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The Lichen Genus *Cladia*

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Summary

THE genus *Cladia* is represented in New Zealand by three species, one of which—*Cladia sullivanii*—is regarded by some botanists as of varietal rank only. Its validity as a species is affirmed and a new variety is described, while it is here first recorded from Tasmania. Chemical and morphological distinctions separate the three species. The named subspecific "taxa" in *C. aggregata* are shown to have no valid status.

HISTORY OF THE GENUS *Cladia* NYL.

Under the name *Lichen aggregatus*, Swartz in 1788, described a Jamaican lichen discovered in 1770. Ten years later Acharius transferred this species to *Cenomyce*, now known as *Cladonia*, where with *C. retipora* it constituted the section *Clathrinae*. Nylander in 1870 gave valid reasons for removing section *Clathrinae* from *Cladonia* and erecting it as an autonomous genus which he named *Cladia*. To avoid any confusion between the name *Cladia* and the name *Cladium* (a genus of sedges) Dr J. Müller (Argov.) proposed to substitute the name *Clathrina* for the name *Cladia*, and to the three species listed by Nylander—*Cladia aggregata*, *C. retipora*, and *C. schizopora*—he added *Clathrina sullivanii* and *C. Ferdinandii*. The status of *C. Ferdinandii* remains in doubt as no specimens have been located in Australian herbaria, while *C. schizopora* has since been placed in Section *Chasmaria* of *Cladonia*.

Duvigneaud has made *Clathrina* the genotype of a new family—*Clathrinaceae*—on the grounds that whereas in *Cladoniaceae* the podetia have a carpogenic origin, they have a thalline origin in the new family. Dr I. M. Lamb and Dr C. W. Dodge endorse this view, but retain the original name *Cladia* for the genus. The following brief diagnoses serve to further distinguish the two genera *Cladonia* and *Cladia*.

Cladonia (Hill.) Vain.

Primary thallus squamulose except in sections *Pyenothelia* and *Cladina* where it is crustose. Podetia simple to densely ramose, frequently scyphiferous, corticate with vertical hyphae or ecorticate; squamulose or esquamulose; sorediose or esorediose; rarely isidiiose; axils open or closed; chondroid axis and medulla usually well developed; walls rarely perforate. Apothecia scarlet, brown, pale, or nigrescent; small to large; solitary, aggregate, or clustered.

Cladia Nyl.(In *Bull. Soc. Linn. Normandie* 11, 4, 167 (1870).)

Primary thallus nodular or unknown. Pseudopodetia dichotomously branched, often sympodial; esquamulose, esorediose, ascyphous, and without isidia, glossy or dull; cortex of conglutinate longitudinal hyphae. Chondroid axis absent; medulla thin, arachnoid, poorly developed; walls clathrate to sparingly perforate, sometimes imperforate. Apothecia minute, black, peltate, on tips of terminal branchlets, often aggregate in small cymes, numerous.

KEY TO SPECIES OF *Cladia* NYL.

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|---|----------------------|
| 1. Apices of podetia blunt; perforations very numerous | 2 |
| Sterile podetia ending in 2 (1-3) short spinose branchlets; wall perforations fewer and more irregularly spaced or absent | <i>C. aggregata.</i> |
| 2. Plants snow-white, greyish, or faintly yellowish. Perforations occupying not less than half podetial surface. Interior white | <i>C. retipora.</i> |
| Plants brown and black, or greenish-grey. Perforations fewer and less regular. Interior walls usually black | <i>C. sullivanii</i> |

DESCRIPTION OF *Cladia retipora* (LA BILL.) NYL. (Plate 1)

Primary thallus nodular, white. Pseudopodetia robust or slender, 1.5-5mm diam., 25-80mm tall; colour white, pale greyish, or faintly yellowish; pliant and spongy when moist, brittle when dry; cortex continuous; walls uniformly clathrate from base to apex in 3-8 series, forming an even network. Perforations 5-11 per cm in each series. Medulla thin, white, poorly developed. Plants forming open cushions 10-100cm diam. Apothecia minute, black, peltate, crowded on apical branchlets. Spermatogonia minute on separate plants or podetia; spermatogonial jelly not seen. Plants K±, P—, KC±. Atronorine, rangiformic acid, and usnic acid commonly present.

