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CONTRIBUTIONS TO THE STUDY OF HIGHER FUNGI ON SABLE ISLAND, NOVA SCOTIA

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ABSTRACT

This study documents 27 taxa of Higher Fungi found on Sable Island, a remote emergent sand bar 160 km east of the Nova Scotia mainland. Of these, two are new basidiomycete records for the province, *Deconica subcoprophila* and *Volvopluteus* aff. *gloiocephalus*. Thirteen other taxa represent range extensions within Nova Scotia. *Suillus luteus* is suggested as the probable identity of the only ectomycorrhizal fungus described colonizing the roots of the solitary pine tree growing on Sable Island.

Keywords: coprophilous fungi, coastal dunes, *Deconica, Suillus luteus, Volvopluteus*

INTRODUCTION

Sable Island is located 160 km east of the Nova Scotia mainland. Although the island is part of the province of Nova Scotia, it is distinguished from the rest of the province by its remote location, and by numerous unique features: a landscape dominated by one of the largest coastal dune systems in Atlantic Canada; an extensive freshwater lens; the world's largest grey seal (*Halichoerus grypus*) breeding colony; a population of feral horses (the only terrestrial mammal on the island); and many rare and endemic flora and fauna. The island is a distinct biogeographic region within Nova Scotia and is the smallest ecodistrict in the province (Neily *et al*. 2017).

Sable Island is an emergent sandbar approximately 40 km long, with a maximum width of 1.3 km, and a surface area of 3,400 ha

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(~30 km^2) (Colville *et al*. 2016). The island's dimensions vary as its shoreline is subjected to seasonal and long-term changes in patterns of sand erosion and deposition. Severe weather events also have short- and/or long-term impacts on the island's topography. Sable Island's climate is Maritime Temperate (Meteorological Service of Canada 1999), and compared with the rest of Nova Scotia, the island has milder temperatures, less snow, more frequent cloud cover and fog, and stronger winds.

There has been a continuous human presence on Sable Island since 1801. Over two centuries ago, the island was primarily known as a hazard to navigation. In 1801 the Government of Nova Scotia set up the lifesaving service–the Sable Island Humane Establishment–which operated until 1958. The human impact on the island was greatest during this period. Introductions of livestock and cultivation of crops, hunting, construction, and vehicle traffic influenced the island's landforms and the composition of vegetation communities. In 1944, the Meteorological Service of Canada (MSC) established the aerological station on Sable Island, and other organizations such as the Canadian Coast Guard, Fisheries and Oceans Canada, and Dalhousie University have had long-term programs on the island. In 2013 the island became the Sable Island National Park Reserve, and the island and most infrastructure are now owned and managed by Parks Canada. Although MSC's aerological program ended in 2019, the Sable Island Station continues as the operational centre for the island.

Roughly 50% of the island's land surface is vegetated (Colville *et al*. 2016), and about 185 plant species occur in distinctive vegetation communities comprised of herbs and low shrubs. Approximately 20% of plant species are introductions, but many are found mostly in areas where human activities and structures provide suitable habitat.

Given the island's dynamic landscape as well as recent changes in jurisdiction and human activities, there have been changes in many areas where the fungi taxa reported here were recorded. For example, several specimens were collected from a well-vegetated slope at the edge of a freshwater pond south of the Sable Island Station. Since then, the adjacent south beach dune has retreated, and the pond area is now a sandflat frequently subjected to ocean overwash. Other specimens were found in vegetation communities that have since been altered by sand transport, or by nesting and grazing activities. A few fungi

specimens were recorded on or near human structures which have since been removed or modified. Since most infrastructure is surrounded by fences to keep the horses away from buildings and equipment, fungi occurring inside these exclosures (e.g., the exclosure at the Sable Island Station) are in habitats generally not affected by horse activities (grazing, trampling, and dung/urine).

Numerous botanical surveys, beginning with Macoun's work on Sable Island in 1899 (Macoun 1902) have contributed to knowledge of the island's vascular plant species and communities. Among the few that have focussed on the less conspicuous flora are Richardson *et al*. 2009 (lichens), and Mills & Lucas 2016 (bryophytes). Prior to this study, the last work on the island's mycoflora was conducted in the 1980s. Redhead & Catling (1983) reported two fungi from Sable Island which were new records for Nova Scotia: *Peziza ammophila* and *Hygrocybe coccineocrenata* (as *H. turunda*). Although David Malloch collected fungi on the island in the 1980s, with results being available in a project report (Malloch 1982) and in a note on a single species, *Protubera sabulonensis* (Malloch 1989), most of the identifications have only recently been published (Malloch 2016). The species reported in Redhead & Catling (1983) and in Malloch (2016) represent a complete list of Sable Island fungi based on collections made in the 1980s, a total of 118 species. Of these, 116 were reported by Malloch (2016), of which 51 were coprophilous fungi that were grown in a moist chamber from horse dung samples collected on the island.

Although Sable Island is considered part of Halifax County for administrative purposes, it is an ecologically unique location (Neily *et al*. 2017) and consequently new reports from the island of species that have been previously recorded on the mainland in Halifax County could be viewed as range extensions within the province. This paper presents two new records for Nova Scotia and extends the range of thirteen taxa within the province.

MATERIALS AND METHODS

The taxa listed in this publication were collected on Sable Island, Nova Scotia in the summer and fall of 2009, 2011, 2014, and 2015 using an opportunistic sampling approach. Morphological characteristics (e.g., size, shape, colour, odour, etc), dehydrated specimens and

spore prints, habitat details, site coordinates, and field number were recorded for each collection. Photographs, mostly *in situ*, were also taken for each specimen. Microscopic characteristics were observed by rehydrating desiccated collections in 3% KOH.

