ARKIV FÖR BOTANIK

UTGIVET AV

K. SVENSKA VETENSKAPSAKADEMIEN

BAND 30 A. N:o 10.

THE SOUTH AMERICAN CLADINAE

BY

ROLF SANTESSON

WITH 3 PLATES AND 3 FIGURES IN THE TEXT

COMMUNICATED SEPTEMBER 9TH 1942 BY
OTTO ROSENBERG AND ROB. E. FRIES

STOCKHOLM

ALMQVIST & WIKSELLS BOKTRYCKERI-A.-B.

BERLIN NW 7	LONDON	PARIS
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11 KARLSTRASSE	136, GOWER STREET	11 RUE DE LILLE

1942

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Contents.

Preface.

The Regnellian lichen herbarium, i. e. the South American collections in the Botanical Department of the Swedish Natural History Museum in Stockholm, comprises at present about 15,000 lichen numbers from all parts of South America. During the 40 years, that the famous lichenologist the late Dr G. MALME was studying South American lichen, he published many very important papers dealing with the taxonomy of South American lichens, especially that of crustaceous Brazilian species, founded on the material in this herbarium. In recent years several new collections have been added to the herbarium, and thus there is still a great part of our material that needs revision similar to that made by MALME. As the successor of Dr MALME as »Regnellian amanuensis» I am going to proceed with the researches of South American lichens.

At present all taxonomical studies are made difficult by the impossibility of getting type material from several foreign

museums. The material in the Regnellian herbarium together with the collection in the Botanical Museum of Upsala is so large, however, that I have no hesitation in publishing this paper now. The material of the group *Cladina* of the genus Cladonia is rich enough to give a good idea not only of the taxonomic problems but also of the distribution of the species within the area treated here. In DES ABBAYES' monograph of *Cladinae* (1939), we get a survey of the collections in the foreign herbaria. DES ABBAYES' monograph is founded on the material of the largest public museums in Europe (excluding the Swedish ones), a few in North America and several private collections, in all 23 herbaria. In his monograph he publishes 62 South American collections. From the two herbaria here concerned, Stockholm and Upsala, I have been able to study 75 different South American collections comprising a very much larger number of herbarium specimens.

This paper is also partly founded on my own fieldstudies in South America. In 1939—41 I spent one year and a half studying lichens in Chile and in southern Argentina, and I also made short visits to Brazil (Rio de Janeiro and Santos—São Paulo) and Venezuela (La Guaira—Caracas). As for the present almost all the material that I collected during the expedition is left abroad, I have to leave the results of those studies for later publication.

To Prof. G. EINAR DU RIETZ and Prof. GUNNAR SAMUELSSON I wish to express my great gratitude for their good advice on the preparation of this paper. My thanks are due to Prof. J. A. NANNFELDT for the loan of lichens from the museum of Upsala.

In this paper the following abbreviations have been used: C = hypochlorite of calcium; K = potassium hydrate; KC = potassium hydrate + hypochlorite of calcium; Pd = paraphenylenediamine; S = the Swedish Natural History Museum, Stockholm; U = the Botanical Museum of Upsala.

I. Earlier surveys.

Until recent years the South American species of the group *Cladinae* of the genus *Cladonia* seemed to be well known from taxonomic point of view. Four species were referred to the area, viz. *Cladonia sylvatica* (L.) HOFFM., *Cl. rangiferina* (L.) WEB., *Cl. alpestris* (L.) RABENH. and *Cl. pycnoclada* (PERS.) NYL., the last-mentioned being generally divided into two varieties, var. *flavida* VAIN. and var. *exalbescens* VAIN. Many of the forms and varieties described from Europe were re-

ported from South American collections and a few new ones were also described. The rich collections now available in our herbaria have, however, clearly shown the deficiencies of this old taxonomy.

Traditionally the *Cladinae* group has been regarded as a good subgenus of the genus *Cladonia*. In 1866 NYLANDER described *Cladina* as a proper genus. VAINIO saw the impossibility of the delimitation of the genus from *Cladonia* and in 1887 he degraded *Cladina* to a subgenus of *Cladonia*. It kept that position in almost all lichenological works until 1938, when MATTICK made a new grouping of the genus *Cladonia* (MATTICK 1938 and 1940). He gave *Cladina* the rank of a subsection beside *Unciales* and *Chasmariae* in the section *Perviae* of the subgenus *Eucladonia*. The very great agreements between *Cladinae* and species of *Unciales* and *Chasmariae* are quite clear to all who have studied exotic *Cladonia*. As far as I can see MATTICK's arrangement must be the most correct taxonomic system.

In 1939 H. DES ABBAYES published a monographic revision of *Cladinae*. From many points of view it is an excellent work, adding much to our knowledge of the morphology, anatomy and chemical constitution of the species of the group. The taxonomic and phytogeographical chapters also reveal many interesting facts, but are impaired by errors. In the literature we already find objections to this revision and some new species have also been described (ASAHINA 1940, MATTICK 1940, MAGNUSSON 1941, SANTESSON 1942). Especially the treatment of the South American species in DES ABBAYES' monograph is so incorrect that a new revision is necessary.

The species of *Cladinae* were grouped by DES ABBAYES into three series: *Impexae*, *Tenues* and *Rangiferinae*. The taxonomic affinity between the species seems to be correctly established in this system. Of the three series only *Impexae* and *Rangiferinae* are represented in the South American lichen flora.

According to DES ABBAYES the following species of *Cladinae* are to be found in South America:

Impexae: Cladonia impexa HARM., *Cl. fallax* DES ABB., *Cl. Sandstedei* DES ABB.

Rangiferinae: Cl. mitis SANDST., *Cl. sylvatica* (L.) HOFFM., *Cl. rangiferina* (L.) WEB.

However, that list must be changed very much for taxonomic as well as for nomenclatorial reasons, as will be seen by the following.

Cladonia impexa. The delimitation of *Cl. implexa* in DES

ABBAYES' sense is quite untenable, as has already been pointed out by MAGNUSSON (1941) and MATTICK (1940) i. a. The South American collections cited under that name represents mainly the species here described as *Cl. confusa*. Some specimens of *Cl. pohlia* R. SANT. are perhaps included under that name too (partly f. *exalbescens* (VAIN.) DES ABB.?). See pages 13 and 15.

Cladonia fallax. In his monograph DES ABBAYES has a long chapter on *Cl. pycnoclada* and the necessity of rejecting that name as a nomen confusum. It is quite true that the name *Cl. pycnoclada* has been used for several species by VAINIO and almost all authors before and after his *Cladonia* monograph. But there is no greater reason for rejecting the name *Cl. pycnoclada* than that of *Cl. sylvatica*. We need not hesitate about what really is *Cl. pycnoclada* (PERS.) NYL. The description by PERSOON (1826) is short but quite clear: »In insulis Maclovianis (locis turfosis). Les ramifications de cette variété sont très touffues et non recourbées au sommet. Elles sont d'un blanc jaunâtre.» Thus it is a yellow-white species of the series *Impexae*, growing in the Falkland Islands: that is the species to which DES ABBAYES gave the name of *Cl. fallax*.

In the whole of South America there are only three yellow-white species of *Cladinae*: *Cl. confusa* R. SANT., *Cl. fallax* DES ABB. and *Cl. laevigata* (VAIN.) GYELN., the last-mentioned being a typical species of *Rangiferinae* with polytomous ramification and curved apices of the branches and the first one mentioned being distributed only in tropical and subtropical areas of South America.

I have seen no specimens of *Cl. pycnoclada* s. str. collected outside South America. The report of its growing on Tristan da'Cunha may be quite right, but I doubt DES ABBAYES' statement concerning the specimens from Formosa, U. S. A. and Hawaii. The Hawaiian specimens are certainly *Cl. leiodea* H. MAGN.

Cladonia Sandstedei. DES ABBAYES' comprehension of this species is quite right. Probably the correct name of the species may be *Cl. hirta* (TAYL.). See page 17.

Cladonia mitis. DES ABBAYES reports the species as collected in South America, once in Colombia and several times in southern Argentina and Chile. I have not seen the collection from Bolivia but the identification seems to be very uncertain. All the cited specimens from Argentina and Chile (Patagonia and Tierra del Fuego) are named *Cl. mitis* f. *laevigata* and represent a proper species, *Cl. laevigata* (VAIN.) GYELN.

Cl. mitis certainly does not belong to the South American flora. See page 9.

