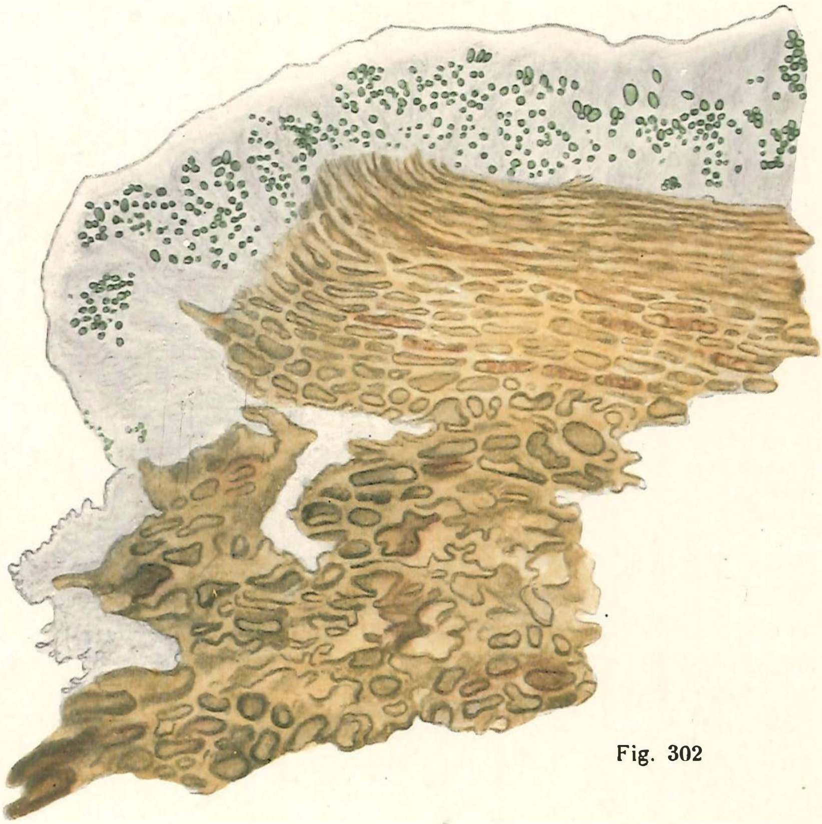


Fig. 302

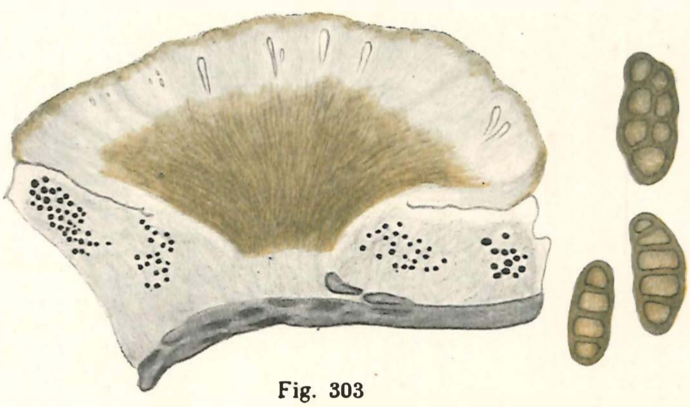


Fig. 303

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 1)

PLATE 111.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 1.

Fig. 304. Margin of the thallus (to the right), with recently captured gonidia. (×840).

Fig. 305. Gonidial layer with cortex and cuticle. (×1185).

Fig. 306. Gonidia with divided contents. Several of this type were observed in the thallus. (×1185).

Fig. 307. Margin of apothecium with the adjacent thallus, in which two gonidia. The thallus partly covers the margin of the apothecium; from which some few hyphæ are continued upwards into the thallus. To the right an ascus and some isolated spores. (×840).

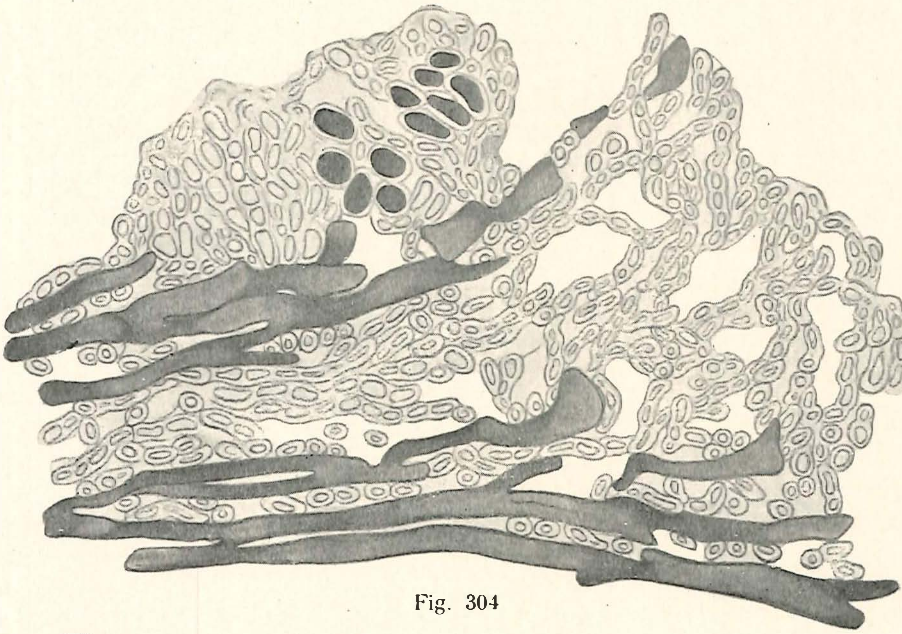


Fig. 304

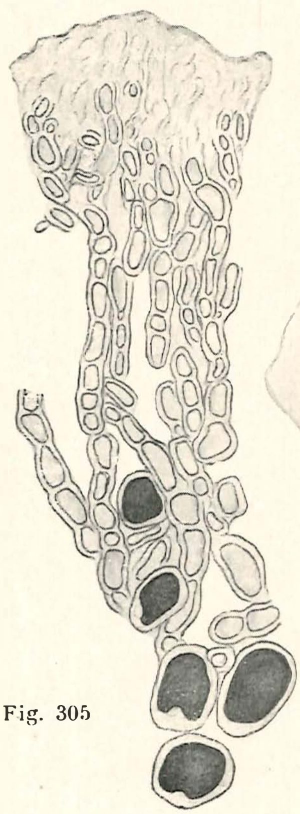


Fig. 305

Fig. 307

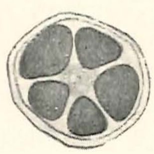


Fig. 306

O. Galløe del.

DIPLOTOMMA ALBOATRUM (Hoffm.) Th. Fr.
(Specimen 1)

PLATE 112.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 1.

