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Short Communication

Myxomycetes of Subantarctic Macquarie Island

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Abstract
An expedition to subantarctic Macquarie Island was carried out during the period of late January to early May of 1995 with the objective of documenting myxomycete biodiversity. Collecting on the island yielded 412 field collections, with another 14 collections were obtained with the use of the moist chamber culture technique. A total of twenty-six species representing 13 genera was recorded. This is the largest set of data yet available on the myxomycetes associated with any high-latitude area of the Southern Hemisphere. Prior to the expedition, only a single species was known from Macquarie Island. The purpose of this paper is to describe this expedition from the viewpoint of the author.

Keywords: Biodiversity, ecology, field collecting, slime molds, southern high latitudes

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Macquarie Island (latitude 54° 30' S, longitude 158° 57' E) is an isolated oceanic island located 1,000 km southeast of Tasmania, Australia (Figure 1). While politically a part of Tasmania, the nearest land masses are Auckland Island and Campbell Island, lying 640 and 700 km to the north-northeast, respectively. However, both of these two islands belong to New Zealand. Macquarie Island consists of an uplifted fragment of a submarine ridge that forms an elongated and undulating plateau 34 km long and up to 5.5 km wide. Most of the land surface of the island occurs on the top of the plateau, which ranges in elevation from 200 to 300 meters above sea level. Macquarie Island is unique among the subantarctic islands in having a tectonic origin from uplifted oceanic bottom strata lifted above sea level in the middle to late Pleistocene (Selkirk et al. 1990).

Macquarie Island is characterized by having an equable oceanic climate that is cool, moist, and windy with low mean temperatures (annual mean of 4.8º C, with a range of 3.3º C), a mean annual precipitation of 895 mm, consistently high relative humidity (89% average), and a mean wind speed of 9.3 m/sec. The surface of the island is dotted with numerous lakes, ponds (tarns), and small streams, and the edge of the plateau falls away abruptly to a narrow, low-lying coastal fringe of old raised beaches. Plateau slopes are steep, generally with angles of 40º to 45º but as steep as 80º in some places. The west coast of the island is more rugged with steeper slopes and broader raised coastal beaches than the less steep slopes and more narrow beaches found on the east. Both the east and west coasts of the island are indented by small bays.

Macquarie Island has a depauperate flora consisting of fewer than fifty species of vascular plants. There are no woody plants present, with the thin creeping stems of New Zealand bidibid (*Acaena magellanica* and *A. minor*) probably representing the closest approach to woodiness. The lower slopes and raised coastal beaches of Macquarie Island are usually covered by herbfield communities in which three plants are the usual dominants (Figure 2). These are tussock grass (*Poa foliosa*), silver-leaf daisy (*Pleurophyllum hookeri*), and Macquarie Island cabbage (*Stilocarpa polaris*). Tussock grass is the overwhelming dominant in some relatively level areas on the east coast. These areas (wet tussock) are often intersected by deep gaps among the tussocks created by yearling elephant seals, which are sometimes not noticed until one is almost upon them. In those areas where the water table is close to the surface, extensive areas (mires) are dominated by bryophytes. In a few shallow valleys on the east coast, there are fernbrake

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communities in which prickly shield fern (*Polystichum vestitum*) forms a nearly complete cover over the lower slopes (Figure 3). Tussock grass and Macquarie Island cabbage are the tallest plants on the island and can reach a height in excess of a meter. The cover of vegetation at higher elevations on the top of the plateau is sparce, especially the more windswept areas. The plants present in these feldmark communities are mostly bryophytes.

