

## MOELLEROPSIS (LECANORALES) AS A COMPONENT OF ERIODERMA HABITATS IN ATLANTIC CANADA\*

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One of the many sterile epiphytic lichens from high humidity forest habitats in Atlantic Canada has been identified as belonging to *Moelleropsis* (Lecanorales). The assignment was made on the basis of the granular, virtually undifferentiated thallus which is remarkably similar to that of the European *M. nebulosa* (Hoffm.) Gyel., but pseudofruticose ramifications from the thallus surface and fruiting bodies were not observed. The Canadian *Moelleropsis* is described as a subspecies of *M. nebulosa*, namely ssp. *frullaniae*. The epithet refers to the hepatic *Frullania tamarisci* ssp. *asagrayana* which is the preferred substrate of the lichen. The taxonomic difficulties in assessing cell size differences between the symbionts of closely related lichens are outlined.

Un type de lichen stérile épiphytique parmi beaucoup qui se trouvent dans les forêts à haute humidité dans le Canada Atlantique a été identifié comme faisant partie des *Moelleropsis* (Lecanorales). Cette classification a été faite à cause du thallus granulé et pratiquement non-différentié qui est très semblable à celui du lichen européen *M. nebulosa* (Hoffm.) Gyel., sauf que des ramifications pseudo-fruticoses à la surface du thallus et les corps reproducteurs n'ont pas été observés. Le lichen canadien *Moelleropsis* est décrit comme étant une sous-espèce de *M. nebulosa*, c'est-à-dire ssp. *frullaniae*. Cette épithète rapporte à l'hépatique *Frullania tamarisci* ssp. *asagrayana* qui est le substrat préféré de ce lichen. Les difficultés taxonomiques rencontrés dans l'évaluation des différences en dimensions des cellules entre les symbiontes des lichens de proche parenté sont discutées.

### Introduction

In the course of ecological observations in Nova Scotian habitats of *Erioderma mollissimum* (Samp.) Du Rietz and *E. pedicellatum* (Hue) P. M. Jørg. (Maass 1983), an unusual cyanophilic lichen was observed which, by comparison with one of Zahlbruckner's exsiccatae from the European Alps (Kryptogamae Exsiccatae # 1543) and similar specimens from Europe, proved to be closely related or identical to *Moelleropsis nebulosa* (Hoffm.) Gyeln. (synonyms: *Pannaria nebulosa* (Hoffm.) Nyl. and *P. pezizoides* f. *nebulosa* Ach.; order Lecanorales). All the North American specimens seen so far were without apothecia, but the granular nature of their bluish green areolate thallus (Fig 1) is so characteristic that a confusion of the lichen with other subcrustose taxa is unlikely (for morphological descriptions and keys see Gyelnik 1940, James in Duncan 1970, Dahl and Krog 1973, and Jørgensen in Poelt and Vezda 1977). A comparison of the morphological features of the Canadian *Moelleropsis* and of European *M. nebulosa* has therefore been made to evaluate the taxonomic status of the Canadian populations. In addition, ecological observations on the habitats of *Moelleropsis* are reported.

### Methods

*Scanning electron microscopy.* Specimens were prepared by freeze drying or critical point drying followed by sputter coating with gold. They were examined and photographed on a JEOL JXA-35 C instrument at voltages between 15-35 KV.

*Mass spectrometry (MS).* Mass spectra (70 eV) were recorded on a Du Pont 21-110B instrument using a direct introduction probe and samples were obtained by extraction of the lichens with acetone.

One-directional thin layer chromatography (TLC) was carried out using the procedures of Maass (1975).

### Results and Discussion

Scanning electron micrographs show that the mycobiont of the Nova Scotian lichen (Figs 2, 4, 5, 7, 8 and 10) is closely similar to the vegetative phase of the European species (Figs 3, 6, 9, and 11) apart from minor morphological differences which might be caused by differences in the climate, the substrate and/or the algal component. Each granule consists of concealed phycobiont colonies and a peripheral confluent layer of the mycobiont. The hyphae of this essentially single layered cortical envelope (Fig 14) are considerably broadened and irregularly folded, with the result that the surface of the granules appears lobulate (Figs 7-9). Most granules have an opening in the center which may facilitate gas exchange. The lobules of the Canadian lichen tend to have a smoother surface than those of European *M. nebulosa* and are generally less compacted and larger (6-16 x 5-6  $\mu\text{m}$ , as compared to 4-8 x 3-5  $\mu\text{m}$ ). Interspersed amongst the lobules, knob-like enlargements of the terminal ends of the hyphae also may be seen (Figs 8, 10 and 11). They are strikingly pronounced in material from Portugal which is also distinguished by the presence of numerous ovoid conidia (about 18 x 7  $\mu\text{m}$  large). It is possible that these conidia do not belong to *Moelleropsis* but to a parasitic lichen fungus. The granules are interconnected by a loose network of hyphae (Fig 4). In Figs 5 and 6, some straying hyphae can be seen which originate in the granules and form an alga-free zone at the edge of the thallus. They are smoother and larger (3-6  $\mu\text{m}$  in diameter) in the Canadian lichen than in European *M. nebulosa* (2.5-4  $\mu\text{m}$  in diameter), with a clearly rugose surface (and more knotty) and may appear as a densely woven whitish, very primitive hypothallus protruding from the edges. The differences are most readily observable under the light microscope but are also evident on scanning electron micrographs (compare Figs 4 and 9).

In the moist state, the rounded, finely rugose to smooth granules of the thallus (Fig 1) have a characteristic appearance, with their deep bluegreen colour in the centre imparted by the phycobiont and a whitish fuzzy halo by shiny fungal hyphae. At least some of the granules are easily detached and serve as vegetative propagules. Sometimes they were seen adhering to the backs of mites inadvertently collected with the specimens. Thus the granules of *Moelleropsis* may be regarded as soredia, in spite of claims to the contrary (Gyelnik 1940). Morphologically they are very similar to the soredia of *Parmeliella jamesii* S. Ahlner & P.M. Jørg.

The vegetative thallus of *Moelleropsis* does not contain a medulla, nor does it have a multi-layered cortex as in members of Pannariaceae. It is a largely undifferentiated crust in which the algae are confined to the soredia or soredioid granules. This applies to the Canadian lichen as well as to the European *M. nebulosa*. Sometimes the peripheral granules are distinctly flattened and assume the shape of squamules although internally these structures, which may be termed pseudosquamules, are undifferentiated like the sphaerical granules. Presumably the pseudosquamules arise by the differential growth rates of the two symbionts. Certainly the bluegreen striping which is visible in the pseudosquamule shown in Fig 1 must be a result of the relatively more rapidly advancing marginal hyphae. Pseudosquamules appear to be formed more frequently in the European counterpart and are often found on thalli that are densely covered by pseudofruticose (branched but undifferentiated) appendages. These appendages seem to be formed by the sequential formation and division of granules and may be regarded as very primitive isidia, because of their ability to fragment. Such more or less upright isidioid structures have not been seen in any of the Canadian specimens.

