NOTES ON THE LICHENS OF GWAII HAANAS

WITH SPECIAL EMPHASIS ON

THE SEASIDE CENTIPEDE LICHEN (*HETERODERMIA SITCHENSIS*)

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1.0 INTRODUCTION & ACKNOWLEDGEMENTS

The Seaside Centipede Lichen, *Heterodermia sitchensis* Goward & Noble, was described in the mid 1980s from the west coast of Vancouver Island, British Columbia (Goward 1984). To date this species has been reported from very few localities, all of which occur in and around Pacific Rim National Park Reserve. Listed as endangered by COSEWIC in 1996 (Goward 1996), *H. sitchensis* has subsequently been the object of intense study, prompted by a mandated requirement for Parks Canada to act as the lead agency responsible for the preparation of a recovery plan. The present study continues work already conducted in 2001 and 2002 by seeking new occurrences in promising habitat on Haida Gwaii (Queen Charlotte Islands), especially within Gwaii Haanas National Park Reserve. Finding this species here would considerably extend the known range of *H. sitchensis*, and would contribute toward downlisting it from endangered to threatened or special concern. For a full account of earlier findings on the distribution and ecology of *H. sitchensis*, see Goward & Wright (2003).

Assistance was received from many people, most of whom are on staff with Parks Canada. Above all, I appreciate the enormous efforts of Brian Reader who, besides providing logistical support throughout the study, contributed a wealth of local knowledge. Also greatly appreciated was the competent boat-handling skills and traditional knowledge of Lee Edenshaw, who kindly provided transportation to the study sites. Judson Brown made possible our flight to Ellen Island, while Doll and Goli kindly provided accommodation at Hotsprings Island. Norm Sloan and Doug Burles are thanked for providing background information on the study area. Patrick Bartier and Lynda Melney kindly prepared the map that appears as Figure 1. Finally, I wish to extend special thanks to Tor Tønsberg, of Norway, and Ken Wright, both of whom volunteered their time, unbounded enthusiasm, and sharp eye to this project. Funding was received from Parks Canada.

2.0 OBJECTIVES

The primary purpose of this study is to assist in the preparation of a recovery strategy for *H. sitchensis* by: 1) contributing to our knowledge of this species' global range; and 2) gain further insights into its distributional ecology. An unrelated third objective is to search for lichens new to GHNPR.

3.0 METHODS

Based on earlier work (Goward & Wright 2003), the presence of *H. sitchensis* can be predicted on the basis of three broad environmental factors: 1) it exclusively colonizes young, defoliated twigs of old or slow-growing Sitka spruce; 2) it occurs in open, but not exposed seaside sites; and 3) it requires some form of nutrient enrichment, especially nitrogen. Only in sites in which all three factors overlap is *H. sitchensis* likely to be found.

Candidate localities were identified using a nautical chart of Gwaii Haanas and its vicinity. Also employed were maps showing the locations of sea lion haulouts (Olesiuk et al. 1993), seabird nesting colonies (Harfenist et al. 2002), and limestone outcrops. Additional information on local conditions was received from Lee Edenshaw and Brian Reader.

The lichen crew this year consisted of four people: Brian Reader, Tor Tønsberg, Ken Wright, and myself. At each candidate site, we searched for *H. sitchensis* for a minimum of about three hours. For reasons of efficiency, we usually divided into two groups. At each site, notes were taken on "indicator species", including *Physcia tenella* and various cyanolichens. Besides indicating nutrient-enrichment, these lichens often co-occur with *H. sitchensis.* Where applicable, notes were also taken on potential sources of nutrient enrichment. Finally, the location of each study site was noted on a map, the notations later being used to create a GIS map of the study area (Figure 1).

Dr. Tor Tønsberg (University of Bergen) is a Norwegian lichenologist with a specialty in sorediate crustose species. While the remaining crew members (Trevor Goward, Brian Reader, Ken Wright) scoured the forest for *H. sitchensis*, Tor focussed his attention on rare or otherwise poorly known microlichens, of which he made numerous collections. I also made several collections, mostly of interesting macrolichen species. The resulting specimens were later air-dried, curated, packeted, accessioned, and identified with the aid of dissecting and compound microscopes, and thin-layer chromatography. Upon completion of the project, all specimens were deposited in the cryptogamic herbaria of the universities of Bergen (BG) and of British Columbia (UBC). Taxonomic concepts follow Esslinger (1997) in most regards.