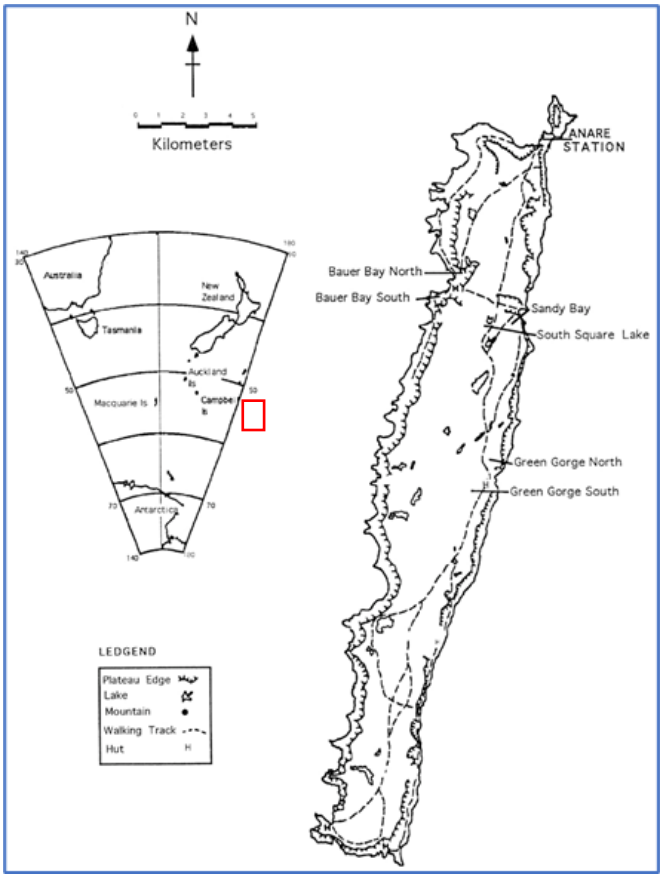

Figure 1. Map of Macquarie Island showing its location in relation to Australia and New Zealand.

Figure 2. Herbfield community on Macquarie Island

Macquarie Island supports a fairly conspicuous if not diverse fauna dominated by seabirds and seals. Penguins are abundant on the island (Figure 4), with the royal penguin (*Eudypes schlegeli*) and the king penguin (*Aptenodytes patagonicus*) the most common. The southern elephant seal (*Mirounga leonina*) is the most common seal, with fur seals (*Arctocepalus forsteri*) also present but in smaller numbers. At the time the project described herein was carried out, there were still populations of four non-indigenous small mammals (cats, rabbits, mice, and rats) on Macquarie Island.

The Australian government established an Australian National Antarctic Research Expedition (ANARE) station on Macquarie Island in 1948 (Figure 5). This station is maintained by 18 to 20 people during the winter, with the number expanding to at least twice that many during summer. The station serves as the center for research activities carried out on the island, and the project described herein was based at the station.

The impetus for the expedition to Macquarie Island was a specimen of a myxomycete collected by Dr. Ron Seppelt in 1979 and later sent to the author for identification. This specimen turned out to be *Lamproderma ovoideum*, a species not previously known from the southern high latitudes (Stephenson et al. 1992). It also provided evidence of the occurrence of myxomycetes, a rather poorly studied group of organisms in the southern high latitudes, on Macquarie Island

The author arrived on Macquarie Island on January 23, 1995 after a four-day voyage through very rough seas aboard the French icebreaker L'Astrolabe. The island falls within the range of latitudes long referred to as the "Furious Fifties," and strong westerly winds were evident during the entire voyage, with ocean swells sometimes reaching 12 meters. The L'Astrolabe was on its way to Antarctica and dropped off the author and four other scientists on Macquarie Island. Since the icebreaker could not come close to shore, the five reached the island aboard two small zodiacs.

Field collecting on Macquarie Island began within a few days after arrival and lasted until just before leaving the island to return home on May 4. The methods used in carrying out field collecting were essentially those described by Stephenson in a number of previous papers (e.g., Stephenson 1988). Visits were made to different localities and/or to different types of vegetation throughout the northern portion of Macquarie Island. At each collecting site potential substrates were examined carefully for the fruiting bodies of myxomycetes. A "collection" was defined as one or more fruiting bodies

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sharing the same substrate and considered to have originated from a single plasmodium. The methods for making a collection involved removing all or most of the fruiting bodies along with a portion of the substrate upon which they occurred. All collections were taken back to a laboratory at the ANARE station, air-dried, and placed in small boxes or other suitable containers for storage. Ultimately, these were sent to the Eumycetozoan Laboratory of the University of Arkansas in the United States for final identifications. Later, all collections were transferred to the herbarium (ADT) of the Australian Antarctic Division in Kingston, Tasmania.