Fig. 308. Primordium of apothecium embedded in the thallus. Below, cells of the periderm. Otherwise, *vide* the text. (×840).

Fig. 308

O. *Galløe del.*

DIPLOTOMMA ALBOATRUM (Hoffm.) Th. Fr.
(Specimen 1)

PLATE 113.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 1.

Fig. 309. Portion of stipes, composed of lighter and darker hyphæ. (×840).

Fig. 310. To the left, ascogenous hyphæ with a young ascus and several still younger primordia. The asterisks mark the anastomosing cells mentioned in the text. In the centre a similar ascogonium. To the right two paraphyses. (×840).

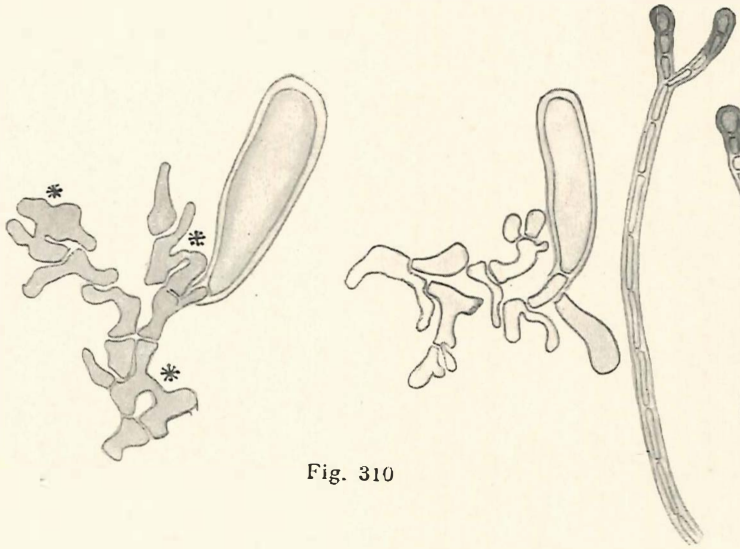


Fig. 310

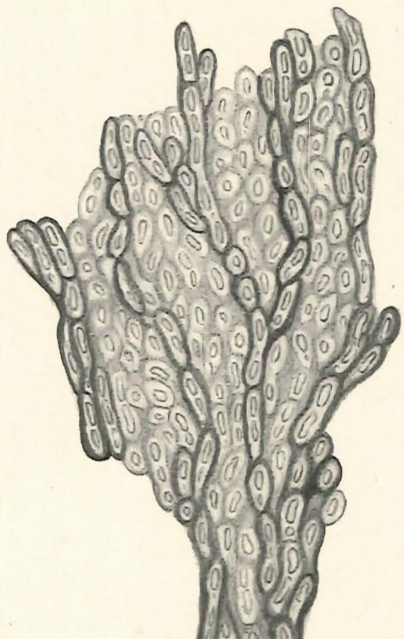


Fig. 309

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 1)

PLATE 114.

DIPLOTOMMA ALBOATRUM.

(Hoffm.) Th. Fr.

Specimen 2.

Fig. 311. Pycnide on the thallus. (×105).
Fig. 312. The same pycnide in vertical section. (×695).
Fig. 313. Conidia-bearing hyphæ from the pycnide. (×1500).

