Lichens of Cypress Island, Washington – the seen and the unseen

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Abstract. A group of Northwest Lichenologists explored the lichen biodiversity on Cypress Island in the San Juan Islands on the Pacific coast north of Seattle, hosted by the Washington Department of Natural Resources. We compiled our observations separately by habitat: (1) uplands with serpentine bedrock, (2) uplands with basalt bedrock, and (3) rocky saltwater shorelines. Combining our results with previous efforts, we report 243 lichen species from Cypress Island. Despite the respectable species list, we were struck by the absence of numerous species that are regionally common. We report those here, but were unable to be convinced by various hypotheses for their absence. They fall in several functional groups, including nitrophiles, cyanolichens, oceanic species, and widespread green algal foliose species. In addition to a traditional species list, we present two artistic expressions of the lichen biota.

***Key words*. Lichenized fungi, Pacific Northwest, San Juan Islands, serpentine, species inventory.**

INTRODUCTION

Just the name "Cypress Island" conjures images of bald cypress (*Taxodium*) swamps dripping with *Tillandsia*. But Cypress Island in the San Juan Islands of Washington (**Fig. 1**) is nothing like that – instead it's mostly a hilly dryish forest. Cypress Island lacks cypress trees, but it does have junipers, in particular *Juniperus maritima* R. P. Adams, a close relative of the inland and more widespread (Rocky Mountain juniper) *J. scopulorum* Sarg., and it is associated with dry rocky habitats in the rain shadow of the Olympic Mountains. *Juniperus maritima* was treated as a synonym of *J. scopulorum* by Hitchcock and Cronquist (2018), but Adams (2007, 2015) demonstrated genetic and morphological differentiation, as well as hybridization. We were, therefore, intrigued by this unusual tree species as well as its habitats: the scattered grassy balds on rocky areas, patches with thin soils, and exposed serpentine and basalt.

The San Juan Islands form an archipelago in the northern extension of Puget Sound north of Seattle. So close to a major metropolitan area, tourism and recreation are popular on the islands, which has resulted in frequent incidental lichen collecting. The only attempt at a comprehensive lichen list for any of the islands, however, was Rhoades (2009) for nearby South Lopez Island. Also nearby, Ryan (1988a, 1988b) focused on zonation of seashore lichens on Fidalgo Island. Also highly relevant to lichens of the San Juan Islands is Noble's (1982, reprinted and supplemented 2017) comprehensive treatment of the lichen biota in nearby southwestern British Columbia.

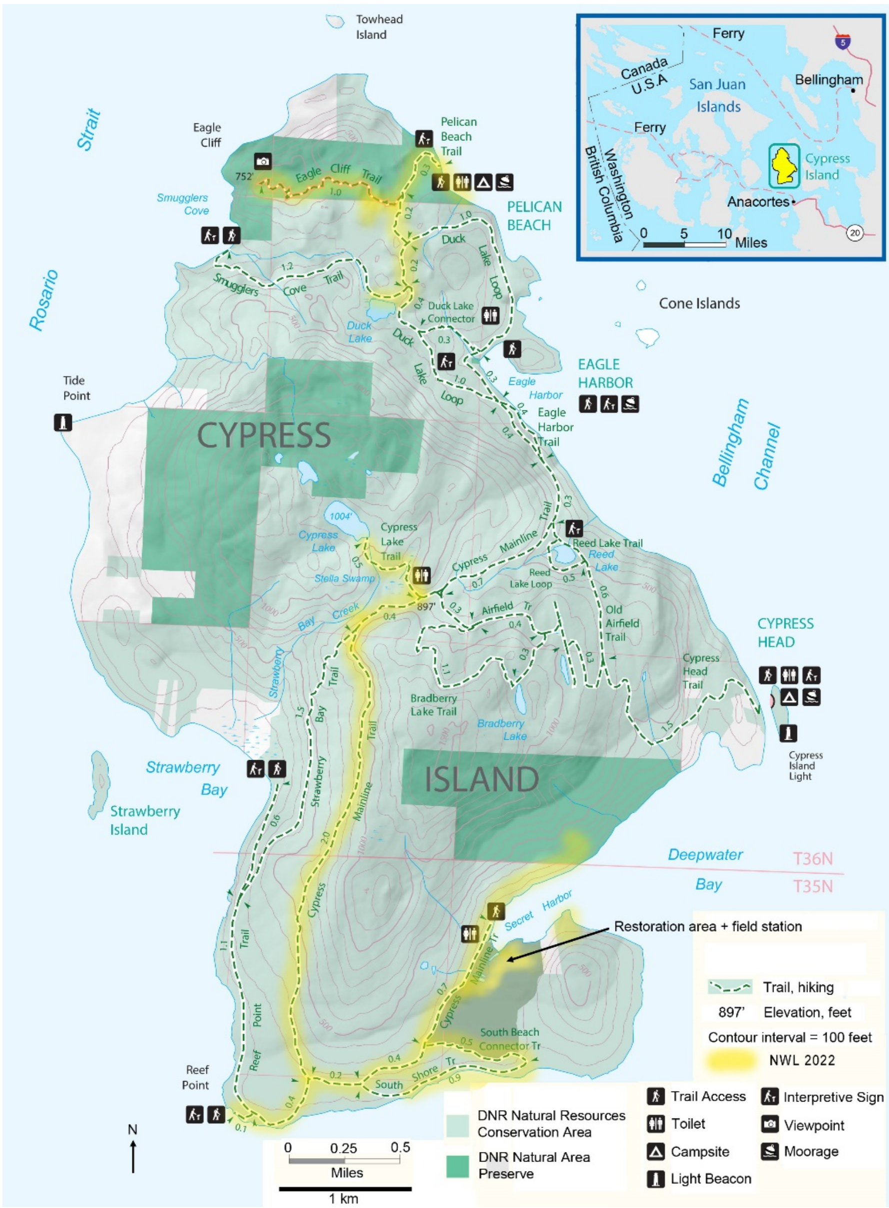

Figure 1. Cypress Island within the San Juan Islands, Washington, adapted from Cypress Island Trail Map, Washington Department of Natural Resources 2015. Focal areas studied by the authors in 2022 are indicated by yellow bands. Inset map shows the regional location.

