STUDIES ON MACQUARIE ISLAND LICHENS 1: GENERAL

by
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INTRODUCTION

This article serves as an introduction to a series of papers on the taxonomy and distribution of Macquarie island lichens, and includes a key to all lichen genera recorded from this Island. Future papers will present the results of the author's revisions.

GEOGRAPHY

Macquarie Island is situated in the Southern Ocean on longitude 158° 52' E and between latitudes 54° 29' S and 54° 47' S. It is the southern-most island in the chain comprising Bluff, Stewart, Snares, Auckland and Campbell Islands which stretch south from New Zealand along the New Zealand Plateau—Macquarie—Balleny Ridge. It lies approximately 1530 kilometres south-south-east of Tasmania, Australia, and about 1370 kilometres north of the Antarctic Continent (Fig. 1).

The island, a dependency of Tasmania, is 34 kilometres long and 7 kilometres wide at its widest point (Fig. 2). The main body of the island consists of a large central plateau, about 250 metres above sea level, which is undulate on the top and divided into two halves by a low col. The southern half is the highest, rising to a maximum 433 metres at Mount Hamilton. The plateau area is covered with grass and herbs and is studded with lakes and tarns. The edge of the plateau drops abruptly into the sea on the western side, separated from it by tumbled rocks or in places a narrow shingle beach. By comparison the eastern escarpment drops steeply down onto a wide raised beach terrace.

Fig. 1. Location of Macquarie Island.

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This subantarctic island lies north of the Antarctic Convergence, and is subject to persistent wind and cloud cover. There is little bright sunshine and it is mostly wet and cold. Rain, drizzle, snow and hail are frequent. The annual precipitation is 1020 mm. Temperatures fluctuate from near 0°C to about 15°C and the daily range is rarely more than 3.5°C.

**MACQUARIE ISLAND**

![Map of Macquarie Island]

Fig. 2. Macquarie Island.
HISTORY

On 11 July 1810 Macquarie Island was sighted for the first time from the deck of the brig *Perseverance* under the command of Captain Fredrick Hasselburgh (Law & Burstall, 1956: 1). The *Perseverance* was en-route from Sydney to Campbell Island with provisions and stores for the sealers working on that island.

Hasselburgh named this new island after Lachlan Macquarie, then Governor of the Colony of New South Wales. He landed a party of eight men with provisions and salt; this gang was the first of many to engage in the steady slaughter of the fur seals which inhabited the island. Exploitation of the fur seals continued for the next ten years, by which time they were nearly exterminated.

It was at this time that the Australian sealing companies turned their attention to the sea elephants, killing them for their oil. By 1834 when the elephant seal was no longer present in workable numbers, the sealing ventures on the island had almost ceased (Cumpston 1968: 70-72).

On 10 January 1840, the United States Exploring Expedition of 1838-1842 under the command of Lieutenant Charles Wilkes arrived at the island. He found the place “...drear and inhospitable.”.

The next fifty years saw very little activity in the seal-oil industry on Macquarie Island. The *Jessie Niccol* owned by Cormack, Elder and Company, under the directorship of William Elder, a New Zealand chemist, visited the island several times for oil. Joseph Hatch, also a New Zealander, reopened the industry in 1873 taking over the operations of the Elder Company. The production of seal oil and penguin oil continued under his direction until 1919. The licence to kill seals and penguins on the island was cancelled on 2 February 1920 (Cumpston 1968: 316).

Captain R. F. Scott, en-route to the Antarctic Continent in the *Discovery*, paid a short visit to the island on 22 November 1901 and the British Antarctic Expedition 1907-1909, led by Sir E. H. Shackleton, landed at Lusitania Bay. Both of these visits were very brief.

On 11 December 1911, the Australasian Antarctic Expedition (A.A.E.), under the leadership of Sir Douglas Mawson set up a scientific base on the isthmus at the foot of Wireless Hill and members of this expedition spent two years on the island.


