Rhodora

JOURNAL OF

THE NEW ENGLAND BOTANICAL CLUB

Vol. 52. May, 1950 No. 617

NOTES ON THE CLADONIAE OF CONNECTICUT—IV[1]

ALEXANDER W. EVANS

(Plate 1161)

THE writer's first report on the *Cladoniae* of Connecticut, which was published in 1930, was based on collections made down to the close of 1928. This report was followed by three series of Notes, published in 1932, 1935, and 1938, respectively, and by a Supplementary Report, published in 1944, which brought the record of explorations down to the close of 1943. The present article brings the record down to the close of 1949.

In the Supplementary Report emphasis was laid on the lichen-substances found in the various species and on the demonstration of these substances by means of Asahina's microchemical methods. The data included were based in part on Asahina's publications and in part on independent investigations. Unfortunately several papers on the chemistry of *Cladonia*, published by Asahina during the years 1941, 1942, and 1943, were unknown to the writer at that time but have since become available. These papers deal with numerous species found in Connecticut and were based in part on North American specimens from the herbarium of Yale University. Some of the specimens in fact had been collected in Connecticut. The writer's Supplementary Report thus duplicates the earlier studies of Asahina to a certain extent, and if the observations on the species occurring in Connecticut are compared they will be found to be in essential agreement. The few cases in which there are slight discrepancies will be discussed in the following pages.

[1] CONTRIBUTION FROM THE OSBORN BOTANICAL LABORATORY.

The names of most of the collectors mentioned in the present paper have already been cited by the writer in his earlier publications on the *Cladoniae* of the state. The following collectors, however, who are cited under individual species, have not previously been listed: S. C. Ball, J. H. Barnhart, P. R. Burkholder, H. S. Clark, M. E. Hale, Jr., Miss M. Kincaid, Mr. and Mrs. W. A. Miner, E. W. Sinnott, D. M. Smith, D. Spencer, and Mrs. C. Spencer. Specimens collected by the writer are listed with dates only, and all other specimens are listed with dates and collectors' names. With rare exceptions, which will be especially noted, the specimens listed are preserved in the herbarium of Yale University.

The arrangement in Vainio's Monographia Universalis (1887, 1894) is again followed in the present paper, although certain inconsistencies in this arrangement are now recognized. Full synonymy is given in the case of species or forms listed for the first time from Connecticut or in the case of names that are different from those used in earlier reports.[2] In most cases, however, each name is followed merely by a date and a page-number, referring to one of the writer's articles cited in the bibliography.

Subgenus CLADINA

CLADONIA RANGIFERINA (L.) Web. (1930, p. 375). It has long been known that the lichen-substances in this species are fumarprotocetraric acid and atronorine. The podetia in consequence turn red with P[3] and yellow with K[3], but the color produced by the latter reagent may be obscured, owing to the large amount of fumarprotocetraric acid present. The atronorine, however, can readily be demonstrated by means of the G. A. o-T. solution. The following records are based on specimens which are indefinite as to form: Andover (1944), Bozrah (1945), Coventry (1948), Ellington (*Miner*, 1944), Granby (1949), Manchester (1945), Newtown (1944), Norfolk (1945), Preston (1946), Sprague (1945), Tolland (1944), and Waterbury (1945).

CLADONIA RANGIFERINA f. CRISPATA Coem. (1930, p. 377). Bloomfield (*Neale*, 1945), Cornwall (1945), Goshen (1949), Meriden (*Johnson*, 1945), Norfolk (*Hale*, 1949), Southington (*Bunn*, 1944), and Tolland (1944).

CLADONIA RANGIFERINA f. INCRASSATA Schaer. (1938, p. 7). Meriden (*Johnson*, 1948).

[2] These are designated by asterisks.

[3] The letter K is an abbreviation for an aqueous solution of potassium hydroxide; the letter P, for an alcoholic solution of paraphenylene-diamine.

CLADONIA RANGIFERINA f. PROLIFERA Flot. (1930, p. 377). Southington (*Bunn*, 1944) and Torrington (1944).

CLADONIA RANGIFERINA f. UMBELLATA Anders (1935, p. 35). Southington (*Bunn*, 1945), Torrington (1944), and Winchester (1946).

CLADONIA SYLVATICA (L.) Hoffm. (1930, p. 378). Usnic and fumarprotocetraric acids have long been considered normal components of *C. sylvatica*, and the latter substance is of course responsible for the bitter taste of the podetia and for the more or less definite red color produced by the addition of P. The P+ reaction, moreover, has been used to distinguish *C. sylvatica* from the closely related *C. mitis*, which is normally P−.

In 1941 Asahina published the results of his microchemical studies on *C. sylvatica* and *C. mitis* and reached conclusions some of which are at variance with the views usually held. His material of *C. sylvatica* included 84 numbers of Sandstede's *Cladoniae* Exsiccatae (81 from Europe and 3 from North America) and about a dozen specimens from eastern Asia, mostly from Japan. With the exception of No. 1209, which proved to be referable to *C. mitis*, Asahina reported that almost all ("fast alle") of Sandstede's specimens contained usnic and fumarprotocetraric acids. He reported also that rangiformic acid, a substance found in *C. mitis*, was lacking in *C. sylvatica*.

According to Asahina's account most of the Asiatic specimens agreed with those from Europe and North America in being P+ and in thus conforming to the usual conception of *C. sylvatica*. Three of the specimens from Japan, however, proved to be P− and he distinguished these as f. *inactiva*. He referred these specimens to *C. sylvatica*, rather than to *C. mitis*, on account of their dense branching and short internodes. He thus laid greater emphasis on morphological features than on chemical features in separating *C. sylvatica* from *C. mitis*. The results of Asahina's studies on the latter species will be discussed below.

In March, 1944, Braeden and his colleagues also published an account of the chemical substances found in *C. sylvatica*, based on an analysis of material collected in Ireland. They reported the presence of usnic acid in considerable amount and the probable presence of fumarprotocetraric acid in small amount. In addition to these they extracted a snow white crystalline substance, which they identified as ursolic acid. This substance was originally obtained from the leaves of *Arctostaphylos Uva*

Ursi but has since been found in a number of other phanerogams.

Independent observations on the chemical features of *C. sylvatica* were published by the writer in August, 1944, in ignorance of the earlier papers by Asahina and Braeden. In addition to usnic and fumarprotocetraric acids a colorless substance was reported. This substance in the G. E. solution deposits minute crystals in the form of needles or rods, usually arranged in dense circular clusters in which the elements radiate out from the center. Since these crystals could not be referred to any lichen-substance known to the writer they were provisionally designated by the letter E. Such crystals can readily be demonstrated in most specimens of *C. sylvatica*, although an occasional example fails to show them.

The question naturally arises whether crystals of the type E are referable to ursolic acid or represent a fourth constituent of the species. Through the cooperation of Dr. D. M. Bonner a sample of ursolic acid from the Eastern Regional Research Laboratory at Philadelphia has been available for study. This sample, which had been extracted from apple skins, consists of fairly large colorless crystals in the form of thin narrow plates with truncate ends. They appear at first sight different from crystals of the type "E". Dr. Asahina, however, to whom the matter was referred, suggested in a letter dated September 21, 1949, that crystals of ursolic acid be finely pulverized and then dissolved in acetone and treated with the G. E. solution in the usual way. By this method he obtained crystals in the form of "fine prisms or needles radiated or irregularly scattered" but was unable to obtain similar crystals from Japanese specimens of *C. sylvatica*.

The writer has followed Dr. Asahina's suggestions with pure ursolic acid and also with a mixture of ursolic acid and fragments of *C. submitis*, a species which lacks the substance E. In both cases crystals similar to those described by him made their appearance, and these crystals are essentially like the crystals of type E obtained from European and North American specimens of *C. sylvatica*. It seems justifiable, therefore, to consider the substance E and ursolic acid identical and to interpret this acid as a frequent accessory component of *C. sylvatica*.

The following records are based on specimens indefinite as to form: Bozrah (1945), Colebrook (1945), Cornwall (1944), Danbury (*Barnhart*, 1890, N. Y.), Ellington (1944), Hamden (1946), Lisbon (1947), Montville (1947), Newtown (1944), Norfolk (*Evans*, 1945; *Hale*, 1949), North Stonington (1946), Prospect (1949), Sharon (*Green*, 1884, Eckfeldt Herbarium, earliest record for town), Southbury (1949), Torrington (1944), Washington (1949), Wethersfield (1944), Woodbury (*Sinnott*, 1944), and Woodstock (*Kincaid & Neale*, 1947).

CLADONIA SYLVATICA f. PROLIFERA Sandst. (1930, p. 381). Norfolk (1945) and Salisbury (1948).

CLADONIA SYLVATICA f. PYGMAEA Sandst. (1930, p. 381). Colchester (1947), Colebrook (*Hale*, 1947), Lisbon (1947), Meriden (*Johnson*, 1945), Norfolk (1945), Preston (1946), Southington (*Bunn*, 1943), and Tolland (1944).

CLADONIA SYLVATICA f. SPHAGNOIDES (Floerke) Oliv. (1930, p. 380). Avon (1949) and Bozrah (1945).

*CLADONIA SYLVATICA f. SUBSPUMOSA Sandst. Clad. Exsic. 1061. 1923 (as modification); Bericht. Uebersicht 34. 1930 (as form). Southington (*Bunn*, 1945).

In this unusual form the branches are densely crowded in the apical portion of the podetia, and the ultimate branchlets are straight or nearly so, in many cases forming star-like whorls around open axils.

*CLADONIA MITIS Sandst. (1930, p. 381; 1944, p. 533).

The morphological differences between *C. mitis* and *C. sylvatica* are brought out by Sandstede in his original description of *C. mitis*, as well as in his later descriptions. The podetia in typical examples, according to his account, form rather loose branch-systems, the ultimate branchlets of which tend to diverge in various directions. In *C. sylvatica*, on the other hand, the podetia form denser branch-systems, the ultimate branchlets of which tend to curve in one direction. These differences are clearly shown in Sandstede's plates in Rabenhorst's Kryptogamen-Flora (1931, *pl. 3, f. 1, 2, 3, and 6* for *C. mitis*, and *pl. 2, f. 3 and 4* for *C. sylvatica*). He mentions also a slight difference in color, assigning a paler shade to *C. mitis* than to *C. sylvatica*. The morphological differences, although distinct in typical examples, are based on variable characters, and specimens are frequently met with which are difficult to determine on the basis of morphological features alone. In his delimitation of *C. mitis* Sandstede lays especial emphasis on the absence of a bitter taste in sepa-

rating the species from *C. sylvatica*, in which a bitter taste is more or less apparent. This difference in taste points to the absence of the bitter fumarprotocetraric acid in *C. mitis* and to the presence of this acid in *C. sylvatica*. In consequence of this difference *C. mitis* is normally P− and *C. sylvatica* P+. Sandstede, in fact, ascribes a greater importance to this chemical difference than to morphological differences in distinguishing between these two species. In 1938 he reported that Asahina had extracted both usnic and rangiformic acids from *C. mitis* (p. 91) but that the latter substance could not be demonstrated by microchemical methods.

In the same year Lamb (p. 160), in reporting *C. mitis* for the first time from the British Isles, showed that some of his specimens were not P− throughout, but that their ultimate branches turned yellow and then red upon the application of P. He added that the color was "never intense as in *C. sylvatica*" and concluded that the amount of [fumarprotocetraric] acid present was insufficient to give the podetia a bitter taste.

Des Abbayes in 1939 used the P− reaction in his key (p. 68) to distinguish *C. mitis* from the P+ *C. sylvatica* but modified this distinction by stating that P might produce slowly and in rare instances a yellow or pale red coloration. In his opinion (p. 124) *C. mitis* is not a mere chemical variation of *C. sylvatica* but represents a valid species. Although he regards the absence of fumarprotocetraric acid as the most important character separating *C. mitis* from *C. sylvatica* he maintains that in many cases the two species can be distinguished by morphological differences alone, such as those brought out by Sandstede.

In Asahina's account of *C. mitis* (1941, p. 623) he again shows that rangiformic acid represents a component of the species but this time describes characteristic crystals formed in the G. E. solution. His observations are based on 92 numbers of Sandstede's *Cladoniae* exsiccatae and on 12 specimens from Vermont and Connecticut. Sandstede's specimens include 81 from Europe and 11 from New England. Asahina here, as in the case of *C. sylvatica*, lays greater emphasis on morphological than on chemical features and includes under *C. mitis* 31 numbers of Sandstede's *Cladoniae* to which he assigns a P+ reaction. He demonstrated the presence of rangiformic acid in 14 of these but

was unable to do so in the others. As a result of his studies he reached the conclusion that a difference in reaction with P can no longer be trusted in separating *C. mitis* from *C. sylvatica.*

In 1943 the writer published the results of his independent microchemical studies on *C. mitis,* based on 83 numbers of Sandstede's *Cladoniae* exsiccatae and on numerous other specimens from Europe and North America. Sandstede's material included most of the numbers studied by Asahina. In nearly half of these various specimens usnic acid was the only substance demonstrated. The others yielded in addition crystals of four unknown substances, designated by the letters A, B, C, and D. These substances occurred singly or in various combinations. Specimens containing the substance C were shown to differ morphologically from the others and were transferred to *C. submitis,* a species proposed as new. Crystals of the D-type were obtained also from specimens of *C. rangiformis* Hoffm. but were not referred to rangiformic acid because Asahina's 1941 report was at that time unknown to the writer. On the basis of this report it is now possible to identify the substance D with rangiformic acid, since the crystals of the D-type (see Evans, 1943, *f. 5*) are essentially like those of rangiformic acid (see Asahina, 1941, *f. 7*). The identity of substances A and B is still obscure. Since these crystals are pale yellow and since they always occur in species containing the yellow usnic acid, it is possible that they may represent aberrant crystals of this acid. Further investigation may decide their identity more definitely.

If the results obtained by the writer are compared with those reported by Asahina they are found to agree in a general way but to differ in certain particulars. Leaving out of consideration the substances A and B, which Asahina did not associate with *C. mitis,* the most marked discrepancy is in relation to rangiformic acid. The writer demonstrated this substance in about 12 per cent of the specimens examined, whereas Asahina reported it in about two-thirds. This discrepancy may be due in part to the fact that he did not, at that time, distinguish between the crystals of rangiformic acid and those of the substance C. A series of 7 specimens from Connecticut, for example, in which he reported rangiformic acid, contain the substance C instead and are among the specimens transferred by the writer to *C. submitis.* The

discrepancy may also be due in part to the fact that the material distributed by Sandstede under certain numbers is not altogether uniform. In Nos. 56, 57, 60, 69, and 118, for example, Asahina reported the presence of rangiformic acid, and yet the writer was unable to detect this substance after repeated tests, indicating that these numbers at least may contain admixtures.