Some of us came to Cypress Island to look for rare and uncommon lichens. Where are they? Washington has far fewer records of rare coastal lichens than, say, Oregon. Some have thought this was due to a lack of search effort. But the lichens of San Juan Islands are not just lacking the rare and uncommon lichens – this island is missing many of the common species as well. There are so many possible reasons for this: the dry climate for a coastal island, the past management of the island, air pollution, the serpentine rock, climate change, or dispersal limitations linked to island biogeography. How can we sort out why the lichens of Cypress Island are so surprising?

Kruckeberg et al. (1967) wondered the same thing for vascular plants and other organisms:

"One special quality of the fauna and flora is the absence of certain mainland forms. The fact, for example, that the island has no moles, chipmunks, tree squirrels, marmots, porcupines, mountain beavers, rabbits, woodrats, domestic rats, or bears would be of interest to the forest scientist wanting to study the effect of mammals on reforestation. Here the problem is simplified; the variables are reduced. The fact that the island appears to have few weed species such as Scotch broom, bramble, mustard, and bindweed would be of interest to the botanist wanting to study the relationship between native plants and soils, as well as problems of dispersal and establishment. Why are many common Puget Sound native plants apparently absent from, or rare on Cypress? What might we learn from study of the limiting factors?"

STUDY AREA

Cypress Island is 22 km^2 in area while the largest in the group is San Juan Island itself at 143 km^2. Most of the larger islands are populated by humans, while Cypress Island no longer has permanent residents.

Rhoades (2009) summarized the geology, climate, vegetation, and Native American uses of the San Juan Islands. Briefly, the bedrock derives from submerged terranes scraped from the sea floor by the continental subduction zone. The island has two distinct geologic areas, the larger, southern part of ultramafic rock (serpentine and peridotite) and a northern mass of mafic rock, basalt. Submerged during the last continental glaciation, the island emerged by isostatic rebound following the glacial retreat. So lichens have had about 11,000 years to colonize Cypress Island.

Topographically the island is hilly, with gentle to steep slopes and isolated rock outcrop areas. The shoreline is mostly steep and rocky, with occasional beaches and estuaries. The highest point that we visited was the rocky summit of Eagle Cliff at 230 m, one of the higher hilltops on the island.

Climatic normals for nearby Anacortes for 1981-2010 show a relatively dry climate, but with temperatures moderated by the ocean effect. Total annual precipitation averaged 71 cm, including an average of 8 cm of snow. High temperatures averaged 8ºC in January and 23ºC in July, while average low temperatures were 3º and 12ºC in January and July, respectively. Climatic patterns within the San Juan Islands are complex and poorly represented by weather stations, but there is a definite gradient of increasing precipitation from the SW to NE.

In the 20th century virtually the whole island was clearcut. Since then, the road network has gradually been assimilated into the forest, so that now only a few roads and trails remain on the island. Current forests are mostly young and dominated by *Pseudotsuga menziesii*, with pockets of *Alnus rubra* and *Pinus contorta*, and scattered *Juniperus maritima* on drier sites. Pacific madrone (*Arbutus menziesii*) is a significant component of the forests as well. Nonforested rocky sites support *Festuca roemeri* var. *roemeri* grasslands, locally known as "balds".

METHODS

A group of NW Lichenologists was fortunate to be hosted by the Washington Department of Natural Resources (DNR) on Cypress Island at their off-grid Secret Harbor field station for several days. We and our food and gear were delivered from Anacortes by DNR boat. As the sole occupants of the field station, we cooked for ourselves and spread out for sleeping in the bedrooms and in tents in the lawn.

We interspersed collecting in the field with studying specimens at the field station. Picture piles of scopes, books, laptops, specimens, and reagents and abundant chatter and casual advice. We accumulated a species list on a white board, supplementing and amending the pre-existing unpublished list compiled from previous visits by Katherine Glew, Fred Rhoades, Tor Tønsberg, and John Villella. In addition, two artists in attendance, Natasha Lavdovsky and Tiffa Theden, enhanced their work by interacting with the group and with the lichens we found.

We visited three very different habitats (**Fig. 1**) and compiled our observations separately for these: (1) uplands with serpentine bedrock, (2) uplands with basalt bedrock, and (3) rocky saltwater shorelines. Because the serpentine vs. basalt was clearly separated by our southern vs. northern sites, we easily assigned collections to one or the other, even if bedrock was not locally apparent.

A question arose persistently: what species were missing? In other words, what species did we expect to find but were not seen? The local lichens were so different from our expectations for coastal NW forests that we became intrigued by the phenomenon – is it real and if so, what are the possible reasons for it? This evolved into a theme of this account – attempting to document not only the species that were present, but those that were expected but absent.

Lichen community composition and appearance can provide clear evidence of historic and current nitrogen and sulfur deposition. In addition to being indicators by absence, presence, or abundance, individuals can be stunted and deformed. We also collected material to test for elemental content (not reported here) in the lab as an indication of atmospheric deposition. "Lichens don't lie!"

Do handheld UV lights function well for UV spot tests? We sampled three battery-powered hand-held LED UV lights (1. UV Beast V3 365 nm, 2. Alonefire SV40 15W 365nm UV Flashlight, 3. unknown model) against a 265–365 nm fluorescent UV lamp (unmarked manufacturer, older unit with 5 C batteries) to test the difference in reactions. We tried night exploration near the field station as well as inside comparisons with an array of reindeer lichens (*Cladonia* subg. *Cladina*).