Texts used for identification of taxa were: *Peziza domiciliana,* Beug *et al*. (2014); *Agaricus* aff. *sylvaticus,* Nauta (2001), Kerrigan (2016), and Baroni (2017); *Suillus luteus,* Smith & Thiers (1971) and Grund & Harrison (1976); *Inocephalus murrayi,* Horak (1975); *Gloeophyllum sepiarium,* Gilbertson & Ryvarden (1988); *Neolentinus sepiarium,* Mochizuki (2019); Hygrophoraceae, Bird & Grund (1979), Hesler & Smith (1963), and Stuntz (1975); *Crucibulum leave*, Fay *et al*. (2019); *Mutinus elegans*, Kuo (2006); *Volvopluteus* aff. *gloiocephalus*, Butler (2012) and Justo *et al*. (2011); *Fomes fomentarius,* Gilbertson & Ryvarden (1988); *Panaeolus* spp., Menser (2019), Ola'h (1969) and Stamets (1978); *Psathyrella candolleana*, Smith (1972) and Kits van Waveren (1977); *Schizophyllum commune*, Ginns (2007) and Cooke (1961); *Agrocybe pediades,* Hermansen (1986); *Protostropharia semiglobata*, Kroeger (2009); *Deconica* spp., Guzmán (1983); and *Lepista nuda,* Moser (1983) and Butler (2004).

Index Fungorum (http://www.indexfungorum.org/), the global fungal nomenclatural database, was used to ensure that current taxonomic names were applied to collections. Secondary reports of fungi from the literature, including the electronic databases Mycoportal (http://mycoportal.org) and Canadensys (http://www.canadensys.net/) were used to determine range extensions and new records.

The collections examined in this study, and photographs, are housed at the E.C. Smith Herbarium (ACAD) at Acadia University, Wolfville, Nova Scotia. The ACAD accession number for each collection, followed by the original field number (in parentheses), is provided in the Annotated Species List.

Specimens recorded in 2014 and 2015 (total three) were collected under Parks Canada Agency Research and Collection Permits (permit number SINP-2012-12893). Permits were not required prior to park establishment in 2013.

RESULTS

Most fungi specimens (88%) reported here were collected in 2009. Of the 43 fruitbody collections studied, 27 taxa belonging

to 14 families were identified (Table 1). Of these, six genera and 15 species are new to Sable Island. The six new genera are *Suillus*, *Neolentinus*, *Crucibulum*, *Volvopluteus*, *Fomes*, and *Schizophyllum*. Twelve of the 15 species are also new to Halifax County.

Of the 27 taxa recorded, 19 were found once. Of the remaining eight taxa, four were recorded at two sites, two at three sites, and two at five sites. Most (13 of 15) new records and range extensions are based on a single collection/site. Site and collection details are provided in the Annotated Species List below.

Table 1 List of fungi taxa collected between 2009 and 2015 on Sable Island, Nova Scotia, with new record status (X) indicated for the province, Halifax County, and Sable Island.

Taxa	NS	Hfx	SI[1]	Earlier Record[2]	Month[3]
ASCOMYCOTA					
Pezizaceae					
Peziza domiciliana	-	X	X	-	July
BASIDIOMYCOTA					
Agaricaceae					
Agaricus aff. *sylvaticus*	-	X	X	-	Aug
Boletaceae					
Suillus luteus	-	-	X	-	Oct
Entolomataceae					
Inocephalus murrayi	-	X	X	-	Aug
Gloeophyllaceae					
Gloeophyllum sepiarium	-	-	-	DM	July
Neolentinus lepideus	-	-	X	-	Aug
Hygrophoraceae					
Cuphophyllus pratensis	-	-	-	DM	Oct
Gliophorus psittacinus	-	-	-	DM	Nov
Humidicutis marginata	-	-	-	DM	Aug
Hygrocybe coccineocrenata	-	-	-	R&C	Oct
Hygrocybe ceracea	-	X	X	-	Oct
Hygrocybe conica	-	X	X	-	Oct
Hygrocybe grundii	-	X	X	-	Oct
Nidulariaceae					
Crucibulum laeve	-	X	X	-	Oct
Phallaceae					
Mutinus elegans	-	-	-	DM	Sep
Plutaceae					
Volvopluteus aff. *gloiocephalus*	X	X	X	-	Jun/Oct

Table 1 cont'd

Table 1 cont'd

Taxa	NS	Hfx	SI[1]	Earlier Record[2]	Month[3]
Polyporaceae					
Fomes fomentarius	-	X	X	-	Sep
Psathyrellaceae					
Panaeolus papilionaceus	-	-	-	DM	Jun
Panaeolus semiovatus	-	-	-	DM	Jun
Panaeolus subbalteatus	-	-	-	DM	Jun
Psathyrella candolleana	-	X	X	-	Aug
Schizophyllaceae					
Schizophyllum commune	-	X	X	-	Oct
Strophariaceae					
Agrocybe pediades	-	-	-	DM	Jun
Protostropharia semiglobata	-	-	-	DM	Jul
Deconica coprophila	-	-	-	DM	Jul
Deconica subcoprophila	X	X	X	-	Jul
Tricholomataceae					
Lepista nuda	-	-	X	-	Oct
Total	**27**	**2**	**12**	**15**	**12**

[1] Although Sable Island is administratively within Halifax County, a new record from the island for a species previously recorded in Halifax County is viewed as a range extension within Nova Scotia.

[2] Previously reported from Sable Island by Malloch 2016 (DM), or by Redhead & Catling 1983 (R&C).

[3] Month collected during this study.

ANNOTATED SPECIES LIST

ASCOMYCOTA

Pezizaceae

Peziza domiciliana Cooke, *Gard. Chron.*, N.S. 7(no. 182): 793 (1877)

Plant pathologist Ken Harrison first documented *P. domiciliana* in Nova Scotia in 1938, growing in the greenhouses, cellars, and mushroom caves of Kings County (Gourley 1982). This is the first report for *P. domiciliana* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected at an abandoned building near West Light; fruit-bodies (43.93192N, -60.02032W) were growing in a shaded and sheltered area under the outdoor steps, in sand against the concrete wall of the building's basement; Z. Lucas; 19933F (15-04); July 11, 2015.