4.0 RESULTS AND DISCUSSION

4.1 *Summary of sites surveyed in 2003*

Fieldwork was conducted between 21 July and 1 August 2004, and consisted of surveys of numerous sites preselected for *H. sitchensis*. A total of 31 sites in 22 localities were surveyed in 2003 (Figure 1). These extended from Cape St. James (St. James Island) in the south to Dodge Point (Lyell Island) in the north, with an additional site (Lina Island) in the vicinity of Queen Charlotte City. Eight sites were located in rather exposed situations, while another eight sites, though less exposed, could be described as nutrient-poor; they supported an acidophytic lichen flora dominated by *Hypogymnia, Parmelia*, and *Platismatia*. The remaining 15 sites contained lichens indicative of nutrient enrichment: *Collema*, *Leptogium*, *Lobaria, Nephroma*, *Physcia*, *Polychidium,* *Pseudocyphellaria,* and *Sticta*. These and other similar observations are summarized in Table 1. A log of daily activities is provided in Appendix 1.

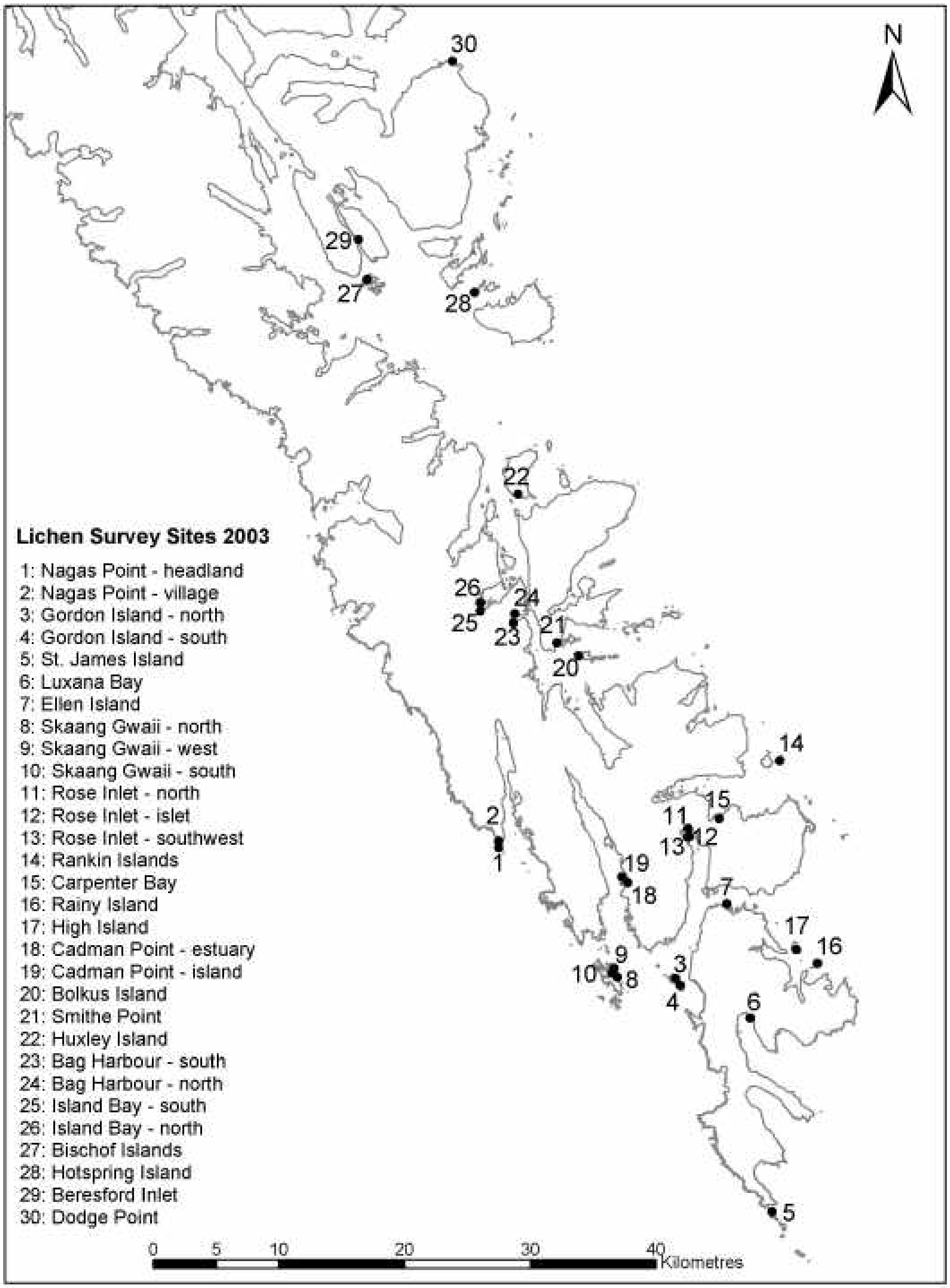

Figure 1. Map of sites surveyed for *Heterodermia sitchensis* in Gwaii Haanas National Park Reserve, July 2003.

Table 1. Listing of sites surveyed for *Heterodermia sitchensis* in Gwaii Haanas National Park Reserve, July 2003. Bold-faced site names denote village sites. Legend: A = acidic conditions; C = rich in cyanolichens; E = exposed; P = *Physcia tenella* present.

ID No.		*Locality*	*Site*	*Latitude*	*Longitude*
1	E	Flamingo Inlet	Nagas Point - headland	52 10.98	131 21.85
2	C	Flamingo Inlet	**Nagas Point - village**	52 11.28	131 21.89