When it became apparent that we could contribute something useful to the published literature, we agreed to a plan where each author would submit, before leaving the Island, a paragraph that would lead off with an observation or a question. The paragraph would then have at least one more sentence to develop the idea, and a conclusion or transition to another idea. Amazingly enough, most participants contributed paragraphs as requested, and we incorporated those throughout this article.

The group defined and assigned crude abundance ratings (**Table 1**) to make the species list more useful (Miller et al. 2011). Authorities for names are in MycoBank (https://www.mycobank.org/). We followed McCune (2017) for *Caloplaca,* because many North American taxa have not been sequenced and cannot be placed in the numerous segregate genera by morphology alone. We also applied *Cetraria* broadly because the commonly used segregate genera are not supported by phylogenetic analysis of molecular and morphological data (Thell et al. 2002, Nelsen et al. 2011, Divakar et al. 2017). The only two classifications consistent with the data are placing almost all cetrarioid species in *Cetraria* or placing most of them in either *Cetraria* or *Nephromopsis* (Divakar et al. 2017). Because the latter has met with resistance from other North American lichenologists, we chose the broadest view, placing *Kaernefeltia*, *Tuckermannopsis* and *Vulpicida* in *Cetraria*. Finally, we followed McCune and Stone (2022) for nomenclature of *Bryoria*. Vouchers were deposited in the herbaria BG, EVE, OSC, SRP, WTU, and WWB. We also incorporated records from previous visits by querying the Consortium for Lichen Herbaria and obtaining records from previous known visitors in recent years (Glew, Rhoades, Tønsberg, Villella). Some participants used an iNaturalist project entitled "NW Lichenologist Cypress Island Survey" to quickly record and compile photo vouchers. Four observers from the group contributed 97 observations of 61 species to that project.

Table 1. Abundance codes assigned to species based on group consensus. Species that were detected but were very small or otherwise hard to detect were simply recorded as "present".

Code	Meaning
A	abundant, occurring > 50% of available substrate units
C	common, regularly encountered
I	4 to 10 occurrences
R	1 to 3 occurrences
P	Present
-	not seen

RESULTS

Combining our results with previous efforts, we report 243 lichen species from Cypress Island (**Table 2**).

Table 2. Lichens found on Cypress Island, near Anacortes, Washington. "Serp", "Basalt", and "Seashore" refer to observations from our visit in 2022 from the serpentine areas on the south end of the island, basalt areas on the north, and immediate seashore without regard to rock type, respectively. Records needing verification are indicated by "V". Square brackets indicate incorrect old records that need reassignment to modern species concepts. Abundance codes: A = abundant, C = common, I = infrequent, R = rare, P = Present; see more details in Table 1. A few lichenicolous fungi are included, but we did not make a comprehensive effort for them.

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Abrothallus parmeliarum	P				parasite on *Parmelia hygrophila*; Rhoades
Acarospora fuscata s. lat.	P				Tønsberg 48181
Alectoria imshaugii		R			
Alectoria sarmentosa	P	I			
Alyxoria culmigena				P	Stone (= *Opegrapha herbarum*)
Alyxoria varia				P	Stone
Arthonia sp.	P	P			McCune, wood, and *Juniperus* bark.
Arthonia sp. nov. ined.					Tønsberg, on *Jamesiella anastomosans* on bark
Aspicilia cinerea		P			McCune
Bacidina arnoldiana		P			McCune
Bryobilimbia hypnorum		P			McCune
Bryoria fuscescens	P	R	R		Rhoades, Rosentreter, incl. *B. lanestris*
Bryoria glabra	V				G. Howard (NY), dubious

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Bryoria pseudofuscescens var. friabilis?	P				Rhoades
Bryoria pseudofuscescens var. pikei		I	I		Rosentreter (formerly *B. capillaris* misapplied)
*Bryoria fremontii (*incl. *B. tortuosa)*	P	R			Ireland (US), Rhoades, Hardman, Nelson, one bright yellow
Buellia alboatra				C	
Buellia microbola				P	McCune, Stone (=*Rinodina microbola*)
Buellia muriformis		P			McCune
Buellia punctata	P	P		P	McCune, Tønsberg
Byssoloma marginatum	P				Tønsberg 48110, on *Alnus rubra*
Calicium glaucellum		P			Stone
Caloplaca sp.				C	Stone; dark reddish orange apothecia with thick margin
Caloplaca citrina	P				Rhoades
Caloplaca flavogranulosa				P	McCune
Caloplaca holocarpa		P			McCune
Caloplaca inconspecta				C	
Caloplaca litoricola				C	McCune (basalt)
Caloplaca luteominia var. luteominia				C	McCune, Stone
Caloplaca marina				C	
Caloplaca pyracea		P			Rosentreter
Caloplaca phlogina		P			Rosentreter
Caloplaca rosei				C	McCune
Caloplaca subsoluta		P			Villella, McCune
Caloplaca verruculifera				R	McCune (Fig. 2)
Candelariella citrina		P			Villella (Fig. 2)
Candelariella vitellina				P	McCune
Carbonicola myrmecina		P	P		Rosentreter
Catinaria atropurpurea		I-C			Stone
Cetraria aculeata		R			Rosentreter
Cetraria canadensis	P	I	I		Rosentreter
Cetraria chlorophylla	P	C	C		
Cetraria merrillii	V				Rhoades (WWB)