BASIDIOMYCOTA

Agaricaceae

***Agaricus* aff. *sylvaticus* Schaeff.**, *Fung. bavar. palat. nasc.* (Ratisbonae) 4: 62 (1774)

This red-staining *Agaricus* sp. is clearly in the section *Sanguinolenti* and, following Nauta (2001) and Baroni (2017), most closely resembles *A. sylvaticus* Schaeff. The eastern North American members of the section *Sanguinolenti* probably represent a complex of related species requiring more taxonomic work to resolve (Kerrigan 2016). *Agaricus haemorrhoidarius* Schulz., a related species, has been documented growing in Kings County, Nova Scotia, in conifer woods (Gourley 1982). However, due to the heterogeneity of this species complex, it is difficult to know whether the collection listed in Gourley (1982) is the same as our collection from Sable Island without examining the Kings County collection. This is the first report for *Agaricus* aff. *sylvaticus* from Sable Island, and it represents a new record and a range extension for this unresolved species complex within the province.

Material examined

1) Collected near the edge of a concrete path inside the station exclosure; the fruitbody (43.93320N, -60.00723W) was growing in soil with 100% vegetation cover; Z. Lucas; 19934F (09-117); August 6, 2009.

Boletaceae

***Suillus luteus* (L.) Roussel**, *Fl. Calvados*: 34 (1796)

Suillus luteus, a widespread and popular edible ectomycorrhizal (ECM) mushroom, was first reported in Halifax, Kings, Pictou, and Lunenburg Counties growing under *Pinus* spp. (Gourley 1982). Although *S. luteus* has been reported from Halifax County, this is the first report of *S. luteus*–and of any known ECM mushroom–from Sable Island. Mycologist David Malloch (2016) provided a brief description of the ECM fungus colonizing a solitary and stunted *Pinus sylvestris* (Scots Pine). This tree, planted in the 1960s, is one of only three trees presently recorded on Sable Island. Two *Alnus incana*, introduced about 30 years ago, survive as thin stems <50 cm high growing in a hollow and sheltered by beach grass, *Ammophila breviligulata*. Malloch (2016) investigated the pine and noted (p. 142)

a "well-developed mantle and Hartig net" and that the root tips he collected all seemed to be colonized by one fungal symbiont, but he could not identify the ECM fungus in the absence of fruiting bodies. Our collection, identified as *S. luteus*, was found growing at the base of the same *P. sylvestris*, and is the likely identity of the ECM fungus that eluded Malloch. This is the first report for *S. luteus* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected at the base of an introduced and solitary *P. sylvestris*; the fruitbody (43.93123N, -60.00242W) was growing in a thick layer of decomposing plant material with little sand present in a moist and shaded environment, sheltered by dense vegetation around the tree. Nearby vascular species included *Trifolium* sp., *Achillea millefolium*, *Juncus* sp., and grasses; Z. Lucas; 19935F (09-142); October 9, 2009.

Entolomataceae

Inocephalus murrayi (Berk. & M.A. Curtis) Rutter & Watling, *Malay. Nat. J.* 50: 231 (1997)

Inocephalus murrayi–as *Nolanea murrayi* (Berk. & M.A. Curtis) Dennis–was first collected on wet humus and sphagnum moss in Hants and Colchester Counties, Nova Scotia, in 1931 by Michigan State University mycologists Lewis Wehmeyer and Alexander Smith (Gourley 1982). This is the first report for this species from Sable Island and represents a range extension within the province.

Material examined

1) Collected in a shrub-herb community on a low hill just east of a freshwater pond south of the station; the single fruitbody (43.92917N, -60.00962W) was growing in soil with 100% cover including *Thalictrum polygamum*, *Rubus arcuans*, *Symphyotrichum novi-belgii*, and *Anthoxanthum odoratum*; Z. Lucas; 19936F (09-123); August 13, 2009.

Gloeophyllaceae

Gloeophyllum sepiarium (Wulfen) P. Karst. [as '*Gleophyllum*'], *Bidr. Känn. Finl. Nat. Folk* 37: 79 (1882)

Gloeophyllum sepiarium (Fig 1) was first collected in Nova Scotia (no specific location listed) by physician J. Sommers and

Fig 1 ***Gloeophyllum sepiarium*** **is one of several lignicolous species that occur on woody debris that has washed up on, or been brought to, Sable Island.**

naturalist Alexander MacKay in 1881 (Gourley 1982). This species was previously reported from Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected on the inside slope of a low south beach dune; the fruitbody (43.93140N, -59.90980W) was found growing on a piece of driftwood partly buried in the sand; Z. Lucas; 19938F (09-104); July 18, 2009; Fig 1.

2) Collected from a south beach dune 100 m northwest of the Old No.3 house foundation; fruitbodies (43.93167N, -59.88540W) were growing on a large driftwood tree trunk; Z. Lucas; 19939F (09-105); July 18, 2009.

Neolentinus lepideus (Fr.) Redhead & Ginns, *Trans. Mycol. Soc. Japan* 26(3): 357 (1985)

This fungus was first collected in Nova Scotia in 1908 by Alexander MacKay, in Halifax, Kings, and Pictou Counties growing on coniferous and deciduous wood (Gourley 1982). This is the first report for *N. lepideus* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected at the north side of the road to the gas storage building at the Sable Island Station; the fruitbody (43.93332N, -60.00560W) was growing on the base of a wooden post, at the sand surface; Z. Lucas; 19940F (11-014); August 11, 2011.