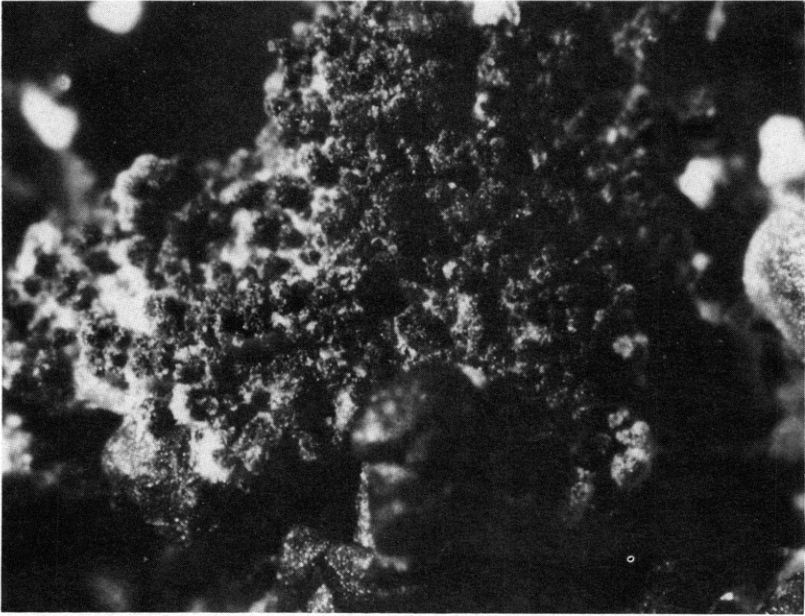


Fig 1. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Kemptville, on *Acer*) in the wet state. x 30.

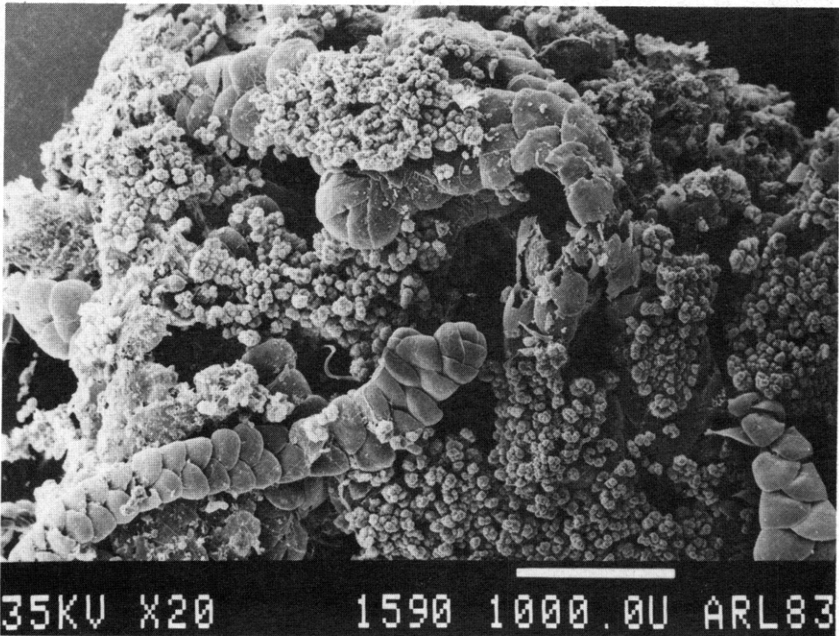


Fig 2. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Ash L. area, on *Abies* over *Frullania tamarisci* subsp. *asagrayana*). SEM, x 20.

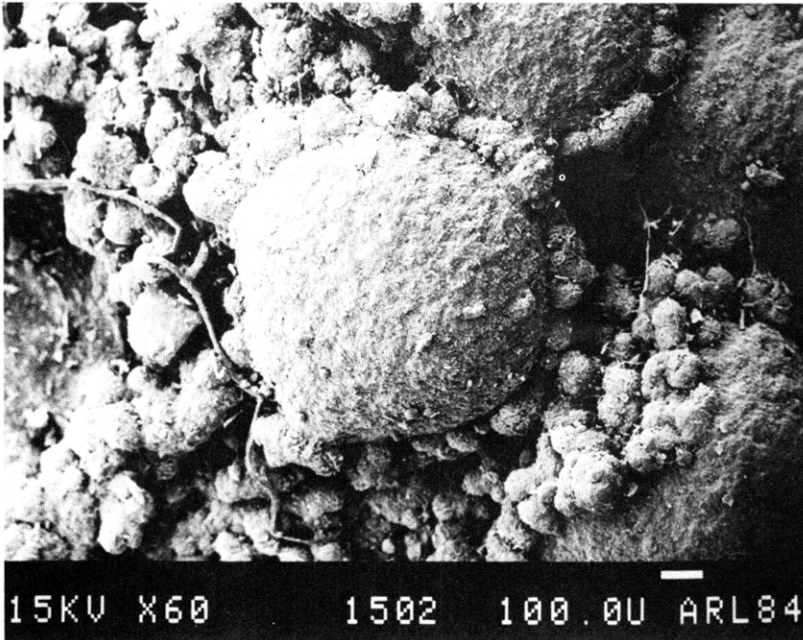


Fig 3. *Moelleropsis nebulosa* from France. Thallus with granules and apothecium. SEM x 60.