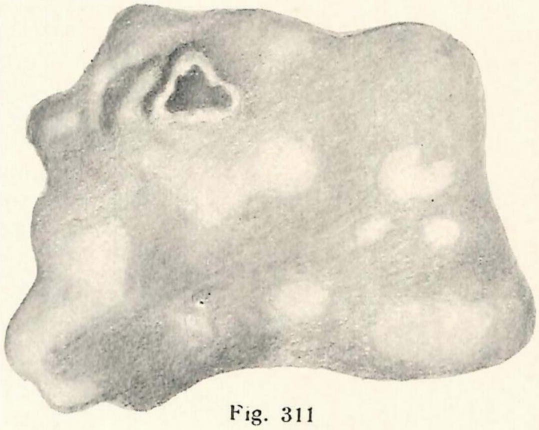


Fig. 311

Fig. 313

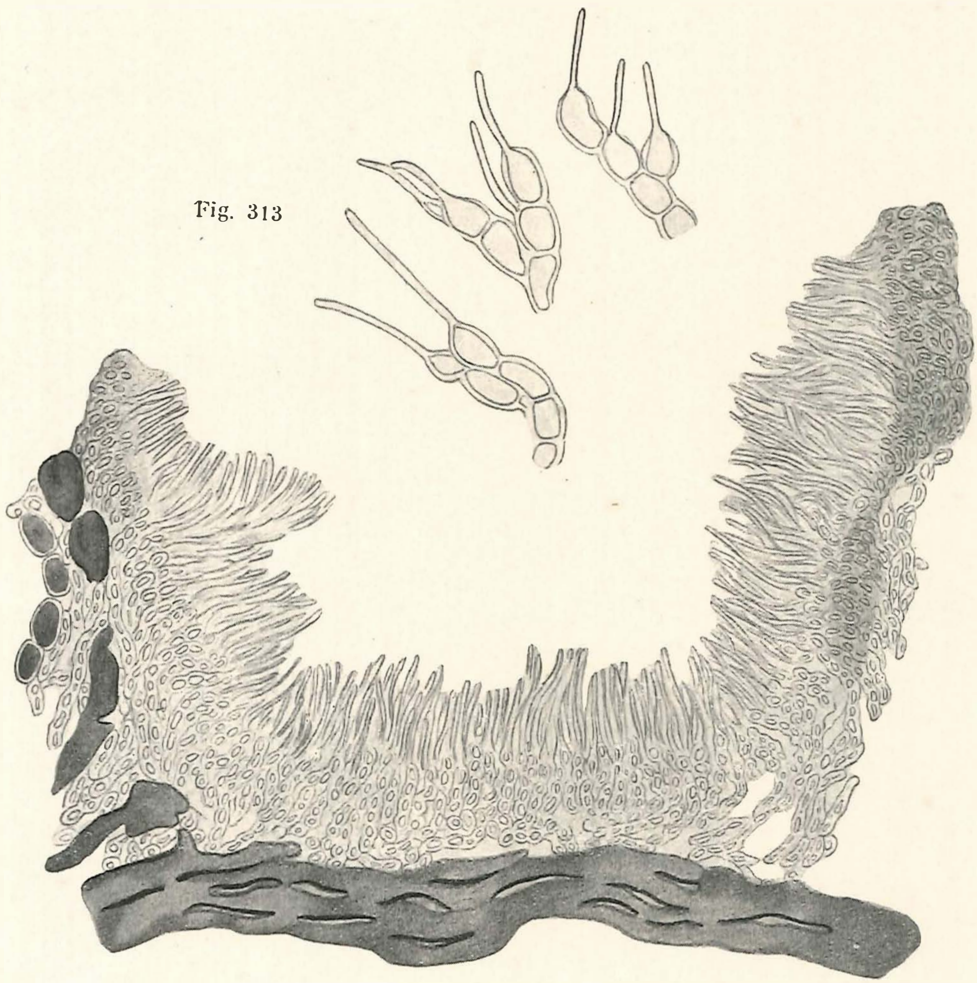


Fig. 312

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 2)

PLATE 115.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 2.

Fig. 314. Thallus on periderm, with pruinose apothecia of all ages. In several places quite young apothecia still entirely covered by the thallus. (×26).

Fig. 314

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 2).

PLATE 116.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 2.

Fig. 315. Apothecium, in which the sides of the calyx are colourless (*vide* the text). (×105).

Fig. 316. Apothecium, in which the whole calyx is brown (*vide* the text.) (×105).

Fig. 317. Portion of the thallus with farinose surface and a young, pruinose apothecium. (×105).

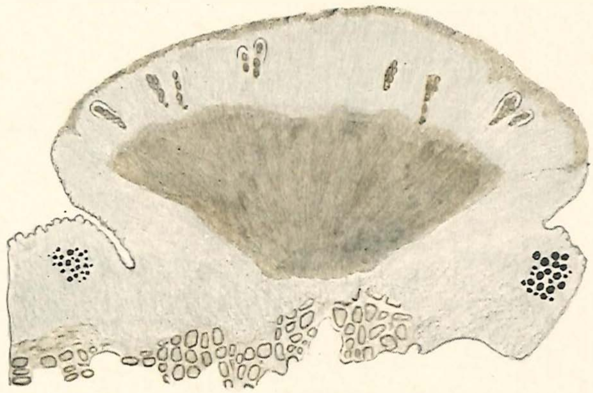


Fig. 315

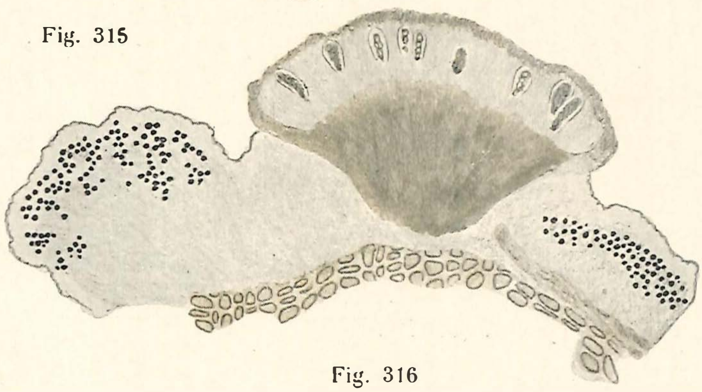


Fig. 316

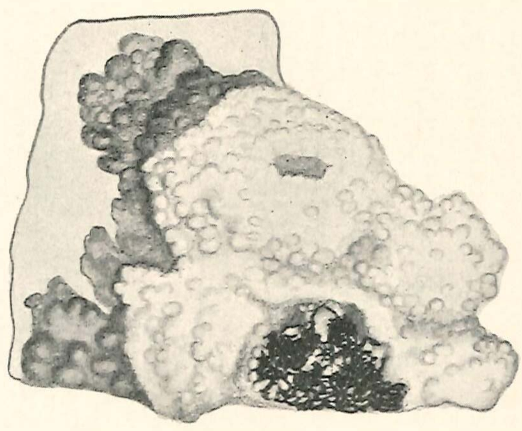


Fig. 317

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 2).

PLATE 117.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 2.

Fig. 318. Thallus and margin of the thallus (to the left in the Fig.), and also two apothecia. ($\times$26).

Fig. 319. Cortex and portion of the gonidial layer. ($\times$840).

Fig. 320. Ascus and paraphyses. ($\times$840).

Fig. 321. Isolated spores. ($\times$840).

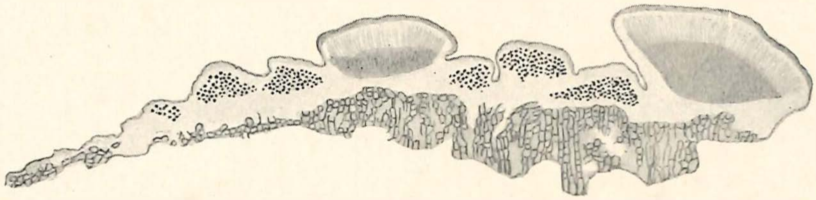


Fig. 318

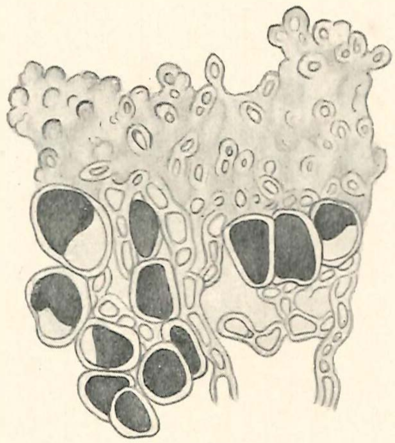


Fig. 319

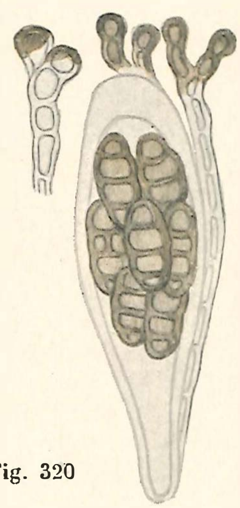


Fig. 320

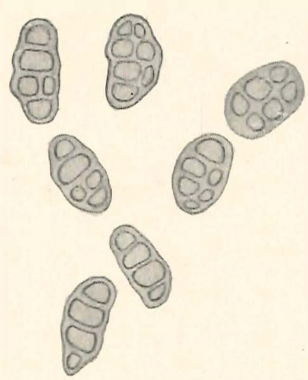


Fig. 321

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 2)

PLATE 118.