Cladonia sylvatica. The species is common to the temperated zone of the whole northern hemisphere, but seems to be lacking in the southern hemisphere. DES ABBAYES reports two South American collections, one from Bolivia and one from Brazil. Of the cited collection said to be from Bolivia, La Paz, leg. MIGUEL BANG, specimens were found in the museum of Upsala. The specimens are very typical *Cl. sylvatica*, but the whole appearance of the collection immediately made me doubt its being from Bolivia. Dr. HERMAN PERSSON, Stockholm, had the kindness to examine the mosses intermixed with the lichens in the collection. The typical *Hedwigia albicans* (WEB.) LINDB. and a form (probably North American) of *Dicranum scoparium* (L.) HEDW. were found. The latter species does not belong to the South American flora and thus confirms the supposition of a confusion of the labels of the specimens. The identification of the Brazilian collection is most uncertain.

Cladonia rangiferina. The distribution of *Cl. rangiferina* seems to agree very well with that of *Cl. sylvatica* and the species is lacking in South America. However, DES ABBAYES reports it from Colombia (2 collections), Peru (1 coll.) and Chile (1 coll.). As I have not seen the collections from Peru and Colombia I cannot decide their identity, but they are certainly not *Cl. rangiferina*. The specimen from Chile is certainly *Cl. vicaria* (see page 11), a species very common in Patagonia and Tierra del Fuego.

In his survey of *Cladonia* MATTICK (1940) diverges much from DES ABBAYES' monograph. As to the species from South America we may understand the following from MATTICK's list of species:

Cladonia signata. It seems quite correct that this species may be looked upon as a species of *Cladinae*, which was also indicated by SANDSTEDE (1938), and not as VAINIO and DES ABBAYES say as a species of *Chasmariae*.

Cladonia pycnoclada. What MATTICK means by this species is hard to understand, as *Cl. fallax*, *Cl. flavida* as well as *Cl. Sandstedei* are accepted by him. Perhaps he takes up under this name the species here described as *Cl. pohlia*, and from tropical areas outside South America probably other, undescribed species.

Cladonia flavida. This species in MATTICK's list is mainly identical with *Cl. confusa*. *Cl. pycnoclada* α *flavida* VAIN. is

in the main (most of the species cited by VAINIO) identical with *Cl. pycnoclada* s. str. As to the areas outside South America we find under that name in MATTICK's survey *Cl. Skottsbergii* H. MAGN. and probably other, undescribed species.

Cladonia impexa, Cl. alpestris, Cl. mitis, Cl. sylvatica and Cl. rangiferina. These species are said to be cosmopolitic or almost cosmopolitic. However, they are not members of the South American flora.

Cladonia fallax. Must be named *Cl. pycnoclada* (PERS.) NYL. (s. str.). See above page 4.

Cladonia Sandstedei. A good species, see below page 17.

I have made these comments on the two lists of DES ABBAYES and MATTICK as they are the most important and most modern surveys of *Cladinae*. Other statements in the literature I shall not discuss. Instead I will give lists of all the specimens examined by me. Only the determinations by RÄSÄNEN of the material of the Finnish Expedition to Tierra del Fuego in 1928—29 (RÄSÄNEN 1932) I want to correct here, as they are very instructive: *Cl. rangiferina* f. *nivea* RÄS., f. *erythrocraea* FLK., f. *incrassata* SCHAER. and f. *bicolor* RÄS. are *Cl. vicaria* R. SANT., *Cl. sylvatica* var. *sylvestris* f. *sphagnoides* FLK., var. *laevigata* VAIN., *Cl. pycnoclada* var. *flavida* VAIN., *Cl. substellata* f. *divergens* VAIN. and f. *subuncinalis* VAIN. are *Cl. laevigata* (VAIN.) GYELN., *Cl. alpestris* (L.) RABENH. is *Cl. pycnoclada* (PERS.) NYL. s. str.

In »Die Pflanzenareale» SANDSTEDE (1932) made a survey of the distribution of *Cladoniaceae* in the whole world. Representing *Cladinae* he marks on the map only the distribution of *Cl. pycnoclada* and *Cl. subsylvatica* STIRT. (The latter probably only a deformed *Cl. sylvatica*, he declares in the text!). The distribution of *Cl. pycnoclada* sens. latissimo is inexactly indicated.

II. Remarks on morphology etc.

As to the comparative morphology and anatomy of *Cladinae* I refer to the detailed and very good descriptions in DES ABBAYES' monograph.

On account of scarce material of exotic *Cladinae* most earlier authors had a very confused idea of the species of *Cladinae*. The strong individual variation of the species is very prominent and the variation series very similar to the different species. Thus the characters separating the species are rather easy to overlook, when only a few collections are

studied. The very great number of forms and varieties now distinguished creates a chaotic nomenclature of very little value. Until we know more about the influence of the habitat factors on the variation, the description of single forms and varieties founded on only a few specimens from exotic collections is quite worthless. In the collections of South American *Cladinae* I have been able to distinguish a great number of forms, however, forming a continuous series without prominent intervals. It seems to me quite useless to introduce a number of names for those. The variation amplitude of a species will not be better known by a great number of names.

ÅBERG has in the *Sphagnum*-taxonomy (ÅBERG 1934) introduced a very good way of nominating the forms, viz. by a system of short descriptive names, containing the characters distinctive of the forms in question. The same name is used for the similar forms of the different species of a genus or of a group of species and of course without an author's name. Such a nomenclature may be used for *Cladinae* by a monographic revision of all the species of the genus.

Even in DES ABBAYES' monograph we find such forms as *Cladonia rangiferina* f. *cymosa* (ACH.) VAIN. and *Cl. sylvatica* f. *polycarpia* (FLK.) HARM. »C'est la forme normale avec des apothécies.» The taxonomic term of form is thus given a very remarkable value. Would the lichenologic taxonomist apply the same term in the phanerogamic taxonomy and put form names on, for instance, apple trees without leaves, with leaves, with flower-buds, with flowers, with fruits etc.?

The ramification system of the podetia is the most important taxonomic character in *Cladinae*. The three series of species of *Cladinae*, viz. *Rangiferinae*, *Impexae* and *Tenues*, are founded especially on the ramification system of the species and give a very good view of the taxonomic affinity of the species. In *Rangiferinae* the ramification is predominantly polytomous with unilaterally deflexed tips of the branches, in *Tenues* it is dichotomous and in *Impexae* tri- or dichotomous with tips erect or deflexed in all directions. Sympodial main axes are very well differentiated in *Rangiferinae*, the sympodial tendency in *Impexae* being rather slight or entirely absent.

The chemical reactions, the colour and the taste of the thallus have been of great importance for the differentiation of the species of *Cladinae*. Often many of the species distinguished in recent years have been looked upon as only »chemical species», und thus as of doubtful taxonomic value. Some such »species» have been described, e. g. *Cl. subimpexa* DUVIGN., but most are good species, very well differentiated by many morphological characters. The contents of different

lichen acids are, however, rather constant in the species of *Cladinae* and of great value for the determination of single specimens. The morphology and anatomy will always be the fundamental thing and the presence or absence of the lichen acids is only an aid to taxonomic study. Sometimes in normally acid-bearing species we find acid-free specimens and in some cases we see the contrary (e. g. *Cl. alpestris*). ASAHINA (1934) as well as M. LAMB (1939) and others have given many such examples. I join LAMB in the statement that »the absence of a characteristic lichen acid in morphologically identical specimens of a normally acid-bearing species cannot be regarded as an important taxonomic difference».

Many lichen acids have been established in species of *Cladinae* (ASAHINA 1934 and 1940, DES ABBAYES 1939). The most common ones are usninic and fumarprotocetraric acid and atranorine. More rare are sylvatic, perlatolinic, psoromic, rangiformic and rhodocladonic (?, in pycnoconidangia) acids and erinacein. The presence of usninic acid gives the thallus a yellowish colour and is to be found in *Cl. laevigata*, *Cl. confusa* and *Cl. pycnoclada* among the South American species. The fumarprotocetraric acid, which highly concentrated gives a bitter taste to the thallus, is to be found in *Cl. vicaria* and *Cl. Sandstedei*, and is very rare in *Cl. pycnoclada* (and *Cl. signata*?). The atranorine is to be found in *Cl. vicaria* and *Cl. Sandstedei*.

III. Synopsis of the South American species.

Key to the known species.

Rangiferinae.

Podetia thick with polytomous ramification and very distinctly sympodial main stems. Tips of the branchlets more or less unilaterally deflexed.