Hygrophoraceae

Cuphophyllus pratensis (Pers.) Bon, *Docums Mycol.* 14(no. 56): 10 (1985) [1984]

Cuphophyllus pratensis, as *Hygrophorus pratensis* var. *pratensis* (Fr.) Fr., was first documented in Nova Scotia in the 1930's from Colchester, Hants, Kings, and Pictou Counties by Lewis Wehmeyer and Alexander Smith (Gourley 1982). This species was previously reported (as *Hygrocybe pratensis*) on Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected inside the station exclosure; fruitbodies (43.93313N, -60.00723W) were growing in sandy soil in an area of vegetated terrain mowed several times a year; Z. Lucas; 19941F (09-157); October 12, 2009.

Humidicutis marginata (Peck) Singer, *Sydowia* 12(1-6): 225 (1959) [1958]

Humidicutis marginata, previously known as *Hygrocybe marginata* (Peck) Murrill, was first documented in Nova Scotia from Colchester, Kings, and Lunenburg Counties in humus under *Acer* sp. in 1931 by Lewis Wehmeyer and Alexander Smith (Gourley 1982). *H. marginata* was previously reported on Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected in a shrub-herb community on a low hill just east of Bartonia Pond (a freshwater pond that has since disappeared); fruitbodies (43.92917N, -60.00962W) were growing on a vegetated slope with 100% cover comprised of *T. polygamum*, *R. arcuans*, *S. novi-belgii*, *A. odoratum*, and mosses; Z. Lucas; 19942F (09-122); August 13, 2009.

Hygrocybe coccineocrenata (P.D. Orton) M.M. Moser, in Gams, *Kl. Krypt.-Fl.*, Edn 3 (Stuttgart) 2b/2: 68 (1967)

Hygrocybe coccineocrenata was first reported from Sable Island, and Nova Scotia in general, by Redhead & Catling (1983), as *H. turunda* var. *sphagnophilus* (Peck) Bon. The collections examined in our study most closely resemble Hesler & Smith's (1963) and Stuntz's (1975) description of *H. turunda* var. *sphagnophilus* in that the pileal squamules are not darkly coloured in this

species, in contrast to *H. turunda* var. *turunda*. Both *H. turunda* and *H. turunda* var. *sphagnophilus* are now classified as *H. coccineocrenata*. According to Hesler & Smith (1963) and Redhead & Catling (1983), this species is typically associated with moss (often *Sphagnum* moss). Our collection was growing on moist sand, with no moss present.

Material examined

1) Collected in a dune slack east of the West Light area; fruitbodies (43.93232N, -60.01643W) were growing in moist sand with *Myrica pensylvanica*, *Vaccinium macrocarpon*, and *Juncus* sp. nearby; Z. Lucas; 19943F (09-134); October 2, 2009.

Hygrocybe ceracea (Sowerby) P. Kumm, *Führ. Pilzk.* (Zerbst): 112 (1871)

Hygrocybe ceracea, as *Hygrophorus ceraceus* (Wulfen) Fr., was originally documented in Nova Scotia growing under *Fagus* sp. and *Acer* sp. in Colchester and Kings Counties in 1931 by Lewis Wehmeyer and Alexander Smith (Gourley 1982). Bird & Grund (1979) studied another collection from Kings County made in 1967 and identify the habitat of *H. ceracea* as moist soil or moss in either coniferous or deciduous forests. Hesler & Smith (1963) identify moss and soil as the habitat of this species, with no mention made of forests. This is the first report for *H. ceracea* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected from a gentle northwest-facing slope 10 m south of Pinetree Pond West; fruitbodies (43.93072N, -60.00265W) were growing in sand rich in organic material in an area with 100% vegetation cover, including *M. pensylvanica*, *Fragaria virginiana*, *A. millefolium, Juncus* sp.*, A. odoratum,* and *Maianthemum stellatum*; Z. Lucas; 19944F (09-143); October 10, 2009.

Hygrocybe grundii Malloch, *Fleshy fungi (Basidiomycota) of the Atlantic Maritime Ecozone*: 124 (2010)

This species, now known as *H. grundii* (Malloch 2010), was originally described as *Hygrocybe macrosporus* Bird & Grund from one collection made in a hemlock forest in the Kentville ravine, Kings County in 1967 (Bird & Grund 1979). This is the first report for

H. grundii (Fig 2) from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected 50 m west of Lily Pond North; fruitbodies (43.93153N, -60.01843W) were growing in soil with 100% vegetation cover including *T. polygamum, Vaccinium angustifolium, R. arcuans, Mitchella repens, Juncus* sp., *A. odoratum*, and *Festuca rubra*; Z. Lucas; 19945F (09-146); October 11, 2009; Fig 2.

Hygrocybe conica (Schaeff.) P. Kumm., *Führ. Pilzk.* (Zerbst): 111 (1871)

Hygrocybe conica was first collected on humus in mixed woods, in Nova Scotia, from Kings, Colchester, and Annapolis Counties in 1908 by Lewis Wehmeyer and Alexander MacKay (Gourley 1982). This is the first report for *H. conica* from Sable Island, and it represents a range extension for this species within the province.

Fig 2 ***Hygrocybe grundii*** **is one of many members of the Hygrophoraceae found on Sable Island. This species is not commonly encountered in Nova Scotia.**

Material examined

1) Collected in a sparsely vegetated area ~30 meters inland from the south beach, east of the south beach road; fruitbodies (43.93020N, -60.00139W) were growing in sandy soil on a south-west-facing slope with 20% vegetation cover including *Anaphalis margaritacea*, *Solidago sempervirens,* and *A. breviligulata*; Z. Lucas; 19946F (09-144); October 9, 2009.

2) Collected inside the station exclosure; fruitbodies (43.93313N, -60.00723W) were growing in soil in an area of vegetated terrain that was mowed several times a year; Z. Lucas; 19947F (09-159); October 12, 2009.

