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STATUS OF ENDANGERED
WILDLIFE IN CANADA

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COMITÉ SUR LE STATUT
DES ESPÈCES MENACÉES
DE DISPARITION AU
CANADA

OTTAWA (ONT.) K1A 0H3
(819) 997-4991

STATUS REPORT ON THE SEASIDE CENTIPEDE *HETERODERMIA SITCHENSIS* IN CANADA

BY

TREVOR GOWARD

STATUS ASSIGNED IN 1996
ENDANGERED

REASON: HIGHLY RESTRICTED ENDEMIC WITH CRITICALLY LOW POPULATIONS AND COMPLEX MICROHABITAT REQUIREMENTS.

OCCURRENCE: BRITISH COLUMBIA

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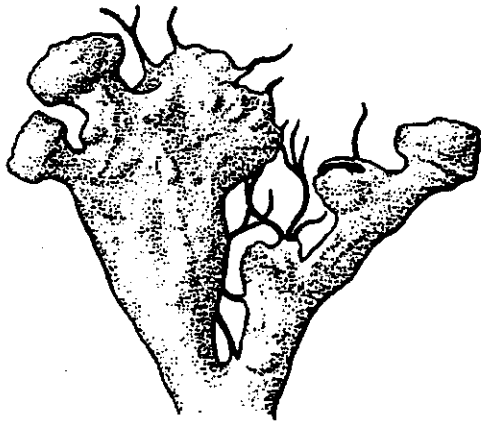
STATUS REPORT ON LICHENS AT RISK IN CANADA



Seaside Centipede

Heterodermia sitchensis

COSEWIC
COMMITTEE ON THE STATUS OF ENDANGERED WILDLIFE IN CANADA

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JUNE 1994

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SPECIES:	"Species" means an indigenous species, subspecies, variety or geographically defined population of wild fauna and flora.
VULNERABLE: (V)	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
THREATENED: (T)	A species likely to become endangered if limiting factors are not reversed.
ENDANGERED: (E)	A species facing imminent extirpation or extinction.
EXTIRPATED: (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
EXTINCT: (X)	A species that no longer exists.
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STATUS REPORT ON THE SEASIDE CENTIPEDE *HETERODERMIA SITCHENSIS* IN CANADA

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ENDANGERED

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ABSTRACT

Heterodermia sitchensis (Seaside Centipede Lichen) is an epiphytic member of the Physciaceae. It occurs in sheltered foreshore forests along the humid west coast of North America, and is possibly endemic to British Columbia. To date, it has been reported from only two localities worldwide, with a total of approximately 20 thalli colonizing an area less than 2 m^2.

H. sitchensis appears to be an obligate epiphyte of *Picea sitchensis* restricted to undisturbed forest ecosystems. Its narrow ecology reflects a strong requirement for continuous high humidity and moderate temperatures.

The author recommends a status of endangered in recognition of this species' highly restricted global distribution, its obviously specialized ecological requirements, and its extreme vulnerability to habitat destruction.

FIGURES

Figure 1: *Heterodermia sitchensis*: Habit (from Goward 1984).

Figure 2: *Heterodermia sitchensis*: World distribution.

Figure 3: *Heterodermia sitchensis*: Approximate potential range in Canada.

Figure 4: Schooner Cove is the holotype locality of *Heterodermia sitchensis*.

Figure 5: *Heterodermia sitchensis* colonizes the foreshore branches of *Picea sitchensis*.

Figure 6: Localities examined for *Heterodermia sitchensis* (and other rare lichens) during 1991 and 1992.

SECTION I : SPECIES INFORMATION

1. Classification and Nomenclature

A. Species

(1) Scientific Name

Heterodermia sitchensis Goward & Noble *in* Goward

(2) Bibliographic Citations

Bryologist 87: 366. (1984).

(3) Type Specimen

British Columbia, Vancouver Island, 12 km SE of Tofino, Schooner Cove, 30 March 1983. T. Goward 83-326.
Holotype: University of British Columbia, Vancouver (UBC).
Isotypes: National Museums of Natural Science, Ottawa (CANL).
University of Helsinki, Helsinki (H).