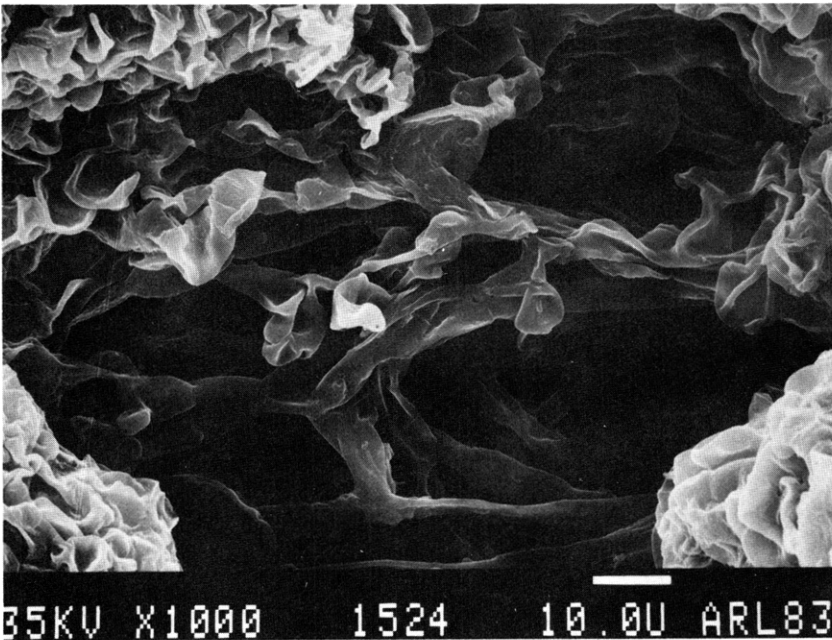


Fig 4. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Dufferin Mines, on *Abies*). Hyphae connecting the basal parts of the granules. SEM, x 1000.



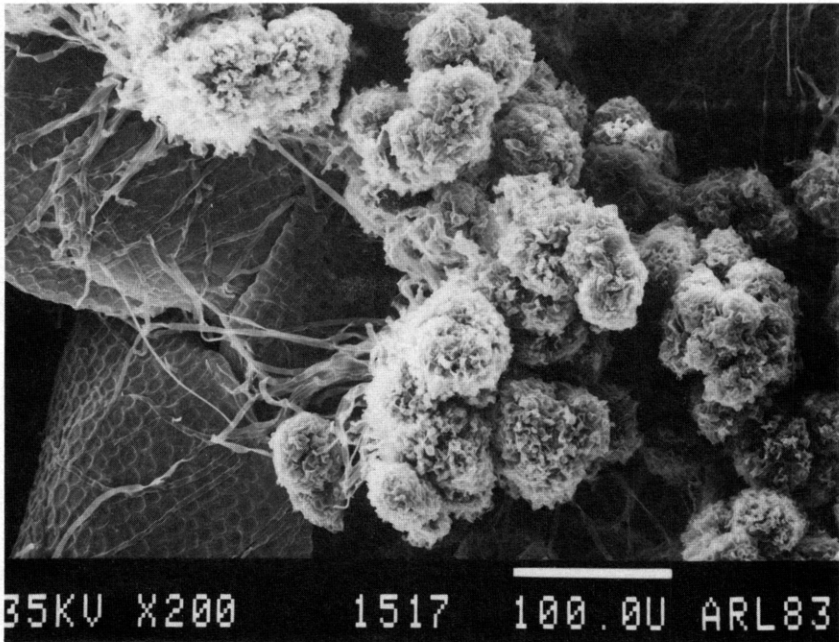


Fig 5. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Dufferin Mines, on *Abies* over *Frullania tamarisci* subsp. *asagrayana*). Note the granules and straying hyphae of the mycobiont. SEM, x 200.

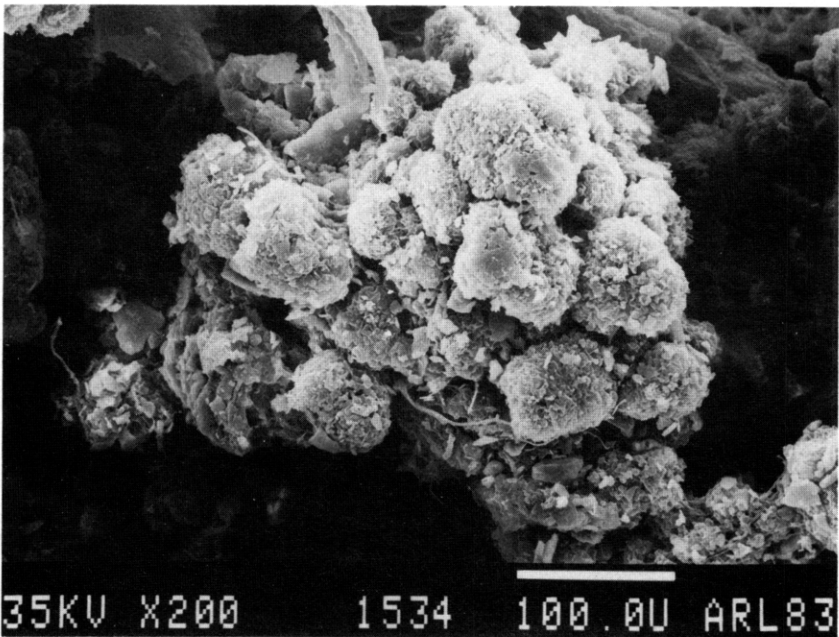


Fig 6. *Moelleropsis nebulosa* from Austria with a conglomerate of granules. Straying hyphae are visible in right upper edge of photograph and soil particles in lower left. SEM, x 200.

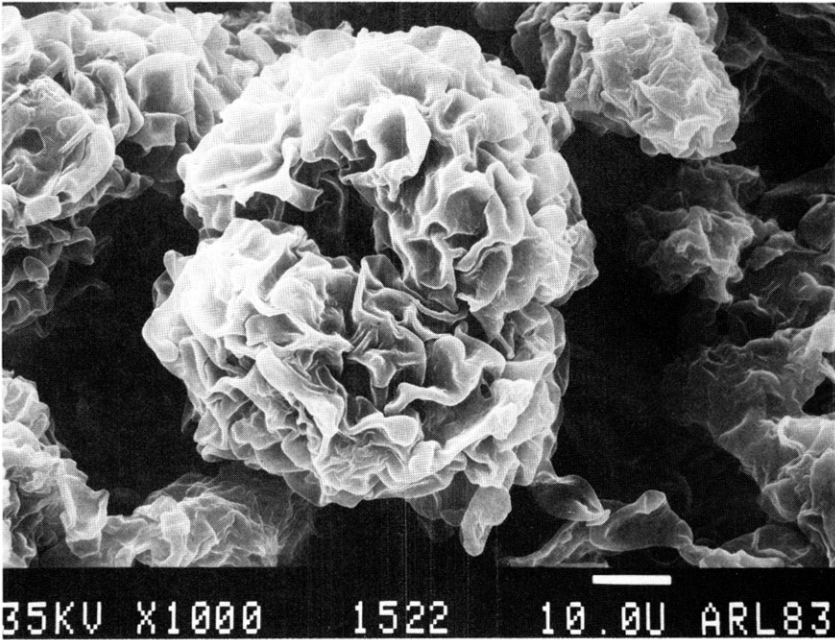


Fig 7. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Dufferin Mines, on *Abies*). View of a single granules which is covered by a confluent layer of lobulate hyphae had has an opening in the center. SEM, x 1000.