I. Podetia yellow-white, their surface glabrous.
1. *Cl. laevigata* (VAIN.) GYELN.

II. Podetia grey or lilac-grey, their surface tomentose.
2. *Cl. vicaria* R. SANT.

Impexae.

Podetia thin with di- or trichotomous ramification and without or with not very distinctly sympodial stems. Tips of the branchlets erect or deflexed in all directions.

I. Podetia yellowish white or yellow-grey.
   A. Ramification predominantly trichotomous, most angles not perforated. 3. *Cl. confusa* R. SANT.
   B. Ramification predominantly dichotomous, most angles perforated. 5. *Cl. pycnoclada* (PERS.) NYL. s. str.

II. Podetia grey or greyish white, rarely brownish grey.
   A. Ramification trichotomous. 4. *Cl. pohlia* R. SANT.
   B. Ramification dichotomous.
      1. Main stems distinguishable at the base of the podetia. 6. *Cl. Sandstedei* DES ABB.
      2. No main stems (no tendency to sympodial ramification).
         a. Podetia with a brownish tint, tufts not very dense. 7. *Cl. signata* VAIN.
         b. Podetia purely greyish white, tufts very dense. (*Cl. Evansii* DES ABB.).

Chemical reactions of the species.

Pd + ochraceous red,	K + yellow.	*Cl. vicaria*, *Cl. Sandstedei*.
Pd + ochraceous red,	K—.	*Cl. pycnoclada*, *Cl. signata*.
Pd—,	K + yellow.	(*Cl. Evansii*).
Pd—,	K—.	*Cl. laevigata*, *Cl. confusa*, *Cl. pohlia*.

Rangiferinae DES ABB.

1. **Cladonia laevigata** (VAIN.) GYELN.

Syn.: *Cladonia sylvatica* γ *laevigata* VAIN. 1887 I pag. 33, *Cl. mitis* f. *laevigata* (VAIN.) DES ABB. 1939 pag. 122, *Cl. laevigata* (VAIN.) GYELN. Lichenotheca no. 148, 1937.

Icon.: Tabula nostra I, fig. 4.

Exsic.: LECHLER, Plantae Magell., no. 1013.

VAINIO (1887) divided *Cl. sylvatica* into three varieties: α *sylvestris*, β *portentosa* and γ *laevigata*. The last-mentioned variety differed from the others by its nitidous thallus surface. In the schedulae of Lichenotheca, no. 148, GYELNIK published *Cladonia laevigata* (VAIN.) GYELN n. comb. The species distributed under that name is not *Cl. laevigata* but probably *Cl. confusa* (I have not seen the specimen). VAINIO's var. *laevigata*, however, is a very well delimitated, proper species.

The podetia are 4—10 cm high, growing in not dense tufts of a light yellow-white colour or light straw coloured, often with brown tips. The ramification of the podetia is at

the base typically sympodial, with long, rather straight main stems, (1—)1.5—2.5(—3) mm thick, and with rather short branches, about 0.2 mm thick at the ends. The habit thus reminds of that of *Cl. mitis*, but the podetia are more robust and the small branches are shorter and not so strongly deflexed. The ramification is polytomous or trichotomous with rather dense branchlets at the ends of the podetia, which thus get a densely digitated appearance at the ends. The angles are mostly perforated. The surface of the podetia is very smooth and nitidous, thus the extreme contrary to the tomentose surface-structure of for instance *Cl. vicaria* and *Cl. confusa*. At the bases and on the main stems of the podetia the stratum gonidiale has been dissolved in small verrucose spots. Between these glabrous yellow-white spots the pale brownish-white stratum chondroideum is naked, thus not completely covered by the stratum arachnoideum, which is the rule in the *Cladinae*.

The apothecia are rare. They are small (0.5 mm), dark brown or almost black, convex but hardly semiglobose, with a distinct, pale brown margin. The hymenium is about 50 μ high. The asci are about 40×10 μ, with a very thick wall at the top. The paraphyses are straight and scarcely branched. Spores 8—12×2—3 μ, ellipsoid to semicylindrical.

The pycnoconidangia are ovoid or more or less dolioliform, slightly constricted at the base. Their contents are uncoloured.

The reactions: Pd—, K—.

Cl. laevigata is a species very common in the southernmost part of South America: in Patagonia and Tierra del Fuego and also in the Valdivian region. See further page 23 and Fig. 2 and Plate II, Fig. 1.

I have examined the following specimens of *Cl. laevigata*.

Patagonia. Nahuel Huapí, Brazo del Viento, alt. more than 1330 m. 1934, E. LJUNGNER. (S.) — Punta Arenas. 1852, W. LECHLER, Plant. Magell. no. 1013. (S. U.) — Straits of Magellan. 1852, N. J. ANDERSSON (S. U.).

Tierra del Fuego. Bog at the mouth of the Rio Fontaine. 1908, C. SKOTTSBERG, no. 143. C. ap. (S. U.) — Rio Bueno, in a bog. 1928 and 1929, H. ROIVAINEN. (S.) — Estancia Cameron, Puesto Medio. 1928, H. ROIVAINEN. (S.) — Lago Fagnano, in a bog. 1929, H. ROIVAINEN. (S.) — Lago Roca, in a forest, 1902, C. SKOTTSBERG. (S.) — Isla Clarence, Estero Staples, in a bog. 1929, H. ROIVAINEN. (S.) — Tekenica Bay. 1902, C. SKOTTSBERG. (S.) — Cap Horn, 1883, HARIOT. (U., isotype.) — Staten Island, Puerto Abrigado. 1934, A. CASTELLANOS, no. 1554. (S., Mus. Nac. Buenos Aires.)

Falkland Islands. On the ridge south of Port Stanley. 1904, S. BIRGER. (U.).

There are also specimens from South Georgia, Cumberland Bay, Morain Fiord. 1902, C. SKOTTSBERG (S. U.).

2. **Cladonia vicaria** nov. spec.

Exsic.: LECHLER Plantae Magell., no. 994.
Icon.: Tabula nostra I, fig. 1.
Spec. orig.: P. DUSÉN, no. 159 a (Tierra del Fuego) in Mus. Botan. Stockholm.

Thallus primarius evanescens.

Podetia crassa, basi 1.0—2.0 mm crassa, usque 15 cm alta, basi axem sympodialem efficientia, summo polytomiis (raro trichotomiis) inaequalibus ramosa, axillis perforatis (vel rarissime integris), ramulis ultimis curtis, sat crassiusculis, plus minusve unilateraliter divaricatis, sat laxe caespitosa, vulgo tota erecta, albida vel cinereo-albida pro parte pallide fusco-lilacina, basi emorienti nigricantia, ecorticata, in parte superiore aequaliter arachnoideo-tomentosa, in parte inferiore leviter verruculosa, gustu mitia.

Apothecia sparsa, peltata, in apice ramorum 4:na—5:na, convexa vel semiglobosa, tenuissime marginata vel immarginata, fusco-nigricantia. Hymenium circ. 50 μ altum, in parte superiore fuscescens, in parte inferiore pallide fulvescens. Paraphyses circ. 1 μ crassae, apice leviter incrassatae. Asci octospori, circ. 7—9 μ crassi. Sporae ellipsoideae, circ. 2 μ latae, 5—7 μ longae, membrana tenui.

Pycnoconidangia fusco-nigricantia, ovoidea vel dolioliformia, basi plus minusve constricta, materiam albidam continentia. Pycnoconidia leviter curvata, circ. 0.5 μ lata, 4—6 μ longa.

React.: K + flav., C—, KC + flav. vel fulv., Pd + ochraceo-rubescens.

In 1877 KREMPELHUBER described *Cladonia rangiferina* var. *patagonica*. Perhaps this variety is identical with *Cl. vicaria*, but the diagnosis is too short for a decision. »Podetia et rami (ramulique) decorticata, sterilia». VAINIO (1887) supposes the variety to be identical with *C. pycnoclada* sens. lat.

The rich collections in our herbaria clearly show that the species is well differentiated from *Cl. rangiferina* and that the differences between these two species are too great to be only variety characters.

The podetia are 5—15 cm high, the ramification resembling that of *Cl. rangiferina*, but the small branches are much shorter and thicker and more obtuse. The whole habit is

much more robust and more inflated. The colour is white or greyish, on sun-exposed parts of the podetia it is of a grey lilac or bluish lilac tint. I have never seen a specimen of *Cl. vicaria* with the greenish grey colour so characteristic of *Cl. rangiferina*. The surface of the podetia is covered with a fine smooth tomentum. This stratum arachnoideum is rather thick. A verrucose surface, so common in *Cl. rangiferina*, we find very seldom in *Cl. vicaria*, and then only on older parts of the podetia.