DIPLOTOMMA ALBOATRUM.

(Hoffm.) Th. Fr.

Specimen 3.

Fig. 322. Thallus with apothecia of all ages. At *a* are seen bare grains of quartz, not yet covered by the lichen. At *b* two quite young apothecia just on the point of breaking through. Note the white, pseudo-lecanorine margin round the older apothecia. ($\times$26).

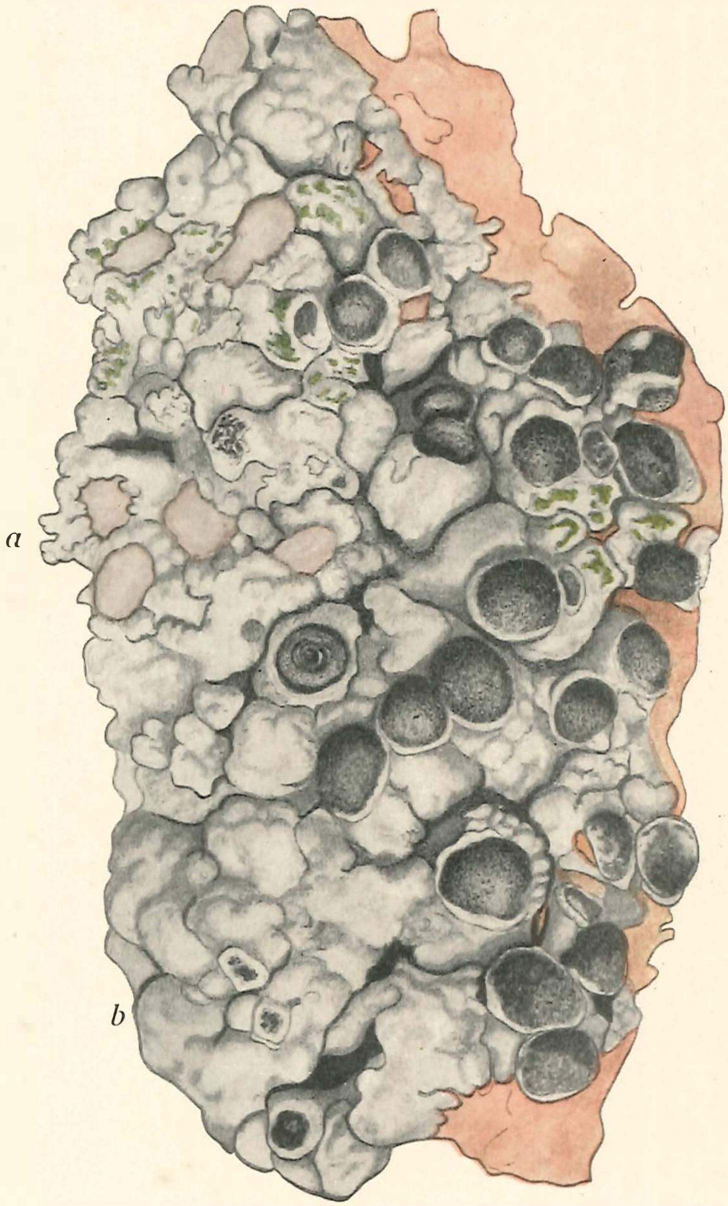


Fig. 322

O. *Galløe del.*

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 3).

PLATE 119.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 3.

Fig. 323. An 'inner margin' in the course of spreading over a still uncovered grain of quartz (faintly reddish). In the margin in several places free gonidia lying on the surface itself. Below, a rather young apothecium. ($\times$ 105).

Fig. 324. Apothecium on the thallus. ($\times$ 105).

Fig. 323

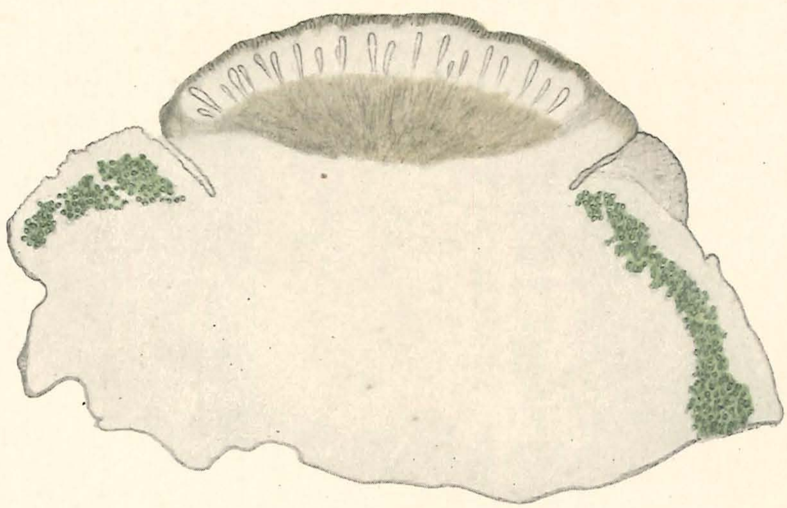


Fig. 324

O. *Galløe del.*

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 3).

PLATE 120.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 3.

Fig. 325. Cortex and gonidial layer. (×840).

Fig. 326. Hyphæ from the medullary layer, near the surface of the substratum. (×1185).

Fig. 327. Higher magnification of the margin of apothecium shown in Fig. 323. The apical parts of the marginal hyphæ are covered by a dead, white cuticle, further mentioned in the text. (×1185).