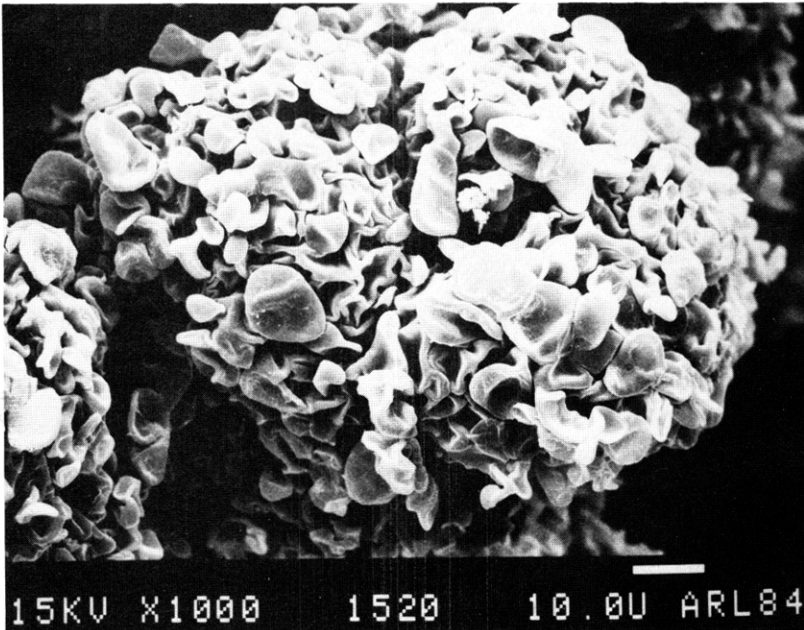


Fig 8. *Moelleropsis nebulosa* ssp. *frullaniae* from Newfoundland (Conne River Road, on *Abies*). Granule with many knob-like thickenings of hyphal ends. Lobules otherwise similar to those in Fig 7. SEM, x 1000.

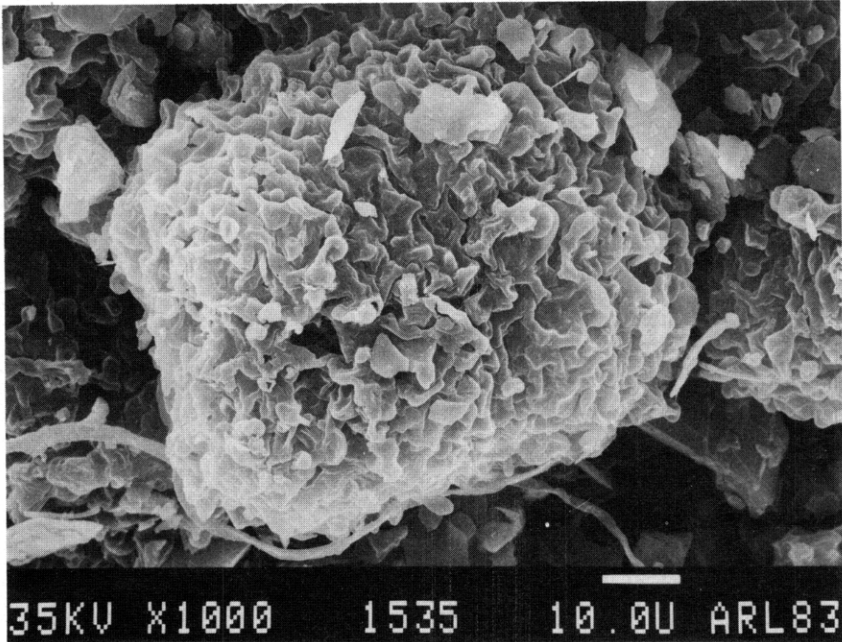


Fig 9. *Moelleropsis nebulosa* from Austria. Note the comparatively large granule with smaller, more densely packed lobules, as compared with the features seen in Figs 7 and 8. SEM, x 1000.

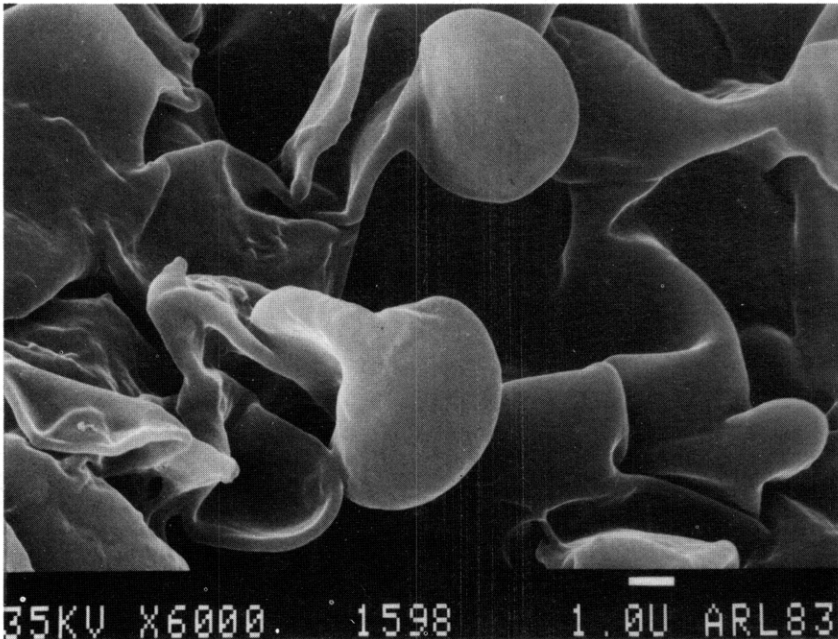


Fig 10. *Moelleropsis nebulosa* ssp. *frullaniae* from Nova Scotia (Ash L. area, on *Abies*). Close-up of confluent lobules. Note the presence of inflated hyphal ends. SEM, x 6000.