3	E,A	Gordon Islands	Gordon Island - north	52 05.96	131 08.85
4	E	Gordon Islands	Gordon Island - south	52 05.69	131 08.52
5	E	St. James Island	St. James Island	51 56.35	131 01.05
6	P	Luxana Bay	Luxana Bay	52 04.53	131 03.49
7	C	Ellen Island	**Ellen Island**	52 09.31	131 05.71
8	C	Skaang Gwaii	**Skaang Gwaii - north**	52 06.21	131 13.17
9	C	Skaang Gwaii	**Skaang Gwaii - west**	52 06.00	131 13.33
10	E	Skaang Gwaii	Skaang Gwaii - south	52 05.84	131 12.92
11	C	Rose Inlet	Rose Inlet - north	52 12.40	131 08.76
12	C	Rose Inlet	Rose Inlet - islet	52 12.07	131 08.64
13	C	Rose Inlet	Rose Inlet - southwest	52 12.03	131 08.76
14	E,P	Rankin Islands	Rankin Islands	52 15.56	131 02.74
15	A	Carpenter Bay	Carpenter Bay	52 12.93	131 06.67
16	E,A	Rainy Island	Rainy Island	52 07.05	130 59.12
17	E,A	High Island	High Island	52 07.59	131 00.67
18	C	Louscoone Inlet	Cadman Point - estuary	52 09.91	131 12.69
19	A	Louscoone Inlet	Cadman Point - island	52 10.14	131 13.13
20	C	Bolkus Island	**Bolkus Island**	52 19.41	131 17.27
21	C	Smithe Pt	**Smithe Point**	52 19.89	131 18.89
22	A	Huxley Island	Huxley Island	52 26.10	131 22.37
23	A	Bag Harbour	Bag Harbour - south	52 20.60	131 22.00
24	CP	Bag Harbour	Bag Harbour - north	52 20.99	131 21.97
25	C	Island Bay	Island Bay - south	52 20.99	131 24.40
26	A	Island Bay	Island Bay - north	52 21.36	131 24.41
27	C	Bischof Islands	Bischof Islands	52 34.73	131 34.12
28	C	Hotspring Island	**Hotspring Island**	52 34.55	131 26.50
29	C	Beresford Inlet	Beresford Inlet	52 36.39	131 34.96
30	A	Lyell Island	Dodge Point	52 44.29	131 29.31
31	C	Lina Island	Lina Island	53 14.00	132 07.00