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Cetraria muricata			R		Rosentreter
Cetraria orbata	P	I	I		
Cetraria pinastri	P	R	R		
Cetrelia cetrarioides		R			Tønsberg
Chaenotheca chrysocephala		P			Hardman, on *Thuja*
Chaenotheca ferruginea		I	I		
Chaenotheca trichialis		R			Nelson, Hardman (on *Arbutus*)
Chrysothrix granulosa	P	C	C		Previous visit as *C. chlorina*
Cladonia borealis	P	R			Rhoades (as *C. coccifera*), Rosentreter, McCune, TLC: usnic and barbatic acids
Cladonia cariosa		I			
Cladonia cervicornis ssp. *verticillata*		P			Ponzetti
Cladonia chlorophaea		P			Rosentreter
Cladonia ciliata	P	R			Rhoades, Rosentreter
Cladonia ciliata var. tenuis		P			McCune
Cladonia fimbriata		C	C		
Cladonia furcata	P	C	C		
Cladonia gracilis ssp. *turbinata*	P	R			Rhoades, Rosentreter
Cladonia macilenta		P			McCune, TLC: thamnolic and barbatic acids
Cladonia poroscypha		P			Rosentreter 22116
Cladonia portentosa ssp. *pacifica*	P	C	C		McCune, TLC: usnic and perlatolic acids
Cladonia pyxidata	P	C	C		
Cladonia rangiferina		I			McCune
Cladonia scabriuscula		I	?	P	McCune
Cladonia squamosa	P	C	C		incl. var. *subsquamosa*
Cladonia straminea (as *C. metacorallifera*)		?			Nelson - need to verify
Cladonia subulata		P			Rosentreter
Cladonia transcendens		C	C		
Cladonia umbricola	P? V				Rhoades
Cladonia uncialis			R		
Cladonia verticillata	P	R			Rhoades, Ponzetti
Cladonia verruculosa		C	C	P	

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Cliostomum griffithii	P	C	C	C	
Collema furfuraceum			R		Stone
Collemopsidium foveolatum	P			P	Rhoades, Glew
Cresponea chloroconia		C		P	black dentate margin
Cyclohymenia epilithica			C		McCune
Cyphelium inquinans		P			Hardman and Stone (on *Juniperus*), McCune (on fallen wood)
Dermatocarpon leptophyllodes		I	I		Rosentreter, McCune, Villella, Stone
Dermatocarpon reticulatum			R		McCune, Hardman, Beck, Stone
Dimerella lutea			R		Nelson, on basalt!
Diploschistes scruposus	P		P		McCune, Rhoades
Evernia prunastri	P	C	C		
Fellhanera bouteillei	P	I	I		
Fuscopannaria aurita		0	R		Villella
Fuscopannaria cyanolepra		R			Hardman & McCune
Fuscopannaria thiersii		R			Stone, Nelson, Villella
Fuscopannaria pacifica		R			
Graphis elegans	P				Villella
Graphis scripta		I			Stone
Halecania viridescens		P			McCune
Hertelidea botryosa		P			McCune
Hydropunctaria maura group				C	
Hypocenomyce scalaris			P		Beck
Hypogymnia apinnata	P	C	I		
Hypogymnia enteromorpha	V				Ireland (US), Rhoades (WWB)
Hypogymnia imshaugii	P	R			Rhoades
Hypogymnia inactiva	P	R			
Hypogymnia occidentalis	P				Rhoades
Hypogymnia physodes	P	A	A		
Hypogymnia tubulosa	P	C	C		
Hypotrachyna afrorevoluta		P			McCune

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Hypotrachyna sinuosa	P	C	C		
Icmadophila ericetorum		R			
Imshaugia aleurites	P	C	R		
Jamesiella anastomosans	P	P			Tønsberg
Japewia subaurifera		P			Tønsberg, on *Alnus rubra*
Lecanora cf. andrewii		P			McCune
Lecanora campestris?				P	McCune
Lecanora confusa				P	McCune
Lecanora expallens group	P			I	Glew and Tønsberg, need to check chemistry
Lecanora farinaria		P			Tønsberg, with TLC support
Lecanora orae-frigidae	P				Glew, Tønsberg, Villella
Lecanora pacifica	P				Villella
Lecanora poliophaea				R	
Lecanora rupicola			P		McCune
Lecanora semitensis			P		McCune
Lecanora symmicta	V				Villella
Lecanora xylophila	P			P	Glew, Tønsberg, Villella
Lecidea fuscoatra s.l.			P		McCune
Lecidea lactea			P		McCune
Lecidea plana	V				Rhoades
Lecidella asema				C	
Lecidella scabra		P			McCune
Lepra amara		P	P		Tønsberg, with TLC support; Rosentreter; McCune
Lepra borealis	P				Tønsberg
Lepra ophthalmiza		P			McCune
Lepraria finkii	P	P		P	McCune, Stone, Tønsberg
Lepraria incana (pacifica?)	V				Rhoades
Lepraria neglecta s.l.			P		Villella 2185 (BG)
Lepraria rigidula		P			Tønsberg
Lepraria torii	P				Tønsberg
Leptochidium albociliatum		R			McCune, Hardman
Letharia vulpina	P	I	I		Rhoades, Rosentreter
Lichenomphalia umbellifera	P				Rhoades
Loxospora elatina		P			McCune