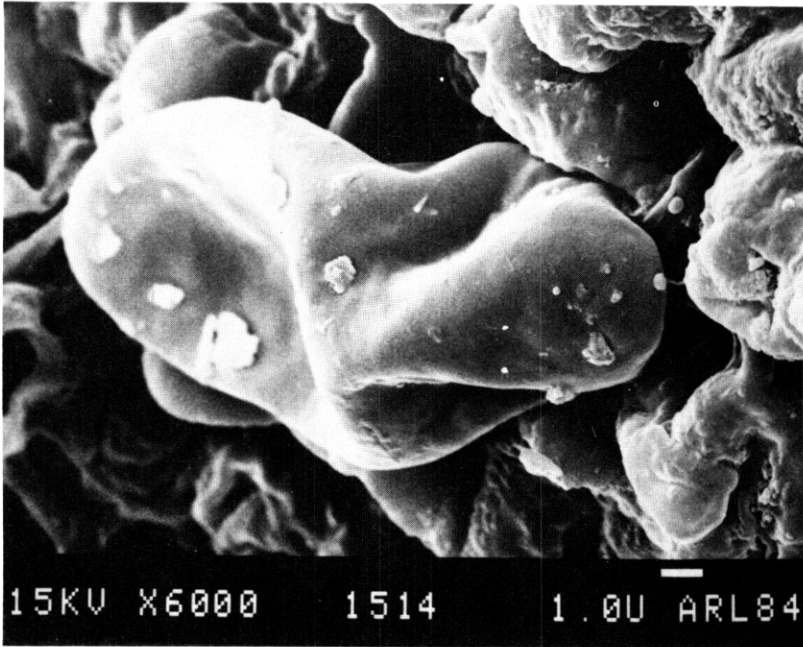


Fig 11. *Moelleropsis nebulosa* from France. Close-up of confluent lobules and of the knob-like inflation of a hyphal end. SEM, x 6000.

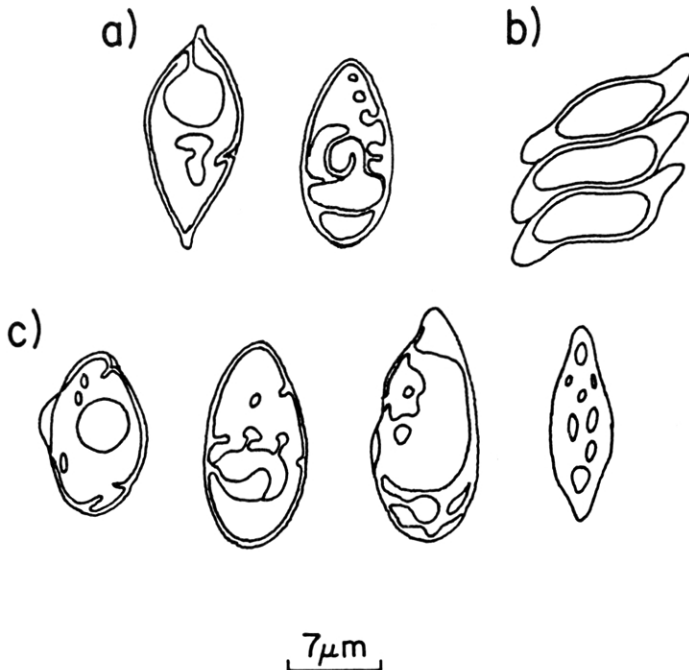


Fig 12. *Moelleropsis nebulosa*. Mature spores with pitted ornamentation, and stacked immature spores; a) and b) from a German, c) from a French specimen.

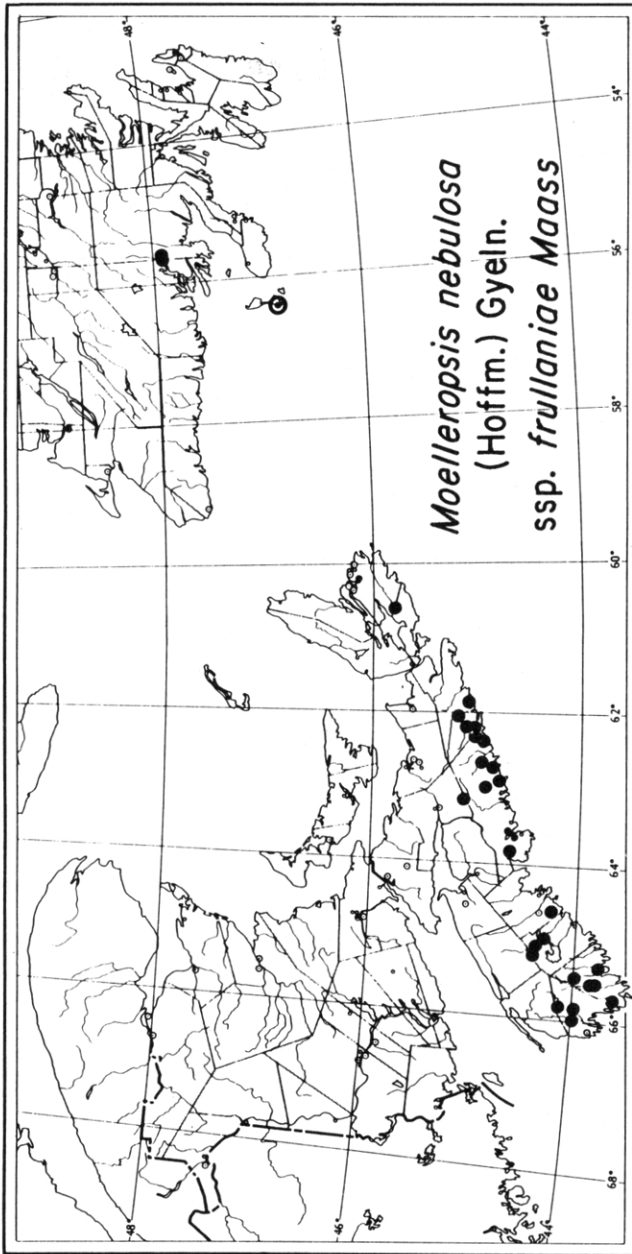


Fig 13. *Moelleropsis nebulosa* ssp. *frullaniae* in Atlantic Canada. The open circle indicates the reported occurrence of *M. nebulosa* on Sainte Pierre and Miquelon (see text).