DISTRIBUTION:—Australia, Tasmania, New Zealand, New Caledonia, Campbell Island, Auckland Island, Chatham Island.

HABITATS:—Sea-level to 1,200m usually on peaty soils amongst tussocks or other low vegetation, in manuka heaths, on fell-fields; more rarely on rocks, logs and sand dunes.

I am indebted to Dr R. T. M. Pescott, Director of the National Herbarium of Victoria, and to Mr K. Mair, Director and Chief Botanist of the Botanic Gardens at Sydney, for the loan or gift of *Cladia* specimens from Australian and Tasmanian sources, including all three species. All specimens of *C. retipora* forwarded appear to belong to the same taxon as those in New Zealand and New Caledonia. Var. *corallizon* F. Wilson is quite synonymous with the type form and should be dropped.

At Lewis Pass in Canterbury, New Zealand, the writer has observed cushions of *Cladia retipora* over a square metre in area, and Dr Pescott informs me that cushions the size of a football occur on the Grampian Mountains in Australia. These massive cushions are apparently restricted to subalpine zones for lowland plants are normally only 5-10cm in diameter. Vainio and Müller (Argov.) describe the colour as brown, but this colour only develops after lengthy storage. Plants collected by the writer in Chatham Island in 1925 were white when secured but are now quite brown, as are many other early collections—but not all. Several specimens have the apical network black to a depth of 1 to 3mm but are otherwise snow-white.

DESCRIPTION OF *Cladia sullivanii* (Müll. Arg.) MART. (Plate 2)

Primary thallus unknown. Pseudopodetia dying at base, 2.5–11cm tall, .5–4mm diam.; subcylindric, angular, or somewhat flattened; colour stramineous and black, brown, or pale greenish grey; corticate, dull, opaque; spongy when moist, rigid when dry; branching dichotomous and sympodial; branches patent or suberect; sterile apices blunt or obtusely cornute; axils closed; podetial walls much perforated; perforations circular, oval, or elongate in several series but fewer and less regular than in *C. retipora*. Medulla thin, usually black and visible through the fenestrations. Apothecia minute, .25–.3mm diam., peltate, dark brown or black, aggregated or singly on ultimate branchlets. Spermatogonia terminal on separate podetia, circ. .03mm diam., ostiole .006–.01mm, K– or faintly K+. Divaricatic acid when present diagnostic; P–.

DISTRIBUTION:—Eastern Australia, Tasmania, and New Zealand south of the Volcanic Plateau in North Island.

HABITATS. Subalpine peat bogs, and lowland peat soils and heaths.

The type form of *C. sullivanii* is wholly subalpine. The type plants were collected on the Grampian Mountains by Mr D. Sullivan and were named for him by Dr J. Müller (Argov.). They differ from *C. retipora* not only in colour but also in habit and fenestration pattern, in the black colour of the central canal, and in the chemical substances present. Tasmanian specimens labelled *C. retipora* var. (L. 601, and L. 602) loaned to me by the Director of the National Herbarium at Sydney prove to be typical *C. sullivanii*, not previously recorded from Tasmania. They were collected in 1901 by Mr A. H. Lucas on Mount Wellington and at Greeneston. Two very distinct varieties occur in New Zealand—*C. sullivanii* var. *sullivanii* the type form, always brown or stramineous and black, robust, and forming spongy cushions in subalpine bogs; and var. *compacta* var. nov., never brown or brown and black, but greenish grey, more slender and more compact, and never spongy.

Cladia sullivanii (Müll. Arg.) Mart. var. *compacta* var. nov.

(Holotype in Herbarium, Botany Dept., D.S.I.R., Lincoln, Canterbury, N.Z.)