4.2 Status of *Heterodermia sitchensis* in Gwaii Haanas

Despite intensive searching, no populations of *H. sitchensis* were observed in Gwaii Haanas in 2003. Indeed, a majority of the sites examined by us proved to be inappropriate for this species, owing to either exposure to wind, or substrate acidity, or both (Table 1). For example, only in three sites -- Luxana Bay, Bag Harbour and Rankin Island -- was *Physcia tenella* noted. *Physcia tenella* is an indicator of nitrogen enrichment, and a companion species of *H. sitchensis*. Its presence in the first two sites was apparently due to localized nutrient enrichment as a result of bird perches, probably bald eagles, while in the third site it was favoured by nitrogen from a large seabird nesting colony. Had the third site been located farther south, in Pacific Rim National Park Reserve, it would have likely supported *H. sitchensis*. That it didn't could be owing to a general absence of this species in Haida Gwaii or, related to this, it could reflect the here greater spatial segregation between nutrient-enriched sites and treed sites suitable for colonization. In the south, winter storms are both less intense and less frequent than they are in Gwaii Haanas; and as a result, seabird colonies and sea lion haulouts more frequently overlap with sites supporting mature Sitka spruce.

4.3 Lichens new to Gwaii Haanas

The lichen flora of Haida Gwaii is comparatively well known, owing to intensive studies conducted over a period of more than thirty years by Dr. Irwin Brodo, of the Canadian Museum of Nature. Dr. Brodo has published several papers on the lichens of these islands, and has compiled an unpublished checklist of all species recorded to date. Because the following 25 species are lacking from this checklist, they are assumed to be new to Haida Gwaii. Species accompanied by an asterisk in the following list are apparently new to British Columbia.

Table 2. Noteworthy lichens collected in Gwaii Haanas National Park Reserve, July 2003. List provided by Tor Tønsberg.

Arthrorhaphis aeruginosa R. Sant. & Tønsberg
**Biatora alaskana* Printzen & Tønsberg
B. rufidula (Grawew) S. Ekman & Printzen
**Botryolepraria lesdainii* (Hue) Canals, Hernández-Mariné, Gómez-Bolea & Llimona
**Chrysothrix chrysophthalma* (P. James) P. James & J.R. Laundon
Cliostomum cf. leprosum (Räsänen) Holien & Tønsberg
Gyalideopsis anastomosans P James & Vezda
Gyalideopsis muscicola P James & Vezda
Gyalideopsis piceicola (Nyl.) Vezda
Halecania viridescens Coppins & P. James
Leioderma sorediatum D.J. Galloway & P.M. Jørg.
**Micarea myriocarpa* Coppins
Micarea xanthonica Coppins & Tønsberg
Ochrolechia cf. subviridis (Høeg) Erichsen
**Opegrapha fumosa* Coppins & P. James
**Opegrapha sorediifera* P. James
Parmeliella parvula P.M. Jørg.
Pseudocyphellaria mallota (Tuck.) H. Magn.
**Psoroma tenue* Henssen var. *boreale* Henssen
Ropalospora viridis (Tønsberg) Tønsberg
Rinodina stictica Sheard & Tønsberg
Santessoniella grisea (Hue) Henssen

Scoliciosporum cfr. *sarothamni* (Vainio) Vezda
**Topeliopsis toensbergii* Vezda & Kantvilas
Trapelia corticola (Sm.) M. Choisy

4.4 *Lichens as indicators of environmental continuity*

Carpenter Bay is underlain by limestone. In principle the presence of base-rich rock should yield a fairly rich epiphytic flora including several nutrient-demanding species. Yet the trees here were found to be essentially devoid of macrolichens. This is a recurrent pattern in Gwaii Haanas, where large tracts of forest often either lack macrolichens, or support only young, regenerating macrolichens. Such a pattern is consistent with the hypothesis that the lichens of this region are subject to periodic diebacks. I speculate that prolonged winter storms create a kind of waterfall-spray-zone effect, drenching the lichens with salt water for prolonged periods, and thereby leading to their demise.

The widespread occurrence of lichen diebacks is doubtless causally related to the fragmented distributions of many macrolichen species, especially dispersal-limited species like *Lobaria oregana* and *Usnea longissima*. In extreme cases, diebacks must even lead to local extirpations. It follows that dispersal-limited species (including *H. sitchensis*) are likely to become established only in localities where die-backs occur very infrequently. Presumably such localities could be expected to gradually accumulate a wide range of slow-dispersing lichens, most or all of which would have highly localized distributions. According to this perspective, the presence of such species can itself be taken as indicative of long environmental continuity. By contrast, the absence of such species could theoretically be owing to any of several factors -- periodic dieback, exposure to strong winds, acidic bedrock, etc. Thus not all oldgrowth forests provide conditions suitable for the establishment of slow-dispersing lichens. Some oldgrowth forests, this is to say, remain ecologically "immature," at least as regards habitats critical to lichen establishment.