Under the light microscope, squash preparations of granules show very compact and rolled up filaments of *Nostoc* with pale heterocysts and large bluegreen cells of 8-18  $\mu\text{m}$  in size. The phycobiont of European *M. nebulosa* which has much smaller cells (3-6  $\mu\text{m}$  in diameter, in agreement with measurements reported by Gyelnik, 1940) has also been identified as *Nostoc* and agrees with the algal components of *Pannaria* (Duncan 1970). However, usually it lacks heterocysts and resembles the more juvenile, hormogonial stage of a *Nostoc*. Staining with chloro-zinc-iodide for cellulose showed that its cells are connected by plasmodesmata as expected of a

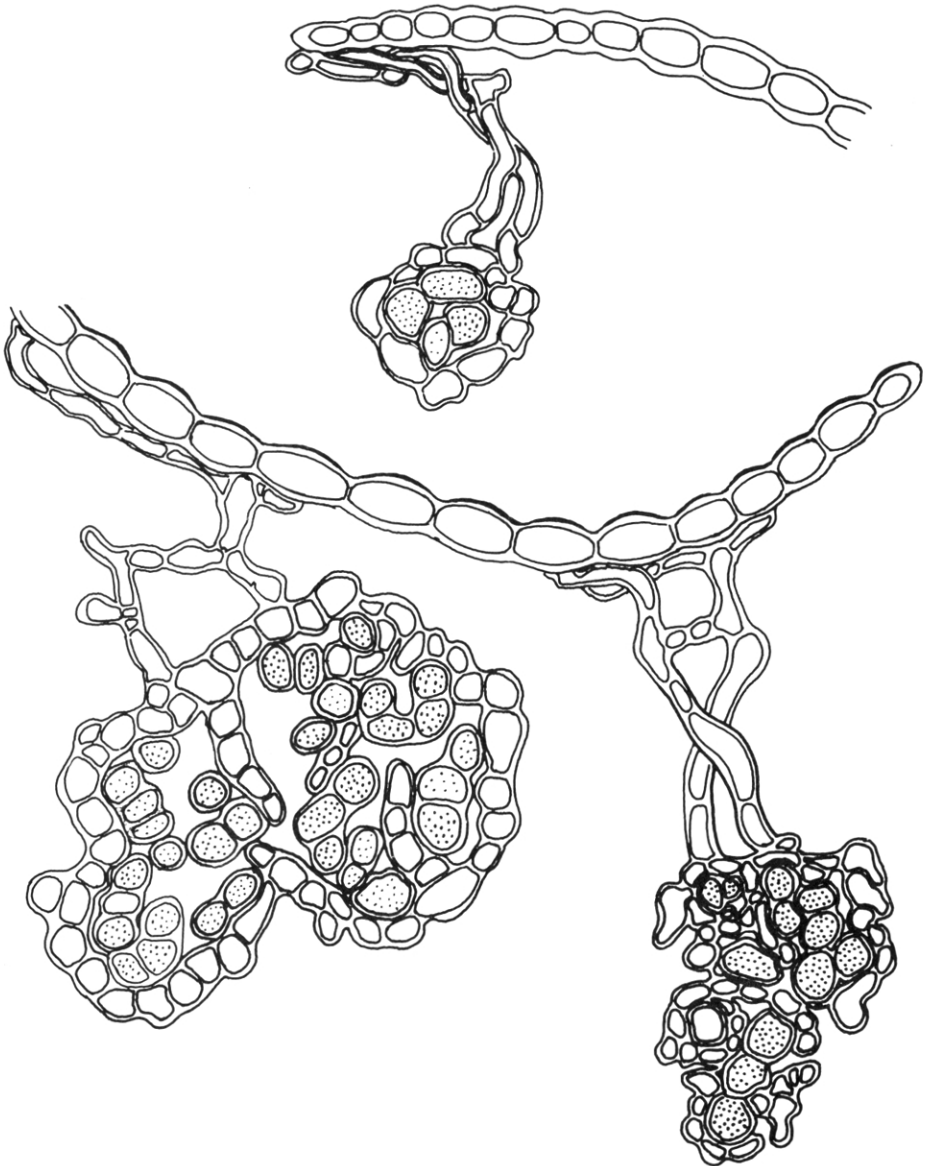


Fig 14. Freezing microtome section of *Moelleropsis nebulosa* ssp. *frullaniae*. Phycobiont cells have been highlighted by dots. Note that the lichen may be attached to the convex and concave faces of the *Frullania* leaves. x 150.



member of the Nostocales. The cells are much more interlaced by fungal hyphae than with the Canadian *Moelleropsis* and are therefore readily disconnected from each other, so that in squash preparations only very short chains made up of few algal cells may be seen. This would seem to indicate a relatively more parasitic role of the mycobiont in European *M. nebulosa*.

In freezing microtome sections of freshly collected *Moelleropsis* (Fig 14) it can be seen that the cells of the hyphae are more or less isodiametric in shape. They seem to have coalesced into a single cortical layer of cells. Their arrangement is otherwise comparable to mycobiont cells in a pseudoparenchymatous tissue. It is noteworthy that single hyphae have penetrated through the inside of the granules and have made superficial contact with the cells and filaments of the phycobiont, without the formation of haustoria. Even in the freezing microtome sections the surface of the granules is uneven. This indicates that the lobulation of the surface of the granules as seen in scanning electron micrographs cannot entirely be blamed upon artifact formation. The bluegreen pigmentation of the phycobiont was strongly developed in some of the cells and very weakly in others. These differences were consistently present within each granule and may reflect symbiotically (parasitically) relatively unaffected and strongly affected (degenerate) states of the phycobiont respectively.

Acetone extracts of the Canadian *Moelleropsis* as well as the European *M. nebulosa* were found to contain neither steroids nor phenols when examined by TLC and MS. The chemistry of the Pannariaceae, a family within which *Moelleropsis* originally had been placed, is not well defined in that it encompasses species containing either steroids, atranorin, pannarin, pannaric acid, methyl prophyricate or none of these compounds (Jørgensen 1978, Henssen and Renner 1981). Henssen (1969; see also Jørgensen 1978) has transferred *Moelleropsis* from this family to the Placynthiaceae (Peltigerineae, Lecanorales) on the basis of developmental studies of the apothecia. On the other hand, some important anatomical features of the apothecia are in agreement with those of a *Pannaria* (Jørgensen 1978). For Placynthiaceae, only *Dichothrix* (= *Calothrix* s. lat.) and *Scytonema* (both included in Nostocaceae according to Drouet 1978) have so far been listed as algal symbionts (Henssen and Jahns 1974). The uniquely pitted spores of *M. nebulosa* (Fig 12) were not mentioned in the original description of *Moelleropsis* (Gyelnik 1940) and might serve as another important character to assess the taxonomic placement of the genus. Perhaps *Moelleropsis* deserves to be moved into a family of its own, unless it is considered to be an affiliate of the Pannariaceae with an extremely reduced thallus anatomy. Even without the inclusion of *Moelleropsis*, the Pannariaceae contain elements with a variable spore morphology (Jørgensen 1978). The final taxonomic decision must await the publication of Henssen's developmental studies.

In Europe, *M. nebulosa* has been found mostly on wet sandy soils of shaded road banks and cliff habitats. Exceptionally it has been seen to colonize fallen twigs, rotting wood or sandstone, but never tree bark. Admixtures by *Sphagnum* of the Subsecunda group in some of the samples indicate that the substrate is relatively acidic. None of the verified samples contained *Frullania*.