The first localities visited were in herbfield communities near the ANARE station, and the first collecting trip yielded one plasmodium and a small fruiting of what was tentatively identified in the field as *Didymium squamulosum*. Over the next few weeks, most collecting was carried out in herbfield communities, but visits were also made to mire, tussock grass, and feldmark communities. Several trips to the rather bleak feldmark communities on the top of the plateau yielded no evidence of myxomycetes. This was undoubtedly the result of the almost complete absence of substrates suitable for the growth and development of these organisms. The same was true for mire communities, and surveys of tussock grass communities produced relatively few collections of myxomycetes. Mire communities are constantly wet, which would not be favorable for myxomycetes, which require periodic dry conditions in order to complete their life cycle. Fernbrake communities were less assessable from the ANARE station and were not investigated until later into the author's visit to Macquarie Island. However, they proved to be the second most productive collecting sites on the island. Fernbrake communities occur on sites that are moist but not constantly wet, and there is abundant decaying organic material on or within which the feeding stages in the myxomycete life cycle would be expected to occur.

In an effort to supplement field collections, samples of various types of dead plant material were collected and used to prepare a set of moist chamber cultures as described by Stephenson and Stempen (1994). Fruiting bodies appearing in the cultures were handled in the same manner already described for field collections. In addition, a few samples of surface soil and litter were collected and processed for dictyostelids, using the methods described by Landolt and Stephenson (1989).

Over a period of almost three and a half months, a total of 412 field collections of myxomycetes were obtained on Macquarie Island. Approximately 95% of these collections could referred to already described species, but two represented species that were later described as new to science. These were *Didymium macquariense* (Stephenson and Moreno 2006) and *Lepidoderma cristatosporum* (Moreno et al. 2018). The three most abundant species were *Trichia verrucosa* (80 collections), *Diderma alpinum* (78), and *Craterium leucocephalum* (59). Collectively, these three species made up 53% of all field collections. Four other species were represented by at least 15 collections, and one of these was one of the species (*D. macquariense*) later described as new to science. In contrast, four species (*Craterium minutum*, *Hemitrichia pardina*, *Physarum* sp. (not identified to the level of species but clearly different from any other member of the genus recorded during the present study), and *Metatrichia floriformis* were each represented by a single collection. Altogether, 23 species in 11 genera were recorded from the 412 field collections.

Only 37 of the 159 moist chamber cultures yielded evidence (plasmodia or fruiting bodies) of myxomycetes. Many of the plasmodia that appeared in cultures failed to produce fruiting bodies, and only 14 collections were generated from this component of the project. However, the collections added three additional species and two additional genera to the total recorded for the entire project. These were *Echinostelium minutum*, *Stemonitis fusca* (the diminutive form sometimes recognized as *S. nigrescens*), and *Trichia contorta*. This brought the total number of myxomycetes known from Macquarie Island to 26 species in 13 genera. In addition to the species mentioned above, the species now known from the island are *Collaria lurida*, *C. rubens*, *Diderma radiatum*, *D. ochroideum*, *D. squamulosum*, *Lamproderma arcyrioides*, *L. ovoideum*, *Perichaena chrysosperma*, *Physarum bitunicatum*, *P. cinereum*, *P. compressum*, *P. straminipes*, *Trichia alpina*, and *T. botrytis*.

The cultures prepared for the isolation of dictyostelids produced the first record of a member of this group of organisms from the southern high latitudes (Stephenson et al. 1998). *Dictyostelium mucoroides*, the species recorded, was recorded obtained from samples collected at nine different localities, which suggests that it is not uncommon on Macquarie Island.

Field collecting on Macquarie Island was invariably limited to those days when weather conditions were favorable. On average, at least some precipitation (rain, sleet, or snow) occurs 316 days each year, which accounts for the name "green sponge" that is sometimes applied to Macquarie Islands. Wind speeds in excess of

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30 km/hour at lower elevations on the island are typical, but wind speeds on the top of the plateau are appreciably higher and thus can be exceeding dangerous. On windy days, it was sometimes possible to seek shelter from the wind by confining collecting activities to the base of one of the steep slopes dropping down from the top of the plateau.