Plantae 2.5–6cm altae, 2–10cm diam., confertae. Podetia virescenti-cinerascentia, base aliquando leviter fuscentia; 1–2mm diam., dichotome irregulariter; superne sat dense ramosa. Foramina minutae, vulgo numerosae, aliquando paucae, irregulariter.

Plants rarely over 6cm tall and forming compact cushions. Podetia grey or ashy-green, darkening at base, 1–2mm diam., slender at base, thicker above and more densely branched. Perforations small, numerous or few, irregularly arranged. Medulla black wholly or partially. Vainio and other European botanists believed *C. retipora* to be brown in colour and regarded *C. sullivanii* as possibly conspecific with *C. retipora*.

DISTRIBUTION. Peat bogs and peat soils on the Southland Plains as at Awarua, Makarewa, Pukerau, Kuriwao, etc.—a lowland variety.

In var. *compacta* the plants remain fairly rigid even when moist, whereas in the typical variety they become quite soft and spongy. The black medulla is usually evident in some if not all podetia. The wall perforations may be numerous, or relatively few, or may be absent altogether in some podetia as in *C. aggregata*. In *C. retipora* the fenestration pattern is truly clathrate, but this is scarcely so in *C. sullivanii*, and never so in *C. aggregata*. Some forms of *C. aggregata* closely approach var. *compacta* of *C. sullivanii*, but there is rarely any difficulty in distinguishing them. Spermatogonia and apothecia are commonly present, though the latter are sometimes immature or abortive.

DESCRIPTION OF *Cladia aggregata* (Swartz) Nyl. (Plate 3)

Primary thallus unknown. Pseudopodetia corticate, glossy or dull, ramose, esquamulose, esorediose, and ascyphous; branching dichotomous, often sympodial; patent, erect, or curving; sterile podetia terminated by 1-3 (usually 2) subulate spines; colour light, dark, or reddish brown, stramineous, or palescent; habit open to densely pulvinate; .5-15cm tall, robust, slender, or filiform. Medulla thin, white, rarely farinose. Apothecia small, aggregate, peltate, black, apical. Spermatogonia on separate plants or stems, brownish below, black above, terminating apical branchlets. $K\pm$, $P\pm$. Barbatic acid diagnostic, fumarprotocetraric acid and stictic acid accessory.

DISTRIBUTION. Most countries in southern hemisphere, West Indies, Mexico, India, Japan, Korea, etc.

HABITATS. Dry peat soils, heaths, rock crevices, tree-bases, logs, etc.

POLYMORPHY IN *Cladia aggregata* (Sw.) Nyl.

Cladia aggregata is possibly the most polymorphic lichen in the New Zealand flora. Few, if any, of the described "varieties and forms" show any constancy, and what one author regards as a variety, another deems a form. The following, described as varieties and forms of *Cladonia aggregata* would, if valid, require to be transferred to *Cladia*.