The apothecia, which are dark brown, 0.3—0.5 mm in diam., we find in cymose bunches at the ends of the podetia, hardly in racemose stands as in *Cl. rangiferina*.

The pycnoconidangia accord with those of *Cl. rangiferina*. They are ovoid, more or less constricted at the base and have an uncoloured jelly.

The reactions: Pd + red, K + yellow.

This species is very common in Patagonia and Tierra del Fuego, where it grows especially in the bogs and in wet forests. See further page 24 and Figs. 1 and Plate II, Fig. 2.

I have examined the following specimens of *Cl. vicaria*.

Patagonia. Skyring Water, Puerto Pinto. 1908, C. SKOTTSBERG. (U.) — Punta Arenas. 1852, V. LECHLER, Plant. Magell. no. 994. (U.). 1896, P. DUSÉN, no. 13. (S. U.).

Tierra del Fuego. Bog at the mouth of Rio Fontaine. 1908, C. SKOTTSBERG. (U.) — Rio Bueno, in a bog. 1928 and 1929, H. ROIVAINEN. (S.) — Fiordo Finlandia, in *Nothofagus betuloides* forest. 1929, H. ROIVAINEN. (S.) — Rio Azopardo, in a bog. 1896, P. DUSÉN, no. 159 a. (S. U.) — Above the Rio Azopardo valley, alt. 700 m. 1908, C. SKOTTSBERG. (U.) — Lago Fagnano, in a bog. 1929, H. ROIVAINEN. (S.) — Lago Roca, in a forest. 1902, C. SKOTTSBERG. (S.) — Ushuaia, in a bog and in forest, alt. 275—500 m. 1902, C. SKOTTSBERG. (S. U.) — Tekenica Bay. 1902, C. SKOTTSBERG. (S.) — Staten Island, Port Cook. 1903, C. SKOTTSBERG. (S.).

There are also specimens from South Georgia, Cumberland Bay, Morain Fiord, 1902, C. SKOTTSBERG. (S.) — Pot Harbour, alt. 50—250 m. 1910 C. A. LARSEN. (S. U.) — Sine loco. 1883, MOSTAFF and 1921, D. BERGSTRÖM. (S.).

Impexae DES ABB.

3. **Cladonia confusa** nov. spec.

Syn.: *Cladonia pycnoclada* VAINIO, MATTICK etc. pro parte [non *Cl. pycnoclada* (PERS.) NYL.]; *Cl. pycnoclada* var. *flavida* VAINIO, pro parte; *Cl. impexa* DES ABBAYES pro parte.

Icon.: Tabula nostra I, fig. 3.

Exsic.: Krypt. Exs. Vindob. no. 2272. GYELNIK, Lichenotheca, no. 148 (?, non vidi). SANTESSON, Lich. Exs. Herb. Regnell., no. 351. (Typi duplum.)

Spec. orig.: E. ASPLUND, no. L 107 (Ecuador) in Mus. Botan. Stockholm.

Thallus primarius evanescens.

Podetia sat tenuia, circiter 0.3—0.8(—1.2) mm crassa, 5—13 cm alta, basi axem leviter sympodialem trichotomiis (raro dichotomiis) instructa efficentia, in summo apice trichotomiis (raro di- vel tetrachotomiis) subaequalibus ramosa, axillis integris vel perforatis, ramulis ultimis tenuibus, vulgo rectiusculis divaricatis, caespitoso-conferta, vulgo erecta, saepe thyrsos densos formantia, tota stramineo-albida vel basi emorienti cinereo-fuscescentia vel nigricantia, ecorticata, semipellucida, parte superiore subarachnoideo-tomentosa, parte inferiore verruculosa, gustu mitia.

Apothecia sat sparsa peltata, primo convexa et tenuissime marginata, dein globosa, immarginata, fusca vel testacea. Hymenium circ. 50 μ altum, in parte superiore fuscescens, in parte inferiore pallide fulvescens vel fere incoloratum. Paraphyses circ. 1 μ crassae, apice leviter incrassatae. Asci octospori, circ. 6—9 μ crassi. Sporae ellipsoideae, circ. 2×(4—)5—7 μ, membrana valde tenui.

Pycnoconidangia fusco-nigricantia, dolioliformia vel ovoidea, basi plus minusve constricta, materiam albidam continentia.

Pycnoconidia leviter curvata, circ. 0.5 μ lata, 4—6 μ longa.

React.: Thallus K—, C—, KC—, Pd—.

There are many collections of this new species in our herbaria. Thus we have a good opportunity of studying its variation.

The podetia are up to 13 cm long. At the base the main-branches are rather distinct, up to 1.2 mm thick, with numerous branches often at right angles to the main-branches. In the upper part of the podetia there are no distinct main-axes; all branches have more or less the same thickness. The outermost branches are about 1 mm long and 0.1 mm thick, usually straight and divaricating in all directions. In the upper part of the podetia there is a pronounced trichotomous ramification. Sometimes there are irregularities and the angles

may have two or four branches. The angles are usually not perforated or have very small perforations. The podetia form very dense tufts, denser than in *Cl. impexa*, but not so dense as in *Cl. Evansii*, and their upper parts are well capitiformly rounded similar to *Cl. alpestris*. The colour is yellow-white, usually marguerite yellow or sea-foam yellow (cf. RIDGWAY, Color Standards) seldom with a pale tint of buff or greenish. At the decaying base the thallus has a grey brown or greyish black colour. The surface of the podetia is in the upper part evenly tomentose or sometimes the stratum arachnoideum is disconnected and the stratum chondroideum thus partly naked. At the base the podetia are usually verrucose on the surface, the verrucas being often rather glabrous. The apothecia are rare, single or in pairs, in the apices of the smallest branches. They are semiglobous with impressed attaching points, pale brown to black brown, 0.2—0.3 mm in diam.

The species is distributed all over tropical and subtropical South America. See page 21 and Fig. 2.

I have examined the following specimens of *Cl. confusa*.

Colombia. Bogotá, on earth. F. APPOLLINAIRE. (S. U.) — Bogotá, alt. 2700 m, on earth among shrubs. A. LINDIG, no. 2676. (U.) — Antioquia, Santa Elena, alt. 1500—2000 m. 1930, A. ARCHER, no. 1267 (S.).

Ecuador. Prov. Imbabura, lake Cuicocha, Islote Chica, in a block field, alt. 3150 m. 1939, E. ASPLUND, no. L 107. (S.).

British Guiana. Basin of Essequibo river, Kurupukari (4° 40′ N.). 1937, A. C. SMITH, no. 2177. (S.).

Brazil. Serra de Stabira do Campo. 1835, P. V. LUND. (U.) — Rio de Janeiro. A. GLAZIOU, no. 5031. (U.) — Rio de Janeiro, Serra do Picú, on rocks in high regions. 1886, H. SCHENCK, no. 4567 and 4568. (U.) — Serra do Itatiaya, on earth and rocks, alt. 2200 m. 1902, P. DUSÉN. (U.) — Theresopolis, Serra dos Orgãos, on rocks. 1887, H. SCHENCK, no. 4561. (U.) — Santos, Sororocaba, in open sandy place. 1874, HJ. MOSÉN, no. 3129. (S. U.) — Santa Catharina, São Antonio, on dry granitic rocks in glades in forests. 1886, H. SCHENCK, no. 4564. (U.) —

Argentine. Sine loco. 1872—74, LORENTZ & HIERONYMUS. (U.).

Galapagos Islands. Santa Cruz. 1934, R. BLOMBERG. (S.).

I have seen only two collections from areas outside South America, viz.:

Jamaica. Vicinity of St. Helens Gap, St. Andrew, alt. 1476 m. 1920, MAXON & KILLIP, no. 615. (S.).

Mexico. Between St. Jago Amatlan et Trapicha de la Conception, Oajaca dept., alt. about 2000 m. 1842, LIEBMANN. (U.).

4. **Cladonia pohlia** nov. spec.

Icon.: Tabula nostra I, fig. 2.
Spec. orig.: R. SANTESSON, no. 6665 (Venezuela) in Mus. Botan. Stockholm.

Thallus primarius evanescens.