There is evidence of a lack of uniformity also in some of the numbers to which Asahina assigned a P+ reaction. No. 323 belongs in this category. In the set of the *Cladoniae* exsiccatae belonging to Yale University this number is P− and contains no rangiformic acid, although this substance is present in Asahina's set. Nos. 60 and 69, moreover, contain both P− and P+ material, and in the latter ursolic acid can be demonstrated without difficulty. The writer would transfer this P+ material to *C. sylvatica*. The material distributed under these two numbers, therefore, includes both *C. mitis* and *C. sylvatica*.

In the experience of the writer the P+ reaction found in occasional specimens of *C. mitis* is faint and restricted to the apical portions of the podetia. In *C. sylvatica*, on the contrary, the reaction is more extensive and much more pronounced. It still seems justifiable therefore to regard a P− reaction or a faint P+ reaction a characteristic feature of *C. mitis* and a definite P+ reaction a characteristic feature of *C. sylvatica*. Usnic acid could then be considered the characteristic constituent of *C. mitis*, with rangiformic and fumarprotocetraric acids as accessory components; and, in the case of *C. sylvatica*, usnic and fumarprotocetraria acid would represent the characteristic constituents, with ursolic acid as an accessory component.

No definite stations for *C. mitis* from Connecticut were known at the close of 1943 (see Evans, 1944, p. 533), although specimens of other species had been recorded under this name at earlier dates. It is now possible, however, to accredit the species to the state. The form represented is the following:—

*CLADONIA MITIS f. TENUIS Sandst. Abhandl. Naturw. Ver. Bremen **25:** 110. 1922. On earth in a pasture, Norfolk (1945). Sandstede interprets f. *tenuis* as a small race of the species.

CLADONIA SUBMITIS Evans (1944, p. 533). The podetia of *C. submitis* are definitely P−, and the characteristic lichen-substances present are usnic acid and the substance C.[4] The

[4] This substance is being investigated by Asahina, but the results of his work have not yet been published.

following records are based on specimens that are indefinite as to form: Andover (1944), Chaplin (1948), Chester (1945), Colebrook (*Hale*, 1948), Coventry (1948), East Lyme (1944), East Windsor (1945), Essex (1945), Groton (*Mrs. Upson*, 1944), Hamden (1946), Killingly (1945), Lebanon (1947), Lisbon (1947), Monroe (1946), Norfolk (1945), Plainfield (1948), Plymouth (1949), Preston (1946), Salem (1947), South Windsor (1945), Sprague (1945), Thompson (1945), Tolland (1944), Trumbull (1945), Washington (1946), Waterbury (1945), and Woodbury (*Sinnott*, 1944).

CLADONIA SUBMITIS f. DIVARICATA Evans (1944, p. 534). Cheshire (1948), East Lyme (1944), Essex (1945), Lisbon (1947), New Canaan (1947), Salem (1947), Southington (*Bunn*, 1945), and Tolland (1944).

CLADONIA SUBMITIS f. PROLIFERA Evans (1944, p. 534). Andover (1944, Chester (1945), East Lyme (1944), Hamden (1946), Meriden (*Johnson*, 1944), Monroe (1946), Salem (1947), and Thompson (1945).

CLADONIA SUBTENUIS (Des Abbayes) Evans (1944, p. 536). The podetia of this species are strongly P+; they contain usnic and fumarprotocetraric acids as characteristic lichen-substances, with ursolic acid as an accessory constituent. The species thus agrees chemically with *C. sylvatica*. Bethel (1947), Bozrah (1945), Bristol (1944), Colebrook (1945), Cornwall (*Johnson*, 1946), Danbury (1949), East Lyme (1944), East Windsor (1945), Ellington (1944), Killingly (1945), Lisbon (1947), Montville (1947), Morris (1946), New Fairfield (1947), Newington (1944), Norfolk (*Evans*, 1945; *Hale*, 1949), North Haven (1945), Plainville (1945), Preston (1946), Sprague (1945), Tolland (1944), West Hartford (1944, Winchester (1946), and Windsor Locks (1947).

CLADONIA SUBTENUIS f. PROLIFERA Evans (1944, p. 539). Bethany (1945).

CLADONIA SUBTENUIS f. SETIGERA (Des Abbayes) Evans (1944, p. 539). Bozrah (1945) and Brookfield (1944).

CLADONIA ALPESTRIS (L.) Rabenh. (1930, p. 387). Except in the rare f. *aberrans* Des Abbayes, which has not been found in Connecticut, *C. alpestris* is definitely P− and contains usnic acid as its characteristic lichen-substance. Perlatolic acid, psoromic acid, and the substances A, B, and C represent accessory constituents (see Evans, 1944, p. 540). Colebrook (*Hale*, 1947). This is the third station in the state for this rare and striking species. According to its collector it occurs in considerable abundance in an old pasture.

Subgenus PYCNOTHELIA

CLADONIA PAPILLARIA (Ehrh.) Hoffm. (1930, p. 389). Atronorine has long been recognized as a characteristic constituent of

C. papillaria, and this was the only lichen-substance reported by the writer in 1944 (p. 541). Asahina, however, had already demonstrated the presence of a second constituent, protolichesteric acid, in the species (1942, p. 490).

CLADONIA PAPILLARIA f. MOLARIFORMIS (Hoffm.) Schaer. (1930, p. 390). Bethany (1944), Bozrah (1945), Brookfield (1944), East Granby (1949), Groton (*Mrs. Upson*, 1944), Killingly (1945), Lisbon (1947), Plainfield (1948), Redding (1949), Somers (1947), Thompson (1945), and Westbrook (1945).

CLADONIA PAPILLARIS f. PAPILLOSA Fr. (1930, p. 391). Bethany (1944), East Granby (1949), Ellington (1944), Groton (*Mrs. Upson*, 1944), Killingly (1945), Norwalk (1946), Plainfield (1948), Roxbury (1949), and Thomspon (1945).

CLADONIA PAPILLARIA f. PROLIFERA (Wallr.) Schaer. (1932, p. 124). Granby (1949).

CLADONIA PAPILLARIA f. STIPATA Floerke (1930, p. 391). Granby (1949), Meriden (*Burkholder*, 1944), and Southington (*Bunn*, 1945).

Subgenus CENOMYCE

Section COCCIFERAE

The lichen-substances found in the Connecticut representatives of the red-fruited *Cladoniae* have been tabulated by the writer (1944, p. 559) and will not be further discussed in the present report.

Subsection SUBGLAUCESCENTES

CLADONIA FLOERKEANA (Fr.) Floerke (1930, p. 392). Although the following varieties are little more than forms they are given varietal rank by recent authors:—

CLADONIA FLOERKEANA var. INTERMEDIA Hepp (1930, p. 393). Brookfield (1944), Ellington (1944), Enfield (1945), Glastonbury (1944), Granby (1949), Greenwich (1931), Groton (1949), and Vernon (1946).

CLADONIA FLOERKEANA var. CARCATA (Ach.) Vainio (1930, p. 394). Monroe (1946).

CLADONIA FLOERKEANA var. CARCATA f. SQUAMOSISSIMA (Th. Fr.) Vainio (1930, p. 394). Southington (*Bunn*, 1944).

CLADONIA BACILLARIS (Ach.) Nyl. (1930, p. 395). Andover (1948), Avon (1949), Bethel (1947), Bolton (1944), Bridgewater (1945), Brookfield (1944), Bozrah (1945), Canaan (1945), Colebrook (*Hale*, 1947), Coventry (1948), East Haven (1944), East Lyme (1944), Ellington (1944), Fairfield (1931, listed, 1932, p. 161, as *C. borbonica* f. *cylindrica*, not new to town), Granby (1949) Greenwich (1926, listed, 1930, p. 482, as *C. borbonica* f. *cylindrica*, not new to town), Groton (1949), Hampton (1948), Lebanon

(1947), Lisbon (1947), Meriden (1933, listed, 1935, p. 56, as *C. borbonica* f. *cylindrica*, earliest record for town), Montville (1947), Morris (1946), Norfolk (*Evans*, 1945; *Hale*, 1949), Norwalk (1946), Putnam (1945), Redding (1949), Ridgefield (1947), Somers (1949), Sprague (1945), Stonington (1949), Thomaston (*Johnson & Neale*, 1945), Thompson (*Neale*, 1947), Tolland (1944), Vernon (1949), Voluntown (1946), Warren (1947), Washington (1946), Waterbury (1949), Watertown (1949), Wethersfield (1944), Willington (*Neale*, 1948), and Wilton (1931, listed, 1932, p. 161, as *C. borbonica* f. *cylindrica*, not new to town). The specimens upon which these records are based are indefinite as to form.

CLADONIA BACILLARIS f. CLAVATA (Ach.) Vainio (1930, p. 397). Ellington (1944), Meriden (*Johnson*, 1944), Tolland (1944), Torrington (1946), and Woodbridge (1944).

CLADONIA BACILLARIS f. PERITHETA (Wallr.) Arn. (1930, p. 397). Bethlehem (1949), Colebrook (*Hale*, 1947), Granby (1949), Madison (*Johnson*, 1946), Monroe (1946), Scotland (*Johnson*, 1946), and Southington (*Bunn*, 1947).

CLADONIA BACILLARIS f. TENUISTIPITATA Sandst. (1935, p. 39). Bethel (1949), Canaan (1945), and Cornwall (1944).

CLADONIA MACILENTA Hoffm. f. STYRACELLA (Ach.) Vainio (1930, p. 399). Bethany (*Johnson*, 1945), Bethel (1949), Bolton (1944), Brookfield (1944), Coventry (1948), Danbury (1949), East Haddam (*Johnson*, 1946), East Lyme (1944), Ellington (1944), Groton (1949), Guilford (1945), Mansfield (1945), Marlboro (1945), Milford (1944), Montville (1946), Morris (1946), Newington (*Miner*, 1944), Pomfret (*Neale*, 1947), Saybrook (1945), Somers (1949), Southington (*Bunn*, 1944), Voluntown (1946), Washington (1949), Waterbury (1945), and Watertown (1949).

*CLADONIA MACILENTA f. OSTREATA (Nyl.) Sandst. in Rabenhorst, Kryptogamen-Fl. **9:** Abt. 4^2: 116. 1931. *C. macilenta* var. *ostreata* Nyl. Enum. Gén. Lich. 97. 1857. On an old stump, Groton (*Spencer*, 1949).

The small primary squamules of this distinct form are persistent and grow in loose mats. They are either simple or sparingly incised, and their margins are densely sorediose. At first sight these squamules resemble the form of *C. incrassata* which grows in similar localities. Their positive reactions with K and P, however, will at once distinguish them and indicate their affinity with *C. macilenta*.

*CLADONIA DIDYMA (Fée) Vainio f. PYGMAEA Vainio, Acta Soc. F. et Fl. Fennica **4:** 143. 1887 (as *C. didyma* **γ. *pygmaea*); in Sandstede, Clad. Exsic. *1186*. 1922 (as form). *C. didyma* m.

subulata Sandst. Clad. Exsic. *1685*. 1927; in Evans, Rhodora **34:** 127. 1932 (as form). Groton (1949).

In the opinion of the writer f. *subulata*, which has previously been reported from Connecticut (1932, p. 127), should be regarded as a synonym of the earlier f. *pygmaea*.

Subsection Stramineo-flavidae

Cladonia pleurota (Floerke) Schaer. (1930, p. 400). Bozrah (1945), Bridgeport (1945), Bristol (1944), Brookfield (1944), Canaan (1945). Canterbury (1948), Colebrook (*Evans*, 1945; *Hale*, 1947), East Lyme (1944), Ellington (1944), Groton (*Mrs. Upson*, 1944), Hampton (1948), Killingly (1945), Mansfield (1945), Norwalk (1946), Plainville (1945), Redding (1947) Ridgefield (1947), Sprague (1945), Stafford (1944, Thompson (1945), Tolland (*Miner*, 1944), Waterbury (1945), and West Haven (1945).

Both usnic acid and zeorine have been demonstrated in all the specimens of *C. pleurota* listed in the present report.

Cladonia pleurota f. decorata Vainio (1930, p. 402). Brookfield (1944), Cheshire (*Mrs. Upson*, 1945), Columbia (1948), Coventry (1948), East Lyme (1944), Lebanon (1947), Meriden (*Johnson*, 1945), Morris (1946), Southington (*Bunn*, 1944), and Warren (1947).

Cladonia pleurota f. extensa (Ach.) Sandst. (1944, p. 555). Cheshire (*Mrs. Upson*, 1945), Hampton (1948), Sharon (*Green*, 1884, Eckfeldt Herbarium, earliest record for town of *C. pleurota*), and Southbury (1949).

*Cladonia pleurota f. frondescens (Nyl.) Sandst., in Rabenhorst, Kryptogamen-Fl. **9**, Abt. 4^2: 146. 1931. Southington (*Bunn*, 1949). This form has been reported (1930, p. 403) from other stations in Connecticut under the name *C. pleurota* var. *frondescens* (Nyl.) Oliv.

Cladonia deformis (L.) Hoffm. (1944, p. 555). Norfolk (*Hale*, 1949), the second station in Connecticut for this rare and distinctly northern species.

Cladonia cristatella Tuck. f. abbreviata Merrill (1930, p. 409). Colebrook (*Hale*, 1948).

Cladonia cristatella f. aurantiaca Robbins (1935, p. 41). Meriden (*Johnson*, 1944) and Southington (*Bunn*, 1944).

Cladonia cristatella f. Beauvoisii (Del.) Vainio (1930, p. 405). Andover (1944), Beacon Falls (*Johnson*, 1945), Coventry (1948), Norfolk (*Evans*, 1948; *Hale*, 1949), Norwalk (1946), Sprague (1945), Tolland (1944), Washington (1946), and West Hartford (1949). In all of these specimens except the last f. *vestita* is present also.

CLADONIA CRISTATELLA f. DEGENERATA Robbins (1930, p. 408). Beacon Falls (*Johnson*, 1945), Southington (*Bunn*, 1944), and Stratford (1945).

CLADONIA CRISTATELLA f. OCHROCARPIA Tuck. (1930, p. 409). Southington (*Bunn*, 1944).

CLADONIA CRISTATELLA f. PLEUROCARPA Robbins (1930, p. 408). Scotland (*Johnson*, 1946).

CLADONIA CRISTATELLA f. RAMOSA Tuck. (1930, p. 406). Meriden (*Johnson*, 1944) and Southington (*Bunn*, 1944).

CLADONIA CRISTATELLA f. SCYPHULIFERA Sandst. (1935, p. 41). Canaan (1945), Cheshire (*Mrs. Upson*, 1944), Granby (1949), Meriden (*Johnson*, 1944), Suffield (1949), and Trumbull (1945).

CLADONIA CRISTATELLA f. SQUAMOSISSIMA Robbins (1930, p. 408). Cheshire (*Mrs. Upson*, 1944), Ellington (1944), Norfolk (1948), and Southington (*Bunn*, 1944).