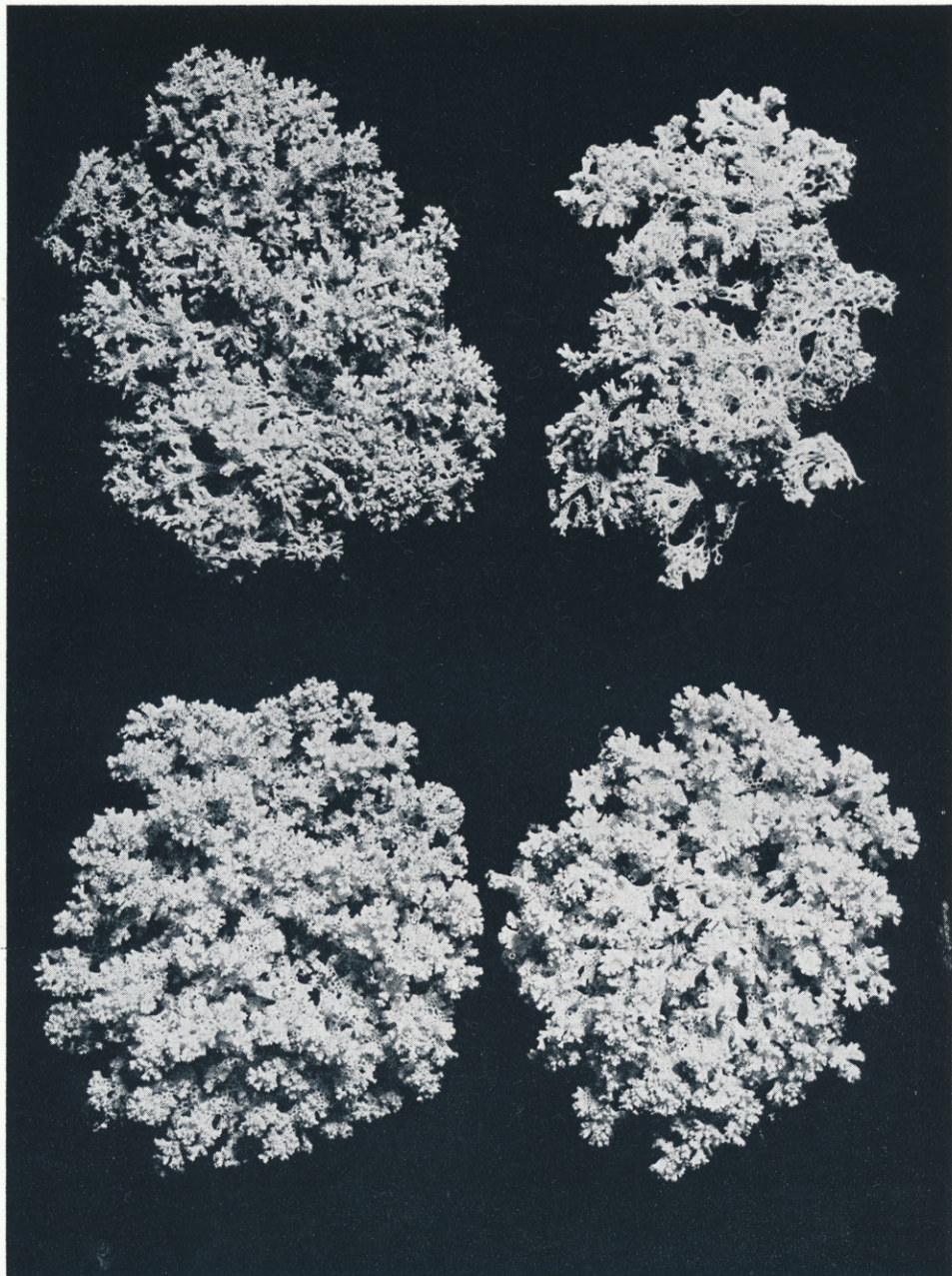
var. *inflata* F. Wilson
var. *pygmaea* Müll. Arg.
var. *trichophora* (Müll. Arg.) Vain.
f. *divergens* Hellb.
f. *fiordense* Mart.
f. *racemosa* Gray.

var. *tenera* F. Wilson
var. *straminea* Müll. Arg.
f. *cetrarioides* Hellb.
f. *subdivergens* Hellb.
f. *imperfurata* Sandst.
f. *tenuior* Nyl.