Gliophorus psittacinus (Schaeff.) Herink, *Sb. severočesk. Mus.*, Hist. Nat. 1: 82 (1958)

Gliophorus psittacinus was first documented growing on humus in mixed woods in Nova Scotia by Lewis Wehmeyer and Alexander Smith in 1931 (Gourley 1982). This species was previously reported, as *Hygrocybe psittacina* (Schaeff.) P. Kumm., from Sable Island from collections made in the early 1980s (Malloch 2016). Interestingly, Malloch (2016) reported that "this species is often bright green when fresh, although the ones on Sable Island were always yellow to orange" (p. 142). Our collection was greenish in colour, conforming to the more standard colour for *G. psittacinus*.

Material examined

1) Collected in a shrub-herb community just east of the helipad at the station; fruitbodies (43.93291N, -60.00502W) were growing in sandy soil with a high organic matter content and ~100% vegetation cover, including *T. polygamum*, *M. pensylvanica*, *Empetrum nigrum*, *A. millefolium*, *Sibbaldiopsis tridentata*, *M. stellatum,* and grasses; Z. Lucas; 19948F (14-08); November 14, 2014.

Nidulariaceae

Crucibulum laeve (Huds.) Kambly, *Gast. Iowa*: 167 (1936)

Seven collections of *C. laeve* have been reported from Nova Scotia from Kings, Cape Breton, and Colchester Counties (Mycoportal 2016). This is the first report for *C. laeve* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected 4 m northwest of the gas storage building at the station; fruitbodies (43.93338N, -60.00542W) were growing on old leaf, stem, and dung litter in sandy soil with 50% cover including *Rosa virginiana*, *A. margaritacea, Juncus* sp. *A. breviligulata*, and *F. rubra*; Z. Lucas; 19949F (09-141); October 7, 2009.

Phallaceae

Mutinus elegans (Mont.) E. Fisch., *Syll. fung.* (Abellini) 7: 13 (1888)

Mutinus elegans was previously reported on Sable Island from collections made in the early 1980s (Malloch 2016), and this was the first record of this species in Nova Scotia.

Material examined

1) Collected on Steeple Dune; the fruitbody (43.97490N, -59.76283W) was growing in tall marram grass (*A. breviligulata)* on a sandy substrate in a sheltered, well-shaded area; Z. Lucas; 19950F (11-015); September 6, 2011.

Plutaceae

Volvopluteus* aff. *gloiocephalus (DC.) Vizzini, Contu & Justo**,** *Fungal Bio.* 115(1):15 (2011)

Our collections represent a new record for *Volvopluteus* aff. *gloiocephalus* (Fig 3)–formerly *Volvariella gloiocephala* (DC.) Boekhout & Enderle–in Nova Scotia. While the cap diameter (>5cm) and the average basidiospore length (>12.5 µ m) conform to the description of *V. gloiocephalus* published by Justo *et al*. (2011), neither pleurocystidia nor cheilocystidia were found in the collections described here which is why our collections are listed as having an affinity with *V. gloiocephalus*.

Material examined

1) Collected on a low west-facing slope in a sheltered hollow 2 m from the east side of an abandoned wooden structure (the aframe); fruitbodies (43.93468N, -59.98465W) were growing in sand (possibly on buried beach grass litter) in an area with ~30% vegetation cover (*S. sempervirens* and *A. breviligulata*), and although this is an area of horse rubbing/sheltering activity, there was no fresh dung in the site; J. Barkhouse and Z. Lucas; 19951F (09-091); June 30, 2009.

2) Collected from the inside slope of a south beach dune; fruitbodies (43.93350N, -59.85195W) were growing in sandy soil with

Fig 3 ***Volvopluteus* aff. *gloiocephalus* reported here is the first for both the Province of Nova Scotia and Sable Island.**

20% vegetation cover including *Lathyrus japonicus* var. *maritimus*, *A. millefolium,* and *A. breviligulata*; Z. Lucas; 19952F (09-162); October 13, 2009; Fig 3.

Polyporaceae

Fomes fomentarius (L.) Fr., *Summa veg. Scand.*, Sectio Post. (Stockholm): 321 (1849)

Nine collections of *F. fomentarius* have been reported from Nova Scotia, in Kings and Hants Counties on a range of hosts (Mycoportal 2016). The earliest was collected in 1880 by J. Sommers and Lewis Wehmeyer (Gourley 1982). This is the first report for *F. fomentarius* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected on the north beach above the high tide line; fruitbodies (43.93455N, -60.01138W) were growing on the unburied sides of a driftwood birch log, and the condition of the bark suggested that the log may have been on the beach for only a few months or less; Z. Lucas; 19953F (09-121); September 13, 2009.

Psathyrellaceae

Panaeolus papilionaceus (Bull.) Quél., *Mém. Soc. Émul. Montbéliard*, Sér. 2 5: 152 [122 repr.] (1872)

This species was previously reported on Sable Island from collections made in the early 1980s (Malloch 2016). Alexander MacKay first collected this species in Nova Scotia, as *P. campanulatus* (L.) Quél., in 1908 on cow dung in pastureland from Colchester, Kings, Lunenburg, and Pictou Counties (Gourley 1982). Gerhardt (1996) found that the taxa formerly known as *Panaeolus sphinctrinus* (Fr.) Quél., *P. campanulatus* (L.) Quél., *P. retirugis* (Fr.) Gillet, and *P. papilionaceus* (Bull.) Quél.–a complex of closely related species with overlapping descriptions–were all the same species and grouped them under *P. papilionaceus*. The three collections described below fall into several species of *Panaeolus* that are now classified as *P. papilionaceus*.

Material examined

1) Collected on a dune north of the Old Main area; fruitbodies (43.93502N, -60.04983W) were growing on a weathered dung pile among *L. japonicus* var. *maritimus, A. millefolium, A. breviligulata,* and *Poa pratensis*.; J. Barkhouse and Z. Lucas; 19954F (09-054); June 24, 2009.