CLADONIA CRISTATELLA f. SQUAMULOSA Robbins (1930, p. 410). Meriden (*Johnson*, 1944) and Southington (*Bunn*, 1944).

CLADONIA CRISTATELLA f. VESTITA Tuck. (1930, p. 407). Avon (1949), Bridgeport (1945), Chaplin (*Neale*, 1946), Ellington (1944), Farmington (1944), Groton (*Mrs. Upson*, 1944), Killingly (1945), Newton (1944), Putnam (1945), Redding (1949), and Trumbull (1945).

CLADONIA INCRASSATA Floerke (1932, p. 129). Brookfield (1944), Danbury (1949), Enfield (1945), Granby (1949), Lebanon (1947), Middlebury (1948), Norfolk (*Ball*, 1945), Oxford (1945), Seymour (1948), Somers (1949), Tolland (1944), Voluntown (1946), and Waterbury (1945).

CLADONIA INCRASSATA f. SQUAMULOSA (Robbins) Evans (1932, p. 129). Southington (*Bunn*, 1944) and Voluntown (1946).

Section OCHROPHAEAE

Subsection UNCIALES

The lichen-acids found in various species of *Unciales* were listed by Asahina in 1942 (pp. 293–502). The species studied included *C. Boryi*, *C. caroliniana*, and *C. uncialis*, the three representatives of the subsection found in Connecticut. Asahina reported the presence of usnic acid in all of these species but found no other lichen-substance in either *C. Boryi* or *C. caroliniana*. In most European specimens of *C. uncialis*, however, he found that squamatic acid was present in addition. The specimens tested were those distributed by Sandstede in his *Cladoniae* Exsiccatae and a few of these, mostly from northern Europe, were found to contain usnic acid only.

Two years later the writer (1944, p. 562) confirmed Asahina's statements independently. He demonstrated usnic acid in the three species under consideration and showed that all the specimens of *C. uncialis* from Connecticut contained squamatic acid also, although some of the specimens from farther north in America lacked this substance. He found further that substances A and B (see Evans, 1943, pp. 421, 422) might be present in *C. caroliniana* and substance A in *C. uncialis*.

CLADONIA UNCIALIS (L.) Web. (1930, p. 413). The following records are based on specimens that are indefinite as to form: Bozrah (1945), Chester (1945), East Haven (1944), East Lyme (1944), Harwinton (1946), Hebron (1944), Lebanon (1947), Litchfield (*Smith*, 1947), Manchester (1945), New Canaan (1947), Norfolk (*Evans*, 1945; *Hale*, 1949), North Branford (*Burkholder*, 1944), Preston (1946), Roxbury (1949), Sprague (1945), Tolland (1944), Torrington (1946), Union (1947), Warren (1947), Washington (1949), Waterbury (1945), Waterford (1949), Watertown (1949), Winchester (1946), and Woodbridge (1944).

CLADONIA UNCIALIS f. OBTUSATA (Ach.) Nyl. (1930, p. 415). Southington (*Johnson*, 1945; *Bunn*, 1947).

CLADONIA UNCIALIS f. SETIGERA Anders (1932, p. 134). Thomaston (*Johnson & Neale*, 1945).

CLADONIA UNCIALIS f. SORALIGERA Robbins (1935, p. 42). Manchester (1945) and Preston (1946).

CLADONIA UNCIALIS f. SPINOSA Oliv. (1930, p. 417). Cheshire (*Mrs. Upson*, 1944), Cornwall (1944), Southington (*Bunn*, 1945), and Woodbridge (1944).

CLADONIA UNCIALIS f. SUBOBTUSATA Coem. (1932, p. 133). Manchester (1945) and Southington (*Bunn*, 1947).

CLADONIA CAROLINIANA (Schwein.) Tuck. f. DILATATA Evans (1932, p. 138). Avon (1949), Bozrah (1945), Cheshire (*Mrs. Upson*, 1944), East Lyme (1944), Glastonbury (1945), Meriden (*Burkholder*, 1944), Preston (1946), Sprague (1945), Warren (1947), and Watertown (1949).

CLADONIA CAROLINIANA f. FIBRILLOSA Evans (1932, p. 139). Cheshire (*Mrs. Upson*, 1944) and Southington (*Bunn*, 1944).

CLADONIA CAROLINIANA f. PROLIFERA Evans (1932, p. 139). East Lyme (1944), Hamden (*Johnson*, 1945), Meriden (*Johnson*, 1945), Monroe (1946), New Canaan (1947), Preston (1946), Sprague (1945), anf Woodbridge (1944).

CLADONIA CAROLINIANA f. TENUIRAMEA Evans (1932, p. 139). Avon (1949), Bozrah (1945), Danbury (1949), East Haven (1944), Groton (*Mrs. Upson*, 1944), Harwinton (1946), Killingly (1945), Lisbon (1947), Meriden (*Johnson*, 1945), Monroe (1946),

North Stonington (1946), Redding (1949), Sprague (1945), Torrington (1946), Warren (1947), and Woodbridge (1944).

CLADONIA BORYI Tuck. f. LACUNOSA (Bory) Tuck. (1930, p. 418). Avon (1949), Lebanon (1947), Salisbury (*Dix*, 1946), and Southington (*Bunn*, 1945).

CLADONIA BORYI f. PROLIFERA Robbins (1930, p. 419). Salisbury (*Dix*, 1945) and Southington (*Bunn*, 1945).

CLADONIA BORYI f. RETICULATA (Russell) Merrill (1932, p. 141). Cheshire (1948).

Subsection CHASMARIAE

Group MICROPHYLLAE

CLADONIA FURCATA (Huds.) Schrad. (1930, p. 420). In 1942 (p. 664) Asahina reported on the chemistry of *C. furcata*. Although Zopf had maintained that the species produced both fumarprotocetraric acid and atronorine, Asahina found that the vast majority of the specimens at his disposal contained fumarprotocetraric acid only. These specimens included a series from Japan, 60 European specimens distributed by Sandstede in his *Cladoniae* Exsiccatae, 5 North American specimens also distributed by Sandstede, and 43 additional North American specimens from the herbarium of Yale University. Among all these specimens atronorine was demonstrated in only 5, 4 from Europe and 1 from North America. The last came from the island of Nantucket and was collected by W. H. Sheldon in 1940 (No. 105). On the basis of these results Asahina concluded that fumarprotocetraric acid was the only lichen-substance characteristic of *C. furcata* and that specimens containing atronorine should be either excluded from *C. furcata* altogether or interpreted as a transitional form between *C. furcata* and *C. subrangiformis* Sandst. The latter species was proposed as new by Sandstede in 1922 (p. 165) and was based on a series of specimens from various parts of Europe. In the opinion of Des Abbayes (1937, p. 160) it represents a subspecies of *C. furcata*, and there is as yet no evidence that it occurs in North America.

Two years after the publication of Asahina's paper the writer (1944, p. 565) reported independently that many specimens of *C. furcata* lacked atronorine and suggested that this substance be interpreted as an accessory component of the species. Over 200 specimens from Connecticut have since been tested, and only two of these—one from New Milford (1930, p. 420) and the other

from Washington (1930, p. 423)—have yielded the characteristic crystals of atronorine when treated with the G. A. o-T. solution. Specimens from eastern Massachusetts, however, have given different results. Thirty-five specimens from the Cape Cod region, Martha's Vineyard, and Nantucket were tested, and 18 were found to contain atronorine. Of the specimens from Nantucket, 17 in number, only 3 lack this substance. Since the specimens with atronorine are not morphologically different from those without, the writer still feels justified in interpreting atronorine as an accessory constituent of *C. furcata*, in spite of its relatively rare occurrence.

In the following lists of stations most of the records are new, but a few represent revisions of older records. Stations dated 1928 or earlier, for example, have previously been reported simply under the species, without reference to definite varieties or forms.

CLADONIA FURCATA var. PALAMAEA (Ach.) Vainio (1930, p. 425). Bethany (1945), Bethel (1949), Bozrah (1945), Brookfield (1944), Chester (1945), Guilford (1932, not before recorded), Lisbon (1947), Madison (1927), Manchester (1945), New Haven (*Nichols*, 1909), North Haven (1927), North Stonington (1946), Ridgefield (*Mrs. Hartmann*, 1939, listed, 1944, p. 565, as var. *racemosa*), Salem (1947), Salisbury (*Dix*, 1946), Southington (*Bunn*, 1944), Stonington (1940, listed, 1944, p. 565, as var. *racemosa*), Warren (1947), and Woodbridge (1944).

CLADONIA FURCATA var. PALAMAEA f. RIGIDULA (Mass.) Oliv. (1935, p. 44). Cornwall (1944), Middlefield (1927), Southington (*Bunn*, 1946), Thomaston (*Johnson*, 1945), and Weston (1941).

CLADONIA FURCATA var. PINNATA (Floerke) Vainio (1930, p. 424). Thomaston (*McDonnell*, 1935, listed, 1938, p. 13, as var. *racemosa* f. *squamulifera*).

CLADONIA FURCATA var. PINNATA f. FOLIOLOSA (Del.) Vainio (1930, p. 424). Norfolk (*Hale*, 1949).

CLADONIA FURCATA var. RACEMOSA (Hoffm.) Floerke (1930, p. 422). Barkhamsted (1928), Bethany (1925), Bethel (1947), Bozrah (1945), Branford (1928), Bristol (1944), Colebrook (1945), Ellington (1944), Groton (1949), Guilford (1935), Killingworth (1932, listed, 1935, p. 43, as *C. furcata*), Ledyard (1927), Lisbon (1947), Manchester (1943), Middlebury (*Musch & Evans*, 1929, listed, 1932, p. 153, as *C. furcata*), Middletown (*Wright*, 1883, listed, 1930, p. 424, as var. *pinnata*), Monroe (1933, listed, 1935, p. 43, as *C. furcata*), Montville (1947), Morris (1946), Newington (1944), New Milford (1928), Newtown (1928), North Branford

(*Nichols*, 1909; *Musch & Evans*, 1927, listed, 1930, p. 423, as var. *racemosa* f. *furcatosubulata*), Oxford (1945), Preston (1946), Saybrook (*Musch & Evans*, 1928, not before recorded), Seymour (*Musch & Evans*, 1928, listed, 1930, p. 424, as var. *pinnata*), Sharon (*Green*, 1884, Eckfeldt Herbarium, not before recorded), Thompson (*Neale*, 1947), Tolland (1944), Torrington (1946), Union (1947), Washington (1949), Westbrook (1935), West Hartford (1944), West Haven (*Hall*, 1872, 1873, not before recorded), Wethersfield (1944), and Woodbridge (1926).

CLADONIA FURCATA var. RACEMOSA f. CORYMBOSA (Ach.) Vainio (1930, p. 423). Clinton (1935), East Haven (*Hall*, 1875, not before recorded), Southington (*Bunn*, 1944), and Sprague (1945).

CLADONIA FURCATA var. RACEMOSA f. FURCATOSUBULATA (Hoffm.) Vainio (1930, p. 422). Bethlehem (1949), Branford (1928, not before recorded), Brookfield (1944), East Hampton (1928, listed, 1930, p. 422, as var. *racemosa*), Groton (1949), Manchester (1945), Newtown (1944), Norfolk (*Evans*, 1945; *Hale*, 1949), Southington (*Bunn*, 1945), and Sprague (1945).

*CLADONIA FURCATA var. RACEMOSA f. **prolifera** f. nova, podetia ramulis adventiciis brevibus tecta.—On earth. Southington (*Bunn*, 1944, No. 6034).

This form is analogous to the proliferous forms found in the *Cladinae* and *Unciales*. The short, adventive branches, which characterize the form, spring from prostrate podetia.

CLADONIA FURCATA var. RACEMOSA f. SQUAMULIFERA Sandst. (1932, p. 153). Bethel (1947), Canaan (1928, listed, 1930, p. 424, as var. *pinnata*), Chaplin (*Neale*, 1946), Chester (1945), East Hartford (*Weatherby*, 1905, listed, 1930, p. 424, as var. *pinnata* f. *foliolosa*), Essex (1931, listed, 1932, p. 153, as *C. furcata*), Hartland (1928), Kent (1926, listed, 1930, p. 424, as var. *pinnata* f. *foliolosa*, and p. 425, as f. *truncata*), Killingworth (*Hall*, 1874, earliest record for town), Lisbon (*Mrs. Spencer*, 1947) Meriden (1927, listed, 1930, p. 424, as var. *pinnata*), Monroe (*Neale*, 1945), New Fairfield (1947), New Milford (1928), Norfolk (*Evans*, 1945; *Hale*, 1949), Oxford (1925), Pomfret (*Mrs. Paine*, 1934, listed, 1938, p. 13, as *C. scabriuscula* f. *farinacea*), Thomaston (1940), Thompson (*Neale*, 1947), Union (1947), Warren (1947), Watertown (1949), and Wethersfield (*Clark*, 1933, listed, 1935, p. 43, as *C. furcata*).

CLADONIA FURCATA var. RACEMOSA f. SUBCLAUSA Sandst. (1930, p. 423). Canaan (1945).

CLADONIA SCABRIUSCULA (Del.) Leight. (1930, p. 426).

According to Vainio (1887, p. 345) *Cenomyce scabriuscula* Del., upon which *Cladonia scabriuscula* is based, is the same as *C. furcata* γ. *racemosa* c. *surrecta* Floerke. The species is typified,

therefore, by what is now called *C. scabriuscula* f. *surrecta* (Floerke) Sandst. (see Sandstede, 1931, p. 215). This form is abundant in Europe, in northern Asia, in Canada, and in northern New England. It becomes rarer southward, however, and the specimens listed below represent the first records for Connecticut.

*CLADONIA SCABRIUSCULA f. SURRECTA (Floerke) Sandst. in Rabenhorst, Kryptogamen-Flora **9**, Abt. 4^2: 215. 1931. *C. furcata* *η. *racemosa* **C. surrecta* Floerke, Clad. Comm. 154. 1828. *C. surrecta* Sandst. Abhandl. Naturw. Ver. Bremen **25:** 164. 1922. On roadside banks, North Haven (1945) and Thompson (1945).

The podetia of f. *surrecta* branch sparingly by repeated dichotomies. In its typical development the cortex in the basal portion is continuous or subcontinuous, much as in *C. furcata*. This type of cortex extends upward for a variable distance and passes gradually into a cortex composed of minute areolae, separated by whitish lines. On some of the podetia the areolate cortex extends to the tips of the branches, but as a rule the areolae in the apical portion are replaced by minute appressed or spreading squamules, which give the surface a roughened appearance. Among the squamules ecorticate areas, variable in extent, can be distinguished. Granular soredia also are present on most of the podetia, and there are all gradations between these and the spreading squamules. In addition to the minute squamules a few much larger squamules are usually developed, especially in the basal portions of the podetia.