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Massalongia carnosa		C	C		Stone, Rosentreter
Megaspora verrucosa		P	P		McCune
Melanelixia fuliginosa	P	A	A		including previous IDs as *M. subaurifera*
Melanohalea subelegantula			P?		Beck
Menegazzia subsimilis	P	I	I		
Menegazzia terebrata		R	R		Nelson
Micarea cinerea	P				Tønsberg
Micarea prasina s. l.	P				Tønsberg
Microcalicium ahlneri		?	P		Stone
Miriquidica leucophaea		P			Tønsberg 49559
Montanelia panniformis		?	I		Rosentreter, McCune
Montanelia sorediata			R		Nelson
Mycoblastus caesius		P			McCune
Mycoblastus sanguinarius	P	C	C		
Nephroma laevigatum	P	R	R		on rock only. Rhoades, Rosentreter, McCune, Hardman
Normandina pulchella	P		P		McCune
Ochrolechia androgyna		P			Rosentreter, McCune
Ochrolechia arborea		P			McCune
Ochrolechia oregonensis	P	P			Glew & Tønsberg, Rosentreter (Fig. 2)
[*Ochrolechia pallescens* var. *rosella*]	V				Needs revision from G. Howard specimen in WTU
Ochrolechia subpallescens		P			Rosentreter
Ochrolechia turneri		P			Tønsberg 48158. Plum tree. TLC: variolaric acid
Ochrolechia upsaliensis		P			Rosentreter
Opegrapha cf. fumosa					fertile, sorediate, C+ rose, gyrophoric acid; on trunk of *Holodiscus*, Tønsberg 48174
Ophioparma rubricosa		P			McCune
Parmelia hygrophila	P	P	?	P	
Parmelia pseudosulcata	P			P	Rhoades, Rosentreter, McCune
Parmelia saxatilis		C	C		

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Parmelia sulcata	P	A	A		
Parmeliopsis ambigua	P	I	I		
Parmeliopsis hyperopta	P	I	I		
Parmotrema arnoldii	P	P			McCune, Rhoades
Parmotrema crinitum	P				Rhoades
Parmotrema perlatum		?	?		Rosentreter
Peltigera britannica	P	C	C		
Peltigera didactyla		P			
Peltigera canina	V				Rhoades (WWB)
Peltigera collina		I	I		
Peltigera horizontalis	P, V				Rhoades (WWB)
Peltigera leucophlebia		P	?		
Peltigera membranacea	P	C	C		
Peltigera neopolydactyla		I	?		
Peltigera rufescens	P	R			Stone
Peltigera venosa		R			Rosentreter (Fig. 2)
Pertusaria chiodectonoides		P			Rosentreter
Pertusaria pupillaris		P			Tønsberg 48147, with TLC support, on *Alnus rubra*
Pertusaria stenhammarii		P			Tønsberg, on *Alnus rubra*
Phaeocalicium sp			P		Beck (inadequate to ID to species)
Phaeophyscia orbicularis		I	I	I	
Phaeophyscia sciastra		I			Hardman
Phlyctis argena	P				Tønsberg
Physcia adscendens	P	C	C		Fig. 2
Physcia caesia	P			C	
Physcia tenella		A	A		
Placynthiella icmalea		P			McCune
Placynthiella uliginosa		P			Rosentreter
Platismatia glauca	P	A	A		
Platismatia herrei	P	A	A		
Porpidia flavocaerulescens			R		Villella
Porpidia tuberculosa			P		McCune

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Protoparmelia badia			P		
Protoparmelia ochrococca	P	C	C		
Psora nipponica	P	I	I		Rhoades (WWB), Shaw (WWB), Rosentreter, McCune
Punctelia cf. caseana		R	R	R	Ponzetti, McCune, Stone
Pyrrhospora quernea	P	C	C		McCune
Ramalina dilacerata		R			Fig. 2
Ramalina farinacea	P	C	C		
Ramalina roesleri		R			
Ramalina subleptocarpha		C	C		
Rhizocarpon geographicum gr.			P		McCune
Rinodina conradii		P			McCune
Rinodina disjuncta		P			Tønsberg, with TLC support
Rinodina efflorescens		P			Tønsberg, with TLC support
Rinodina cf. *gennarii*				P	Stone
Rinodina subparieta	P				Tønsberg
Schaereria corticola		P			Tønsberg
Scoliciosporum pruinosum		P			McCune (on *Alnus* trunk)
Scoliciosporum umbrinum		P			McCune
Scytinium californicum gr.	P	P	P		Rosentreter, Villella
Scytinium nanum		P		P	McCune, Stone
Scytinium tenuipalmatum (ined.)	P	C	C		Rhoades, Rosentreter, Stone
Scytinium plicatile		R	R		Stone
Scytinium pulvinatum			P		McCune 39634, with ITS sequence
Sphaerophorus venerabilis		R			Rosentreter
Sphaerophorus tuckermanii		R			
Stenocybe clavata		P			Stone
Stereocaulon sterile		I	I		
Stereocaulon tomentosoides		R			Ponzetti, McCune
Sticta gretae (fuliginosa group)	P	I			
Sticta limbata	P	I			

Species	Prev. visits	Serp	Basalt	Seashore	Observers of less common species and comments
Thelotrema lepadinum	P	C	C		
Trapeliopsis flexuosa	P	P	P		Rosentreter, McCune
Trapeliopsis glaucopholis			P		McCune
Umbilicaria angulata		R	R		Stone, Nelson & Glew, McCune, Theden
Umbilicaria phaea			R		Nelson
Umbilicaria polyrhiza			P		Beck 2512, confirmed at OSU by ITS sequence
Usnea cornuta	P	R	R		Rhoades, Stone
Usnea diplotypus		C	C	P	Stone
Usnea filipendula	V				Questionable
Usnea flavocardia		C		P	Stone
Usnea glabrata		C		P	Stone
Usnea nidulans	P, V				Rhoades (WWB)
Usnea pacificana	P	C			Stone
Usnea quasirigida		R	R		Nelson (specimen), Hardman (photo)
Usnea scabrata		A	C		
Usnea subfloridana	P	C	C		Stone
Usnea wasmuthii		P			Stone
Verrucaria prominula?	P				Rhoades
Xanthoparmelia cumberlandia	P	I	I		
Xanthoparmelia mougeotii			R		
Xanthoria candelaria	P	C	C	A	Rhoades, Stone, Villella
Xanthoria parietina		R	R		
Xanthoria polycarpa	P	I	I		
Xylographa vitiligo		P			McCune
Xylopsora caradocensis	P				Tønsberg (TLC: friesiic acid)

Figure 2. Examples of common or charismatic lichens on Cypress Island, artwork by Tiffa Theden: ink, watercolor, and colored pencil.