Once the above patterns came into focus, late in our exploration of Gwaii Haanas, I attempted to test the resulting "spray exclusion hypothesis" by searching for a highly sheltered site unlikely to experience periodic diebacks. It was decided that the Bischof Islands would serve this purpose. The Bischof Islands form a cluster of small, mutually sheltering islands at the north end of Juan Perez Sound. A lagoon embedded in the largest of these islands provided a convenient mooring place. As predicted, here we encountered a highly diverse lichen flora, including a full suite of cyanolichens and, in addition to this, the only known locality in Gwaii Haanas for *Leioderma sorediatum* and *Pseudocyphellaria rainierensis*. It is therefore provisionally concluded that this site, sheltered from periodic lichen diebacks, has been accumulating epiphytic lichens over a very long period. The above observations further suggest that epiphytic lichen floristic diversity may itself provide a powerful indicator of environmental continuity in the forests of Haida Gwaii. These comments of course apply only to lichen community structure in the lower canopy, and near the upper tide line. No information is currently available on the occurrence of lichens higher in the canopy and farther upslope.

4.5 *Cyanolichens as indicators of old village sites*

A morning tour around Ellen Island revealed a uniformly impoverished epiphytic lichen flora. The only exception to this was a single small node of relative cyanolichen diversity. I later learned that this node coincides with an ancient village site dating back 9600 years b.p. (Lee Edenshaw, pers. comm.). Here a relatively rich assemblage of cyanolichen species was encountered, including *Erioderma sorediatum, Lobaria pulmonaria, L. scrobiculata, Nephroma helveticum, Polychidium contortum, Pseudocyphellaria anomala, P. anthraspis, P. crocata*, and *Sticta limbata.* Interestingly, none of these cyanolichens grew along the shoreline; all occurred only on trees rooted more than about 2 m above high water mark. Given that this site was underlain by siliceous bedrock, I hypothesize that the cyanolichens here are probably favoured by nutrient enrichment from buried shell middens dating from early settlement. According to this hypothesis, the absence of cyanolichens below 2 m could reflect a drop in sea level since the time of occupation.

The Ellen Island village site is representative of what appears to be a strong correlation between cyanolichen diversity and old village sites. Of the 15 cyanolichen "hotspots" noted in this study, at least seven overlap with old village sites (Table 1). Even more, all sites known to have supported a prehistoric village now additionally support a fairly rich cyanolichen flora. Presumably it is the existence of calcium-rich shell middens that provides the link between these two phenomena. If this proves to be the case, then it is interesting to reflect that current cyanolichen diversity in Gwaii Haanas could owe its existence, at least in part, to the nutrient-concentrating activities of early humans. Even more, it suggests that cyanolichens might themselves be used, under some conditions, to detect additional nodes of past human activity.

4.6 *Salmon forests*

At Bag Harbour we visited one of the small estuaries where Dr. Tom Reimchen conducted his well-known studies on the relation of spawning salmon to forest productivity. According to Reimchen, salmon are carried on shore by bears that partly, but not entirely consume them. Nutrients from the resulting salmon carcasses are taken up by the roots of trees, and hence incoprorated into the huge spruces, hemlocks, and red-cedars that line the margins of the estuaries. It is precisely these nutrients, argues Reimchen, that promote the enormous productivity of such ecosystems.

To judge from the predominantly acidophytic lichen flora along the north shore of Bag Harbour, the bedrock in this vicinity is rather acidic. Nor does rock type appear to change at the estuary, notwithstanding that the epiphytic flora changes very markedly. In the place of a flora dominated by chlorolichens (i.e., lichens with algal photocells), the Sitka spruce trees here support a wide array of cyanolichen species (i.e., lichens with cyanobacterial photocells). Included here are *Erioderma sorediatum, Leptogium brebissonii, Lobaria pulmonaria, L. scrobiculata, Nephroma helveticum, Polychidium contortum, Pseudocyphellaria anomala, P. anthraspis,* and *P. crocata*. All of these are nutrient-demanding species, strongly indicative of enrichment. Their presence here is consistent with Reimchen's hypothesis regarding nutrient enrichment from decaying salmon. In this connection, it is interesting that this "nutrient hotspot" occupies only a small area along the immediate margin of the estuary; outside this area the epiphytic flora reverts to chlorolichens.