2) Collected on the West Spit; fruitbodies (43.96320N, -60.13882W) were growing in a fresh dung pile in an area densely vegetated with *Honckenya peploides*, *L. japonicus* var. *maritimus*, and *A. breviligulata*.; J. Barkhouse and Z. Lucas; 19955F (09-064); June 26, 2009.

3) Collected 30 metres south of an abandoned wooden structure (the aframe); fruitbodies (43.93438N, -59.98463W) were growing on dung in a sparsely vegetated area (~20% cover) with *R. virginiana, A. breviligulata,* and *P. pratensis*; J. Barkhouse and Z. Lucas; 19956F (09-093); June 30, 2009.

Panaeolus semiovatus (Sowerby) S. Lundell & Nannf, *Fungi Exsiccati Suecici* 11-12: 14 (no. 537) (1938)

Panaeolus semiovatus was first reported in Nova Scotia by J. Sommers in 1881 growing on dung in Halifax County (Gourley 1982). This species was previously reported from Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected on the beach at base of the north beach dune; fruitbodies (43.93612N, -59.93128W) were growing on a weathered dung pile; J. Barkhouse and Z. Lucas; 19957F (09-055); June 24, 2009.

2) Collected in a sandy area at the south end of a north-south cut through the north beach dunes; fruitbodies (43.93450N, -59.92273W) were growing on a dung pile on bare sand with sparse *A. breviligulata* nearby; J. Barkhouse and Z. Lucas; 19958F (09-073); June 27, 2009.

3) Collected in the northwest area of Steeple Dune; fruitbodies (43.97455N, -59.76223W) were growing on dung in a field of mostly *A. breviligulata* and *P. pratensis*; J. Barkhouse and Z. Lucas; 19959F (09-077); June 28, 2009.

Panaeolus subbalteatus (Berk. & Broome) Sacc., *Syll. fung.* (Abellini) 5: 1124 (1887)

Panaeolus subbalteatus (Fig 4) was previously reported from Sable Island from collections made in the early 1980s (Malloch 2016). Surprisingly, prior to Malloch's (2016) report, this cosmopolitan species had not been previously reported from Nova Scotia. However, one of the authors of this paper (KW) had found, but did

Fig 4 ***Panaeolus subbalteatus*** **is one of numerous coprophilous mushrooms on Sable Island. The uniform cap colour and apparent absence of horse dung associated with the collections reported here is atypical for this species.**

not formally document, *P. subbalteatus* in the mid-1990's growing on composted horse manure in a residential flower planter box in Shelburne County. Standard published descriptions of *P. subbalteatus* describe the cap colour as dark brown to almost black when moist, fading to cinnamon brown with a darker ring around the cap margin (Stamets 1978). The collections described below match published descriptions of *P. subbalteatus* except that there was no dung evident in the sandy soil beneath the fruitbodies and the cap colour for each collection from Sable Island was dark brown rather than zonate. The colour difference could be due to the fruitbodies being very moist at the time of collection. The apparent lack of horse dung associated with the fruitbodies could be because the horse dung was too well decomposed to discern. Alternatively, the collections described below may represent the natural variation in this species or could be an undescribed species of *Panaeolus*, closely related to *P. subbalteatus*.

Material examined

1) Collected in vegetated terrain on the north side of West Spit; fruitbodies (43.95282N, -60.11497W) were growing in sand in a vigorous stand of *A. breviligulata*; J. Barkhouse and Z. Lucas; 19960F (09-050); June 23, 2009.

2) Collected on the northeast side of a small dune hummock inside a north-south cut; fruitbodies (43.93480N, -60.04572W) were growing in a sandy area with *A. breviligulata*; J. Barkhouse and Z. Lucas; 19961F (09-057); June 25, 2009.

3) Collected on top of a small dune hummock in the outer half of the north-south cut (through the north beach dune) just east of the site of the Nova Scotia Field Camp (now demolished and removed); fruitbodies (43.93505N, -60.04573W) were growing in a sandy area with *A. breviligulata*; J. Barkhouse and Z. Lucas; 19962F (09-058); June 25, 2009.

4) Collected on the West Spit; fruitbodies (43.95483N, -60.12215W) were growing in sand with 30% vegetation cover including *H. peploides, L. japonicus* var. *maritimus*, and *A. breviligulata*; J. Barkhouse and Z. Lucas; 19963F (09-060); June 25, 2009; Fig 4.

5) Collected on northwest-facing slope of an inland dune, northeast of No.2 Pond East; fruitbodies (43.93533N, -59.94562W) were growing on an exposed slope with 20% beach grass (*A. breviligulata*) cover; J. Barkhouse and Z. Lucas; 19964F (09-070); June 27, 2009.

Psathyrella candolleana **(**Fr). Maire, *Mém. Soc. Sci. Nat. Maroc.* 45: 112 (1937)

Psathyrella candolleana was first recorded in Nova Scotia (Kings County) in 1931 by Ken Harrison (Gourley 1982). There are four records of *P. candolleana*, all from Kings County (Mycoportal 2016). This is the first report for *P. candolleana* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected from an accumulation of driftline debris in an area of occasional saltwater flooding; fruitbodies (43.92984N, -60.01043W) were growing on a rotting driftwood log near *S. sempervirens* and *Cakile edentula*; Z. Lucas; 19965F (15-028); August 14, 2015.

Schizophyllaceae

Schizophyllum commune Fr., *Observ. mycol.* (Havniae) 1: 103 (1815)

Schizophyllum commune has been reported from Kings County, Nova Scotia, on a range of hosts as early as 1881 by J. Sommers and Alexander MacKay (Gourley 1982). This is the first report for *S. commune* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected 4 m north of the gas storage building at the station; fruitbodies (43.93712N, -59.88960W) were growing on old leaf, stem, and weathered dung litter in a sandy soil with 50% cover including *R. virginiana*, *A. margaritacea*, *Juncus* sp., *A. breviligulata*, and *F. rubra*; Z. Lucas; 19966F (09-102); October 7, 2009.