Epiphytic lichens on Cypress Island appear to represent mostly early colonizing species. *Physcia adscendens* and *Hypogymnia physodes* are unusually prolific. Many of the species associated with remnant trees and old-growth forests in the Pacific Northwest (e.g., see Neitlich and McCune 1996, Peterson and McCune 2001) were sparse or absent. This observation begs the question whether ground and rock-dwelling species are also dominated by early colonizers, but unfortunately we have insufficient data to test these ideas statistically.

Cypress Island has a thick mantle of serpentine-derived soils, as well as exposed rock, but only the *Aspidotis densa* among the vascular plants is a reliable indicator of these. Serpentine associated lichens that we observed included *Fuscopannaria thiersii*, *Imshaugia aleurites*, and some tiny cyanobacterial lichens that we have not yet identified. Many species seen on the northern part of the island with basalt bedrock were not seen in the area underlain by serpentine (Table 2). Conspicuous examples included *Cladonia uncialis*, *Lepraria neglecta* s.l., the *Rhizocarpon geographicum* group, and *Umbilicaria angulata*.

Near the end of the trail up to Eagle Cliff is a fascinating sheer rock wall. The first inkling of a distinctive lichen community comes when you see penny-sized brown thalli stuck tightly to mirror-smooth rock. As we inspected these thalli of *Caloplaca demissa*, unusual because of the lack of yellow or orange apothecia, we saw straight lines scraped across the shiny plane. Although we initially thought that the lines were the result of glacial action, the smooth face and the scraped lines appear to be where a fault rubbed two rock faces together: slickensides. We found several other lichen species (e.g. *Collema furfuraceum, Dermatocarpon leptophyllodes*) there that were nowhere else. If you are lucky enough to visit Cypress Island, make sure to climb up the trail to that special place near the northwest corner of the Island.

Another interesting place on Cypress Island was the beach at the south end of the island, along the South Shore Trail. The beach here has tall cliffs left as a hill of glacial moraine, then carved open by the ocean. The beach has collected boulders of all sorts fallen from the moraine, probably from varying distances away. The lichens on the boulders reveal subtle differences in habitat preferences, with each boulder supporting only one or two species (Table 2).

Our trials with LED UV lights produced positive reactions in *Ochrolechia arborea* (spectacular yellow orange) on a picnic table (**Fig. 3**), *Ochrolechia androgyna s.l.,* and *Pyrrhospora quernea*. But they did not reliably produce positive reactions to detect squamatic acid in *Cladonia.* Caution should be used when using LED-based UV lights, because their inclusion of long-wave UV only and some visible light can obscure some expected reactions.

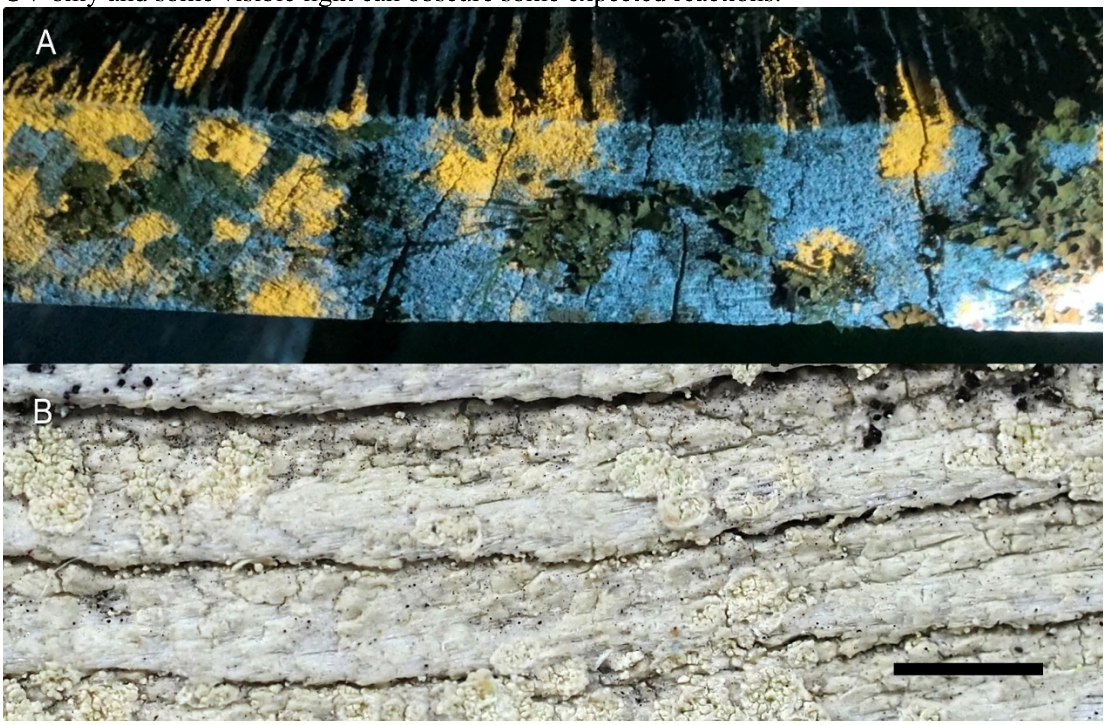

Figure 3. *Ochrolechia arborea* on a picnic table outside at Cypress Island. A. Thallus glowing yellow-orange under long-wave UV light at night (N. Nelson photo). The table is about 8 cm thick. B. Closeup of thallus showing discrete soralia from that picnic table under visible light; scale bar 1 mm (B. McCune photo).