Podetia sat tenuia 0.3—1.0 mm crassa, 6—11 cm alta, basi axem leviter sympodialem trichotomiis (raro dichotomiis) efficientia, summo trichotomiis (raro di- vel tetrachotomiis) subaequalibus ramosa, axillis perforatis vel raro integris, ramulis plus minusve rectiusculis divaricatis, thyrsos densos formantia, versus apicem divisiones subaequales capitiformes efficientia, tota albida vel albido-cinerascentia vel basi emorienti nigricantia, ecorticata, semipellucida, in parte superiore arachnoideo-tomentosa, in parte inferiore verruculosa, gustu mitia.

Apothecia sparsa, in apice ramulorum solitaria, peltata, semiglobosa, immarginata, pallide fuscescentia. Hymenium circ. 50 μ altum, in parte superiore fuscescens, in parte inferiore fere incoloratum. Paraphyses circ. 1 μ crassae, apice leviter incrassatae. Asci octospori, circ. 6—8 μ crassi. Sporae ellipsoideae, circ. 2 μ latae, 4—7 μ longae, membrana tenui.

Pycnoconidangia fusco-nigricantia, dolioliformia vel ovoidea, basi plus minusve constricta, materiam albidam continentia.

Pycnoconidia leviter curvata, breviter acicularia, 0.5 μ lata, 4—7 μ longa.

React.: Thallus K—, C—, KC—, Pd—.

I have seen only two collections of this characteristic species, but both rich ones.

The podetia are up to 11 cm high, quite straight or at the base somewhat decumbent. In the basal part of the thallus main-branches are rather distinct or there are many stems of about the same thickness. Thus at the base there is a slight sympodial tendency of the ramification, but in the upper part of the thallus the ramification is regularly trichotomous. There are only seldom two or four branches arising from the same point. The thickest podetia are up to 1.0 mm thick and the small branches at the end of the podetia 0.1—0.2 mm. The angles are perforated, but not widely. The podetia grow in dense tufts like those of *Cl. Evansii*, at the tops forming rounded heads, about 3—4 cm diam. The colour is whitish grey: pale gull grey, pearl grey or pale olive grey (cf. RIDGWAY). The surface of the podetia is evenly tomentose, like

that of *Cl. Evansii*. Apothecia are rare. Pycnoconidangia are numerous at the tips of the branches, they are pale brown, dolioliform and slightly constricted at the base. Their jelly is colourless.

This new species differs from *Cl. Evansii*, the species nearest related, in having trichotomous ramification, perforated angles and negative KOH-reaction.

By the pure white grey colour and the very densely ramified podetia growing in tufts like *Cl. alpestris* this species differs from *Cl. impexa* and *Cl. signata*, from the latter also by the Pd— reaction.

The Japanese species *Cl. pseudoevansii* ASAHINA (1940) has a yellowish colour, dichotomous ramification and predominant non perforated angles.

Cl. pohlia is probably a Caribbean species. See page 22, Fig. 3 and Plate III, Fig. 2.

The two known localities are:

Venezuela. Federal District. In the coastal cordillera between Caracas and La Guaira, on the ground in the edge of a low rain forest, alt. 1600—1800 m (cf. Plate III, Fig. 2). 1941, ROLF SANTESSON, no. 6665 (S.).

Cuba. Prov. Oriente, Serra de Nipe, head-waters of Rio Piloto. 1914, E. L. EKMAN, no. 2519 (S.).

5. **Cladonia pycnoclada** (PERS.) NYL. s. str.

Syn.: *Cenomyce pycnoclada* PERS. 1826 pag. 212, *Cladonia fallax* DES ABB. 1939, pag. 85, *Cl. pycnoclada* var. *flavida* VAIN. 1887, I, pag. 38 pro max. parte. Vide etiam p. 4 supra.

Icon.: DES ABBAYES 1939 Pl. I, Fig. 3—6, SANDSTEDE 1938 Pl. I, Fig. 3.

Exsic.: LECHLER, Plantae Maclov., no. 64.

When referring this species to the genus *Cladonia* NYLANDER (1866) was examining a species from New Zealand, certainly not *Cl. pycnoclada* s. str.

Under the name of *Cl. fallax* DES ABBAYES gives a good and detailed description of this species, making it unnecessary to describe the species here.

Among the yellow species of *Impexae* *Cl. confusa* seems to be the species nearest related to *Cl. pycnoclada*. However, *Cl. pycnoclada* has the dichotomous ramification dominating (but not so extremely as in *Cl. leiodes* H. MAGN.) and as a rule the angles are perforated. The Pd reaction of *Cl. pycnoclada* is positive (yellow). *Cl. confusa* has mainly trichotomous

ramification, the angles are usually not perforated and the Pd reaction negative.

Cl. impexa is of a much darker colour with a greenish grey tint, not pale yellow-white as in *Cl. pycnoclada* and *Cl. alpestris*. The last-mentioned species differs from *Cl. pycnoclada* in having polytomous ramification, thicker branches and negative Pd reaction etc.

As seen from the map (Fig. 3) *Cl. pycnoclada* is distributed in the temperate, not too dry areas of South America and also in the Andean zone. DES ABBAYES cites finds from Colombia and Peru too. In the Valdivian region, in western Patagonia and on Tierra del Fuego it is very common. See further page 24, Fig. 3 and Plate III, Fig. 1.

I have examined the following specimens.

Bolivia. Sine loco. M. BANG, no. 1849. (S. U.).

Juan Fernandez. Masafuera, Innocentes. 1917, C. & I. SKOTTSBERG, no. 346. (S. U.) — Masatierra, Salsipuedes, in a dry open place, alt. 625 m. 1917, C. & I. SKOTTSBERG, no. 348. (S. U.).

Valdivian region of Chile. Valdivia, Los Ulmos. 1862, H. KRAUSE. (U.).

Patagonia. Chiloë. Isla San Pedro, in mosses near the seashore. 1908, C. SKOTTSBERG, no. 123. (U.) — Islas Guaitecas, Melinca, in a mire. 1897, P. DUSÉN, no. 136. (S. U.) — Boca Chica. 1897, P. DUSÉN, no. 142. (S.) — Seno Skyring, Puerto Pinto. 1908, C. SKOTTSBERG. (U.).

Tierra del Fuego. »America maxime australis.» 1866, WESTERGREEN. (U.) — Rio Azopardo, on earth. 1896, P. DUSÉN. (S. U.) — Isla Clarence, Estero Staples. 1929, H. ROIVAINEN. (S.) — Bahia Orange. 1883, HARIOT. (U.) — Cap Horn. 1883, HARIOT. (U.) — Staten Island, Port Cook. 1903, C. SKOTTSBERG. (S.). 1934, A. CASTELLANOS, no. 1548. (S. Mus. Nac. Buenos Aires.) — Isla Observatio. 1902, C. SKOTTSBERG. (S.).

Falkland Islands. Port Stanley. 1850, W. LECHLER, no. 64. (S.). 1908, C. SKOTTSBERG. (S.) — Port Louis. 1902, C. SKOTTSBERG. (S.).

6. **Cladonia Sandstedei** DES ABB.

DES ABBAYES 1938 pag. 349.

Icon.: DES ABBAYES 1939, Fig. XXX et Pl. II, Figs. 1—3.

Exsic.: MALME, Lich. Exs. Herb. Regnell., no. 226, GYELNIK, Lichenotheca, no. 149, SANDSTEDE, Clad. Exs. no. 1472, WRIGHT, Lich. Cub. no. 38.

In 1847 TAYLOR described a *Cenomyce hirta* from Peru (HOOKER's herb.). Judging from his description: »—reminds of *Cl. rangiferina*, Ach., — but ultimate branches are not

drooping; — podetiis — caespitosis, fuscocinerascentibus, — ramis — flexuosis, axillis imperforatis, ultimis minutis bi—tripinnatis.», the species is probably identical with *Cl. Sandstedei*. However, until authentic specimens have been examined we have better use the sure name given by DES ABBAYES.

A very good description of *Cl. Sandstedei* is given by DES ABBAYES (1939). He also describes *f. dendroides*, characterized by densely branched, thyrsoid podetia.