In Canada, *Moelleropsis* inhabits the trunks of live trees, most often *Abies balsamea* (L.) Mill. and *Acer rubrum* L., but occasionally also *Picea rubens* Sarg. and *Betula lutea* Michx.f. Many of the collections are from existing *Erioderma* habitats (29 out of 46). Of the remaining 17 specimens, 12 were found together with *Coccocarpia* which in eastern Canada is typically associated with *Erioderma* habitats (Maass 1983). In southern Nova Scotia, where *Moelleropsis* was more often found on *Acer* or *Betula* than on *Abies*, the lichen is characteristic of swampy deciduous forests containing *E. mollissimum*. However, in northern Nova Scotia and Newfoundland, where the predominant phorophyte was *Abies*, the lichen occurs mostly within habitats of *E.*

*pedicellatum* or within mixed habitats of *E. pedicellatum* and *E. mollissimum*. The more northerly distribution of *Moelleropsis* on *Abies* follows distributional patterns that have been observed for *Coccocarpia palmicola* (Spreng.) Arvids. & D. Gall., and *Thelotrema lepadinum* (Ach.) Ach. (Maass, unpublished) as well as *Pannaria ahlneri* P. M. Jørg., Jørgensen 1978) and members of Lobariaceae. In northern Europe as well, coniferous bark is often the preferred substrate for *Lobaria scrobiculata* (Scop.) DC., *L. pulmonaria* (L.) Hoffm. (Ahlner 1948), *P. ahlneri* (Jørgensen 1978), and *Pseudocyphellaria crocata* (L.) Vain. (Ahlner 1948). Although occasionally *Moelleropsis* may be found on the naked bark of trees, it most often grows over *Frullania tamarisci* (L. Dum. subsp. *asagrayana* (Mont.) Hatt. and decaying lichens including *Parmeliae* and members of Lobariaceae.

The complicate bilobed leaves of *Frullania* trap water and represent a microecosystem containing microorganisms and rotifers. They thereby provide a nutrient-rich moist microenvironment for the establishment of lichen epiphytes that require a relatively more constant water supply. In addition, hepatics are known to produce lunularic acid, a growth inhibitor with antifungal properties (Pryce 1972) to which lichen fungi may be adapted since lunularic acid occurs also in Cyanophyceae and Chlorophyceae (see Pryce 1972). This inhibitor may thus promote the development of slow growing lichens by reducing competition. Furthermore, *Frullania* is known to contain sesquiterpenes such as frullanolide, costunolide and arbusculin- $\beta$  (Perold et al. 1972, Asakawa et al. 1976). Such compounds inhibit cell division, possess antibacterial and antifungal activity cause livestock poisoning and allergic contact dermatitis (Rodriguez et al. 1976). They act as insect feeding deterrents (Burnett et al. 1974) and might thus render *Frullania* and young stages of lichens growing on it unpalatable to predators.

The Canadian *Moelleropsis* seems to be more dependent on humid forest habitats than its European counterpart. The frequent co-occurrence of this lichen and *Erioderma* species, as well as lichens strongly associated with them, such as *C. palmicola*, *Parmeliella jamesii* (to be recorded as new to North America) and *Pannaria ahlneri*, may be attributable to the preference of all of these lichens for *Frullania* as a substrate. In many of the larger habitats with *Abies*, only a single tree trunk was seen to contain *Moelleropsis* and the characteristic lichens associated with it, thus the required environmental chemistry for these species may be quite similar.

Of great interest are reports of the occurrence of *M. nebulosa* (as *Pannaria pezizoides* f. *nebulosa* Ach.) on Saint Pierre and Miquelon by Arnold (1888), Delamare et al. (1888), Lepage (1947) and Le Gallo (1952) Fig 13, although the species is not listed in the checklist of North American lichens by Hale and Culberson (1970). The reports are all based on a specimen or specimens collected by Delamare in association with *Pannaria pezizoides* (G. Web.) Trev. *sensu str.* and identified by Arnold. Le Gallo (1952), in quoting Delamare et al. (1888), gave the following two localities for *P. pezizoides*: on *Abies* bark in the forest of the Cuquemel Chain, Langlade and at the mouth of a brook called Eperlans, Miquelon. In the Cuquemel Chain, which had an uninterrupted wet *Abies* forest, Delamare had also collected *Lobaria scrobiculata* and *Parmeliella plumbea* (Lightf.) Müll. Arg., both from the trunks of *Abies*. The former lichen is a frequent associate of *Moelleropsis* on *Abies* and the latter is sometimes associated with *Moelleropsis* on hardwood trees. Therefore it might be assumed that Delamare's *M. nebulosa* came from the Cuquemel Chain and that it probably belongs to the same taxon that has been collected in Newfoundland and Nova Scotia.

The infertility of the specimens from eastern Canada is puzzling. It is possible, but unlikely, that apothecium formation by *Moelleropsis* depends on a sandy soil substrate. Road banks with wet sandy soil and similar microhabitats comparable to those of *M. nebulosa* in the montane and coastal forests of Europe were rare in the area

studied in Eastern Canada. It appears as though the entire eastern Canadian population consists of a single infertile clone which has become specialized to grow as an epiphyte. However, it is conceivable that the antifungal properties of *Frullania* may interfere with the process of apothecium formation.

It is possible that both the mycobionts and phycobionts of the Canadian lichen are different from those of European *M. nebulosa*, as indicated by their morphological features, and that the Canadian lichen may represent a separate, although closely related taxon of *Moelleropsis*. One hesitates to adopt such a solution to the taxonomic problem because it is known that lichen mycobionts can affect the morphological appearance of the phycobiont, particularly in the case of lichens containing *Nostoc* as an algal symbiont such as *Peltigera canina* (L.) Willd. (Bergman and Hällbom 1982) and *Pseudocyphellaria crocata* (personal observation). Similarly, lichen phycobionts can have a strong morphogenetic effect on the mycobiont as studies with chimeroid associations have shown (James and Henssen 1976, Brodo and Richardson 1978, Tønsberg and Holtan-Hartwig 1983). Therefore, the differences between the two lichens might also be the result of a combination of a single species or strain of a lichen alga (*Nostoc*) with two different mycobionts, or of a single species or strain of a lichen fungus with two different phycobionts. In the first instance, the Canadian lichen would have to be treated as a different taxon, perhaps at the level of a subspecies. In the second instance, the Canadian and European counterparts would have to be considered, in agreement with the terminology proposed by Renner (1982) and with accepted practices in lichen taxonomy, as two different phycotypes of one and the same species, *M. nebulosa*.