Artist and lichenologist Natasha Lavdovsky provided an evening entertainment for the group, playing a recorded soundscape and video composed of her artistic interpretation of thin-layer chromatography of lichen extracts. The sounds were digitally created from audio field recordings originating at a seaside park, about 80 km west of Cypress Island in Canada, where the lichens were sampled. These sounds were then manipulated and pitched up or down, relating to the patterns on the TLC plates (**Figure 4**).

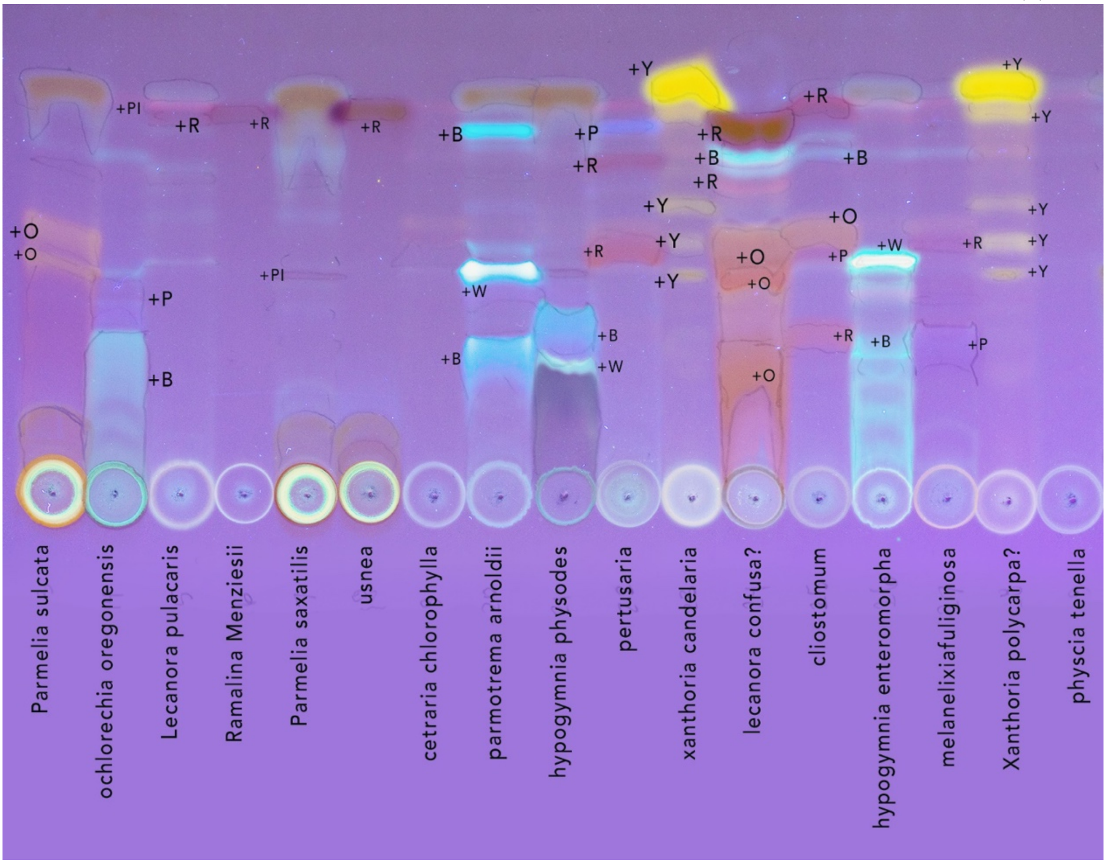

Figure 4. Thin-layer chromatography (TLC) plate photographed under longwave UV light to accentuate the fluorescing lichen substances, an integral step in TLC analysis. Each circle along the bottom of the image corresponds to a lichen collected at one sampling site, and each column of patterns above it represents the separation of lichen substances. These patterns inspired particular sounds in the soundscape.

The soundscape generated enthusiastic and mixed reviews in the group. The coyotes in the distance seemed to have something to say about it as well. It was partly the synthetic, digital quality of the sounds that contributed to the diverse reactions of the audience. Lavdovsky has since come to terms with the artificiality of the soundscape, accepting its alienness. She writes, "Lichens are otherworldly beings. As humans, we are limited in the ways we perceive lichens, often having to resort to chemical processes and technological translations. So far, lichens do not seem to make much noise on their own. However, they might whisper, crackle, or crunch when in relationship to others (from wind, rain, or an animal's foot). How fitting as symbiotic beings. This experimental sound-art project sonifies the hidden, chemical world of a lichen community, while artistically highlighting the relationships that emerge when the scientific process meets a lichen."

Another color phenomenon also drew attention. Why are some of the "*Bryoria tortuosa"* (vulpinic acid-containing form of *B. fremontii*; Table 2) here the color of *Letharia*? Normally *B. tortuosa* is nearly brown with a slight yellow cast but with a yellow pseudocyphellae. We found only a few individuals of the extreme yellow color morph on Cypress Island. This morph is frequent at nearby Deception Pass and elsewhere in the San Juan Islands (Rhoades, pers. obs.).

Although we compiled a substantial list of common lichens that appeared to be missing on Cypress Island (**Table 3**), field observations provided no definitive evidence on the cause of these absences. In this list many of the missing species are cyanobacterial (e.g. *Fuscopannaria, Leptogium, Lobaria, Nephroma*), but many others are green algal, and some are rather oceanic (e.g., *Hypogymnia hultenii*; McCune and Geiser 2009). Others are nitrophilous (*Candelaria, Xanthomendoza*). The list differs markedly from the species missing in a nitrophilous flora on the Oregon coast (McCune 2003).