In addition to hosting a diverse cyanolichen flora, the branches of the trees here also support enormous moss cushions up to 20 cm thick, and composed predominantly of *Antitrichia curtipendula*. Because such cushions are likely to develop only in the presence of nutrient enrichment, and because they can extend 20-30 m into the canopy, they provide a useful macroscale marker of nutrient hotspots. Their presence is probably closely tied, for example, with "salmon forests."

5.0 RECOMMENDATIONS

Winter storms on Gwaii Haanas are more frequent and more severe than in Pacific Rim National Park Reserve, where previous studies on *Heterodermia sitchensis* have been conducted. Unfortunately, only toward the end of field work was a clear search image for candidate sites in Gwaii Haanas formulated. According to the current model, future search efforts should probably focus on old village sites, in which an enhanced nutrient status combines with relatively sheltered conditions. Special attention should be given to large old Sitka spruce trees along the forest fringe, especially trees used as perching sites by eagles or corvids.

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APPENDIX 1

Daily Field Log: 21 July - 1 August 2003.

21 July (Mon): Trevor Goward, Brian Reader, Tor Tønsberg and Ken Wright gathered at the Vancouver Airport for the flight to Sandspit. From Sandspit we shuttled to Queen Charlotte City where we met our guide Lee Edenshaw. The afternoon was spent assembling field equipment and food. Later that evening, we all attended a safety and familiarization meeting with Parks Canada staff in Queen Charlotte City.

22 July (Tue): Brian, Ken and Lee drove to Moresby Camp, then travelled to Ellen Island in southern Gwaii Haanas aboard a 7 m aluminum hulled vessel. En route, they stopped briefly at Dodge Point on Lyell Island to check for *H. sitchensis*. Later that evening they set up camp at Ellen Island warden station. Meanwhile, Trevor and Tor spent the afternoon and early evening doing a lichenological reconnaissance of Lina Island in Skidegate Inlet.

23 July (Wed): Brian, Ken and Lee navigated to Flamingo Inlet on the west coast of Moresby Island. Their first site inspection was on the heavily exposed Nagas Point. This place was surprisingly devoid of macrolichens, perhaps testament to the severity of winter storms here. Extensive patches of the free-living algae *Trentapohlia* were observed. Later they continued eastward to an old village site with extensive *Lobaria pulmonaria* on the spruce branches, indicating some localized form of nutrient enrichment. They then returned to Ellen Island to rendezvous with Trevor and Tor who had travelled down with Judd Brown on a South Moresby Air charter. Later that afternoon we navigated to the Gordon Islands for more site inspections.

24 July (Thu): We navigated to Cape St. James via the west coast of Kunghit Island. Our first study was conducted on the north end of St. James Island, where a few wind-blown Sitka Spruce grow. After boating north into Woodruff Bay for lunch, we continued north and landed in the far end of Luxana Bay. Here *Physcia tenella* was found colonizing spruce branches. Later we headed back to Ellen Island.

25 July (Fri): Trevor and Ken surveyed the perimeter of Ellen Island examining patterns of lichen abundance. We found that macrolichen loadings reached their greatest abundance on easterly exposures. Norm Sloan arrived by float plane with two consultants looking at marine protected areas. All of us excepting Tor boated over to Sgaang Gwaii (Anthony Island) for the afternoon for more searching.

26 July (Sat): In the morning we cruised up Rose Inlet making several landings en route, including one on a small lichen-rich islet at the head of the inlet. In the afternoon we headed north to inspect Little Rankin Island on the east side of Moresby Island. Here *Physcia tenella* was locally heavy on Sitka spruce. Later in the afternoon we visited Carpenter Bay for a search of the shoreline.