It is desirable to isolate the phycobionts from the two sources and to compare their cultural characteristics. Efforts should also be directed at isolating the European mycobiont and recombining it with its own algal partner and with that from the Canadian lichen. Recombination experiments with *Moelleropsis* symbionts may prove to be relatively easy because of the strongly reduced character of the vegetative thallus of the lichen.

In the absence of evidence from cultural experiments and for the purpose of practical classification it is preferable to treat the Canadian lichen provisionally as a subspecies rather than phycotype of *M. nebulosa*. This decision is made on the grounds that the Canadian *Moelleropsis* differs from its European counterpart in its morphology, fertility and ecology.

*Moelleropsis nebulosa* (Hoffm.) Gyel. *ssp. frullaniae* Maass *nova subsp.*

Thallus granulosus aut sorediosus, numquam fruticulosus aut isidiosus, totaliter paraplectenchymaticus, homoeomericus. Hyphae corticis stratum unicellularem formans, plus minusve laxae et inflatae, uoque ad 16  $\mu\text{m}$  latae. Hyphae substrato adhaerentes albae, non fusciscentes, 3-6  $\mu\text{m}$  in diametro (2.5-4  $\mu\text{m}$  in *ssp. nebulosa*). Apothecia pycnidiaque ignota. Gonidia nostocoidea, coloniae 1-14 filamentibus cohaerentibus in centro granularum (6-10 filamentibus fragmentantibus in *ssp. nebulosa*), cellulae *Nostocis* 9-19  $\mu\text{m}$  in diametro (3-6  $\mu\text{m}$  in *ssp. nebulosa*), heterocystae 8-13  $\mu\text{m}$  in diametro (plerumque absentiae in *ssp. nebulosa*).

Incolat *Frullanium* in corticibus *Abietis*, *Piceae*, *Aceris* et *Betulae* in sylvibus humidissimis Novae Scotiae, Terrae Novae et insulae Miquelonensis.

Typus: Terra Nova, in vicinitate Jipujijkuei Kuespem Prov. Park, leg. W. Maass & B. Hoisington 29 Junii 1980 (CANL).

#### *Other Specimens Collected*

Phorophytes are abbreviated as follows: *Abies balsamea* (A), *Acer rubrum* (C), *Betula lutea* (L),

*Picea rubens* (R). All collections numbered below are in the author's herbarium. Representative specimens have been deposited at BG, CANL, FH, H and UPS.

Newfoundland:

Bay D'Espoir area, Hwy. 360 north of Jipuijikkei Kuespem Provincial Park, # 83I-7b (A); Conne River Road 4.3 km west from Hwy. 360 jct., # 83I-6d (A).

Nova Scotia:

Richmond Co.: Enon, # 83A-9d (A).

Guysborough Co.: Wine Harbour, below Copper Lake, # 82G-84c (A); Waternish, 4 km on Bill Ned Lake Road, # 82F-17f (C); between Ash, Bear and South Arm Lakes, # 82L-14c (A); # 82L-14h (L), # 83C-14b (A); New Chester, 2 km north of St. James Church, # 83K-35e (L).

Halifax Co.: Moser River, 4 km on road to Wilson Falls, # 82K-44a (A); near Kindervater Lake north of Wilson Falls, # 82K-45a (L); Dufferin Mines, # 82F-7a (R); # 82L-11a (A); 8 km northwest of Sheet Harbour, # 82E-2k (L); Marinette, # 82E-66h (A); about 2 km northwest from Middle Beaver Lake, # 81H-11c (A); about 6 km north of Tangier, # 82F-1e (C); # 83A-17d (C); about 3 km south of Ship Harbour on Eisan Lake road, # 81C-16c (A); near north end of Ship Harbour Long Lake, # 82E-38c (A); # 82K-15b (A); # 82K-8n (C); Beechville, south of Hwy. 103, # 83J-2e, f (C); Timberlea, near Exit 4 of Hwy. 103, # 83A-38c (C).

Colchester Co.: About 1.5 km east of Croskill Lake, # 82D-3e (A); 2 km northwest of Lanesville, # 84B-1a (A).

Hants Co.: Between Urbania and Admiral Rock, # 84C-6d (D).

Lunenburg Co.: Italy Cross, on Hwy. 103, 2 km southwest from Exit 15, # 82L-1c (C).

Queens Co.: Between Hwy. 8 and Moosehorn Lake, # 81I-2h (C); Caledonia, about 3.5 km on road to Hibernia, # 81I-4b (C); Kejimikujik National Park near turnoff to McGinty Lake, # 81K-4f (C).

Shelburne Co.: Sable River, between Freshwater and Timber Island Brooks, # 82K-58b (A), # 84D-2b, d (A); Shelburne, George Lake, # 83A-46d (C); Middle Ohio, near McGills Island Road, # 84D-5d (A); Upper Ohio, west of Back Lake, # 82C-6f (C), # 82C-6g (A), # 84d-7b (A); Middle Clyde River, # 83A-52d (A); about 2 km southeast of McGill Lake, # 83A-50a (A); Barrington, 3 km from Yarmouth County line, # 81J-1b (C); # 82L-27h (C).

Yarmouth Co.: Hog Lake area between Bell Neck and Springhaven, # 84D-9h (C); East Quinan, west of Kiah's Hill, # 82D-64j (L); Pleasant Valley, # 83A-25g (C); about 6 km north of Kemptville, # 83A-27c (C).

*European specimens of Moelleropsis nebulosa s. str. examined in detail.*

1. Austria, Schladming, Ramsauleiten, on soil at 800-900 m alt., Zahlbruckner # 1543 of Kryptogamae Exsiccatae, FH.
2. France, Dept. Hérault, La Salvetat-sur-Agout, on soil of a shaded roadbank, in part over dead twigs (probably between 700-1000 m alt., about 43°36'N and 2°43'E), Marc # 507, FH.
3. Portugal, Estremadura, Tapada da Matra, on clay soil over *Cirriphyllum crassinervium*, 14 Jan. 1950 Tavares, H.
4. Germany, Bavaria, Oberpfalz, Schwandorf, above Spielberg naear Nabeck, on clay soil of a coniferous forest, Arnold # 1032-b, C.
5. Denmark, Vestjylland, Oxby Sg., Hornsbjerg ved Blaavandshuk, on soil of a N-exposed slope, Skytte-Christiansen # 7348, C.
6. Denmark, Jylland, Ferslev Molleholm, over sandy soil but also on dead fallen twigs of a heath shrub, non-apotheciate, leg. Branth, C.
7. Sweden, Västergötland, Angered sn., Agnesberg, on the clay of a brickyard, 29 July 1943 Degelius, L, S, UPS.

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