The species most closely related to *Cl. Sandstedei* seem to be *Cl. Evansii* and *Cl. signata*. *Cl. pohlia* differs from all these in having trichotomous (or polytomous) ramification and as a rule not perforated angles. *Cl. Sandstedei* generally has a tendency to sympodial ramification and thus there are at the base comparatively distinct main stems. In this character i. a. it differs from *Cl. Evansii* and *Cl. signata*. Also the chemical reactions are different; *Cl. Sandstedei* Pd +, K +; *Cl. signata* Pd +, K —; *Cl. Evansii*, Pd —, K +; *Cl. pseudoevansii*, *Cl. impexa* and *Cl. pohlia* Pd —, K —.

The pycnoconidongia contain a red or reddish jelly. In all other South American species of *Cladinae* the contents are uncoloured.

Cl. Sandstedei is distributed all over tropical and subtropical South America and the West Indies. (See further page 20 and Fig. 1).

I have examined specimens from the following localities.

Colombia. Santander, Mesa de los Santos, alt. 1500 m. 1926, KILLIP & SMITH, no. 15221. (S.) — Santander, Páramo de Romeral, alt. 3800—4100 m. 1927, KILLIP & SMITH, no. 18590. (S.).

Brazil. Sine loco. BLANCHET. (S.) — Minas Geraes, Caldas, Piedra Blanca, in open rocks. 1873, HJ. MOSÉN, no. 2304. (S. U.) — São Paulo, Jacarehy. 1914. P. DUSÉN, no. 15231. Lich. Exs. Herb. REGNELL., no. 226. (S, U etc.) —

Peru. San Martin, Zepelacio, near Moyobamba, alt. about 1100 m, in mountain forest. 1934. G. KLUG, no. 3682. (S. U.) — Roque, 45 km E of Moyobamba, La Campana, on the top, on the earth in campos. 1925, D. MELIN, no. 7, (S. U.).

Bolivia. Dept. La Paz, prov. Yungas, between San Felipe and El Chaco, in low mountain rain forest (»ceja»), alt. about 2500 m. 1920, E. ASPLUND. (S. U.).

The West Indies: Jamaica, at Kingston. 1846—48, A. S. OERSTED. (S. U.) — Below New Haven Cap, alt. 1500—1600 m. 1920, MAXON & KILLIP, no. 923. (S.) — Vicinity of Cinchona, alt. 1500 m. 1920. MAXON & KILLIP, no. 836. (S.) — Cuba. Sine loco. WRIGHT. Lich. Cub., no. 38. (U.) — Prov. Oriente, Sierra Maestra, La Gran Piedra, alt. about

1200 m, on rocks. 1917, E. L. EKMAN, no. 8875 b. (S.) — Porto Rico. Vega Baja, open ground at sea-level, sandy soil. 1916, B. FINK, no. 2142 and 2156. (S.).

7. **Cladonia signata** VAIN.

VAINIO 1887, I, p. 289.
Icon.: SANDSTEDE 1938, pl. I, fig. 5.

A very good description is given by VAINIO l. c.

Cladonia signata holds an intermediate position between *Cladinae* and *Chasmariae*. I could find no thallus primarius and no scales on the thallus of the species examined. Small verrucas at the base of the podetia, looked upon by DES ABBAYES as rudimentary scales are to be found in all the species of *Cladinae*. Thus I have included the species in *Cladinae*. In this species the ramification is very regularly dichotomous; even at the base of the thallus there is no tendency to sympodial ramification. The angles are almost always not perforated and the angles of the branches are rather regularly about 90°. The tufts are rather dense, more or less as in *Cl. confusa*, not so compact as in *Cl. Evansii*. The colour of the podetia is grey or greyish white with almost always a brownish tint. By Pd the podetia get an ochraceous red colour; the K reaction is negative.

The species has been collected only a few times and thus it is not yet very well known.

All known localities are situated in south-eastern Brazil, in the provinces of Rio de Janeiro and Minas Geraes. (See Fig. 3.) VAINIO also cites ESCHWEILER's statement of its occurrence at the Amazon river, a very uncertain statement, however.

I have seen the following specimens of *Cl. signata*.

Brazil. Rio de Janeiro. LEMPRIÈRE. (U.) — Serra do Itatiaya, on the earth and on rocks, alt. about 2200 m. 1901, E. HEMMENDORFF. (S. U.). 1902, P. DUSÉN. (U.) — Minas Geraes, Caldas. A. F. REGNELL. (S.) — Serra de Ouro Preto, on rocks. 1887, H. SCHENCK, no. 4554. (U.)

(**Cladonia Evansii** DES ABB.).

DES ABBAYES 1939 pag. 71.

This species has not yet been found in South America. The known distribution is the southern states of U. S. A. and the West Indies. Thus it will perhaps be found in the neighbouring parts of South America and for that reason it has been included in the synopsis on page 8.

IV. Phytogeographical account.

Although there are big gaps in our knowledge of the distribution of the South American *Cladinae* at least as to the details, I have compiled the known localities on maps in order to give as clear a picture as possible of their distribution. With the exception of *Cl. Sandstedei* only the localities of the collections now examined by me have been marked on the maps. The localities of *Cl. Sandstedei* cited by DES ABBAYES in his monograph have been included in the map of that species. As to the other species I have taken into consideration the probable correctness of published localities and with the lines I have marked the likely limits of distribution of the species. The ecology of the species and the extension of phytogeographic regions were then also considered. From my expedition to Chile I have notes of a great number of localities of the species within the area. These localities, which are at present founded on my field notes only, were, however, not marked on the maps, as I have not the collected material accessible for control examination at present. I have also paid no regard for the moment to my rather numerous vegetation analyses of *Cladina*-heaths and bog vegetation.

Two prominent types of distribution are represented by the species of the South American *Cladinae*. The first one comprises the species growing in tropical and subtropical climate and the second one the species of temperate areas.

The tropical species are: *Cl. confusa*, *Cl. pohlia*, *Cl. Sandstedei* and *Cl. signata*, the temperate ones are: *Cl. laevigata*, *Cl. vicaria* and *Cl. pycnoclada*.

Cladonia Sandstedei (Fig. 1) is distributed all over tropical and subtropical South America. Its southern limit is probably to be found in northernmost Chile and Argentina. The species grows also in the West Indies and will certainly be found in Central America and in southernmost North America. As seen by the map there are no known finds from the north-eastern and south-western parts of Brazil. Certainly this species is rare (or quite absent?) in the dry regions of those areas. Campos and catingas may be no suitable places for the *Cladinae*. During the very intensive lichenological investigations of Matto Grosso in 1892—94 MALME did not collect a single species of *Cladinae*. Quite naturally the species is absent in the very dry regions of northern Chile and in the arid regions of Argentina. As to the habitat ecology of the species we know very little. From the Brazilian and West Indian finds we see that the species stands a very hot

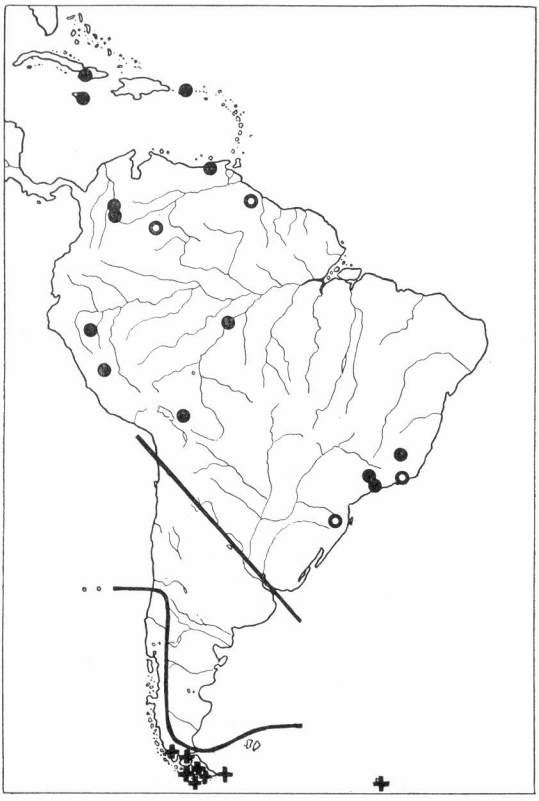

Fig. 1. Total known distribution of *Cladonia Sandstedei* DES ABB. (●; localities not exactly indicated ○) and *Cl. vicaria* R. SANT. (+). The probable southern and northern limits resp. of the species shown by the lines.

climate, but on the other hand we have finds from rather high altitudes in the Andes, in Colombia up to about 4000 m. Wet mountain forests, open earth, sandy soil and rocks are the usually habitat indications on the labels.