Some losses of lichen biodiversity were recent. Conifer trunks (mainly *Pseudotsuga menziesii*) on the exposed point just north of the boat dock were loaded with lichens in 2018, based on careful inspection by one of us (Tønsberg), as were the nearby *Alnus rubra* trees. In September 2022 the same trees were virtually without lichens on their trunks. The reason is obscure; the only culprit that we can hypothesize was the series of extremely hot days in early summer 2021, part of the "heat dome" episode. Although we could not find temperature records for those dates from nearby Anacortes, farther away, Bellingham had record highs of 94, 95, and 99°F (34, 35, and 37°C) on June 26, 27, and 28, of 2021.

Table 3. Common macrolichen species expected to be present on Cypress Island but not found.

Species	Functional group	Comments
Candelaria pacifica	nitrophile	
Cetraria californica	green algal foliose	oceanic (perhaps too oceanic for San Juan Islands?)
Cetraria platyphylla	green algal foliose	expected in dry forests on the island
Esslingeriana idahoensis	green algal foliose	expected in dry forests on the island
Fuscopannaria leucostictoides	bipartite cyanolichen	
Hypogymnia heterophylla	green algal foliose	oceanic; reported from nearby Lopez Island as "second most common *Hypogymnia*" by Rhoades (2009)
Hypogymnia hultenii	green algal foliose	previously *Cavernularia hultenii*
Hypogymnia lophyrea	green algal foliose	previously *Cavernularia lophyrea*
Leptogium saturninum	bipartite cyanolichen	including closely related species
Lobaria anomala	bipartite cyanolichen	previously *Pseudocyphellaria anomala*
Lobaria anthraspis	bipartite cyanolichen	previously *Pseudocyphellaria anthraspis*
Lobaria pulmonaria	tripartite cyanolichen	
Lobaria scrobiculata	bipartite cyanolichen	
Loxosporopsis corallifera	green algal crustose	oceanic
Melanohalea exasperatula	green algal foliose	
Melanohalea multispora	green algal foliose	
Melanohalea subelegantula	green algal foliose	
Nephroma tropicum	bipartite cyanolichen	previously *N. helveticum*
Nephroma parile	bipartite cyanolichen	
Nephroma resupinatum	bipartite cyanolichen	
Niebla cephalota	green algal fruticose	oceanic; several records from San Juan Islands, including nearby Lopez Island (Rhoades 2009)

Species	Functional group	Comments
Parmelia squarrosa	green algal foliose	oceanic
Pilophorus acicularis	tripartite cyanolichen	
Platismatia lacunosa	green algal foliose	oceanic
Ramalina menziesii	forage lichen	oceanic, fog zone
Usnea longissima	forage lichen	oceanic
Usnea madeirensis	forage lichen	oceanic
Xanthomendoza spp.	nitrophile	

DISCUSSION

The local biodiversity of an area deviates from a regional average by a combination of factors that either promote or detract from the survival of individual species. At Cypress Island, we presume that degraded air quality from regional emissions of nitrogen and sulfur compounds have promoted some species and detracted from cyanobacterial lichens (see lists of N and S ratings in McCune and Geiser 2009). Historical logging and fire promote early successional species and detract from late successional species. Climate change toward warmer, drier conditions may be detracting from the oceanic component of biodiversity (see regional climate indicators in Smith et al. 2017, especially zone 10), while replacements from drier climates may be slow to arrive. While we cannot evaluate the relative importance of each of these factors, it is clear that many cyanobacterial, late successional, and oceanic species are missing from the current lichen biodiversity of Cypress Island.

A list of missing species is always a work in progress and even a single item on the list can never be proven. Just one thallus of something can prove its presence, but no amount of searching can prove its absence, because there is always someplace else to look. Nevertheless the absences were striking on Cypress Island. Some species on the absence list will certainly be found on Cypress Island in the future. A follow-up study could take each species absence in Table 3 as an hypothesis, then try to disprove them by searching neglected habitats or particular sites of interest. For example, for oceanic species we should target wind-exposed rugged, immediate shorelines on the north end of the island or the rocky balds near the south end of the island.

Serpentine associates.— Serpentine and other ultramafic rocks are known to have a strong effect on vegetation in the Pacific Northwest (Kruckeberg 1967, 1969). In an unpublished report, however Kruckeberg (1967) noted that one of the few serpentine indicators on Cypress Island was *Aspidotis densa* (= *Cheilanthes siliquosa)* and reported this as a serpentine associate on Cypress Island (Kruckeberg 1964).

Responses by lichens to ultramafic substrates are poorly known and have not been methodically studied in our area. Casual observation suggests that the serpentine lichen biota is a subset of that in areas derived from mafic and granitic rocks. The species present on the serpentine outcrops are also in the biota of more siliceous rocks (Table 2). Very few local lichens have been singled out as specific to serpentine associates, such as *Placidiopsis cinerascens*, suggested by McCune (2017, p. 502) to be “one of the few species clearly associated with serpentine-derived and other ultramafic soils.” An additional species with this affinity is *Fuscopannaria thiersii*, recognized as a serpentine associate when it was described (Jørgensen 2000).

So many mysteries remain in understanding the distribution and abundance of lichens in the San Juan Islands. Our preliminary studies suggest that considerations of air quality, climate, clearcutting, and bedrock may be important, but the relative contributions of these remains to be exposed.

Acknowledgements

We thank the Washington State Department of Natural Resources for providing boat transportation and facilities for our work, with assistance by Paul McFarland and David Wilderman in making the arrangements. Paul McFarland graciously provided boat transportation, orientation, local lore, and advice. Kathleen Phillips assisted with TLC and Claire Morris with PCR. Funding from Shirley Tucker helped to support herbarium and identification work at OSU. We thank curators of the following herbaria for caretaking voucher specimens: BG, OSC, SRP, WTU, and WWB. Andreas Frisch contributed a phylogenetic analysis of the putative new *Arthonia*. Patricia Muir, Martin Hutten, and Dave Wilderman contributed helpful comments on the manuscript.

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