The characteristic lichen-substance of *C. scabriuscula* is fumarprotocetraric acid, and the plants in consequence are definitely P+. According to Asahina (1942, p. 667) this acid is the only substance present in most specimens of the species, but he detected atronorine also in four European examples of f. *surrecta* from Sandstede's *Cladoniae* exsiccatae. The writer (1944, p. 508) found the substance E, now identified with ursolic acid, in many specimens and interpreted this substance as an accessory component of the species. Atronorine, however, could not be demonstrated in any of the material examined.

In 1930 the writer (p. 427) recorded a series of specimens from Connecticut under the name *C. scabriuscula* f. *farinacea* (Vainio) Sandst. and has since reported the same form from numerous

additional stations in the state (1932, p. 154; 1935, p. 45; 1938, p. 13; and 1944, p. 568). Vainio based the form, under the name *C. furcata* γ. *scabriuscula* f. *farinacea*, on specimens collected by Hariot at Punta Arenas, Patagonia, but later (1894, p. 450) reported it also from New Bedford, Massachusetts, citing specimens collected by Willey. In 1926 Sandstede, in his *Cladoniae* Exsiccatae, distributed specimens from Wareham, Massachusetts, collected by Robbins, under the name *C. scabriuscula—farinacea*, and in 1938 (1938a, p. 86) listed the plant definitely as a variety of *C. scabriuscula*. Two years later Degelius (1940, p. 33), in listing specimens of this species from Maine, expressed the opinion that the var. *farinacea* might perhaps represent a distinct species. The writer is now convinced that this is the case and therefore proposes that var. *farinacea* be raised to specific rank, as indicated below.

*Cladonia **farinacea** (Vainio) comb. nov. *C. furcata* γ. *scabriuscula* f. *farinacea* Vainio, Acta Soc. F. et Fl. Fennica **4:** 339. 1887. *C. furcata* var. *farinacea* Vainio in Hariot, Jour. de Bot. **1:** 283. 1887. *C. cenotea* var. *magellanica* Vainio in Hariot, *l. c.* 1887 (as synonym). *C. cenotea* var. *corticata* Vainio in Hariot, *Ibid.* 284. 1887 (*nomen nudum*). *C. scabriuscula—farinacea* Sandst. Clad. Exsic. 1569. 1926. *C. scabriuscula* f. *farinacea* Sandst. in Evans, Trans. Connecticut Acad. **30:** 427. 1930. *C. scabriuscula* f. *subtestacea* Robbins in Evans, *Ibid.* 428. 1930. *C. scabriuscula* var. *farinacea* Sandst. in Hannig & Winkler, Pflanzenareale IV, Heft 7: 86. 1938.

Through the kindness of Dr. Lars Fagerström, of the University of Helsingfors, the writer has had the privilege of studying Hariot's specimen of *C. furcata* γ. *scabriuscula* f. *farinacea* from the Vainio Herbarium. This specimen, which came from Punta Arenas, may be designated the type of *C. farinacea*, although (according to Hariot) Vainio's *C. furcata* var. *farinacea* was based on a specimen collected at Port Famine, Straits of Magellan, by Jacquinot. It may be added that a label bearing the name *C. cenotea* var. *corticata*, listed by Hariot without description, is enclosed with the type. In 1894 (p. 450) Vainio definitely reduced both *C. cenotea* var. *magellanica* and *C. cenotea* var. *corticata* to synonymy under f. *farinacea*.

A careful comparison of Hariot's specimen, which is shown in Fig. 1, with North American specimens which have been referred

to *C. scabriuscula* f. *farinacea* fails to bring out any essential differences, in spite of their wide geographical separation. A characteristic example of the North American plant is shown in Fig. 2.

In fields, on banks, and on soil over rocks. The following represent new stations for the species in Connecticut: Cheshire (*Mrs. Upson*, 1945), Danbury (1949), East Haven (*Neale*, 1947), Ellington (1944), Groton (1949), Madison (*Johnson*, 1946), Marlboro (1945), Norfolk (*Evans*, 1945; *Hale* 1949), Preston (1946), Sprague (1945), Tolland (1944), Union (1947), and Warren (1947). These and the stations already listed under *C. scabriuscula* f. *farinacea* give a total of 69 towns for the state. Outside of Connecticut *C. farinacea* is widely distributed in North America, and its known range in the eastern part of the continent extends as far south as North Carolina and as far west as Wisconsin. There is no evidence that the species occurs in Europe.

The primary squamules of *C. farinacea*, which are sparingly produced, grow in depressed mats and are essentially like those of *C. furcata*. The squamules are short-lived, and many of the colonies consist entirely of podetia, which continue their growth independently and form more or less compact tufts.

The podetia as a rule are less branched than in *C. furcata*, and some of them may remain undivided. The branching is by dichotomies or by whorls of three or four, and the majority of the axils are perforate without being dilated. In a dichotomy or whorl the branches may be subequal and diverge slightly from one another. In many cases, however, one branch is much longer than the others and grows in the same direction as the branching axis, deflecting the shorter branch or branches to one side. If this process is repeated a sympodium is formed. In addition to the open axils some of the podetia show longitudinal slits in the wall.

A normal podetium shows a division into a basal portion with a continuous or subcontinuous cortex, an apical portion producing an abundance of farinose soredia, and an intermediate portion in which the cortex is broken through by a series of sorediose areas, rounded or irregular in outline. In the upper part of this portion the sorediose areas tend to be larger than in the lower part and

usually coalesce to a greater or less extent. Where the cartilaginous layer of the wall is exposed in the apical portion it appears opaque and whitish, becoming darker with age. As a rule the corticate and sorediose portions are about equal in extent and occupy more than two-thirds the length of the podetia. The intermediate portion, in fact, may be lacking altogether, in which case there is a sharp transition between the corticate and sorediose portions.

The podetia vary greatly in size. Robust examples are 80–100 mm. in length and 1.5–2.5 mm. in diameter, but there are all gradations between these and depauperate examples only 10 mm. in length and 0.5 mm. in diameter. The color is greenish or dingy gray, varying to brownish gray. If the tinge is pronounced the specimens represent *C. scabriuscula* f. *subtestacea* Robbins, but this form (in the writer's opinion) is hardly distinct enough to deserve a special name. Podetial squamules, essentially like the primary squamules, are present in some cases, but many podetia lack them. These squamules are usually few in number and scattered. Well-developed apothecia and spermagonia of *C. farinacea* are still unknown.

The chemical features of *C. farinacea* are in agreement with those of *C. scabriuscula*. In other words fumarprotocetraric acid is the characteristic lichen-substance of the species and ursolic acid an accessory constituent. Tests for atronorine have all given negative results.

In its general habit *C. farinacea* resembles sparingly branched specimens of *C. furcata*, and the variations in color are much the same, although brownish shades are more frequently met with in the latter species. Soredia, however, are completely lacking in *C. furcata* and represent one of the most characteristic features of *C. farinacea*. These soredia, farinose in character, abundantly produced, and unaccompanied by minute squamules, will distinguish the species also from *C. scabriuscula*, in which the soredia are granular, sparingly produced, and accompanied by numerous spreading and appressed squamules.

Cladonia multiformis Merrill (1930, p. 428). This species, as shown by Asahina (1942, p. 668) and by the writer (1944, p. 568), contains fumarprotocetraric acid but no atronorine.

Cladonia multiformis f. Finkii (Vainio) Evans (1930, p. 429). Colebrook (*Miner*, 1945), Cornwall (*Green*, 1884, Eck-

feldt Herbarium, determined as *C. gracilis* var. *hybrida*, earliest record for town), Meriden (*Johnson*, 1945), Southington (*Bunn*, 1944), and Warren (1947).

CLADONIA MULTIFORMIS f. SIMULATA Robbins (1930, p. 429). Norfolk (*Hale*, 1949).

CLADONIA SQUAMOSA (Scop.) Hoffm. (1930, p. 432). According to Asahina (1942, p. 625) squamatic acid is the only lichen-substance produced by *C. squamosa*. The writer, however (1944, p. 572), obtained crystals of the F and G types in some cases, in addition to squamatic acid. The chemical composition of these crystals is still unknown. The following records are based on specimens that are indefinite as to form: Cheshire (*Mrs. Upson*, 1944), Cornwall (1944), Ellington (1944), Glastonbury (*Miner*, 1944), Groton (1949), Meriden (*Johnson*, 1945), Oxford (1945), Roxbury (1949), Seymour (1948), and Sprague (1945).

CLADONIA SQUAMOSA f. MURINA Scriba (1930, p. 437). Norfolk (*Ball*, 1945; *Hale*, 1949) and Seymour (1948).

CLADONIA SQUAMOSA f. PHYLLOPODA Vainio (1935, p. 46). Southington (*Bunn*, 1947).

CLADONIA SQUAMOSA f. SQUAMOSISSIMA Floerke (1930, p. 434). Avon (1949), Cornwall (*Neale*, 1946), Madison (*Johnson*, 1948), Meriden (*Johnson*, 1946), Norfolk (1945), Tolland (1944), and Washington (1949).

CLADONIA ATLANTICA Evans (1944, p. 573).

From a chemical standpoint, as already shown by the writer, *C. atlantica* is characterized by the presence of baeomycic acid, in addition to squamatic acid. The baeomycic acid gives a yellow color with P, and characteristic crystals can be obtained by the use of the G. A. Q. solution. These crystals are minute and can easily escape detection. In 1942, however, Asahina (1942a, p. 622) recommended another compound, orthoanisidine, for the demonstration of the acid. A 5 per cent solution of this substance in an equal amount of glycerine and alcohol, known as the G. A. o-Anis. solution, is used. If this solution is added to the dried acetone extract of a lichen containing baeomycic acid, and gentle heat applied, yellow crystals in the form of thick needles or rods, in many cases with frayed ends, will be formed; but, if the acid is present in small amount, several hours may elapse before the crystals make their appearance.

CLADONIA ATLANTICA f. RAMOSA Evans (1944, p. 575). Danbury (1949), Glastonbury (*Miner*, 1945), Milford (1944), New-

town (1945), Roxbury (1949), West Haven (1945), Wethersfield (1944), and Willington (1944).

CLADONIA ATLANTICA f. RAMOSISSIMA Evans (1944, p. 576). Berlin (*Johnson*, 1949), Branford (1945), North Haven (1945), Southington (*Bunn*, 1944), and West Haven (1945).

CLADONIA ATLANTICA f. SUBSIMPLEX Evans (1944, p. 574). Hamden (1946) and Meriden (*Johnson*, 1945).

In addition to the three forms listed a fourth form, f. *microphylla* Evans, was included under *C. atlantica* in 1944. This form agrees with the others in containing baeomycic acid and, therefore, in turning yellow when treated with P, but differs in some of its morphological features. The writer is now convinced that f. *microphylla* is not conspecific with the other forms but that it represents a synonym of *C. Beaumontii* (Tuck.) Vainio, the identity of which was established by Robbins in 1927. At that time he thought that the distribution of the species was "wholly southern," but Fink (1935, p. 261) has since extended its known range northward to Massachusetts.

*CLADONIA BEAUMONTII (Tuck.) Vainio, Acta Soc. F. et Fl. Fennica **10:** 455. 1894. *C. santensis* b. *Beaumontii* Tuck. Syn. N. Am. Lich. **1:** 245. 1882. *C. stenophylliza* Vainio in Sandstede, Clad. Exsic. 1184. 1922 (*nomen nudum*). *C. microphylliza* Merrill, Bryologist **27:** 22. 1924. *C. exasperatula* Merrill, *Ibid.* **27:** 23. 1924. *C. atlantica* f. *microphylla* Evans, Trans. Connecticut Acad. **35:** 577. 1944. On decayed wood in a *Chamaecyparis* swamp, Voluntown (1933), the only known station in Connecticut.

When Tuckerman described this species in 1882, as a variety or form of *C. santensis*, he listed only two specimens, one collected by Curtis in North Carolina and the other by Beaumont in Alabama. Twelve years later Vainio, in raising the plant to specific rank, stated that North Carolina specimens from the Tuckerman Herbarium were strongly K+. In 1927 Robbins showed that the two specimens listed by Tuckerman were specifically distinct. He referred Curtis' specimen to "*C. squamosa* f. *multibrachiata* Floerke" and typified *C. Beaumontii* by Beaumont's specimen. He also showed that both of these were K− and that the K+ specimens studied by Vainio were referable to *C. floridana* Vainio, a species based on specimens collected by Rapp at Sanford, Florida, in 1924. In addition to the type-specimen of *C. Beaumontii* Robbins cited specimens from Sanford, also collected by Rapp, but listed no other stations. He expressed the opinion

that the species was a member of the subsection *Clausae* and that it was perhaps related to *C. pityrea* (Floerke) Fr., belonging to the group *Thallostelides*.

In 1930 Sandstede (p. 49), in his sequence of species, placed *C. Beaumontii* between *C. floridana* and *C. santensis* Tuck., thus implying that it belonged in the subsection *Chasmariae;* but Fink, in 1935 (p. 261), placed it between *C. leptothallina* Merrill and *C. decorticata* (Floerke) Spreng. He thus agreed with Robbins in considering the species a member of the *Clausae* but associated it with the *Podestelides*, rather than with the *Thallostelides*. Three distinct views regarding the taxonomic position of *C. Beaumontii* have thus been brought forward. In the opinion of the writer, however, the morphological and chemical features of the species clearly indicate that Sandstede was correct in placing it among the *Chasmariae*.

The synonyms of *C. Beaumontii* include *C. stenophylliza*, *C. microphylliza*, and *C. exasperatula*, all based on specimens collected by Rapp at Sanford, Florida. The first was reduced to synonymy by Robbins in 1927 (p. 138) and the other two by Sandstede in 1938 (p. 47). The valuable series of *Cladoniae* in the "Severin Rapp Memorial Collection," now the property of the Florida Agricultural Experiment Station at Gainsville, has been sent to the writer for study by the curator, Dr. Lillian E. Arnold, and in this series the three species under consideration are well represented by specimens determined by Merrill. There seems to be no doubt that all three should be regarded as synonyms. It should be pointed out, however, that the determinations were made before the characteristic features of *C.Beaumontii* were well understood.

The yellow color produced in *C. Beaumontii* by the addition of P was first noted by Sandstede (1938, p. 47). This reaction, as in *C. atlantica*, indicates the presence of baeomycic acid, and the two species agree further in producing squamatic acid in addition. The podetia of *C. atlantica*, however, are distinguished from those of *C. Beaumontii* by the presence of open cups, even if these are somewhat obscured in f. *ramosissima* by the excessive production of marginal proliferations. The podetial cortex is further distinguished by being continuous or subcontinuous throughout. In *C. Beaumontii* the podetia are cupless and the blunt apices are

slightly, if at all, dilated; the podetial surface, too, although corticate in large part, shows ecorticate areas of variable extent.