Macquarie Island was declared a Sanctuary for animals and birds on 17 May 1933 upon the recommendation of the Animals and Birds Protection Board of Tasmania. It was not revisited until 7 March 1948 when H.M.A.S. *Labuan* arrived with the first Australian National Antarctic Research Expedition (A.N.A.R.E.). This expedition established a station, at the site of the previous A.A.E. base, which has been continuously occupied since its formation.

HISTORY OF LICHENOLOGICAL INVESTIGATIONS

Macquarie Island has been visited by a number of scientific expeditions in the course of its short history. Few of the early expeditions contributed greatly to the knowledge of the lichen flora. The first known collection of Macquarie Island plants was forwarded to Sir W. J. Hooker at Kew in about 1830, by the Superintendent of the Sydney Botanic Gardens (Cheesman 1919: 10). The eight species mentioned in this publication are only of vascular plants.

Dr. J. H. Scott of Otago University, New Zealand, made a brief visit in 1880 for the special purpose of investigating the flora and fauna, and to him is credited the first observations of the lichens of this island (Scott, 1882):

"*Azorella selago* grows on the hill-sides forming globular masses often 4 feet across. These are green on the surface where the living part of the plant lies as a crust to the great mass of debris which forms the interior. This is the decaying remains of former years growth ... The whole makes a solid mass on which
one can stand... The young shoots are closely packed together and made so uniform a surface that lichens and other small plants are sometimes found growing on it."

The following is the list of lichens included in his report:

*Streptocaulon ramulosum*; *Sphaerophoron coralloides* (?); *Cladonia cariosa*; *Cladonia pyxidata*; *Parmelia paretia*; *Lecanora paretia*; *Lecidea coarciata*.

In 1894, A. Hamilton, then Registrar of the Otago University, visited Macquarie Island, but unfortunately a portion of his collections had to remain on the island for some months after his return. When the remainder of his collection eventually arrived in New Zealand...

"The mosses and lichens collected were so injured by the wet, and by the delay of some months which occurred before they were brought up from the island, that I fear it will probably be impossible to give a list of any value."

(Hamilton 1895: 569).

The Australasian Antarctic Expedition 1911-1914, established a base on Macquarie Island and the expedition's biologist H. Hamilton (son of the former Hamilton) made a collection of lichens. Five fragmentary specimens were sent to Dr. C. W. Dodge at the Missouri Botanical Garden, U.S.A. who published his determinations in the BANZARE Reports (Dodge, 1948):

*Pseudocyphellaria glabra* (Hook.f. & Tayl.) Dodge; *Streptocaulon curticulatum* Nyl.; *Streptocaulon* sp. [later *S. macquariensis* Dodge (Dodge, 1968)]; *Parmelia sublugubris* Dodge; *Cladia aegregata* (Sw.) Nyl.

The remainder of the collection was erroneously forwarded to the British Museum and was unfortunately destroyed by bomb blast during the blitz of London (Dodge, 1948: 5, 13 footnote).

The British, Australian and New Zealand Antarctic Expedition of 1929-1931 collected almost 100 samples, which were sent to Dodge in Missouri. In the BANZARE Reports he described ten species as new (Dodge, 1948); these are marked with an asterisk in the following list of species:

*Buellia mawsoni* Dodge; *Cladia aggregata* (Sw.) Nyl.; *Cladonia mawsoni* Dodge; *Cladonia sarnentosa* (Tayl.) Dodge; *Cladonia subdigitata* Nyl. var. subalbinea Dodge; *Cococcoparia kerguelensis* Dodge; *Coenogonium subtorulosum* Müll. Arg.; *Gasparinaria macquariensis* Dodge; *Lecania johnsoni* Dodge; *Mastodea sp.* [later *M. macquariensis* Dodge (Dodge 1970)]; *Menegazzia circinata* Santesson; *Microthella macquariensis* Dodge; *Mykoblastus campbellianus* (Nyl.) Zahlbr.; *Pannaria sp.*; *Parmelia sublugubris* Dodge; *Parmelia tenuirama* Hook.f. & Tayl.; *Peltigera sp.*; *Pertusaria tyloplaca* Nyl.; *Pseudocyphellaria glabra* (Hook.f. & Tayl.) Dodge; *Psoroma versicolor* Müll. Arg.; *Pyrenodesmis inclinans* (Stirr.) Dodge; *Pyrenodesmis subpyracea* (Nyl.) Dodge; *Ramalina bainserensis* Dodge; *Ramalina inflata* Hook.f. & Tayl.; *Rinodina peleoeucia* Nyl.; *Rinodina subbieidata* (Knight) Dodge; *Sphaerophoron chaidinoides* Dodge; *Siphulastrum usneoides* Dodge; *Stereocaulon corticatum* Nyl.; *Stereocaulon leptaleum* Nyl.; *Stereocaulon pulvinare* Dodge; *Stereocaulon submollescens* Nyl.; *Thelideia sp.*; *Usnea arida* Mot. var. *musicola* Dodge; *Usnea contexta* Mot.; *Usnea turulosa* (Müll. Arg.) Zahlbr.; *Usnea zanthopoga* Nyl.

Since the ANARE station has been occupied several people including N. R. Laird, 1948, N. M. Haysom, 1949 and D. A. Brown, 1956 have made small collections of lichens. These collections were forwarded to Dodge and a further twenty-four species were described as new to science (Dodge & Rudolph, 1955; Dodge, 1968, 1970):

*Bacidia macquariensis* Dodge; *Blastenia macquariensis* Dodge; *Calopla macquariensis* Dodge; *Catillaria rudolphi* Dodge; *Chiodecton acarosporeides* Dodge; *Chiodecton macquariensis* Dodge; *Kuttlingeria macquariensis* Dodge; *Lecanora brownii* Dodge; *Lecanora procierca* Dodge; *Lecidea haysomi* Dodge; *Lecidea macquariensis* Dodge; *Omphalodina macquariensis* Dodge; *Opegrapha macquariensis* Dodge; *Parmelia brownii* Dodge; *Parmelia haysoni* Dodge; *Parmelia macquariensis* Dodge; *Peligeria lairdi* Dodge; *Phlyctis macquariensis* Dodge; *Phylloprenia macquariensis* Dodge; *Physcia macquariensis* Dodge; *Porina macquariensis* Dodge; *Psoroma macquariensis* Dodge; *Squamarina haysoni* Dodge; *Thamnolecania macquariensis* Dodge & Rudolph.

There were also five new records added to the list:

*Lecidea subglobulata* Knight; *Parmelia turgidula* Bitter; *Placopsis perrugosa* (Nyl.) Nyl.; *Ramalina gencillata* Hook.f. & Tayl.; *Stereocaulon argesoides* Nyl.
From 1963 collecting has been carried out systematically on Macquarie Island. **R. B. Filson** spent one day there in March 1963 and four months from December 1963 to March 1964, collecting extensively all around the island (Fig. 3). **K. S. Simpson** made numerous collections from widely scattered localities during the 16 months from December 1964 to March 1966. **R. J. Hnatiuk** spent December 1971 and January 1972 making comparison studies of alpine grassland regions. He collected 240 samples of lichen from 15 separate localities. **D. A. Parker** collected a number of specimens during 1971 and **R. Waterhouse** collected at the north of the island in 1972.

**D. S. Horning** was biologist with the Australian Museum Macquarie Island Expedition during the summer of 1977-78. The lichen specimens were determined by **D. J. Galloway** and the results published by the Museum (Lowry et al., 1978). The following is the list of species not previously reported for the region:

- *Argopsis megalospora* Th. Fr.; *Cladonia aeurii* Räs.; *C. coniocraea* (Flörke) Spreng.; *C. cornuta* (L.) Hofm.; *C. fimbriata* (L.) Fr.; *C. foliacea* (Huds.) Willd.; *Endocarpon informis*; *Hypogymnia lugubris* (Pers.) Krog.; *Lecanora parmelina* Zahlbr.; *Mastodia tessellata* Hook. & Harv.; *Parmelia* (Pseudoparmelia) *caerulea* (Hofm.) Ach.; *Parmelia cunninghamii* Cromb.; *P. signifera* Nyl.; *Parmelia* (Hypotrachyna) *sinuosa* (Sm.) Ach.; *Peltigera horizontalis* (Huds.) Baum.; *P. rufescens* (Weis) Humb.; *Perissaria dactylica* (Ach.) Nyl.; *Pseudocyphellaria delisea* (Fée in Del.) Gall. & James; *Psoroma hypnorum* (Hofm.) S. Gray; *Siphulastrum mamillata* [unpublished ms. name]; *Sphaerotheca globosa* (Huds.) Vain; *S. melanocarpa* (Sw.) DC.; *S. ramulifer* M. Lamb; *Thamnolia vermicularis* (Sw.) Schaer.; *Usnea* (Neuropogon) *antarctica* DuReitz; *Usnea glomerata* Mot.; *Usnea* (Neuropogon) *laxissima* Dodge; *Xanthoria elegans* (Link.) Th. Fr.

**R. D. Seppelt** spent a few days during November-December 1975 at Macquarie Island when he collected a few lichen samples. He was again on the Island for the 1979-80 summer period collecting bryophytes and lichens; he collected 197 specimens from 108 localities (Fig. 3).

**PRINCIPAL VEGETATION FORMATIONS**

The vegetation of Macquarie Island can be divided into five main formations: wet tussock grassland, herbfield, fen, bog and feldmark (Taylor, 1955). Brief notes
Fig. 4. Coastal rock stacks between Bauer Bay and Douglas Point showing abundance of species; dominant lichen is *Parmelia sulcata*. Photo: Ken Simpson.

Fig. 5. View from Mount Law towards Mount Blake (far middle-distance) and Mount Hamilton (left, far distance) showing lichen-covered plateau outcrops (left and right foreground), feldmark skirted by cushions of *Azorella* and *Rhacomitrium* (centre foreground), and plateau herbfield (middle distance). ANARE photo: R. D. Seppelt.
are given below for these, together with the dominant lichen genera occurring in each location.

**Wet Tussock Grassland:**

The wet tussock grassland is found on all steep coastal slopes to an altitude of about 300 metres, on some inland slopes protected by severe winds and on coastal raised beach terraces, except where there is a high water table. This alliance is dominated by *Poa foliosa* and *Stilbocarpa polaris* with *Polystichum vestitum* and *Poa hamiltonii* as minor components in a few localities. The lichens in this alliance are few and are restricted to the bare earth patches between the tussocks or on rocky outcrops emerging from the grass canopy. On the bare patches of earth *Cladonia*, *Baeomyces* and *Peltigera* can be found associated with debris and roots.

The rock outcrops though not strictly part of the grassland have a wider lichen flora including *Psoroma*, *Cladonia*, *Lecidea*, *Lecanora*, *Usnea*, *Ramalina*, *Hypogymnia* and *Menegazzia*.

The maritime communities have been grouped by Taylor (1955: 49) as a separate association under this alliance. The coastal rocks in the splash zone have a large number of crustose species: *Microthelia*, *Caloplaca*, *Placopsis*, *Lecanora*, and *Lecidea* are common. The old sea stacks, e.g. The Nuggets, have many additional genera, *Menegazzia*, *Peltigera*, *Pseudocyphellaria*, *Parmelia* and *Graphis*. These are mostly found on the sheltered side and top.

The cliffs at the edge of the plateau and the edge of the outcrops provide the richest lichen flora on the island. *Usnea*, *Stereocaulon*, *Parmelia*, *Hypogymnia*, *Menegazzia*, *Caloplaca*, *Lecidea*, *Rhizocarpon*, *Lecanora*, *Microthelia* and several other crustose genera grow on these rocky faces which are abundantly covered with lichens.