Strophariaceae

Agrocybe pediades (Fr.) Fayod, *Annls Sci. Nat.*, Bot., sér. 7 9: 358 (1889)

Over a century ago, in 1880, J. Sommers and Alexander MacKay collected *A. pediades* from open spaces in Halifax and Lunenburg Counties (Gourley 1982). This species was previously reported from Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected inland, on a southeast facing slope, 25 m west of Lily Pond-North; fruitbodies (43.93180N, -60.01800W) were scattered

on weathered horse dung in sandy soil with *Juncus* sp. and *A. breviligulata* nearby; J. Barkhouse and Z. Lucas; 19967F (09-034); June 22, 2009.

2) Collected on a dune north of the Old Main area; a group of five fruitbodies (43.93502N, -60.04983W) was growing in a weathered dung pile near *L. japonicus* var. *maritimus, A. millefolium, A. breviligulata*, and *P. pratensis*; J. Barkhouse and Z. Lucas; 19968F (09-053); June 24, 2009.

3) Collected northeast of Gull Pond; clustered fruitbodies (43.93357N, -59.96672W) were growing on dung in an area with 50% vegetation cover including *L. japonicus* var. *maritimus, A. millefolium, A. breviligulata*, and *P. pratensis*; J. Barkhouse and Z. Lucas; 19969F (09-069); June 27, 2009.

4) Collected on the northeast-facing slope of a north side dune; a small group of three fruitbodies (43.93562N, -59.93855W) was growing on a moist dung ball on the sand surface, in a stand of *A. breviligulata*; J. Barkhouse and Z. Lucas; 19970F (09-072); June 27, 2009.

5) Collected in an inland area near the southeast edge of Bald Major; a single fruitbody (43.93197N, -59.87233W) was growing on buried weathered dung in an area of sparse vegetation consisting of *A. margaritacea*, *S. sempervirens, A. breviligulata*, and *F. rubra*; J. Barkhouse and Z. Lucas; 19971F (09-083); June 29, 2009.

Protostropharia semiglobata (Batsch) Redhead, Moncalvo & Vilgalys, in Redhead, *Index Fungorum* 15: 2 (2013)

Protostropharia semiglobata was collected, as *Stropharia semiglobata* (Batsch) Quél., on cow dung in Annapolis, Halifax, Colchester, Kings, Pictou, and Lunenburg Counties by Alexander MacKay in 1908 (Gourley 1982). This species was previously reported (as *S. semiglobata*) from Sable Island from collections made in the early 1980s (Malloch 2016).

Material examined

1) Collected just inside the station exclosure; fruitbodies (43.93377N, -60.00750W) were growing on horse dung in an area with ~50% plant cover including *R. virginiana, A. millefolium, S. novi-belgii, Juncus* sp., *A. breviligulata, F. rubra,* and *M. stellatum*; J. Barkhouse and Z. Lucas; 19972F (09-095); June 30, 2009.

Deconica coprophila (Bull.) P. Karst., *Bidr. Känn. Finl. Nat. Folk* 32: 515 (1879)

Deconica coprophila, according to Guzmán (1983), is uncommon in temperate regions of the world. Guzmán *et al*. (2008) report *D. coprophila*–as *Psilocybe coprophila* (Bull.) P. Kumm.–from Vancouver, British Columbia. This species was previously reported (as *P. coprophila*) from Sable Island from collections made in the early 1980s (Malloch 2016), fruiting from buried horse dung.

Material examined

1) Collected 5 m northwest of a small pond east of the West Light area; fruitbodies (43.93152N, -60.02135W) were growing in a pile of weathered horse dung surrounded by *Juncus* sp. and pond-edge vegetation; J. Barkhouse and Z. Lucas; 19973F (09-098); July 1, 2009.

Deconica subcoprophila (Britzelm.) E. Horak, *Darwiniana* 14: 363 (1967)

Deconica subcoprophila–as *Psilocybe subcoprophila* (Britzelm.) Sacc.–was first reported in Canada from collections made in 2008 in British Columbia (Guzmán *et al*. 2008). Prior to this, its documented range included northern and central Europe, Greenland, southern South America and New Zealand (Guzmán 1983; Johnston & Buchanan 1995). This collection represents a new record for *D. subcoprophila* in Nova Scotia.

Material examined

1) Collected 30 m southeast of a small pond in the West Light area; fruitbodies (43.93118N, -60.02072W) were growing in a weathered horse dung pile in 100% vegetation cover including *T. polygamum, R. arcuans, Trifolium repens*, *S. novi-belgii, Juncus* sp., *Iris versicolor*, and *Sisyrinchium angustifolium*; J. Barkhouse and Z. Lucas; 19974F (09-099); July 1, 2009.

Tricolomataceae

Lepista nuda (Bull.) Cooke, *Handb. Brit. Fungi* 1: 192 (1871)

Lepista nuda–previously known as *Clitocybe nuda* (Bull.) H.E. Bigelow & A.H. Sm.–was first collected in Nova Scotia by J. Sommers in 1880's from woods and orchards in Halifax and Kings Counties (Gourley 1982). Malloch (2016) identified a related species *Lepista sordida* (Schumach.) Singer from collections he made on Sable Island

in the early 1980s. This is the first report for *L. nuda* from Sable Island, and it represents a range extension for this species within the province.

Material examined

1) Collected inside the station exclosure; fruitbodies (43.93313N, -60.00723W) were growing in soil in an area of vegetated terrain that was mowed several times a year; Z. Lucas; 19975F (09-156); October 20, 2009.

2) Collected on the West Spit; fruitbodies (43.94703N, -60.10367W) were all attached to stems of *L. japonicus* (some stems decayed, some live) that were buried in sand with other plant litter (but no dung) in an area vegetated with *L. japonicus* var. *maritimus* and *A. breviligulata*; Z. Lucas; 19976F (09-169); October 12, 2009.