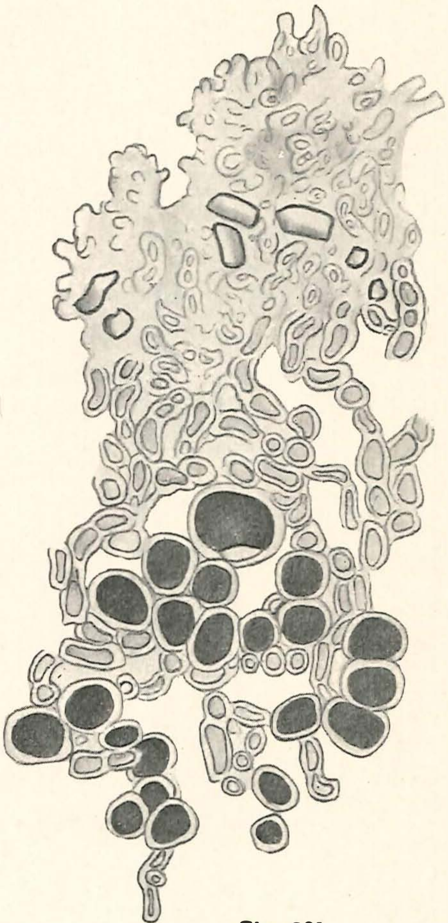


Fig. 325

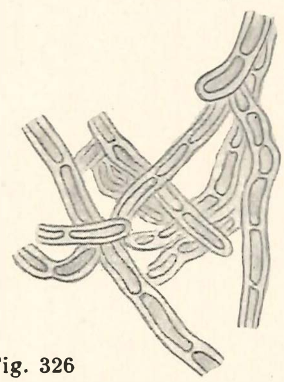


Fig. 326

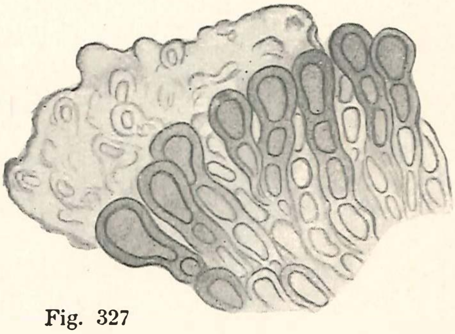


Fig. 327

O. Galløe del.

DIPLOTOMMA ALBOATRUM (Hoffm.) Th. Fr.
(Specimen 3)

PLATE 121.

DIPLOTOMMA ALBOATRUM.

(HOFFM.) TH. FR.

Specimen 3.

Fig. 328. Quite young apothecium, which has just broken through the thallus; it is markedly pruinose, especially in the margin. ($\times$105).

Fig. 329. Three asci, with paraphyses. ($\times$840).

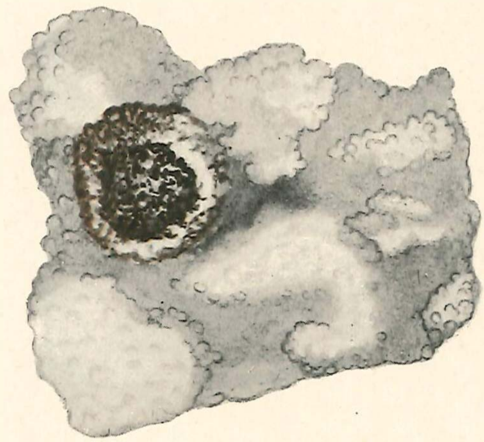


Fig. 328

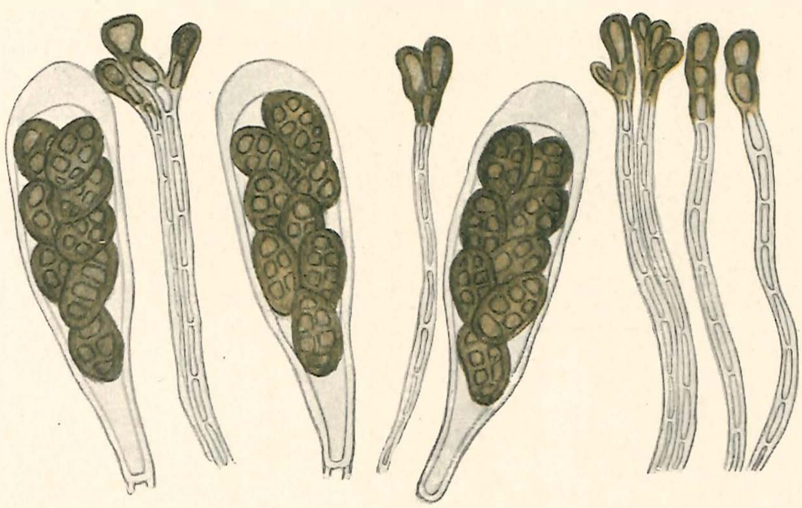


Fig. 329

O. Galløe del.

DIPLOTOMMA ALBOATRUM (HOFFM.) TH. FR.
(Specimen 3)

PLATE 122.

DIPLOTOMMA BETULINUM.

(HEPP.) TH. FR.

Fig. 330. Thallus with soredia and apothecia, on naked wood of *Juniperus*. (×26).