**Herbfield:**

The herbfield alliance is found in areas with a relatively high water table and moderate wind exposure at all altitudes up to 350 metres. It is dominated by *Pleurophyllum hookeri*; however the floristic composition varies greatly. In general the lichen flora is scarce; *Baeomyces*, *Psoroma*, *Lecidea*, and *Cladonia* are found recolonising bare patches of soil between the herbfields while the low branchlets of *Coprosma pumila* and other low bushes are the habitat for *Usnea*, *Hypogymnia*, *Cladia*, *Pseudocyphellaria* and *Sphaerophorus*.

**Fen:**

*Juncus scheuchzerioides* is the characteristic dominant vascular species of the fen alliance which occurs locally in valley bottoms on the plateau and in isolated areas on the raised beach terraces. This alliance is very poor in lichen species; occasional patches of *Psoroma* or *Cladonia* are seen growing on dryer peat patches but in general the areas are too wet for lichen growth.

**Bog:**

The bog alliance occurs locally at all elevations on the island where there is an acidic water table at or above ground surface level. The lichens here are restricted to elevated and better drained areas within the alliance; *Hypogymnia*, *Usnea*, *Cladonia*, *Cladix*, *Pseudocyphellaria*, *Lecidea* and *Psoroma* are found growing over and amongst mosses and *Colobanthus musoides*. Species of *Stereocaulon*, *Placopsis*, *Rhizocarpon* and *Lecidea* are common on rocks beside small streams.

**Feldmark:**

Feldmark is found in all areas subject to high wind velocities at all altitudes and covers the greater part of the island above 180 metres. The dominant lichens are: *Usnea*, *Sphaerophorus*, *Cladonia*, *Cladix*, *Hypogymnia*, *Pseudocyphellaria*, *Lecidea*, *Baeomyces* and *Psoroma*. *Pertusaria* and other crustose genera grow on the
cushions of *Azorella selago*. Moss cushions sometimes provide habitat for small crustose species. Foliose and fruticose species occur amongst the pebbles and gravels of the bare patches on the slopes; here the dominant genera are *Hypogymnia, Stereocaulon, Lecanora, Lecidea, Rhizocarpon* and *Placopsis*. Some crustose species assume a fruticose habit because of the harsh environmental conditions. These will be discussed in more detail in later papers when individual genera are considered.

**ARTIFICIAL KEY TO THE LICHEN GENERA ON MACQUARIE ISLAND**

1. Thallus fruticose or squamulose
   2. Thallus fruticose
      3. Primary thallus granulate crustose
      4. Apothecia sessile
      5. Cephalodia present ........................................*Placopsis*
      5. Cephalodia absent
      6. Apothecia terminal on erect podetia .................*Baeomyces*
      3. Primary thallus lacking or not granulate-crustose
      6. Thallus hollow
      7. Primary thallus absent
      8. Thallus not inflated or lacerate
         9. Thallus a shade of brown with regular patterns of perforations through the outer walls ..........*Cladina*
         9. Thallus a shade of grey with black markings and without perforations ........................................*Hypogymnia*
         8. Thallus much inflated and somewhat lacerate, perforations in walls very irregular; on coastal outcrops ........................................*Ramalina*
         7. Primary thallus erect and subfoliose, apothecia on cup-shaped pseudopodetia ........................................*Cladonia*
      6. Thallus solid
      10. Thallus less than 1 cm tall
         11. Thallus more or less terete, of uniform colouring
            12. Thallus a shade of white or yellowish-white
               13. Thallus with cephalodia ........................................*Stereocaulon*
               13. Thallus without cephalodia ........................................*Thamnolecania*
               12. Thallus a shade of yellow or orange .................*Caloplaca*
         11. Thallus dorsiventral one side a shade of green or brown, the other pale
            14. Thallus without cephalodia
               15. Thallus distinctly isidiose ........................................*Massalongia*
               15. Thallus not isidiose ........................................*Cladonia*
            14. Thallus with dark coloured cephalodia ........................................*Psoroma*
      10. Thallus greater than 1 cm tall
         16. Thallus with central chondroid axis
            17. Thallus a shade of white, pink or greyish-white with cephalodia ........................................*Stereocaulon*
            17. Thallus a shade of yellow, yellow-green or green and black, without cephalodia ........................................*Usnea*
         16. Thallus without a central chondroid axis
            18. Thallus green, yellow-green or brownish green
               19. Thallus dorsiventral, strap-like
                  20. Thallus with distinct soralia ........................................*Ramalina*
                  20. Thallus with dorsiventral lobulate branching at the margins ........................................*Sphaerophorus*
            19. Thallus forming cups, not strap-like ........................................*Cladonia*
18. Thallus a shade of white, pink or brownish white
   21. Thallus hollow or compactly filled with medulla, lacking cephalodia
      22. Thallus hollow with perforations in the axils of the branches ............... Cladonia
      22. Thallus compactly filled with medulla axes not perforated ................. Sphaerophorus
      21. Thallus with tough chondroid axis, cephalodia pink to pale grey ........... Stereocaulon