Cladonia confusa (Fig. 2). Most of what has been mentioned about the previous species also holds good for *Cl. confusa*. The map may probably be completed by finds in Venezuela, Peru, Bolivia and Uruguay to judge from the finds of »*Cl. impexa*» cited by DES ABBAYES. Outside the map there are finds also from the Galapagos Islands and Mexico. The species is found in tropical lowlands as well as in the Andes at altitudes up to more than 3000 m (in Ecuador). The habitats are glades in forests, among shrubs, on earth, in rocks etc.

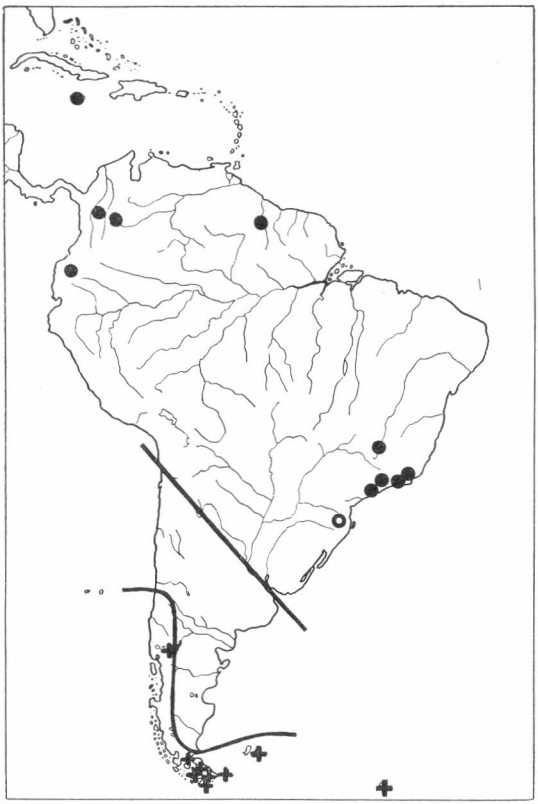

Fig. 2. Total known distribution of *Cladonia confusa* R. SANT. (●; localities not exactly indicated ○) except Mexico and the Galapagos Islands and of *Cl. laevigata* (VAIN.) GYELN. (+) except Tristan da' Cunha. The probable southern and northern limits resp. of the species shown by the lines.

Cladonia pohlia (Fig. 3) is very little known. It seems to be a Caribbean species and will certainly be found to have a much wider distribution than that known at present. The type-locality in the Caribbean coastal cordillera north of Caracas in Venezuela is seen in Plate III, Fig. 2. In the steep slope of the cordillera facing the Caribbean sea the species was rather abundant at the edge of a low rain forest (»selva nublada») on the ground among grasses.

Cladonia signata (Fig. 3) is also very little known. It seems to be a South Brazilian species. All the specimens I have seen are from the states of Rio de Janeiro and Minas Geraes. As to its ecology we know otherwise almost nothing.

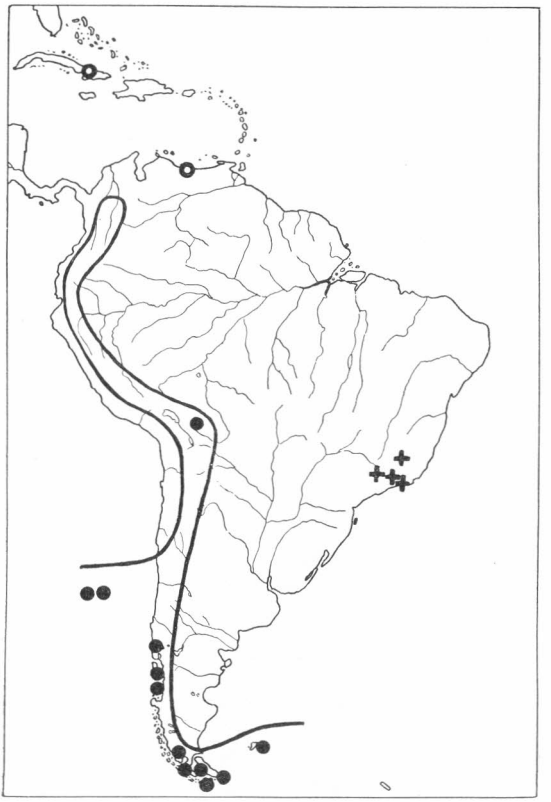

Fig. 3. Total known distribution of *Cladonia pycnoclada* (PERS.) NYL. s. str. (●), *Cl. pohlia* R. SANT. (○) and *Cl. signata* VAIN. (+). The Bolivian locality not exactly indicated. The probable distribution area of *Cl. pycnoclada* shown by the line (cf. p. 24).

Cladonia laevigata (Fig. 2) is common in Tierra del Fuego and South Patagonia and is not rare in West Patagonia, Andean Patagonia and the Valdivian region of Chile. It avoids the dry Patagonian semi-deserts and steppes, and its northern limit seems to be at about lat. 35° in Chile. In the Falkland Islands and in South Georgia it has also been collected, and probably in Tristan da'Cunha too. Southern Pacific South America, including the whole Tierra del Fuego, as delimited in the maps, is the distribution area of a very large number of lichens and also of mosses and vascular plants. The forest region and its nearest neighbourhood forming this area is very well delimited by the dry Patagonian

pampa in the east and in the north by the arid shrubby vegetation of North Chile. Although not forest lichens, *Cl. laevigata* as well as *Cl. vicaria* are restricted to this region. Its habitat ecology is partly very similar to that of *Cl. sylvatica*. In the *Sphagnum* bogs of Tierra del Fuego and Patagonia it has together with *Cl. vicaria* the same importance in the composition of the vegetation as *Cl. sylvatica* and *Cl. rangiferina* in the bogs of northern Europe. The *Empetrum rubrum* - *Cladonia laevigata* - sociation, see Plate II, Fig. 1, quite corresponds to the *Empetrum nigrum* - *Cladonia sylvatica* - soc. of our bogs and we also find quite a similar succession of the plant communities. We find *Cl. laevigata* also in the *Nothofagus* forests, in the luxurious moss carpets of the rain forests (*Nothofagus betuloides*) as well as in the drier deciduous *Nothofagus pumilio* - forests. I have seen dry and light *Nothofagus pumilio* - *Cladina* - heaths, similar to *Pinus sylvestris* - *Cladina* - heaths, in Tierra del Fuego (Ushuaia) and in South Patagonia (Rio Rubens), but they are always only small in extent. In the Valdivian region we find *Cl. laevigata* in moist places at the edge of forests and most commonly in the *Nothofagus pumilio*-forests near the tree limit in the mountains.

Cladonia vicaria (Fig. 1) agrees very well with the preceding species in its distribution and habitat ecology. What has been said about *Cl. laevigata* holds good for *Cl. vicaria* too. A typical *Empetrum rubrum* - *Cladonia vicaria* - sociation of a Fuegian bog is seen in the foreground of Plate II, Fig. 2. In the steppes of Tierra del Fuego *Cl. vicaria* and *Cl. laevigata* are rare on account of the scarceness of suitable habitats.

Cladonia pycnoclada s. str. (Fig. 3) is distributed not only in southern Chile and Argentina but probably also in the entire cordillera of the Andes. The probable distribution area of the species is marked on the map. From the Andean area I have only seen one specimen from Bolivia, but finds from Peru and Colombia are reported by DES ABBAYES. In the Valdivian region of Chile this is the most common species of *Cladinae*. There it lives in very different plant communities, at forest edges, in heaths (Plate III, Fig. 1.) etc. In Tierra del Fuego and Patagonia it grows mostly in relatively dry places and is rather scarce in bog and in other moist localities. We find *Cl. pycnoclada* in open light forested or forestless heaths, on bare earth or in moss mats, in the region of the rain forests and of the decidous forests.

The main part of the distribution area of *Cladonia laevigata* and *Cl. vicaria* were quite covered by the inland ice during the last Quaternary glaciation. In Chile north of

lat. 43° S., however, there was ice-free land, and from there the species extended to the south in the post-glacial period.

No species of *Cladinae* is distributed over the whole of the South American continent, a hardly surprising statement. On account of the very dissimilar nature of the different parts of South America there are very few lichen species of a more or less ubiquitous distribution. The difference between the deserts and the forest regions is of course very great, and there are also very pronounced differences between the temperate forests of the southern Pacific part of South America and the forests of the more northern Andean regions.