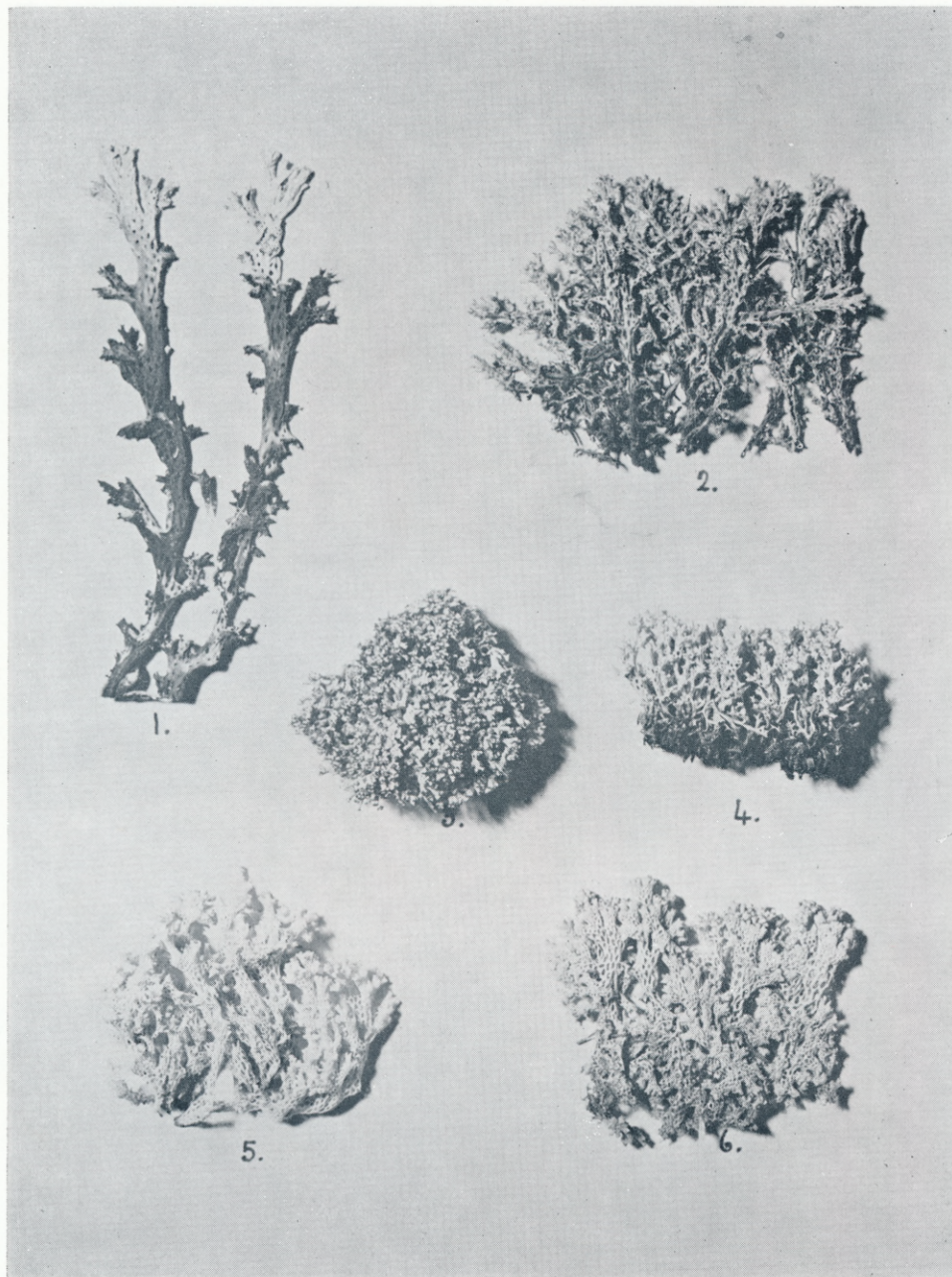
Var. *inflata* and var. *tenera* are Australian "taxa" apparently not quite matched in New Zealand. The only specimens I have seen are several kindly loaned by Dr Pescott and Mr K. Mair, the material being insufficient on which to base an opinion as to their validity as taxa. As most of the types are in Europe, the writer has not seen them, but in some cases he has seen plants named by the author. He has therefore had to rely on published descriptions and on specimens named by Sandstede and others. However, it soon became evident that the "types" could not be typical of any constant groups of variants.

As the names themselves indicate, each "variety or form" is applied to plants possessing one feature in common in addition to the generic characters; but each such group is itself highly polymorphic. Thus var. *trichophora* includes plants having lateral tufts of minute rhizines, but such occur on plants which would otherwise belong to var. *straminea*, f. *imperfurata*, f. *subdivergens*, and possibly other groups. Again f. *imperfurata*, as the name implies, indicates plants devoid, or almost devoid, of perforations in the podetial walls; but such occur in var. *straminea* and are commonest in var. *pygmaea*, which is another very polymorphic group. It seems clear that few if any of the named infraspecific "taxa" forms either a homogeneous or disjunct group.