2. Thallus foliose
   23. Phycobiont blue-green
      24. Thallus gelatenous when wet
         25. Phycobiont Nostoc
            26. Cortex distinctly cellular ........................................... Leptogium
            26. Cortex of interwoven hyphae ...................................... Collema
      24. Thallus not gelatenous when wet
         27. Lower surface not veined
            28. Thallus lobes small, less than 5 mm wide, margins divided, isidiose, lobulate
               29. Apothecia lecanorine, margin prominent ....................... Pannaria
               29. Apothecia lecideine, margin disappearing ..................... Massalongia
            28. Thallus lobes large, up to 1 cm wide margins entire .......... Erioderma
         27. Lower surface veined .................................................. Peltigera
   23. Phycobiont green
      30. Lower surface smooth shining
      31. Thallus hollow
         32. Upper surface white to yellowish-white with perforations into the central cavity .......... Menegazzia
         32. Upper surface grey with black markings without perforations .............. Hypogymnia
      31. Thallus solid
         33. Lower surface white ............................................... Cetraria
         33. Lower surface black ............................................... Platismatia
      30. Lower surface ecorticate, tomentose or rhizinate
         34. Thallus small, less than 10 mm tall, subfruticose
            35. Thallus with dark coloured cephalodia .............................. Psoroma
            35. Thallus without dark coloured cephalodia .......................... Cladonia
               (primary thallus)
         34. Thallus distinctly foliose
            36. Lower surface with rhizines
               37. Lower surface black .............................................. Parmelia
               37. Lower surface pale ............................................... Physcia
            36. Lower surface tomentose with pseudocyphellae ................ Pseudocyphellaria