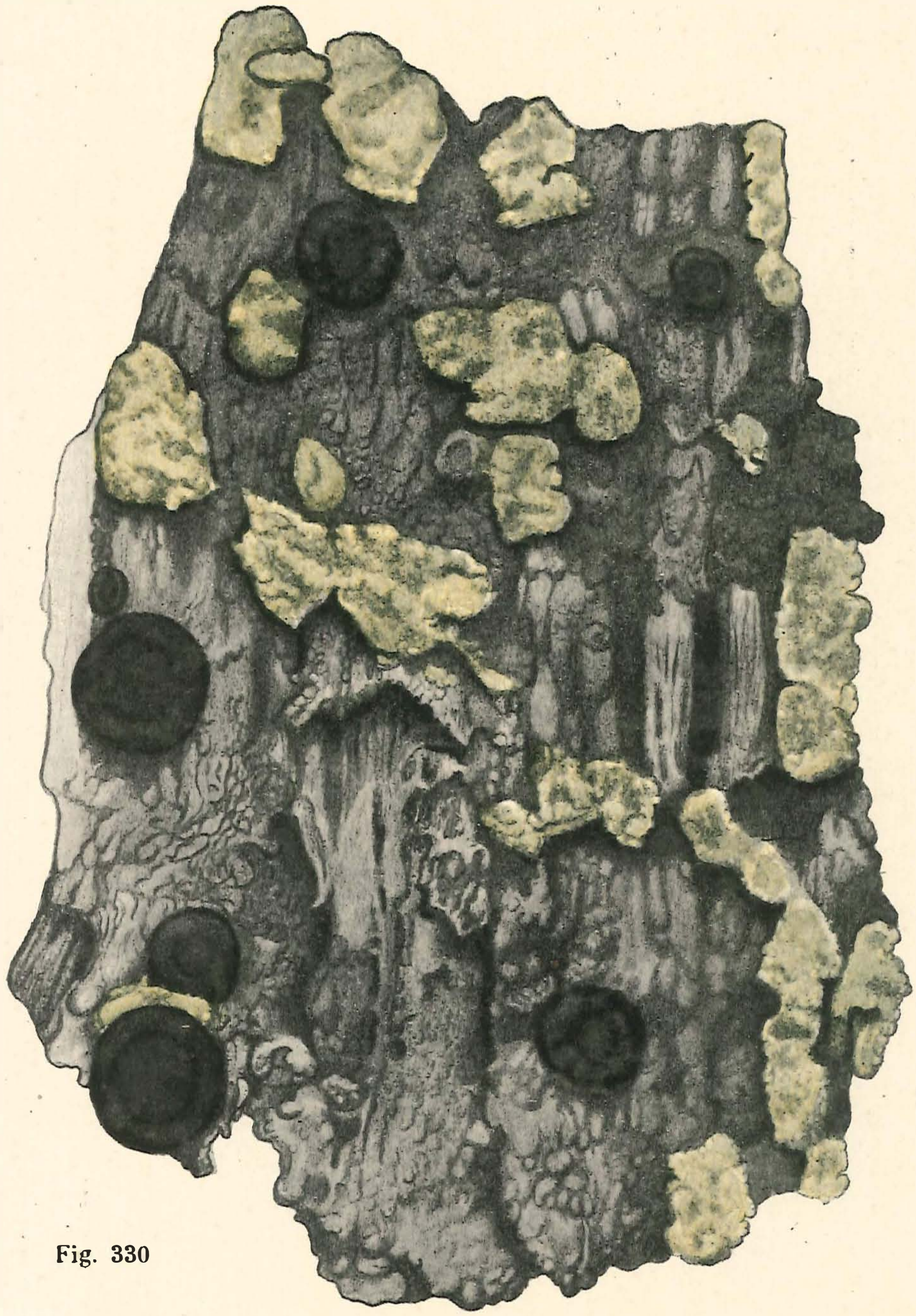


Fig. 330

O. Galløe del.

DIPLOTOMMA BETULINUM (HEPP.) TH. FR.

PLATE 123.

DIPLOTOMMA BETULINUM.

(HEPP.) TH. FR.

Fig. 331. Margin of the thallus (the dark line above). It is very indistinct which parts are still endoxyline, and which epixyline; this can be settled only by means of microscopic preparations. Several yellow soralia are visible. A *Frullania* is spreading over the thallus. (×26).

Fig. 332. Two young soralia. Below to the left a quite young one, still covered by the cortex (therefore grey); the other one is yellow, as the soredia have broken through the middle of the soral, the cortex of which only remains as a greyish margin round the soredia. (×105).

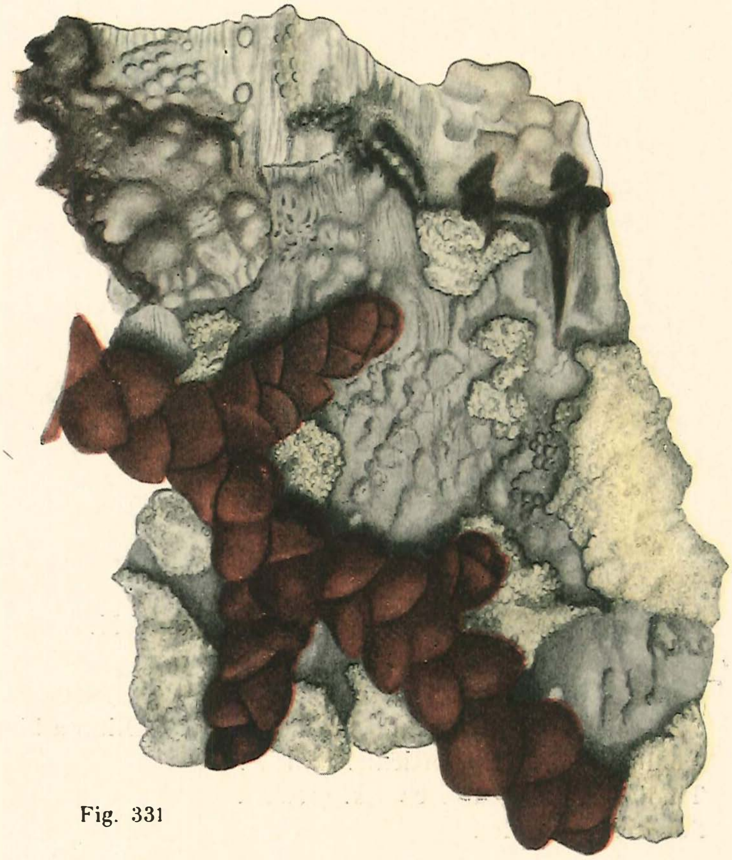


Fig. 331

Fig. 332

O. Galløe del.

DIPLOTOMMA BETULINUM (HEPP.) TH. FR.

PLATE 124.

DIPLOTOMMA BETULINUM.

(HEPP.) TH. FR.

Fig. 333. Section of the thallus. To the right in the section a big soral. (×157).
Fig. 334. Thallus, distinctly corticate. (×157).
Fig. 335. Thallus, with a thin cortex. (×840).
Fig. 336. Soredium. (×840).