On the basis of over 200 personal collections from most parts of New Zealand, from 10 years of field studies, and a study of material housed in national herbaria, I would rule out as invalid taxa "forms" *cetrarioides*, *imperfurata*, and *divergens*, and "varieties" *pygmaea*, *straminea*, and *trichophora*. Of the other "taxa" I



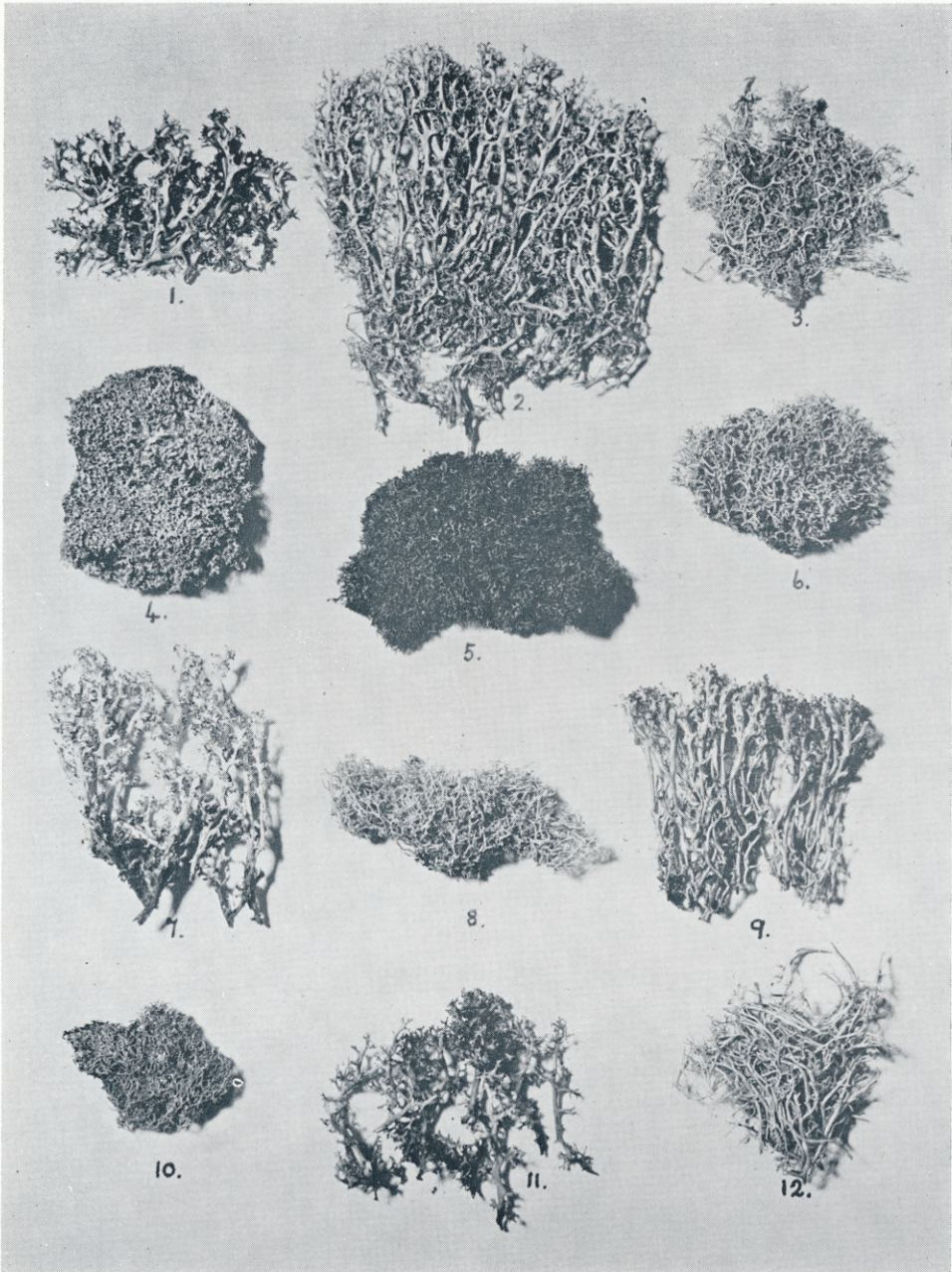
Cladia retipora (La Bill.) Nyl. showing habit of growth.