1. Thallus squamulose or crustose
   38. Fruiting body stipitate, on podetia or pseudopodetia
      39. Ascospores many per ascus
         40. Exciple pale, soft ....................................................... Bia toreilla
         40. Exciple black, brittle ............................................... Sarcogyne
      39. Ascospores eight per ascus
         41. Thallus crustose, apothecia sessile .................................. Icmadophila
         41. Thallus a fine powdery crust, apothecia stipitate ................... Boeomyces
     38. Fruiting body immersed, adnate or sessile
      42. Ascospores more than eight per ascus
43. Apothecia adnate or sessile
44. Exciple pale, soft .............................................. Biatorella
44. Exciple black, brittle ............................................. Sarcogyne
43. Apothecia immersed .............................................. Acarospora
42. Ascospores one to eight per ascus
45. Ascospores simple, unilocular
46. Thallus squamulose
47. Phycobiont blue-green
48. Apothecia lecanorine ......................................... Pannaria
49. Apothecia sessile to adnate
50. Apothecia lecanorine ......................................... Psoroma
49. Apothecia immersed .............................................. Trapelia
46. Thallus crustose
51. Phycobiont blue green ........................................ Pyrenopsidium
52. Fruiting body an apothecium
53. Apothecia immersed in thallus or in warts
54. Apothecia immersed but not in warts
55. Paraphyses unbranched ...................................... Aspicilia
55. Paraphyses branched and anastomosing .......... Trapelia
54. Apothecia immersed in thalline warts ........... Portusaria
53. Apothecia adnate to sessile
56. Disk of apothecium K- or K+ but not K+ purple
57. Apothecia lecanorine ........................................ Lecidea
58. Thallus with cephalodia ............................... Placopsis
58. Thallus without cephalodia ....................... Lecanora
57. Apothecia lecideine ........................................ Lecidea
56. Disk of apothecium K+ purple ..................... Caloplaca
52. Fruiting body a perithecium ................................ Verrucaria
51. Phycobiont blue green ........................................ Pyrenopsidium
45. Ascospores septate or polariibolocular
59. Fruiting body a perithecium or perithecium-like
60. Ascospores many-celled
61. Ascospores transversely septate only
62. Fruiting bodies immersed in stromatic warts ... Trypethelium
62. Fruiting bodies not immersed in stromatic warts . Arthopyrenia
61. Ascospores transversely and longitudinally septate
63. Ascospores hyaline ........................................... Polyblastiopsis
63. Ascospores brown ........................................... Anthracothecium
60. Ascospores two-celled ....................................... Microthelid
59. Fruiting body not perithecial
64. Fruiting body round or misshapen by pressure
65. Ascospores hyaline
66. Apothecia lecanorine
67. Ascospores polaribolocular .......................... Caloplaca
67. Ascospore walls not thickened ....................... Icmadophila
66. Apothecia lecideine
68. Ascospores polaribolocular, two-celled
69. Ascospore walls not thickened
70. Thallus crustose
   71. Apothecial disk pale to dark not orange

69. Thallus squamulose
   70. Thallus squamulose

68. Ascospores more than two-celled
   69. Ascospores polaribilocular

67. Thallus squamulose
   68. Ascospores more than two-celled

66. Ascospores brown
   67. Ascospores transversely septate only

64. Fruiting body elongate, irregular or star-shaped
   65. Ascospores brown

62. Paraphyses branched and anastomosing, exciple usually well developed
   63. Paraphyses unbranched, exciple well developed

61. Hypothecium dark
   62. Hypothecium pale

60. Thallus squamulose
   61. Thallus squamulose

59. Thallus squamulose
   60. Thallus squamulose

58. Paraphyses branched and anastomosing
   59. Paraphyses unbranched

57. Thallus squamulose
   58. Thallus squamulose

56. Thallus squamulose
   57. Thallus squamulose

55. Thallus squamulose
   56. Thallus squamulose

54. Paraphyses branched and anastomosing
   55. Paraphyses unbranched

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   54. Thallus squamulose

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   21. Thallus squamulose

19. Thallus squamulose
   20. Thallus squamulose

18. Thallus squamulose
   19. Thallus squamulose

17. Thallus squamulose
   18. Thallus squamulose

16. Thallus squamulose
   17. Thallus squamulose

15. Thallus squamulose
   16. Thallus squamulose

14. Thallus squamulose
   15. Thallus squamulose

13. Thallus squamulose
   14. Thallus squamulose

12. Thallus squamulose
   13. Thallus squamulose

11. Thallus squamulose
   12. Thallus squamulose

10. Thallus squamulose
   11. Thallus squamulose

9. Thallus squamulose
   10. Thallus squamulose

8. Thallus squamulose
   9. Thallus squamulose

7. Thallus squamulose
   8. Thallus squamulose

6. Thallus squamulose
   7. Thallus squamulose

5. Thallus squamulose
   6. Thallus squamulose

4. Thallus squamulose
   5. Thallus squamulose

3. Thallus squamulose
   4. Thallus squamulose

2. Thallus squamulose
   3. Thallus squamulose

1. Thallus squamulose
   2. Thallus squamulose

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REFERENCES


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