The primary squamules of *C. Beaumontii* are larger and more luxuriant than those of *C. atlantica* and tend to be deeply laciniate with narrow, more or less crenulate, divisions. They are pale grayish above, white beneath, and destitute of soredia. The cylindrical podetia are simple or sparingly branched, and the axils and apices, although closed in some cases, are open in others. Some, but not all, of the podetia bear scattered squamules, smaller than the primary squamules but otherwise resembling them. Even more distinctive, however, are the minute podetial squamules, which are usually produced in abundance. These may be accompanied by isidioid outgrowths but not by soredia. The dark brown apothecia and spermagonia, if present at all, are borne at the tips of the podetia.

The specimens listed below from stations outside Connecticut are in the Yale Herbarium and will give some idea of the distribution of *C. Beaumontii*, which is apparently endemic to North America.

Massachusetts: West Tisbury, Martha's Vineyard (*Torrey*, 1936).

New York (Long Island): Montauk (*Latham*, 1945), Flanders (*Latham*, 1946), and Northwest (*Latham*, 1947).

New Jersey: Green Bank, Burlington Co. (*Dix*, 1943).

North Carolina: Roanoke Island, Dare Co. (*Torrey*, 1937); Chapel Hill, Orange Co. (*Evans*, 1938); Havelock, Craven Co. (*Anderson & Evans*, 1939); Chinquapin, Duplin Co. (*Anderson & Evans*, 1939); Ellerbe, Richmond Co. (*Anderson & Evans*, 1939); Star, Montgomery Co. (*Anderson & Evans*, 1939); and Wingate, Union Co. (*Gray*, 1939).

The specimens from Florida will be listed in another connection.

Cladonia carassensis Vainio, Acta Soc. F. et Fl. Fennica **4:** 313. 1887. *C. japonica* Vainio in Hue, Nouv. Arch. Mus. Hist. Nat. III. **10:** 265. 1898. This rare species has been reported in North America from Massachusetts (Robbins, 1924, p. 146), Connecticut (*Evans*, 1935, p. 47) and Oregon (*Asahina*, 1942, p. 664) and has been collected also in Nova Scotia, Maine, New York (Long Island), and California.

In 1942 Asahina reported the presence of thamnolic acid in specimens from Massachusetts and Oregon and pointed out the strong resemblance between *C. carassensis* and *C. japonica*, in

which he had already demonstrated the same acid (1938, p. 768). He expressed the opinion, in fact, that the two species were synonymous.

Vainio's *C. japonica* was based on specimens collected by Faurie at three different stations in Japan and has since been found in only two or three additional localities in that country. Outside of Japan it has been reported from the Tatra Mountains in eastern Europe, from Haiti, and from New Zealand. The first report from the Tatra Mountains was made in 1930 by Vainio, who cited specimens collected by Timkó under the name *C. japonica* var. *tatrana* Vainio. Later in the same year Sandstede (p. 50) referred Nos. 880 and 1707 of his *Cladoniae* exsiccatae, both of which had been collected by Suza in the Tatra Mountains, to the same species and variety. No. 880 had been issued under the name *C. subsquamosa* f. *subulata* Sandst. and No. 1707 under the name *C. subsquamosa* f. *nuda* Sandst. In 1931 he figured these two forms (*pl. 35, f. 10, 11*) and listed them in the explanation of his plate under *C. japonica* var. *tatrana*. The reports from Haiti and New Zealand were likewise made by Sandstede (1938a, p. 87), who thus ascribed to the species a wide geographical distribution.

The writer has studied Nos. 880 and 1707 and also a Japanese specimen of *C. japonica* (No. 171) from the Asahina Herbarium, collected by Kimura at the Konsei Pass, Nikko, in the province of Simotuke (listed by Asahina, 1938, p. 768). Sandstede's figures of *C. japonica*, based on some of Faurie's material (1938, *pl. 7, f. 52*), as well as those of *C. japonica* var. *tatrana*, have thrown further light on the distinctive features of the species. These various specimens and figures indicate a considerable range of variation but present no characters that would distinguish *C. japonica* from the North American specimens of *C. carassensis*. The writer is therefore convinced that Asahina was justified in considering them conspecific.

The question now arises, are these specimens from the Northern Hemisphere the same as Vainio's specimens from the Carassa Mountains of Brazil, the only station cited for *C. carassensis* in the original description? The writer has studied a Brazilian specimen of *C. carassensis* collected by Vainio in 1885 and representing a part of the material upon which the species is based. This

specimen is labeled f. *irregularis* Vainio, but is essentially like Sandstede's figure of the species (1938, *pl. 5, f. 37*), which is referred to f. *subregularis* Vainio. There is evidently some confusion in names here, since the specimen figured came from "Carassa," Brazil, whereas f. *subregularis* was based on specimens from Massachusetts. In any case the figure, in the opinion of the writer, represents f. *irregularis* and not f. *subregularis*.

The specimens of f. *irregularis* are slightly more robust than northern specimens, and the successive branches of the podetia tend to be closer together, so that the plants at first sight appear distinct. The histological features of the podetia, however, are similar, and the apparent differences might well come within the range of variation of a single species. The writer is therefore inclined to accept the views of Vainio and Sandstede that the specimens from Massachusetts (and from other northern localities) belong to the same species as the plants from Brazil.

The podetia of *C. carassensis* in their usual development bear a striking resemblance to those of *C. atlantica* f. *subsimplex* and f. *ramosa* and also to those of *C. crispata* and *C. squamosa* in certain of their forms. In all these plants the podetia develop open cups, which broaden out gradually or abruptly from terete basal portions. The branching is by irregular dichotomies, with open or closed axils, and by proliferations from the margins of the cups. These may arise singly or in whorls and may in turn form smaller cups or terminate in blunt or sharp apices, closed or with minute perforations. The podetial surface may appear smooth, and the groups of algal cells under these circumstances are indistinguishable. As a rule, however, these groups, covered with a more or less distinct cortex, stand out clearly and may even project slightly. They are irregular in shape and in size, and the bands or lines separating them, although pale at first, may become slightly darkened with age. Podetial squamules may be lacking altogether or present in greater or less abundance. Soredia are never produced.

The podetial wall varies in thickness from about 100 μ to about 400 μ but is mostly between 100 μ and 200 μ. The portion of the wall inside the algal zone is mostly 70–130 μ in thickness and is vaguely divided into two concentric layers. The inner layer bounding the central canal is composed throughout of coalescent

hyphae and represents a true cartilaginous tissue. The outer layer, which may equal the inner in thickness or be considerably thinner, is likewise largely composed of coalescent hyphae but contains air-spaces in which the hyphae are merely interwoven. These air-spaces are narrow in some cases and broader in others, and the cartilaginous tissue may be more or less broken up into strands. In some of the podetia strands of this type can be demonstrated among the groups of algal cells, just within the external, or cortical, layer of the wall. This external layer, which is 10–20 μ in thickness, is variable in its composition. In some of the specimens the hyphae, of which the layer is composed, are coalescent outside the groups of algal cells and form a true cortex, one or two cells in thickness. As a rule, however, air-spaces are present, even outside the groups of algal cells, and are always to be found outside the spaces separating the groups.

From a chemical standpoint *C. carassensis* is amply distinct from *C. atlantica*, *C. crispata* and *C. squamosa*. Owing to the presence of thamnolic acid the plants are definitely K+ and P+. This substance is not produced by the other three species. In *C. atlantica*, which is K− but P+ yellow, the characteristic lichen-substance is baeomycic acid, although squamatic acid is present also; in *C. crispata* and *C. squamosa*, which are both K− and P−, squamatic acid is the characteristic component. In addition to thamnolic acid *C. carassensis* may contain the substances F and G, the chemical compositoin of which is still unknown (see Evans, 1944, p. 577).

Several of the forms of *C. carassensis* and *C. japonica* that have been described are based on slight and inconstant differences. Vainio's f. *subregularis*, for example, is said to differ from [f. *irregularis*] m. *regularis* only in color (see Robbins, 1924, p. 14), and f. *obliqua* Robbins, according to the description, differs from f. *irregularis* in the same way. It is doubtful, also, if the presence of squamules by itself offers sufficient grounds for the recognition of such forms as f. *digressa* Vainio (1887, p. 315) or f. *obliqua* m. *spectabilis* Robbins, since podetia with squamules and podetia without squamules may occur side by side in the same colony. The North American specimens of *C. carassensis* examined by the writer illustrate the two forms listed below.

*Cladonia carassensis f. regularis Vainio, Acta Soc. F. et Fl. Fennica **4:** 315. 1887 (as β. *regularis*); *Ibid.* **14**[1]**:** 237. 1897 (as f. *irregularis* m. *regularis*); in Zahlbruckner, Cat. Lich. Univ. **4:** 454. 1926 (as f. *regularis*). *C. carassensis* f. *subregularis* Vainio in Robbins, Rhodora **26:** 146. 1924. *C. subsquamosa* f. *nuda* Sandst. Clad. Exsic. 1707. 1927. *C. japonica* f. *tatrana* Vainio, Magyar Botan. Lapok **29:** 22. 1930. *C. japonica* f. *nuda* Sandst. in Rabenhorst. Kryptogamen-Flora **9**, Abt. 4[2]: 290. 1931.

Nova Scotia: Bear Cove (*Evans*, 1936); Cape Sable and Sable River (*Evans*, 1936); and Lake Kejimkujak (*Evans*, 1936).

Maine: Hancock (*Evans*, 1936); and Whiting (*Evans*, 1936).

Massachusetts: Mashpee (*Torrey*, 1937); Nantucket (*Sheldon*, 1938); and Wareham (*Robbins*, 1924, distributed in Sandstede's Clad. Exsic. 1393, as *C. carassensis* f. *subregularis* m. *spectabilis;* and *Blake*, 1931).

Connecticut: Stafford (*Evans*, 1932, listed, 1935, p. 47, as *C. carassensis*).

New York (Long Island): Napeague (*Latham*, 1947); Northwest (*Latham*, 1948); and Springs (*Latham*, 1947).

Oregon: Gunter (*Sipe*, 1936); Hecata Beach Road (*Sipe*, 1939); Reedsport (*Sipe*, 1937); and Sultan Lake (*Sipe*, 1939).

In f. *regularis* well-developed cups are present, 2–4 mm. in diameter and approximately horizontal. They are associated in most of the specimens with narrower cups of the same general character and, in some cases, with oblique and irregular cups. In some colonies podetial squamules are present to a greater or less extent; in others they are completely lacking.

Cladonia carassensis f. **subulata** (Sandst.) comb. nov. *C. subsquamosa* f. *subulata* Sandst. Clad. Exsic. 880. 1922. *C. japonica* f. *subulata* Sandst. in Rabenhorst, Kryptogamen-Flora **9**, Abt. 4[2]: 290. 1931.

California: Pilascetos Creek Canyon (*Herre*, 1943).

The podetia in f. *subulata* are more densely crowded than in f. *regularis* and more copiously branched. The cups present, although open, are scarcely or not at all dilated, and many of the branches are cupless and blunt or sharply pointed. Scattered podetial squamules are present in some abundance. The specimens from California agree in all essential respects with the specimens from the Tatra Mountains distributed by Sandstede.

Cladonia cenotea (Ach.) Schaer. (1932, p. 154). Squamatic acid is the only lichen-substance that has been demonstrated in this species (see Asahina, 1942, p. 680, and Evans, 1944, p. 577). The plants are therefore K− and P−.

CLADONIA CENOTEA f. CROSSOTA (Ach.) Nyl. (1944, p. 578). Colebrook (*Hale*, 1948), the second station in Connecticut for this northern form.

CLADONIA DELICATA (Ehrh.) Floerke (1930, p. 438). Thamnolic acid is the characteristic lichen-substance of *C. delicata* (see Asahina, 1942, p. 679, and Evans, 1944, p. 578), and the plants in consequence are K+ and P+. In some cases the yellow color produced by K is transitory and quickly succeeded by brownish hues.

CLADONIA DELICATA f. QUERCINA (Pers.) Floerke (1930, p. 439). Bolton (1944), Enfield (1944), Meriden (*Burkholder*, 1944), and Norfolk (*Hale*, 1949).

CLADONIA CAESPITICIA (Pers.) Floerke (1930, p. 439). Andover (1948), Avon (1944), Bethel (1947), Bethlehem (1949), Bolton (1944), Bridgeport (1945), Canaan (1945), Columbia (1948), Cornwall (1945), East Granby (1947), East Haven (1944), Easton (1949), Ellington (1944), Farmington (1944), Groton (1949), Hampton (1948), Marlboro (1945), Monroe (*Neale*, Montville (1947), Morris (1946), Naugatuck (*Johnson & Neale*, 1945), New Canaan (1947), Newington (1944), Newtown (1944), Norfolk (*Evans*, 1945; *Hale*, 1949), Norwalk (1946), Plainville (1945), Preston (1946), Ridgefield (1947), Salisbury (1948), Saybrook (1945), Seymour (1945), Thompson (*Neale*, 1947), Tolland (1949), Union (1947), Vernon (1946), Warren (1947), Washington (1946), West Haven (1945), Westport (1947), Wethersfield (1944), and Wolcott (1945).

Although atronorine and squamatic acid have been reported in *C. caespiticia*, Asahina showed in 1942 (p. 678) that fumarprotocetraric acid was the only lichen-substance present, and the writer in 1944 (p. 579) confirmed this statement.

Group MEGAPHYLLAE

CLADONIA APODOCARPA Robbins (1930, p. 440). Andover (1944), Bethlehem (1949), Bozrah (1945), Bridgeport (1945), Canaan (1945), Chester (1945), Colebrook (1945), Danbury (1949), East Lyme (1944), Ellington (1944), Essex (1945), Farmington (1944), Glastonbury (1944), Killingly (1945), Manchester (1945), Montville (1947), Norfolk (1948), North Haven (1945), Orange (1944), Preston (1946), Putnam (1945), Redding (1947), Ridgefield (1947), Salem (1947), Salisbury (1945), Somers (1949), Southbury (*Johnson*, 1944), Sprague (1945), Thompson (1945), Union (1947), Washington (1946), Waterbury (1945), Weston (1949), Wethersfield (1944), Winchester (1944), and Woodbury (*Sinnott*, 1944).

The lichen-substances found in *C. apodocarpa* are atronorine and fumarprotocetraric acid (see Asahina, 1942, p. 683, and Evans, 1944, p. 579). The plants therefore turn yellow with K and red with P. The color produced by K, although faint, is usually evident of the reagent is applied to the chalky white lower surface of the squamules.

Cladonia turgida (Ehrh.) Hoffm. (1930, p. 441). Norfolk (*Hale*, 1949).

This rare species is still known from only six towns in Connecticut, all in the northwestern part of the state. It contains both atronorine and fumarprotocetraric acid, thus agreeing with *C. apodocarpa*, but the reaction with P may be faint or even lacking altogether.

Cladonia turgida f. corniculata Floerke (1930, p. 442). Colebrook (*Hale*, 1948).

Cladonia turgida f. scyphifera Vainio (1930, p. 442). Colebrook (*Hale*, 1948).