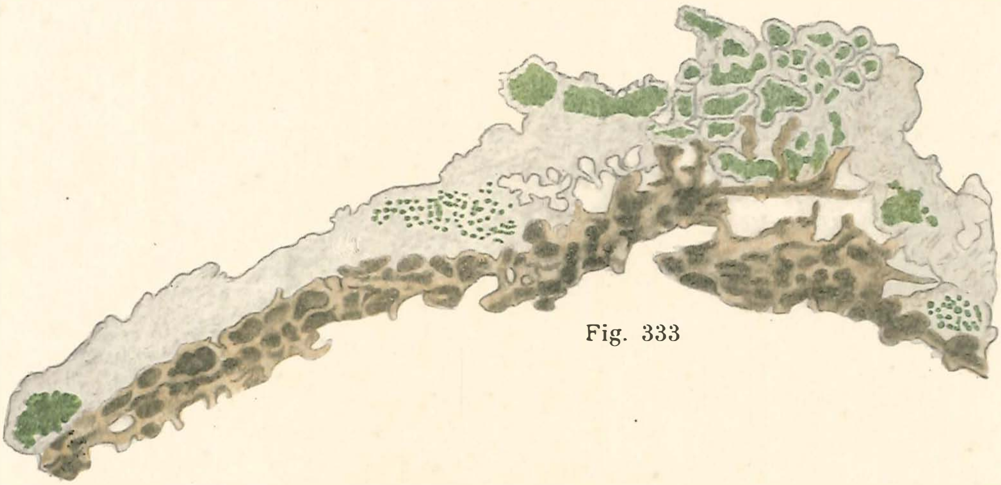


Fig. 333

Fig. 334

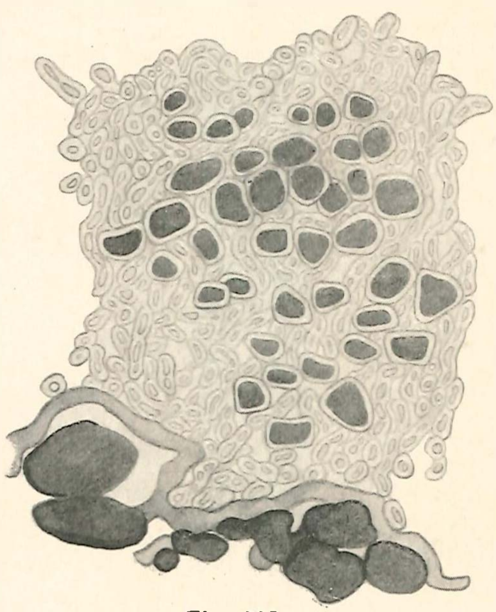


Fig. 335

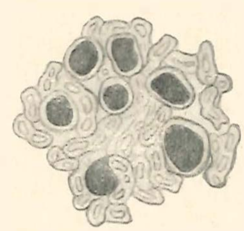


Fig. 336

O. Galløe del.

DIPLOTOMMA BETULINUM (HEPP.) TH. FR.

PLATE 125.

DIPLOTOMMA BETULINUM.

(Hepp.) Th. Fr.

Fig. 337. Margin of the thallus, in this place endoxyline. Farthest to the left two gonidia, not yet quite surrounded by hyphæ. (×840).

Fig. 338. Thallus, in this place corticate. (×840).

Fig. 339. Apothecium. (×105).