Field work on Macquarie Island invariably resulted in encounters with the island's wildlife. Penguins tend not to be aggressive, although their sheer numbers (especially the large colonies of the royal penguin) sometimes hindered movement. Elephant seals are huge animals (lengths of 4 to 5 meters and weights up to 500 kg in males) and potentially dangerous. Consequently, they were avoided. Birds other than penguins rarely allow humans to approach them, but an exception occurred on one collecting trip when a wandering albatross (*Diomedia exulans*) walked right up to the author (Figure 6). The wandering albatross, which has the longest wingspan of any bird in the world, breeds on Macquarie Island.

Almost two-thirds of the 412 field collections of myxomycetes were associated with Macquarie Island cabbage. Most of these occurred on the mats of fine roots and litter found around the base of the plant, with others found on dead or living leaves. Macquarie Island cabbage has large, round succulent leaves that occur on petioles up to a meter in length (Figure 7). The cluster of leaves on a single plant creates an enclosed space where developing fruiting bodies would be protected from temperature extremes and the damaging effects of falling raindrops. Presumably this is an unusually favorable microhabitat for myxomycetes. Ninety percent of all fruitings of *Trichia verrucosa* (Figure 8) were found in this microhabitat, although some of the very largest fruitings of this species occurred beneath the cover provided by the fronds of the prickly shield fern where the latter was abundant in shallow ravines.

When the other more abundant species are considered, some definite patterns emerge. More than 70 percent of all collections of *Craterium leucocephalum*, *Didymium ochroideum*, *D. macquariense*, and *Lamproderma arcyriodes* also were associated with Macquarie Island cabbage. In contrast, *Collaria lurida* was never recorded from any substrate other than the old, dead scapes of silver-leaf daisy, and the majority of collections of *Diderma alpinum* occurred on dead but still attached leaves of this plant.

Some of the species recorded in the project, especially those represented by only one or only a few specimens, did not always conform completely to published descriptions. It is possible that this simply reflects the severe environmental conditions under which myxomycetes exist on Macquarie Island, but the presence of distinct biotypes of some species cannot be ruled out. In an earlier paper (Stephenson 2020), the author compared the assemblage of myxomycetes recorded from subantarctic Macquarie Island with the assemblage recorded from tropical Christmas Island, located in the Indian Ocean (Stephenson and Stephenson 2019). The two islands are about the same size, but the assemblages of myxomycetes present are very different. Sixty-eight species were recorded from Christmas Island, compared to the 26 species recorded from Macquarie Island. More importantly, the two islands shared only nine species in common.

Figure 3. Fernbrake community on Macquarie Island

Figure 4. Colony of royal penguins on Macquarie Island

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Figure 5. Australian National Antarctic Research Expedition (ANARE) station on Macquarie Island

Figure 6. The author's encounter with a wandering albatross

Figure 7. The plant known as Macquarie Island cabbage

Figure 8. Fruiting bodies of *Trichia verrucosa*

When the author arrived on Macquarie Island, he did expect that the number of field collections would exceed 400. Since everything (boot, field gear, clothing, and other personal items) that could be taken to the island had to fit into two small duffle bags, there was very limited "extra" space available. The small pasteboard storage boxes used for storing collections soon ran out, and whatever other containers were available at the ANARE station took their place. As such, numerous collections were placed in the small plastic containers in which 35mm film (which was still being widely used in the 1990s) was sold.

Looking back after almost thirty years, the author still regards the expedition to Macquarie Island as both an incredible personal experience and an extraordinary scientific opportunity to collect and study a group of organisms (in this case the myxomycetes) in a remote and understudied area of the world. In some ways the circumstances were similar to what early naturalists must have encountered in their efforts to document the biodiversity of the regions of the world that still remained unknown in the eighteenth and early nineteenth centuries.

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Conflict of Interest: The authors declare no conflict of interest.

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