FIGS. 1 and 2—*Cladia sullivanii* (Müll. Arg.) Martin var. *sullivanii*.

FIGS. 3 and 4—*Cladia sullivanii* var. *compacta* var. nov.

FIGS. 5 and 6—*Cladia retipora* (La Bill.) Nyl.



Cladia aggregata Nyl. Twelve biotypes selected to show the intense polymorphy of this species.

can express no opinion as I have insufficient knowledge of them, but I have failed to isolate any group of variants sufficiently homogeneous to form a disjunct group. In the case of f. *fiordense*, all plants were collected on Secretary Island, and only after much further exploration of the alpine areas of New Zealand will it be possible to establish it as a disjunct form.

The range of forms from Australia indicates that polymorphy is strong in that region also, and follows the same patterns of variation. So many variants occur in New Zealand that one can observe a continuous series of biotypes between tall and dwarf, robust and filiform, dark brown and pale yellowish green, perforate and imperforate, sympodial or equally dichotomous. A majority of forms are K — but K + forms are not rare. Indeed, it is difficult to match any two gatherings in my herbarium, and it remains to be proved that a single valid subspecific taxon exists in this plastic and wide-ranging lichen.

DISCUSSION

If, as Stebbins affirms, "a species must consist of populations that are separated from each other by complete or at least sharp discontinuities in the variation pattern, and these discontinuities must have a genetic basis", then it is clear that *Cladia retipora*, *C. sullivanii*, and *C. aggregata* are each valid species, distinct both chemically and morphologically. Atroronine and usnic acid are known only in *C. retipora*, divaricatic acid only in *C. sullivanii*, barbatic acid and fumarprotocetraric acid only in *C. aggregata*. Didymic acid is sometimes an accessory in *C. sullivanii* and rarely in *C. aggregata*. For these determinations I am indebted to the late Dr A. W. Evans, of Yale University, U.S.A.

Dr Evans suggested to me the possibility that more than one species was included in the *C. aggregata* complex. P + and P —, K + and K — forms occur, but though K + specimens are mainly light in colour, there appears to be little correlation between morphological and chemical characters. Nylander held the view that light-coloured plants resulted from growth in shade and moist conditions, but light and dark coloured forms often grow almost side by side, giving little support to the theory. He regarded the dwarf forms as in the main immature plants, but neither field evidence nor the existence of fertile plants supports this contention. On the other hand fertile specimens of the dwarf forms are quite uncommon. Most rock frequenting forms are dark in colour, so that environmental factors may be a factor in the colour variation, but other factors are clearly involved.

Dr Isao Yoshimura has recently forwarded to me from Japan numerous specimens of *Cladia aggregata*. These all contain barbatic acid only and show a less wide range of variation than in either Australia or New Zealand. Dr Mariko Nuno has shown that *Cladia aggregata* in the southern hemisphere comprises at least four chemical strains—viz., those containing (1) barbatic acid only, (2) fumarprotocetraric acid only, (3) both acids, and (4) stictic or norstictic acid with or without barbatic acid. Paper chromatography suggests the occasional presence of other lichen substances also. Notwithstanding extreme polymorphism in New Zealand and a variety of chemical strains, there does not appear to be any set correlation between morphological and chemical strains. There is an absence of disjunct or geographically isolated groups in New Zealand. The species comprises a host of biotypes, and none of the proposed subspecific taxa seems to have any validity in New Zealand.

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