All the species of *Cladinae* dealt with above seem to be well confined to the South American flora regions and adjacent. It has been proved that the *Cladinae* are not at all as cosmopolitical as is usually supposed. Wide areas of the world are still so little known as to their lichen flora that a discussion of the affinity of the South American *Cladinae* and *Cladinae* of other flora regions is hardly possible at present. Only very few specimens of *Cladinae* have been collected from the tropical parts of Asia and Africa. I could not prove any affinity of the New Zealand *Cladinae*.

By comparing the species of temperate South America with the *Cladinae* of the same climatic zones of the northern hemisphere we find notable similarities. The taxonomic affinity between *Cl. rangiferina* and *Cl. vicaria* and between *Cl. mitis* and *Cl. laevigata* is very pronounced, the differences being, however, so great that the species cannot be regarded as geographical races only. They are very good examples of vicarious species. It seems quite certain that the species must have the same origin and might once have had a continuous area of distribution. At present the species are separated by the very great distance of the tropical and subtropical zones. *Cladonia mitis* and *Cl. rangiferina* are circumpolar boreal species. The southernmost known localities of *Cl. mitis* are in the Great Smoky Mountains in Tennessee and North Carolina (Degelius 1941), and of *Cl. rangiferina* in South Carolina (des Abbayes 1939). If these species grow in the Rocky Mountains has not yet been established.

The distribution types of these two pairs of species are very similar to that of the genera *Litorella*, *Empetrum* etc. They have a wide boreal distribution combined with a very isolated outlier in southern South America. (Skottsberg 1911, Good 1926, Du Rietz 1940).

The phytogeographical facts about *Cladinae* now disclosed give an additional proof of the fact that the lichens are

by no means very cosmopolitical. *Cladonia rangiferina* has always been taken as a good example of a cosmopolitical lichen. It has, however, now been proved that it is a typically circumpolar boreal species, lacking in South America as well as in Australia and the Oceanic islands (except Hawaii?), Africa and southern Asia. All the monographic revisions of crustaceous, foliose and fruticulose lichens in modern times have proved that the lichens have well delimitated but often wide areas of distribution. MAGNUSSON's monograph of the genus *Acarospora* disclosed that there are no cosmopolitical species among the 200 species of the genus. Of all these no species is common to Europe and South America. The same thing was proved by MOTYKA for the genus *Usnea*, comprising 451 species.

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Tryckt den 11 december 1942.

Uppsala 1942. Almqvist & Wiksells Boktryckeri-A.-B.

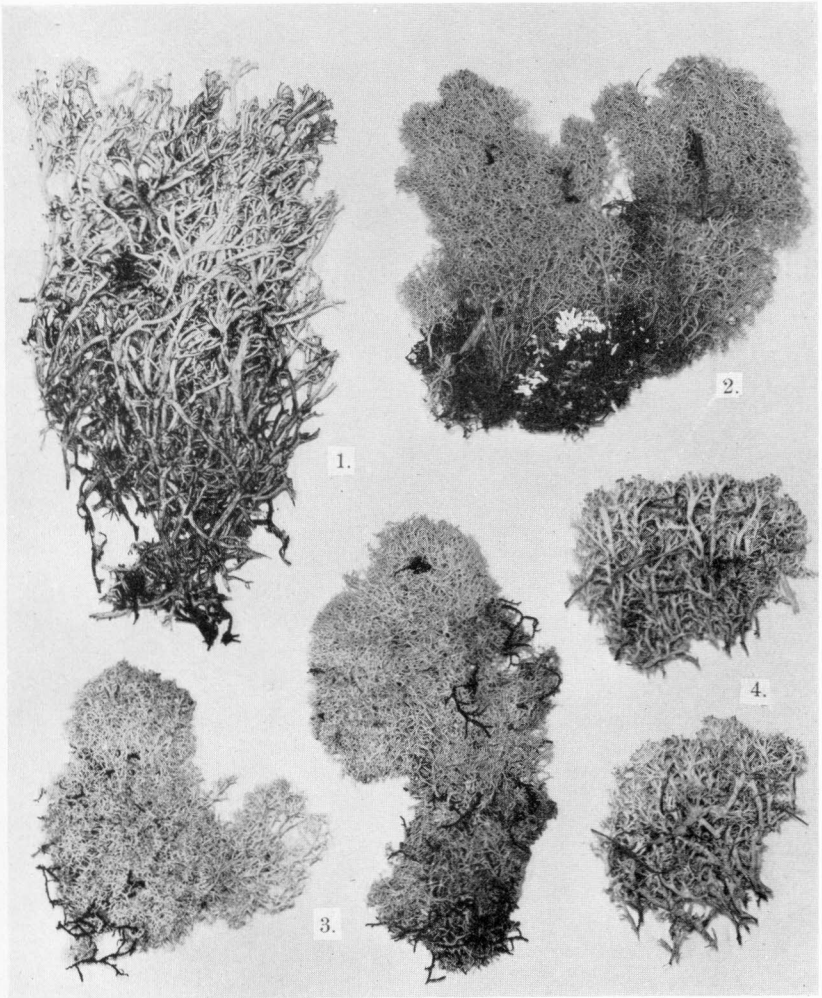

Fig. 1. *Cladonia vicaria* R. SANT. nov. spec. The type-specimen.
» 2. *Cladonia pohlia* R. SANT. nov. spec. The type-specimen.
» 3. *Cladonia confusa* R. SANT. nov. spec. The type-specimen (to the right).
» 4. *Cladonia laevigata* (VAIN.) GYELN. Specimens from Tierra del Fuego, leg. P. DUSÉN. All 0,55 × nat. size.

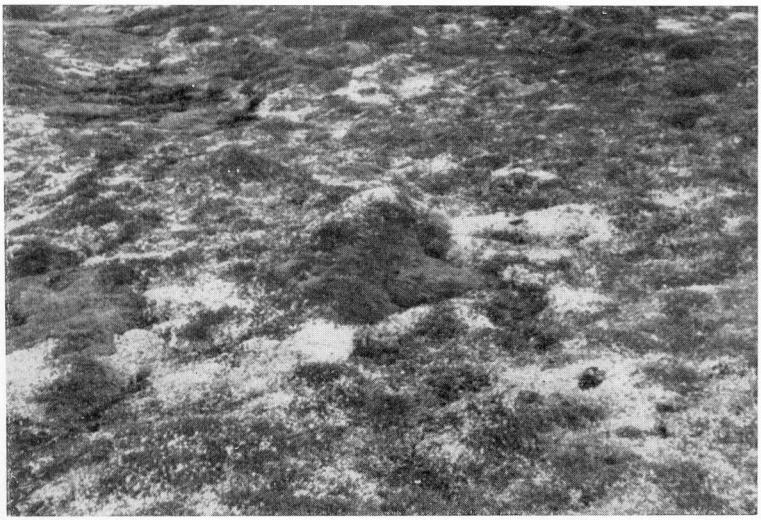

Fig. 1. *Cladonia laevigata* (VAIN.) GYELN. *Empetrum rubrum-Cladonia laevigata*-soc. in a *Sphagnum*-bog. *Cladonia vicaria* R. SANT. is intermixed, but not very abundant. South Patagonia, Rio Rubens between Punta Arenas and Puerto Natales. — Phot. R. SANTESSON, 16. I. 1941.

Fig. 2. *Cladonia vicaria* R. SANT. *Empetrum rubrum-Cladonia vicaria*-soc. in a *Sphagnum*-bog. The big light tuft in the foreground of the figure formed by *Cl. laevigata* (VAIN.) GYELN. In the background several pure *Cl. vicaria* tufts. *Carex magellanica* LAM. rather abundant. Tierra del Fuego, Puerto Yartou on Canal Whiteside. — Phot. R. SANTESSON, 7. II. 1941.

Fig. 1. *Cladonia pycnoclada* (PERS.) NYL. s. str. *Pernettya mucronata-Cladonia pycnoclada*-soc. on volcanic ashes in the delta plain of Rio Choshuenco (Enco). In the background *Nothofagus Dombeyi* forest with *Eucryphia, Guevina* etc. Chile, Valdivia prov., Volcan Choshuenco (Shoshuenco). — Phot. R. SANTESSON, 1. X. 1940.

Fig. 2. *Cladonia pohlia* R. SANT. The type locality at the edge of a low rain forest (»selva nublada»). In the foreground a *Clusia* sp. with epiphytic *Usnea*. Venezuela, the coastal cordillera between Caracas and La Guaira. Phot. R. SANTESSON, 15. VII. 1941.