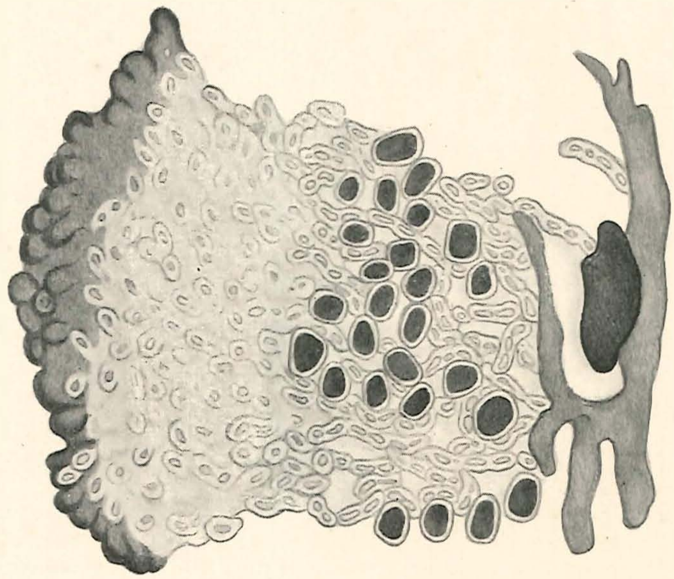


Fig. 338

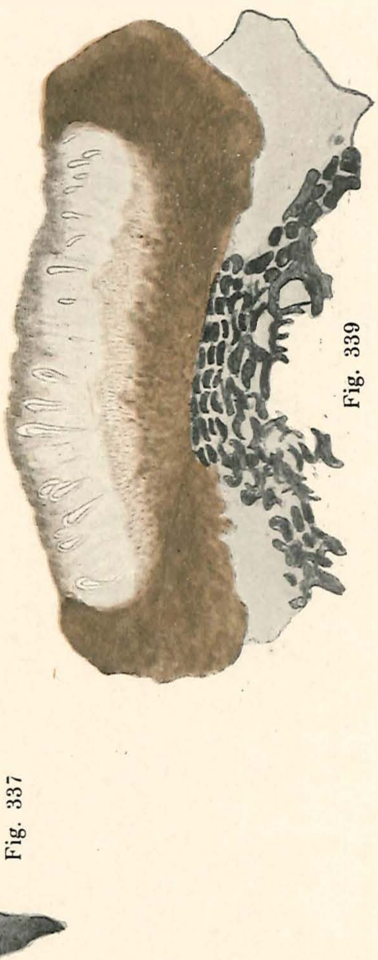


Fig. 339

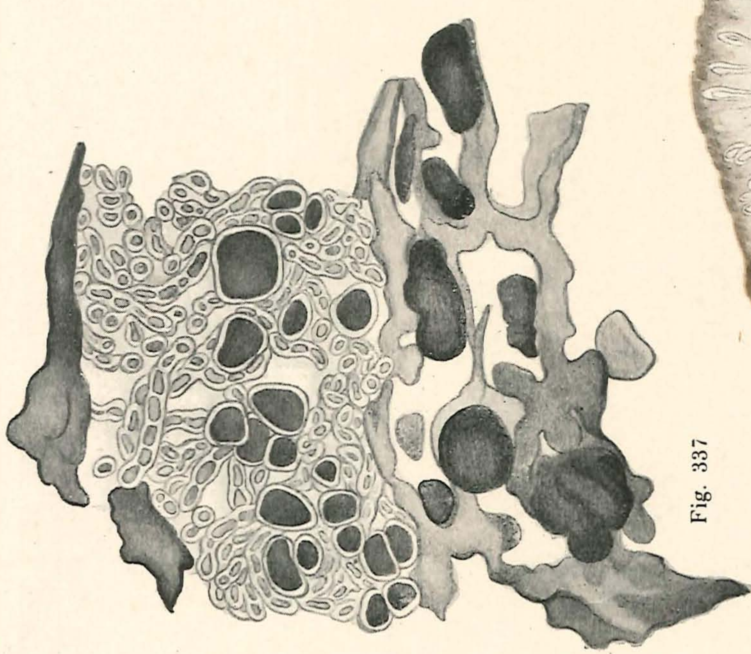


Fig. 337

O. Galløe del.

DIPLOTOMMA BETULINUM (HEPP.) TH. FR.

PLATE 126.

DIPLOTOMMA BETULINUM.

(HEPP.) TH. FR.

Fig. 340. Margin of the apothecium, with highly developed margin of the calyx. (×695).

Fig. 340

O. Galløe del.

DIPLOTOMMA BETULINUM (Hepp.) Th. Fr.

PLATE 127.

DIPLOTOMMA BETULINUM.

(Hepp.) Th. Fr.

Fig. 341. Basal part of calyx, where in a downward direction it merges into the rhizoidal tissue between the cells of the periderm and in a upward direction is transformed into hypothecium (the light tissues above). (×840).

Fig. 342. Two asci and paraphyses. (×840).

Fig. 343. Surface-view of the hymenium, with dark tips of paraphyses and also two asci. (×840).

Fig. 344. Horizontal section of the hymenium with transverse section of paraphyses and asci, and also hymenial gelatine. (×840).

Fig. 345. Various types of spores. (×840). Cp. Fig. 340.

PLATE 127.

DIPLOTOMMA BETULINUM (HEPP.) TH. FR.

O. Galløe del.

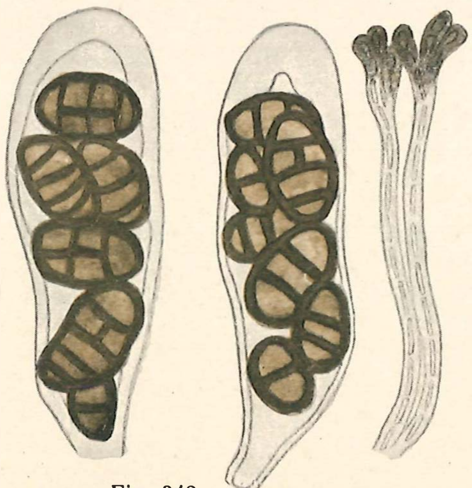


Fig. 342

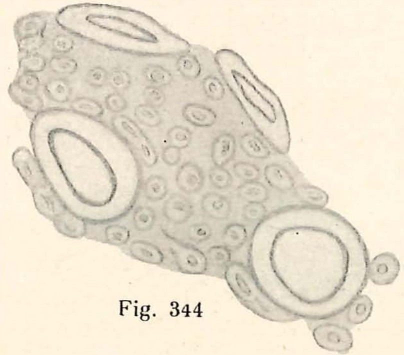


Fig. 344

Fig. 345

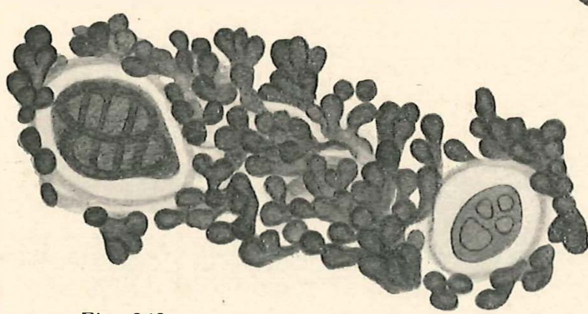


Fig. 343

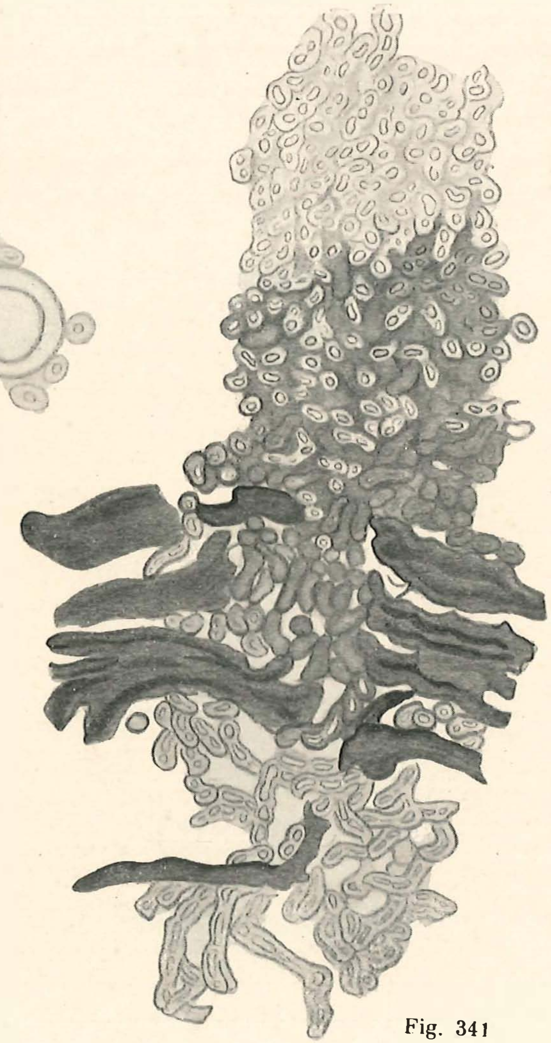


Fig. 341