Subsection Clausae

Group Podostelides

Subgroup Helopodium

Cladonia capitata (Michx.) Spreng. (1944, p. 582).

Fumarprotocetraric acid is the only lichen-substance definitely associated with this species (see Asahina, 1943, p. 48, and Evans, 1944, p. 582), and the plants turn bright red when treated with P.

Cladonia capitata f. epiphylloma Evans (1944, p. 583). Southington (*Bunn*, 1947), the second known station for this form.

Cladonia capitata f. imbricatula (Nyl.) Evans (1944, p. 583). Andover (1948), Bethel (1949), Bethlehem (1949), Bridgeport (1945), Colchester (1947), Glastonbury (1944), Lisbon (1947), Mansfield (1945), Marlboro (1945), New Fairfield (1947), Plainville (1945), Redding (*Mrs. Upson*, 1946), Somers (1949), Tolland (1949), Union (1947), Warren (1947), Washington (1949), and West Hartford (1949).

Cladonia capitata f. pallida (Robbins) Evans (1944, p. 583). Canaan (*Miner*, 1945), Meriden (*Johnson*, 1945), Naugatuck (*Johnson & Neale*, 1945), Southington (*Bunn*, 1944), Union (1947), and Warren (1947).

Cladonia capitata f. squamulosa (Merrill) Evans (1944, p. 583). Southington (*Bunn*, 1945), the second station in Connecticut for this form.

CLADONIA CARIOSA (Ach.) Spreng. (1944, p. 584).

It has long been known that atronorine represents a characteristic lichen-substance of *C. cariosa* (see Asahina, 1943, p. 50, and Evans, 1944, 584), and that the plants in consequence turn yellow when treated with K. One or more other substances, however, may also be present, at least as accessory components, but the identity of these substances is still in doubt.

CLADONIA CARIOSA f. CRIBROSA (Wallr.) Vainio (1944, p. 585). Southington (*Bunn*, 1945), the third station in Connecticut for this rare species.

CLADONIA CLAVULIFERA Vainio (1930, p. 446).

The only lichen substance found in the present species is fumarprotocetraric acid (see Asahina, 1943, p. 52, and Evans, 1944, p. 585). It thus agrees chemically with *C. capitata* and yields an equally vivid red color when treated with P.

CLADONIA CLAVULIFERA f. EPIPHYLLA Robbins (1930, p. 448). Meriden (*Johnson*, 1945) and Southington (*Bunn*, 1944).

CLADONIA CLAVULIFERA f. NUDICAULIS Evans (1930, p. 447). East Windsor (1945), Groton (1949), Manchester (1945), Meriden (*Johnson*, 1945), Montville (1946), Redding (1949), Salem (1947), Southington (*Bunn*, 1944), Thompson (1945), Westbrook (1945), and Wethersfield (1944).

CLADONIA CLAVULIFERA f. PLEUROCARPA Robbins (1930, p. 447). Redding (1949).

CLADONIA CLAVULIFERA f. SUBVESTITA Robbins (1930, p. 447). Avon (1949), East Windsor (1945), Orange (1944), Salem (1947), Southington (*Bunn*, 1944), and Wethersfield (1944).

CLADONIA SUBCARIOSA Nyl. (1930, p. 449). Brookfield (1944), Canaan (1945), Colebrook (1945), Cornwall (1945), Groton (1949), Lisbon (1947), Marlboro (1945), Monroe (1946), Newington (1944), Newtown (1944), Norfolk (1945), Norwalk (1946), Orange (1944), Redding (*Mrs. Upson*, 1945), Torrington (1946), Union (1947), Warren (1947), Waterbury (1945), Weston (1949), Westport (1947), and West Hartford (1944).

The specimens upon which these records are based are sterile or show rudimentary podetia. All, however, turn red with K and yield characteristic crystals when tested for norstictic acid, the only lichen-substance associated with the species (see Asahina, 1943, p. 51, and Evans, 1944, p. 586).

CLADONIA SUBCARIOSA f. EVOLUTA Vainio (1930, p. 450). Andover (1948), Bethel (1949), Bethlehem (1949), Bridgeport (1945), Bristol (1944), Brookfield (1944), Chester (1945), Dan-

bury (1949), East Granby (1947), Enfield (1945), Farmington (1944), Groton (1949), Harwinton (1946), Killingly (1945), Lisbon (1947), Manchester (1945), Montville (1947), Morris (1946), Newington (1944), Plainville (1945), Preston (1946), Redding (1949), Somers (1949), West Haven (1945), and Weston (1949).

CLADONIA SUBCARIOSA f. PLEUROCARPA Robbins (1930, p. 451). Bethel (1949) and Salisbury (1948).

CLADONIA SUBCARIOSA f. RAMOSA Dix (1944, p. 587), Southington (*Bunn*, 1947).

CLADONIA SUBCARIOSA f. SQUAMULOSA Robbins (1930, p. 451). Canaan (1945), Danbury (1949), East Haven (1945), East Granby (1947), Meriden (*Johnson*, 1944), Monroe (1946), Morris (1946), Southington (*Bunn*, 1944), and West Haven (1945).

CLADONIA BREVIS Sandst. (1932, p. 156). Granby (1949), Middlebury (1949), Roxbury (1949), and Southington (*Bunn*, 1945).

This relatively rare species is now known from fifteen towns in the state. In 1943 (p. 53) Asahina showed that psoromic acid was a characteristic lichen-substance of *C. alpicola* var. *karelica* Vainio and that the plants in consequence turned bright yellow when treated with P. This variety is now considered a synonym of *C. brevis*, and the writer (1944, p. 588) has independently demonstrated the presence of psoromic acid in North American material of this species. Although *C. alpicola* (Flot.) Vainio agrees with *C. brevis* in containing psoromic acid the latter is clearly a member of the subgroup *Helopodium*, since the spermagonia are borne on the primary squamules. In the subgroup *Macropus*, to which *C. alpicola* belongs, the spermagonia are restricted to the podetia.

Subgroup MACROPUS

CLADONIA NORRLINI Vainio (1913, p. 454). Colebrook (*Hale*, 1948) and Salisbury (1945, 1948).

In 1944 *C. Norrlini* was known from only one town in Connecticut, North Canaan, where it was discovered in 1928. It is a pleasure to report this rare species from two additional towns. All are in the northwestern part of the state. According to Asahina (1943, p. 55) atronorine and psoromic acid are both produced by *C. Norrlini*, and the plants in consequence turn yellow with K and also with P. He based his observations on No. 1574

of Sandstede's *Cladoniae* Exsiccatae, collected by Robbins at Jackson, New Hampshire, in 1925. In a specimen from Wardsboro, Vermont, however, collected by the writer in 1940, he found atronorine only, although P still gave a slight reaction. In the following year (1944, p. 588) the writer noted the same color-reactions with K and P and reported the presence of atronorine, but not of psoromic acid, in specimens from various parts of North America. Fortunately some of the specimens from Salisbury yield characterisitc crystals of psoromic acid, as well as those of atronorine. It seems justifiable, therefore, to interpret the latter substance as the characteristic lichen-substance of *C. Norrlini* and psoromic acid as an accessory constituent. The presence of atronorine distinguishes the species chemically from *C. alpicola*, in which psoromic acid alone is produced.

CLADONIA DECORTICATA (Floerke) Spreng. (1932, p. 158). Colebrook (*Hale*, 1948), the second station in Connecticut for this rare species.

The negative reactions with K and with P will at once distinguish *C. decorticata* from the other known species of the subgroup *Macropus*. A few years ago (1943, p. 56) Asahina reported the presence of perlatolic acid in the species, and soon afterwards the writer (1944, p. 589) called attention to certain colorless crystals obtained by treating the dried acetone extract with the G. E. solution. It is now possible to identify these crystals with perlatolic acid.

Group THALLOSTELIDES

The lichen-substances found in the species of the *Thallostelides* occurring in Connecticut have recently been listed by Asahina (1943, pp. 227–240) and by the writer (1944, p. 609). In the present report, therefore, these substances will not be discussed in detail. It may be noted, however, that fumarprotocetraric acid is found in all our species, although in a few it occurs only as an accessory constituent.

CLADONIA GRACILIS (L.) Willd. var. DILATATA (Hoffm.) Vainio (1930, p. 457). Colebrook (*Hale*, 1948), East Haddam (*Johnson*, 1946), and Southington (*Bunn*, 1947).

CLADONIA GRACILIS var. DILATATA f. DILACERATA (Floerke) Vainio (1930, p. 457). Meriden (*Johnson*, 1944).

CLADONIA GRACILIS var. DILATATA f. SQUAMULOSA (Schaer.) Sandst. (1930, p. 458). Colebrook (*Hale*, 1948) and Norfolk (*Hale*, 1949).

CLADONIA VERTICILLATA (Hoffm.) Schaer. (1930, p. 458). The following records are based on specimens that are indefinite as to form: Meriden (*Johnson*, 1945), Saybrook (1945), Southington (*Bunn*, 1944, with pale apothecia), West Hartford (1949), and Windsor Locks (1947).

CLADONIA VERTICILLATA f. AGGREGATA (Del.) Oliv. (1935, p. 50). East Lyme (1949), Ellington (1944), Farmington (1944), Goshen (1949), Meriden (*Johnson*, 1944), Norfolk (*Hale*, 1949), Southington (*Bunn*, 1944), Torrington (*Johnson*, 1946), and Warren (1947).

CLADONIA VERTICILLATA f. APOTICTA (Ach.) Vainio (1930, p. 460). Cheshire (*Mrs. Upson*, 1946), Meriden (*Johnson*, 1945), Morris (1946), Norfolk (*Hale*, 1949), Southington (*Bunn*, 1944), and Woodstock (*Kincaid & Neale*, 1947).

CLADONIA VERTICILLATA f. EVOLUTA (Th. Fr.) Stein (1930, p. 459). Andover (1948), Cheshire (*Mrs. Upson*, 1946), Colchester (1947), Colebrook (*Evans*, 1945; *Hale*, 1948), Farmington (1944), Hampton (1948), Norfolk (*Evans*, 1945; *Hale*, 1949), Southington (*Bunn*, 1944), Somers (1949), Sprague (1945), Warren (1947), Woodbridge (1944), and Woodstock (*Kincaid & Neale*, 1947).

CLADONIA VERTICILLATA f. PHYLLOCEPHALA (Flot.) Oliv. (1930, p. 461). Colebrook (1945), Meriden (*Johnson*, 1945), and Southington (*Bunn*, 1944).

CLADONIA MATEOCYATHA Robbins (1930, p. 461). The following records are based on sterile specimens or on specimens with immature podetia: Cheshire (*Mrs. Upson*, 1944), Colebrook (*Hale*, 1948), Orange (1944), Redding (1949), and Southington (*Bunn*, 1944).

CLADONIA MATEOCYATHA f. LEIOSCYPHA Evans (1930, p. 463). Bozrah (1945), Groton (1949), Newtown (1945), Plainfield (1948), and Southington (*Bunn*, 1944).

CLADONIA MATEOCYATHA f. SQUAMULATA Robbins (1930, p. 462). Bethany (*Johnson*, 1945), Colebrook (*Hale*, 1948), Groton (1949), Meriden (*Johnson*, 1945), Putnam (1945), Southington (*Bunn*, 1944), and Wolcott (1945).

CLADONIA PYXIDATA (L.) Hoffm. var. NEGLECTA (Floerke) Mass. f. SIMPLEX (Ach.) Harm. (1930, p. 464). Andover (1944), Branford (1944), Colebrook (1948), Cornwall (1944), East Haven (1945), East Granby (1947), East Lyme (1944), Farmington (1944), Glastonbury (*Miner*, 1944), Groton (1949), Killingly (1945), New Fairfield (1947), Norfolk (*Evans*, 1945; *Hale*, 1949), North Stonington (1946), Preston (1946), Prospect (1949), Salem (1947), Somers (1949), Torrington (1946), Warren (1947),

Washington (1949), Waterbury (1945), and Woodstock (*Kincaid & Neale*, 1947).

CLADONIA PYXIDATA var. NEGLECTA f. LOPHYRA (Ach.) Koerb. (1930, p. 465). Southington (*Bunn*, 1944).

CLADONIA PYXIDATA var. POCILLUM (Ach.) Flot. (1930, p. 465). Salisbury (1948).

CLADONIA CHLOROPHAEA (Floerke) Spreng. f. CARPOPHORA (Floerke) Anders (1930, p. 470). Goshen (*Underwood*, no date, Eckfeldt Herbarium, probably the earliest collection of the species for the town).

CLADONIA CHLOROPHAEA f. COSTATA (Floerke) Arn. (1930, p. 469). Cheshire (*Mrs. Upson*, 1946).

CLADONIA CHLOROPHAEA f. SIMPLEX (Hoffm.) Arn. (1930, p. 468). Colebrook (1945), Cornwall (1945), Newtown (1945), Salisbury (1945), Stafford (1944), Warren (1947), and Willington (1944).

CLADONIA GRAYI Merrill (1932, p. 159). Grayanic acid has been demonstrated in all the specimens listed below under the various forms of this species.

CLADONIA GRAYI f. CARPOPHORA Evans (1938, p. 20). Bozrah (1945), Colebrook (1948), Colchester (1945), East Lyme (1949), East Windsor (1945), Enfield (1945), Harwinton (1946), Lebanon (1947), Montville (1946), Newtown (1944), Norfolk (*Ball*, 1945; *Hale*, 1949), Ridgefield (1947), Roxbury (1949), Sprague (1945), Voluntown (1948), West Hartford (1944), and Woodbridge (1944).

CLADONIA GRAYI f. CYATHIFORMIS Sandst. (1935, p. 53). Andover (1944), Bethel (1947), Bloomfield (1949), Bozrah (1945), Bridgeport (1945), Brookfield (1944), Colchester (1947), Columbia (1948), East Lyme (1944), Ellington (1944), Farmington (1944), Granby (1949), Groton (*Mrs. Upson*, 1944), Hamden (1946), Killingly (1945), Lebanon (1947), Montville (1947), Newington (1944), Newtown (1944), Norwalk (1946), Orange (1945), Preston (1946), Redding (1947), Ridgefield (1947), Saybrook (1945), Sprague (1945), Stafford (1945), Thompson (1945), Union (1947), Warren (1947), Washington (1946), West Hartford (1944), West Haven (1945), and Wethersfield (1944).

*CLADONIA GRAYI f. **lacerata** f. nova, scyphi margine plus minusve profunde et irregulariter lacerato.—Meriden (*Johnson*, 1945, No. 6424).

In this remarkable form the margins of the cups are deeply and irregularly lacerate with narrow divisions.

CLADONIA GRAYI f. PROLIFERA Sandst. (1938, p. 19). East Lyme (1949).