27 July (Sun): In the morning, Trevor and Ken did a reconnaissance of Rainy Island, where macrolichen development was found to be very poor. Meanwhile Tor and Brian expored High Island with similar results. Later, we transited to Louscoone Inlet. Here Ken and Brian searched around the mouth of an estuary on the east side of the inlet, while Trevor and Tor searched a small island adjacent to the estuary. That evening, Trevor and Ken noted a high diversity of cyanolichens at an old village site on the south side of Ellen Island.

28 July (Mon): We packed up and left Ellen Island in the morning, heading north to the warden station on Huxley Island. (Norm Sloan and colleagues departed Ellen Island for Queen Charlotte by float plane in the afternoon). En route, our first site inspection was at the east end of Bolkus Island. Afterward we cruised over to Burnaby Island, where we surveyed the area immediately northeast of Smithe Point. Later we continued north to Huxley Island. After settling into camp, we cruised back south and surveyed a couple of places in Bag Harbour.

29 July (Tue): In the morning we headed south to Island Bay, inspecting the small island at the head of the bay, as well as much of the adjacent shoreline and estuary. Later we returned to Huxley Island and packed up and journeyed north to the Bischoff Islands. Two landings were made in these lichenologically remarkable islands. The rare *Lobaria rainierensis* and *Leioderma sorediatum* were both found here. Our last night in Gwaii Haanas was spent on Hotspring Island, where Trevor spent the evening searching the shoreline for *Heterodermia.*

30 July (Wed): In the morning, the shoreline of Hotspring Island was again searched. The remainder of the day was dedicated to travel: departing Hotspring Island in the late morning and arriving at Moresby Camp by mid-afternoon. En route, we made a brief lichen inspection in Beresford Inlet on Lyell Island.

31 July (Thu): In the morning, we made a thorough examination of Lina Island, where *Pseudocyphellaria mallota* was found. In the afternoon, field gear was cleaned up and returned to storage. Ken compiled a list of sites visited in Gwaii Haanas. In the evening Trevor gave a well-attended public lecture on the lichens of Gwaii Haanas.

1 August (Fri): Returned to Vancouver on an afternoon Air Canada flight.

APPENDIX 2

Seaside centipede lichen (*Heterodermia sitchensis)*: portrait of a lichen.

by Trevor Goward

The Seaside Centipede Lichen (*Heterodermia sitchensis* Goward & Noble) is one of western North America's true lichenological rarities. At the time of its description in the mid 1980s, it was known from only two sites worldwide, both located along the hypermaritime west coast of Vancouver Island (Goward 1984). One of these localities was subsequently lost to housing development, leaving only the type locality, which is in Pacific Rim National Park Reserve. A COSEWIC status report commissioned in 1994 led, a few years later, to *H. sitchensis* being designated as endangered in Canada (Goward 1996). In 2001, Parks Canada initiated further studies on this lichen, prompted by a mandated requirement to develop recovery plans for rare species occurring within its jurisdiction. During the following two summers, I scoured Pacific Rim Park and surrounding areas for *H. sitchensis*, and at the same time attempted to learn what I could about its distribution and ecology. What now follows is some of what was learned (see also Goward & Wright 2003). The assistance of Ken Wright, as well as that of Brian Reader and other Parks Canada staff has been much appreciated.

But first, a description: *H. sitchensis* is a semi-erect, cushion-forming, foliose lichen up to about 2 cm across. The lobes vary from short to longish, are 1-2 mm wide, and have long thin, marginal cilia that call to mind the legs of a centipede. The upper surface is pale milky greenish or bluish, except where interrupted by scattered whitish spots (maculae). Mature thalli usually have urn-shaped sexual fruiting structures (apothecia) near the lobe tips, these with prominent flaring rims that in turn bear powdery asexual reproductive propagules (soredia) on their inner surface. The lower surface is white and under the hand lens looks like matted cotton. This lichen could be confused with *Physcia tenella*, another tree-dwelling species with pale lobes and cilia-bearing lobe margins. In that species, however, the soredia are located on the undersides of the lobe tips, and the lower surface is hard and skinlike, not cottony.

You could say that *Heterodermia sitchensis* is a tree-dwelling lichen with refined tastes. For starters, it is very particular about location, being restricted to open (but not exposed) localities by the sea. And though I have searched for it by the sea on a wide array of host trees, it seems invariably to colonize only one: Sitka spruce (*Picea sitchensis*). What is more, not just any Sitka spruce will do, but it must be an aged Sitka spruce, or else a Sitka spruce that's stressed and slow-growing. So likewise with its position in the canopy, which seems always to be within three or four metres of the ground. Here, moreover, it occupies small twigs less than about 1 cm in diameter and growing less than about 10 cm per year. Finally, only the defoliated portion of those twigs are colonized, the adjacent foliated portions perhaps being too young or too ecologically unstable.