DISCUSSION

This study identifies *Suillus luteus* as the probable mycorrhizal fungal symbiont associated with the solitary pine tree growing on Sable Island. Two new records for Nova Scotia are reported: *Deconica subcoprophila* and *Volvopluteus* aff. *gloiocephalus* (Fig 3). The findings presented here also extend the range, within Nova Scotia, of another thirteen species of Higher Fungi.

David Malloch (2016) draws attention to the almost complete absence of ECM fungi and hosts on Sable Island. Identification of *S. luteus* as the probable fungal symbiont on the one *P. sylvestris* on the island could be determined by morphotyping the ECM on the lone *P. sylvestris* and by DNA sequence comparisons between the mycelium colonizing the root tips and the fruitbody collected at the base of the *P. sylvestris*.

Malloch (2016) noted that despite "the limited number of habitats available on Sable Island, there is a fairly rich coprophilous mycota" (p. 139). Some of the coprophilous, or "dung-loving", fungi reported here include the Basidiomycota *Panaeolus papilionaceus*, *P. semiovatus*, *P. subbalteatus* (Fig 4), *Agrocybe pediades*, *Protostropharia semiglobata*, *Deconica coprophila*, and *D. subcoprophila*. The degree of habitat specialization varies depending on the species. For example, the generalists *D. coprophila* and *D. subcoprophila* grow on the dung of animals such as horse, cattle, and sheep (Guzmán 1983), whereas *P. subbalteatus*, a specialist, grows almost exclusively on horse dung or horse dung enriched soils (Ola'h 1969).

Other species, such as *A. pediades*, are more cosmopolitan in their preferences, typically favouring fertile soils which often include manure enriched habitats (Malysheva & Kiyashko 2011).

Some species of obligate coprophilous fungi with a restricted substrate, such as *P. semiovatus*, would likely not be present on Sable Island if there were no horses. Without the ready availability of horse manure, other fungi such as *A. pediades*, a non-obligate generalist, would likely be present in significantly reduced numbers, or not at all.

Germination of the dormant, thick-walled spores of many coprophilous fungi–often found on the surface of wild fodder plants–is aided by passage through the animal digestive system, which, with its acidic, moist, and warm environment, is ideal for breaking spore dormancy (Piontelli *et al*. 1981). Piontelli *et al*. (1981) also point towards a potentially rich and unstudied aspect of the ecology of coprophilous fungi–their role in the digestive system and overall health of the animals that consume the spores. Future research could focus on these cross-Kingdom interactions.

It is important to note that while *P. subbalteatus* is included as a coprophilous fungus here, there was no observed horse dung associated with the five collections included in this paper. Also, the cap colour of these collections is somewhat atypical. Normally, *P. subbalteatus* is distinguished by a cinnamon brown to tan coloured cap with a darker-coloured ring or zone around the cap margin (Stamets 1978), whereas the collections discussed here all had uniformly dark brown caps. The zonation seems to occur as fruitbodies dehydrate (Stamets 1978). The uniformly dark cap colour of the Sable Island collections could be indicative of moist caps at the time of collection. Phylogenetic work could help to ascertain the taxonomic position of the Sable Island collections within the genus *Panaeolus*.

Two related species of *Deconica* were identified from Sable Island. One conformed to the published micro- and macro-morphological characteristics of *D. coprophila*. The other collection matched the characteristics described for *D. subcoprophila*. *D. coprophila* has already been reported from Sable Island, growing on buried horse dung (Malloch 2016). Prior to the collection of *D. subcoprophila* on Saturna Island, British Columbia, in 1984 (Guzmán *et al*. 2008), this species was thought to be restricted to northern and central Europe, Greenland, southern South America, and New Zealand (Guzmán

1983, Johnston & Buchanan 1995). The reports of *D. subcoprophila* in British Columbia and now in Nova Scotia suggests that further work is necessary to describe the geographic range of *D. subcoprophila* in Canada.

Justo *et al.* (2011) suggest that "North American collections of *V. gloiocephalus* (Fig 3) should be carefully re-examined as some may represent *V. michiganensis*" (p. 476). The basidiospores for the *Volvopluetus* collections reported here are too long (>12.5 um) to be *V. michiganensis*, and they match published descriptions of *V. gloiocephalus* except that they appear to lack hymenial cystidia (Butler 2012, Justo *et al.* 2011). Justo *et al.* (2011) describe *Volvopluteus earlei* f. *acystidiatus* as lacking cystidia but with a basidiocarp diameter (<5 cm) that is much smaller than the *V.* aff. *gloiocephalus* described here. Further molecular work with this collection and other, related, species of *Volvopluteus* could help to increase our understanding of the phylogenetic relationships within this genus. This report is the first record of *Volvopluetus* aff. *gloiocephalus* for both Nova Scotia and Sable Island.

Several lignicolous species are reported here including *Gloeophyllum sepiarium* (Fig 1), *Fomes fomentarius*, *Neolentinus lepideus*, and *Psathyrella candolleana*. The paucity of endemic woody species on Sable Island suggests that either the spores arrived with the non-native wood or were already present on Sable Island and found a suitable habitat in the driftwood. For example, based on its position and condition, the driftwood trunk on which *F. fomentarius* was collected had been on Sable for only a short time suggesting that the fungal mycelium had started colonizing the woody substrate prior to it entering the water and drifting out to Sable Island. Further studies, examining the population structure and migration patterns of Sable Island's mycota and the fungi on the adjacent mainland could contribute to our understanding of island biogeography, with special reference to Higher Fungi.

Future work will involve pursuing some of the lines of inquiry suggested above as well as developing as comprehensive a mycoflora as possible for Sable Island, with new taxa added to the species list for the island and the publication of additional information on frequency, spatial and seasonal distribution, and habitat for these and previously reported taxa.

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