CLADONIA GRAYI f. SQUAMULOSA Sandst. (1932), p. 160). Andover (1944), Avon (1949), Bethany (*Burkholder*, 1944), Brookfield (1944), Chaplin (*Neale*, 1946), Cheshire (*Mrs. Upson*,

1944), Coventry (1948), East Haven (1944), Granby (1949), Harwinton (1946), Newington (1944), Newtown (1945), Norfolk (*Evans*, 1948; *Hale*, 1949), North Haven (1945), Plainville (1945), Seymour (1948), Suffield (1949), Warren (1947), Washington (1946), West Haven (1945), and Westport (1949).

CLADONIA CRYPTOCHLOROPHAEA Asahina (1944, p. 600). Cryptochlorophaeic acid has been demonstrated in all the specimens upon which the following records are based: Bethlehem (*Spencer*, 1949), Cheshire (*Mrs. Upson*, 1944), Colebrook (*Hale*, 1947), Colchester (1945), Columbia (1948), Cornwall (1948), Coventry (1948), East Haven (1945), Ellington (1944), Hebron (1944), Manchester (1945), Meriden (*Burkholder*, 1944), New Britain (1941), Norfolk (*Evans*, 1945; *Hale*, 1949), Plainville (1945), Redding (1949), Saybrook (1945), Seymour (1948), Washington (1949), Woodbridge (1944), and Woodstock (*Kincaid & Neale*, 1947).

CLADONIA CONISTA (Ach.) Robbins f. SIMPLEX Robbins (1930, p. 472). Avon (1944), Bethel (1947), Bethlehem (*Spencer*, 1949), Canaan (1945), East Lyme (1944), Ellington (1944), Essex (1945), Norfolk (1948), North Haven (1945), Preston (1946), Ridgefield (1947), Somers (1949), Stafford (1944), Tolland (1949), Union (1947), Warren (1947), Washington (1949), Willington (1944), Woodbridge (1944), and Woodbury (*Sinnott*, 1944).

These records are based on specimens in which crystals of the substance H (see Evans, 1944, p. 602) have been demonstrated.

CLADONIA FIMBRIATA (L.) Fr. (1930, p. 473). Chaplin (*Neale*, 1946), Colebrook (*Evans*, 1944; *Hale*, 1948), Ellington (1944), Marlboro (1945), Meriden (*Johnson*, 1945), Scotland (*Johnson*, 1946), and Southington (*Bunn*, 1944).

The earlier record for Colebrook (*Nichols*, 1912, 1935, p. 53) was based on specimens of *C. Grayi* f. *cyathiformis* (1944, p. 598).

CLADONIA MAJOR (Hag.) Sandst. (1935, p. 54). Scotland (*Johnson*, 1946), the fifth station in Connecticut for this unusual species.

*CLADONIA CORNUTORADIATA f. SUBULATA (L.) Sandst. Abhandl. Naturw. Ver. Bremen **21:** 373. 1912. *Lichen subulatus* L. Sp. Plant. 1153. 1753 (in part). *Cladonia fimbriata* γ. *cornutoradiata* γ.[2] *subulata* Vainio, Acta Soc. F. et Fl. Fennica **4:** 282. 1887. Norfolk (*Hale*, 1949), the second station in Connecticut for this northern species.

The record for the first station, in the town of Goshen (1938, p. 22), was based on specimens of f. *radiata* (Schreb.) Sandst., in which the podetia form distinct cups with marginal proliferations.

In f. *subulata* the podetia are cupless, cylindrical structures, simple or sparingly and irregularly branched with closed axils. In both forms the podetial surface is sorediose throughout the greater part of its extent.

CLADONIA NEMOXYNA (Ach.) Nyl. (1930, p. 475). Andover (1948), Avon (1944), Columbia (1948), Enfield (1945), Farmington (1944), Hampton (1948), Killingly (1945), Lisbon (1947), Mansfield (1945), Milford (1931), Norfolk (*Evans*, 1945; *Hale*, 1949), North Haven (1945), Putnam (1945), Saybrook (1945), Scotland (*Johnson*, 1945), Seymour (1948), Sprague (1945), Thompson (1945), Union (1947), Warren (1947), Washington (1949), Waterbury (1945), Westport (1947), Willington (1944), and Woodstock (*Kincaid & Neale*).

Homosekikaic acid, the characteristic lichen-substance of *C. nemoxyna*, has been demonstrated in all the specimens of the species that are listed in the present report.

CLADONIA NEMOXYNA f. FIBULA (Ach.) Vainio (1930, p. 477). Bethel (1949), Colebrook (1945), North Haven (1945), Southington (*Bunn*, 1944), Suffield (1949), and Warren (1947).

CLADONIA NEMOXYNA f. PHYLLOCEPHALA Arn. (1930, p. 477). Branford (1945).

CLADONIA NEMOXYNA f. REI (Schaer.) Anders (1938, p. 23). Branford (1945) and Norfolk (1948).

CLADONIA OCHROCHLORA Floerke (1935, p. 55). Cheshire (*Mrs. Upson*, 1944), Ellington (1944), Redding (1949), and Southington (*Bunn*, 1944). A relatively rare species now known from eleven towns in the state.

CLADONIA CONIOCRAEA (Floerke) Spreng. f. CERATODES (Floerke) Dalla Torre & Sarnth. (1930, p. 479). Andover (1948), Avon (1949), Branford (1926, listed, 1930, p. 482, as *C. borbonica* f. *cylindrica*, earliest Branford record for the species), Bolton (1944), East Lyme (1944), Ellington (1944), Enfield (1945), Groton (1949), Hampton (1948), Killingworth (1932, earliest record for town), Lebanon (1947), Lisbon (1947), Manchester (1945), Montville (1946), New Fairfield (1947), Norfolk (*Evans*, 1945; *Hale*, 1949), Norwalk (1946), Old Saybrook (1931, listed, 1932, p. 161, as *C. borbonica* f. *cylindrica*), Redding (1947), Saybrook (1945), Somers (1949), Southington (*Bunn*, 1944), Stratford (*Mrs. Miner*, 1945), Tolland (1944), Vernon (1948), Waterbury (1945), Watertown (1949), West Haven (1945), Woodbridge (1944), and Woodstock (*Neale*, 1946).

CLADONIA CONIOCRAEA f. EXPANSA (Floerke) Sandst. (1932, p. 160). Norfolk (1948).

CLADONIA CONIOCRAEA f. PHYLLOSTROTA (Floerke) Vainio (1930, p. 481). Cheshire (*Mrs. Upson*, 1944), Cornwall (*Johnson*, 1946), Norfolk (*Hale*, 1949), and Saybrook (1945).

CLADONIA CONIOCRAEA f. PYCNOTHELIZA (Nyl.) Vainio (1932, p. 161). Ellington (1944), Norfolk (*Hale*, 1949), Seymour (1948), and Southington (*Bunn*, 1945).

CLADONIA CONIOCRAEA f. ROBUSTIOR (Harm.) Sandst. (1932, p. 161). Southington (*Bunn*, 1945) and Tolland (1944).

CLADONIA CONIOCRAEA f. STENOSCYPHA (Stuckenberg) Sandst. (1938, p. 24). Bethlehem (1949), Branford (1945), Goshen (1949), Norfolk (*Hale*, 1949), and Southington (*Bunn*, 1947).

CLADONIA CONIOCRAEA f. SUBPELLUCIDA (Aigr.) Anders (1944, p. 607). Washington (1949).

CLADONIA CONIOCRAEA f. TRUNCATA (Floerke) Dalla Torre & Sarnth. (1930, p. 480). Andover (1948), Avon (1949), Ellington (1944), Groton (1949), Manchester (1945), Norfolk (*Hale*, 1949), Saybrook (1945), Somers (1949), Southington (*Bunn*, 1944), Tolland (1944), and Vernon (1949).

CLADONIA BORBONICA (Del.) Nyl. (1930, p. 481).

The material of *Cenomyce borbonica* Del., upon which this species was based, was collected on the island of Réunion and is preserved in the Paris Museum. Vainio included the species (1894, p. 343) among the varieties of *C. fimbriata*, under the name γ_1. *borbonica* (Del.) Vainio, and assigned to it an extensive geographical distribution, citing stations in Madagascar and other African islands, in Asia, in Australasia, and in North and South America. The North American stations, however, were confined to Mexico and the West Indies.

Apparently Allen (1930, p. 93) was the first to report *C. borbonica* from Canada and the United States. He listed specimens from the Gaspé Peninsula, Quebec, and noted the occurrence of the species also in Vermont, Alabama, and Florida. Later in the same year (1930, p. 481) the writer included *C. borbonica* among the *Cladoniae* found in Connecticut and proposed f. *cylindrica* Evans and f. *squamulosa* Robbins as new forms. At that time the species was recorded from only 18 towns in the state. Subsequent explorations, however, have increased the number of towns to 74 (1932, p. 161; 1935, p. 56; 1935, p. 24, 1944, p. 607). The species has been reported also from numerous other localities in eastern North America.

In 1940 (p. 717) Asahina showed that a series of specimens of *C. borbonica* f. *cylindrica* from Connecticut and New Jersey con-

tained grayanic acid, as well as fumarprotocetraric acid, and that the closely related *C. Balfourii* contained fumarprotocetraric acid only.

In 1946 (p. 250) Des Abbayes reported *C. borbonica* from Fayal, Flores, and Pico, three islands of the Azores group, and in 1947 (p. 108) referred his specimens more definitely to *C. borbonica* f. *cylindrica.* In doing so he noted that they agreed with specimens of this form from the United States determined by the writer. At the same time he pointed out that the material from the Azores and from the United States differed in certain important respects from the original specimens of *C. borbonica* in the Paris Museum. In these, according to his account, the podetia are branched slender structures, abruptly dilated to form small but distinct cups. In the specimens of f. *cylindrica,* on the contrary, the podetia are not dilated and form indistinct cups. In view of these differences Des Abbayes questions the advisability of retaining the North American and Azorean plants in *C. borbonica* and suggests that they may represent an undescribed species. Asahina has since reported to the writer, in a letter dated March 15, 1949, that he could find no grayanic acid in a specimen of *C. borbonica* from Réunion. This specimen, which he had received from Des Abbayes, had been determined by Nylander.

It thus appears that the specimens referred by American students to *C. borbonica* differ both morphologically and chemically from the specimens of *C. borbonica* collected on the island of Réunion. The writer feels convinced, therefore, that these should be separated out as a distinct species, as suggested by Des Abbayes. Since the epithet *cylindrica* has not been used as the name of a species in the genus *Cladonia,* the simplest procedure would be to elevate *C. borbonica* f. *cylindrica* to specific rank, as follows:—

*CLADONIA **cylindrica** (Evans) comb. nov. *C. borbonica* f. *cylindrica* Evans, Trans. Connecticut Acad. **30:** 482. 1930. In addition to the stations already listed under *C. borbonica* f. *cylindrica* the following new stations for the species may be reported: Andover (1948), Avon (*Miner,* 1944), Bethel (1947), Branford (1941), East Lyme (1944), Ellington (1944), Granby (1949), Meriden (*Johnson,* 1943, 1944), Milford (1944), Montville (1946), Norfolk (*Hale,* 1949), Orange (*Evans,* 1926, listed, 1930,

p. 396, as *C. bacillaris*), Saybrook (1945), Somers (1949), Washington (1949), and Windsor Locks (1947).

The primary squamules of *C. cylindrica* grow in loose mats and tend to disappear from old colonies. They are of small size, and even the best-developed examples rarely exceed 1 mm. in length and in width. Many of the squamules are irregularly crenulate along the broad apical margins; otherwise they are undivided or vaguely incised.

The podetia in characteristic specimens are rarely more than 10 mm. in height and 1 mm. in diameter; many, in fact, are distinctly shorter and narrower. In colonies growing on a subvertical substratum the podetia in many cases, as shown in Fig. 3, curve into a suberect position and form loose clusters, in which the elements are parallel with one another. The majority of the podetia are sterile, unbranched cylinders, which contract abruptly at the rounded, obtuse, or subacute apices, or else form narrow and indistinct cups, which may or may not give off short marginal spines. Fertile podetia, which are usually sparingly produced, are tipped with large apothecia or with irregular rings of smaller apothecia. The podetia are destitute of a cortex, except perhaps at the very base, and are characterized by the presence of farinose soredia, replaced toward the base by larger bodies in the form of coarse granules or minute squamules. Larger squamules, however, are normally lacking. In areas where neither soredia nor larger bodies are present the podetial surface appears whitish and opaque, since the cartilaginous layer is rarely exposed.

Perhaps the closest relative of *C. cylindrica* in the Connecticut flora is the common and variable *C. coniocraea*. This species in its usual development is more robust than *C. cylindrica*, its primary squamules are larger and more complex, and its podetia are considerably taller. These podetia, in f. *ceratodes* at least, taper more gradually and to sharper points than in *C. cylindrica*, and the soredia, which are produced in abundance, are uniformly farinose and not intermingled with larger bodies. Although both species turn a vivid red when treated with P, the presence of grayanic acid will distinguish *C. cylindrica* chemically from *C. coniocraea*, in which this substance is lacking.

In a general way the podetia of *C. cylindrica* resemble those of the red-fruited *C. bacillaris* in certain of its forms, and sterile

specimens of the two have been confused. The application of P will at once distinguish them. In *C. cylindrica* a red color at once appears; in *C. bacillaris* there is no color-change whatever. The following forms of *C. cylindrica* may be distinguished:

*Cladonia cylindrica f. **ramosa** (Evans) comb. nov. *C. borbonica* f. *ramosa* Evans, Trans. Connecticut Acad. **35:** 607. 1944.

*Cladonia cylindrica f. **scyphifera** f. nova, podetia simplicia, scyphifera, a stipite-cylindrico sensim dilatata, scyphis angustis, margine integro aut irregulariter dentato.—On a stump in damp woods. Andover (*Evans*, 1948, No. 6830).

In f. *scyphifera* the podetia are more robust than in the typical form and increase gradually in diameter from about 1 mm. at the base to about 2 mm. at the apex, where shallow but more or less distinct cups can be distinguished. The margins of the cups are entire or irregularly dentate, and some of the teeth are tipped with rudimentary apothecia.

*Cladonia cylindrica f. **squamulosa** (Robbins) comb. nov. *C. borbonica* f. *squamulosa* Robbins in Evans, Trans. Connecticut Acad. **30:** 482. 1930.—Southington (*Bunn*, 1945, 1947), the tenth town in Connecticut where this form has been collected. It is characterized by the presence of distinct podetial squamules in greater or less abundance.

*Cladonia pityrea (Floerke) Fr. var. Zwackhii Vainio f. phyllophora (Mudd) Vainio, Acta Soc. F. et Fl. Fennica **10:** 355. 1894. *C. pyxidata* µ. *pityrea* g. *phyllophora* Mudd, Mon. Brit. Clad. 16. 1865. Tolland (1944). The podetia in this form are squamulose and lack both cups and soredia.