The fact that *H. sitchensis* is confined to small twigs effectively defines it as an early colonizer, a pioneer species. And like other pioneer species, *H. sitchensis* is relatively short-lived. By my calculations, it must complete its life cycle by the time the portion of twig it occupies is ten years old; for by then its place on that twig will have been usurped by other, more aggressive lichens and bryophytes. This observation is probably key to its status as a rare species; for though *H. sitchensis* -- denizen of twigs -- needs to recolonize at frequent intervals, it appears to be woefully inefficient at doing so.

Whether the problem with successful colonization involves limitations of dispersal, or whether it stems from an inability to become established on its host twig is anybody's guess. Probably both. On the one hand, *H. sitchensis* depends for its dispersal on powdery soredia that develop near the lobe tips on the *insides* of tiny "urns." How these soredia can possibly escape from these urns to traverse the distance from one tree to another is unclear to me. Could it be the work of birds?

And on the other hand, *H. sitchensis* is physiologically ill-equipped to colonize conifer twigs in the first place. This is one of the key findings of my study, made in cooperation with Art Fredeen of the University of Northern British Columbia: *H. sitchensis* is a nutriphile, requiring exceptionally high levels of nutrient enrichment. In the twigs studied, the enrichment came in the form of nitrogen (Goward & Fredeen, in prep.), which itself also came in two forms: uric acid and urea. The fact the same twigs, notwithstanding, registered a pH much higher than that of other twigs studied is a minor mystery still in need of solving.

Regardless of the actual details of bark chemistry, there is little doubt that nitrogen enrichment of one kind or another triggers the growth of *H. sitchensis*. To see this, you have merely to look where it grows. Directly below the perching sites of birds for one thing. Here bird droppings create vertical columns of enrichment ("guano falls") that can be traced lichenologically downwards to the forest floor. Another favoured habitat for *H. sitchensis* is sites adjacent to sea lion winter haulouts. The ability of nitrogen-rich aerosols to impregnate the bark of barnyard trees is well known, so why not seaside trees? Calciferous bedrock also appears to benefit *H. sitchensis*, possibly through the uptake of nutrients via the roots of trees. In this case, however, some additional source of nitrogen is apparently required, as for example the aforementioned columns of enrichment. Then there's the salutary influence of seabird colonies: the nesting sites of glaucous-winged gulls, pelagic cormorants, black oystercatchers, and pigeon guillemots all potentially provide nutrients sufficient to support *H. sitchensis* on nearby trees. Finally, one of the more intriguing sources of enrichment includes calcium-rich shell middens from old aboriginal village sites, though here again some supplementary source of nitrogen appears to be required.

Taken together, the above observations imply that the occurrence of *H. sitchensis* can be predicted on the basis of four broad environmental factors: 1) adjacency to the ocean; 2) Sitka spruce; 3) slow-growing twigs; and 4) nutrient enrichment. Only in sites where these four factors overlap is *H. sitchensis* likely to be found.

To date, I have recorded a total of 159 thalli of *H. sitchensis* from nine localities ranging from the Bamfield area in the south to Lawrence Island 75 km farther north. In most localities this species has been documented from only one or a few trees, though at least two hotspots are now known: one in the Broken Group Islands, and another on Florencia Island, just off Pacific Rim. Recently *H. sitchensis* has also been reported from coastal Oregon, where it grows on Cape Lookout (McHenry & Tønsberg 2002).

Despite its occurrence in nine localities, *H. sitchensis* should not be considered secure and of no concern to conservationists. On the contrary, its ecological status as a pioneer species imposes a requirement for frequent colonization, while its requirement for high levels of nutrient enrichment prevents successful establishment at most sites. Even during the two years of my study, I noted major albeit probably temporary declines in population size. What is more, nearly 70% of existing thalli are restricted to two small islands in Pacific Rim National Park Reserve. In my opinion, the small size of even these hotspots renders this species vulnerable to local disturbance.

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