Cladonia pityrea var. Zwackhii f. squamulifera Vainio (1930, p. 485). Cheshire (*Mrs. Upson*, 1946) and Voluntown (1948).

Cladonia pityrea var. Zwackhii f. subacuta Vainio (1930, p. 485) Andover (1948), Bolton (1944), Bristol (1934), Canaan (1945), East Lyme (1944), Hampton (1948), Norfolk (*Hale*, 1949), Union (1947), Warren (1947), and West Haven (1945).

Group Foliosae

Cladonia Robbinsii Evans (1944, p. 611). Andover (1944), Bethany (1945), Cheshire (1948), Chester (1945), Colchester (1947), East Granby (1949), East Lyme (1944), Glastonbury (1944), Groton (*Mrs. Upson*, 1944), Lisbon (1936), Meriden (*Burkholder*, 1944), Newington (1944), New London (1936), Plymouth (1949), Preston (1946), Redding (1949), Saybrook (1945), Stonington (1949), Thompson (1945), Wethersfield (1944), Woodbridge (1944), and Woodbury (*Sinnott*, 1944).

The characteristic lichen-substances of *C. Robbinsii*, as pointed out in the original description (1944, p. 610), are usnic acid, barbatic acid, and the unknown substance F. The species in consequence is P−. In the related *C. foliacea* (Huds.) Willd. usnic acid is likewise present, but the barbatic acid is replaced by fumarprotocetraric acid. This species in consequence is P+ red. Asahina, in a letter dated November 4, 1948, has confirmed the presence of barbatic acid in *C. Robbinsii*.

Cladonia Robbinsii f. squamulosa Evans (1944, p. 613). Meriden (*Burkholder*, 1944), the second known station for this unusual form.

Cldonia strepsilis (Ach.) Vainio (1930, p. 487). Bozrah (1945), Bridgeport (1945), Farmington (1944), Groton (1949), Hebron (1944), Milford (1944), Monroe (1946), Newtown (1944), Norfolk (1945), Norwalk (1946), Redding (1949), Somers (1949), Sprague (1945), Stonington (1949), Trumbull (1945), Waterbury (1945), and Wethersfield (1944).

The specimens upon which these records are based are indefinite as to form and mostly sterile. All have been tested for strepsiline with positive results and the same thing is true of the specimens listed under the following forms:

Cladonia strepsilis f. compacta Anders (1932, p. 163). Avon (1949), Beacon Falls (1928), Bethany (1945), Norfolk (*Hale*, 1949), Prospect (1949), and Southington (*Bunn*, 1945).

Cladonia strepsilis f. coralloidea (Ach.) Vainio (1930, p. 489). Manchester (1945), Meriden (*Johnson*, 1944), Norfolk (1945), Southington (*Bunn*, 1944), and South Windsor (1945).

Cladonia strepsilis f. glabrata Vainio (1930, p. 488). East Lyme (1944).

Cladonia strepsilis f. subsessilis Vainio (1930, p. 489). Brookfield (1944), Killingly (1945), Meriden (*Johnson*, 1945), Southington (*Bunn*, 1945), South Windsor (1945) and Tolland (1944).

Group Ochroleucae

Cladonia piedmontensis Merrill (1930, p. 490).

Usnic acid is the only lichen-substance that has been demonstrated in this species (see Asahina, 1943, p. 244, and Evans, 1944, p. 616). The following records are based on sterile specimens: Bozrah (1945), Meriden (*Johnson*, 1943), and Vernon (1946). These, as well as the specimens listed under the following forms, have been tested for usnic acid and have yielded the characteristic crystals of this substance.

CLADONIA PIEDMONTENSIS f. EPIPHYLLA Robbins (1935, p. 57). Groton (*Mrs. Upson*, 1944).

CLADONIA PIEDMONTENSIS f. LEPIDIFERA (Vainio) Robbins (1930, p. 491). Bethany (1944), Glastonbury (1944), Meriden (*Johnson*, 1945), Newington (1944), Southbury (*Johnson*, 1944), Southington (*Bunn*, 1944), Torrington (1944), and Wethersfield (1944).

CLADONIA PIEDMONTENSIS f. OBCONICA Robbins (1930, p. 491). East Granby (1949) and Southington (*Bunn*, 1944).

CLADONIA PIEDMONTENSIS f. SQUAMOSISSIMA Robbins (1932, p. 164). Southington (*Bunn*, 1949).

CLADONIA PIEDMONTENSIS f. SQUAMULOSA Robbins (1930, p. 491). Bethany (1944), East Granby (1949), Montville (1947), and Southington (*Bunn*, 1944).

At the close of 1943 there were 9 towns in Connecticut from which no *Cladoniae* had been reported. This gap has now been filled, and specimens of the genus from each of the 169 towns in the state are now preserved in the herbarium of Yale University. Owing to the careful exploration of Mr. James M. Bunn, the town of Southington, with 45 species to its credit, stands at the head of the list. In this single town, therefore, all but 15 of the 60 species known from the entire state have been found. In the town of Meriden, which follows closely with 41 species to its credit, Mr. Harry L. Johnson has been especially active and has discovered a number of unusual species and forms. North Branford, with 40 species, comes next in order, followed by Madison (39 species), Salisbury (38), Branford (35), North Haven (34), Cheshire and Killingworth (33 each), Norfolk and Wallingford (32 each), Goshen and Guilford (31 each), and Glastonbury and Old Saybrook (30 each).

At the close of 1943 *C. cristatella*, which at that time had been reported from 134 towns, was apparently the most abundant species in the state, although *C. subtenuis*, listed from 133 towns, was a close second. The latter species, since reported from 15 additional towns, now heads the list with 158 towns to its credit. In other words *C. subtenuis* has been collected in all but 11 towns in the state. The following species are not far behind in order of abundance: *C. Grayi* (reported from 157 towns), *C. bacillaris* (from 151), and *C. cristatella* (from 150), The following come next in order: *C. pleurota* (148 towns), *C. furcata* (134), *C. subcariosa* (127), *C. coniocraea* (119), *C. apodocarpa* (106), *C. ne-*

moxyna (102), *C. caespiticia* (101), *C. submitis* (98), *C. uncialis* (95), *C. capitata* (91), and *C. verticillata* (88).

The rarities of the Connecticut flora, each known from fewer than 10 towns apiece, are essentially the same as at the close of 1943. A list of these rarities follows: *C. alpestris* (reported from 3 towns), *C. Beaumontii* (from 1), *C. carassensis* (1), *C. cariosa* (3), *C. cenotea* (4), *C. cornutoradiata* (2), *C. decorticata* (2), *C. deformis* (2), *C. didyma* (6), *C. digitata* (1), *C. glauca* (3), *C. major* (4), *C. merochlorophaea* (1), *C. mitis* (1), *C. Norrlini* (3), *C. scabriuscula* (2), and *C. turgida* (6).

Several species of *Cladonia* belonging to the flora of the northeastern United States have not yet been found in Connecticut. Some of these, such as *C. alpicola* (Flot.) Vainio, *C. amaurocraea* (Floerke) Schaer., *C. cornuta* (L.) Hoffm., *C. cyanipes* (Sommerf.) Nyl., and *C. gonecha* (Ach.) Asahina, are distinctly northern and are hardly to be expected south of the mountains of Maine, New Hampshire and Vermont. Others, such as *C. leporina* Fr., *C. polycarpia* Merrill, and *C. Ravenelii* Tuck., are southern and have not been found north of New Jersey; *C. polycarpia*, in fact, is not definitely known north of Virginia. It would not be surprising, however, if one or more of the following species should be discovered within the state: *C. acuminata* (Ach.) Arn., *C. calycantha* Del., *C. crispata* (Ach.) Flot., *C. degenerans* (Floerke) Spreng., *C. floridana* Vainio, and *C. impexa* Harm. The first of these is already known from Vermont and Pennyslvania; the second from the Cape Cod region, eastern Long Island, New Jersey, and Pennsylvania; the third from Vermont, New York, and Pennsylvania; the fourth from Vermont, New York, and Pennsylvania; the fifth from the Cape Cod region, eastern Long Island, New Jersey, and Pennsylvania; and the sixth from the Cape Cod region and New Jersey. Two of these species, *C. crispata* and *C. impexa*, have already been reported from Connecticut (1930, pp. 386 and 430), but the records were based on incorrect determinations (1938, p. 9, and 1944, p. 569).

Osborn Botanical Laboratory,
Yale University.

LITERATURE CITED

ALLEN, A. F. 1930. Some *Cladoniae* from the Cap Chat River and vicinity, Gaspé Peninsula, Quebec. Rhodora **32**: 91–94.

ASAHINA, Y. 1938. Mikrochemischer Nachweis der Flechtenstoffe. IX. Mitteilung. Jour. Jap. Bot. **14**: 767–773.

————. 1940. Chemismus der *Cladonien* unter besonderer Berücksichtigung der japanischen Arten. I. *Cladonia chlorophaea* und verwandte Arten. Jour. Jap. Bot. **16**: 709–727.

————. 1941. Chemismus der *Cladonien* unter besonderer Berücksichtigung der japanischen Arten [Fortsetzung]. Jour. Jap. Bot. **17**: 620–630.

————. 1942. Chemismus der *Cladonien* unter besonderer Berücksichtigung der japanischen Arten (Fortsetzung). Jour. Jap. Bot. **18**: 489–502, 663–683.

————. 1942a. Lichenologische Notizen (XIX). Jour. Jap. Bot. **18**: 620–625.

————. 1943. Chemismus der *Cladonien* unter besonderer Berücksichtigung der japanischen Arten (Fortsetzung). Jour. Jap. Bot. **19**: 47–56, 227–244.

BRAEDEN, T. W., J. KEANE, and T. J. NOLAN. 1944. The chemical constituents of lichens found in Ireland. *Cladonia sylvatica* (L.) Harm. emend. Sandst. Sci. Proc. Roy .Dublin Soc. **23**: 197–200.

DEGELIUS, G. 1940. Contributions to the lichen flora of North America. I. Lichens from Maine. Arkiv för Bot. **30A**[1]: 1–62.

DES ABBAYES, H. 1937. Contributions nouvelles à la connaissance des Lichens armoricains—III. Bull. Soc. Sci. Bretagne **14**: 154–164.

————. 1939. Revision monographique des *Cladonia* du sous-genre *Cladina* (Lichens). Bull. Soc. Sci. Bretagne **16**[2]: 1–156.

————. 1946. Les *Cladonia* (Lichens) des Iles Acores. Portugal. Acta Biol. **1**: 243–254.

————. 1947. Lichens des îles Açores récoltés en 1937 par V. et P. Allorge. Rev. Bryol. et Lichénol. **16**: 105–112.

EVANS, A. W. 1930. The Cladoniae of Connecticut. Trans. Connecticut Acad. **30**: 357–510.

————. 1932. Notes on the *Cladoniae* of Connecticut. Rhodora **34**: 121–142, 153–164.

————. 1935. Notes on the *Cladoniae* of Connecticut—II. Rhodora **37**: 33–57.

————. 1938. Notes on the Cladoniae of Connecticut—III. Rhodora **40**: 4–26.

————. 1943. Microchemical studies on the genus *Cladonia* subgenus *Cladina*. Rhodora **45**: 417–438.

————. 1944. Supplementary report on the *Cladoniae* of Connecticut. Trans. Connecticut Acad. **35**: 519–626.

FINK, F. 1935. The Lichen Flora of the United States, i–x, 1–426. Ann Arbor.

LAMB, I. M. 1938. Lichenological Notes from the British Museum Herbarium.—II. Jour. Bot. **76**: 153–165.

ROBBINS, C. A. 1924. Some new *Cladonias*. Rhodora **26**: 145–148.

————. 1927. The identity of *Cladonia Beaumontii*. Rhodora **29**: 133–138.

SANDSTEDE, H. 1922. Die *Cladonien* des nordwestdeutschen Tieflandes und der deutschen Nordseeinseln. III. Abhandl. Naturw. Ver. Bremen **25**: 89–243.

————. 1930. *Cladoniae* exsiccatae. Berichtigte Uebersicht, 1–63. Westerstede.

————. 1931. Die Gattung *Cladonia*. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz **9**, Abt. 4[2]: 1–531.

————. 1938. Ergänzungen zur Wainio's "Monographia *Cladoniarum* universalis" unter besonderer Berücksichtigung der Verhaltens der *Cladonien* zur Asahina's Diaminprobe. Fedde's Repert. Spec. Nov. Regn. Veg. **103** (Beih.): 1–103.

————. 1938a. *Cladoniaceae* A. Zahlbr. II. Die Pflanzenareale IV, Heft 7: 83–92.

VAINIO, E. 1887. Monographia *Cladoniarum* universalis. Pars Prima, Acta Soc. F. et Fl. Fennica **4**: 1–560.

————. 1894. Monographia *Cladoniarum* universalis. Pars Secunda. Acta Soc. F. et Fl. Fennica **10**: 1–498.

————. 1930. *Cladoniae* Hungaricae a G. Timkó lectae. Magyar Bot. Lapok 1930: 1–22.

EXPLANATION OF PLATE 1161

Fig. 1. C. FARINACEA, Southington, Connecticut, *J. M. Bunn*, 1945, No. 6447. Fig. 2. C. FARINACEA, Punta Arenas, Patagonia, *P. Hariot*, 1882 (?), No. 15667, type of *C. furcata* γ. *scabriuscula* f. *farinacea* Vainio. Fig. 3. C. CYLINDRICA, Southington, *J. M. Bunn*, 1945, No. 6450. All × 1½. The writer wishes to thank Dr. John R. Reeder for the photographs used in the preparation of this plate.

A SUBSTITUTE FOR FORMALDEHYDE AND ALCOHOL IN PLANT COLLECTING

H. E. MOORE, JR.

WHILE preparing for three months of field work in Mexico during the fall of 1949, I was referred by Dr. George H. M. Lawrence of the Bailey Hortorium to a note by Swingle (Bot. Gaz. **90:** 333–34, 1930) concerning the use of water soluble oxyquinoline sulphate (now sold as hydroxyquinoline sulphate) as a field preservative for plants on the Humbert-Swingle Madagascar plant exploration trip of 1928. The agent was described as a practically non-poisonous, non-corrosive disinfectant with high antiseptic and preservative properties but low germicidal action. It lacks the disagreeable pungent odor and the drying action on the skin of formaldehyde and is transportable in powder form, thereby eliminating the bulk of either alcohol or formaldehyde.

Schultes has discussed the use of formaldehyde (RHODORA **49:** 54–60, 1947) and Hodge of alcohol (op. cit. 207–210) by the plant collector in the field but apparently the suitability of hydroxyquinoline sulphate has been overlooked. Previous struggles with the discomfort of acrid fumes and rough dry hands and the inconvenience of transport attendant on the use of formaldehyde in the technique described made the substitution of a convenient and satisfactory chemical in powder form seem worth further trial. Consequently a stock of packets was made, each containing 10 grams of the material or sufficient to make a quart or liter of