(4) Synonyms

None.

(5) Common Names

"Seaside Centipede Lichen".

B. Family Classification

(1) Family Name

Physciaceae.

(2) Common Family Name

Physcia Family.

C. Major Plant Group

Lichens (lichenized Ascomycetes).

D. Current Alternative Taxonomic Treatments

The specific distinctness of H. sitchensis has not been challenged since its description. It is important to emphasize, however, that this is a sorediate taxon; it may have evolved from, and hence represent the asexual "secondary species" of, an existing fertile "primary species" of Heterodermia, e.g. H. podocarpa (Bél.) Awas. (Goward 1984) (see 4 D, below).

Taxonomists are not agreed on the most appropriate taxonomic treatment for secondary species. On the one hand, Tehler (1982) argues that such species ought to be assigned to the rank of "forma" under their fertile counterparts. On the other hand, Poelt (1972) recognizes them as distinct species, whereas Mattsson & Lumbsch (1989) would accord them either subspecific or specific status, depending on the degree of morphological and geographic overlap with the fertile "primary" species. H. sitchensis is chemically, morphologically and geographically distinct from H. podocarpa, and would be given species recognition by most, if not all, lichenologists.

Heterodermia was formerly treated as a subgenus of Anaptychia. The first modern author to recognize it at genus level was Poelt (1965), who argued that Heterodermia can be separated from Anaptychia on the basis of critical apothecial, chemical and morphological characters. Though a few authors (e.g. Kurokawa, 1973, Jørgensen 1977) have been reluctant to follow Poelt, most lichenologist now unequivocally recognize Heterodermia as a distinct genus.

E. History of Taxon

The earliest known collection of H. sitchensis was made at the type locality in 1983. The species has remained taxonomically stable since its description in 1984.

2. Description

A. Non-technical Description

This is a semi-erect, cushion-forming, foliose (leaf) lichen averaging to 2 cm across. The lobes are thin, stiff, 0.5-2.0 mm wide, short to elongate, separate to loosely overlapping, sparsely irregularly branched, of uneven thickness, and with strut-like extensions into the medulla. The upper surface is strongly convex, pale greenish white

(but readily discolouring to bluish black), dull, smooth to occasionally bearing scattered "warts" and whitish spots, these 0.1-0.4 mm across and sparse to numerous. Soredia granular, pale whitish green, confined to ring-shaped soralia, these 0.5-1.2 mm across, borne within urnlike outgrowths of the apothecial rim, often becoming exposed as the walls of the "urn" gradually subside or flare. The lower surface is white throughout, cottony, and lacks a cortex. Marginal cilia are numerous, slender, 0.5-2.0 mm long, sparsely to richly branched, and soon blackening. Apothecia are located near the lobe tips, and are stalked. Spores immature.

Chemistry: Cortex K+ yellow, C-, KC-, PD-; medulla K+ yellow, C-, KC-, PD+ yellowish to pale orange. Contains atranorin, zeorin, and unknown fatty acids. The PD+ reaction is unexplained, as no substances reacting with PD have yet been demonstrated with thin-layer chromatography, notwithstanding further testing subsequent to Goward (1984), and prepatory to this report. This may possibly indicate chemical variability within the species. Additional testing is impracticable, however, until a richer herbarium material becomes available.

A somewhat more technical description will be found in Goward (1984).

B. Local Field Characters

This species' combined epiphytic habit, tiny, semi-erect, pale greenish white lobes, marginal "cilia", and cottony (i.e. non-corticate) lower surface are distinctive. The subterminal, sorediate apothecia provide a further critical field character, but as these superficially resemble the soralia of Physcia adscendens (Fr.) Oliv., care must be taken to distinguish between these two species. In P. adscendens, however, the soralia are terminal, not subterminal, and the lower surface is distinctly corticate. When fertile, H. speciosa can also be somewhat similar, especially in the details of the apothecia, but in this species the lobes are strongly appressed, and a partial lower cortex is present.

C. Illustrations

Figure 1 first appeared in Goward (1984), and remains the only existing illustration of H. sitchensis.

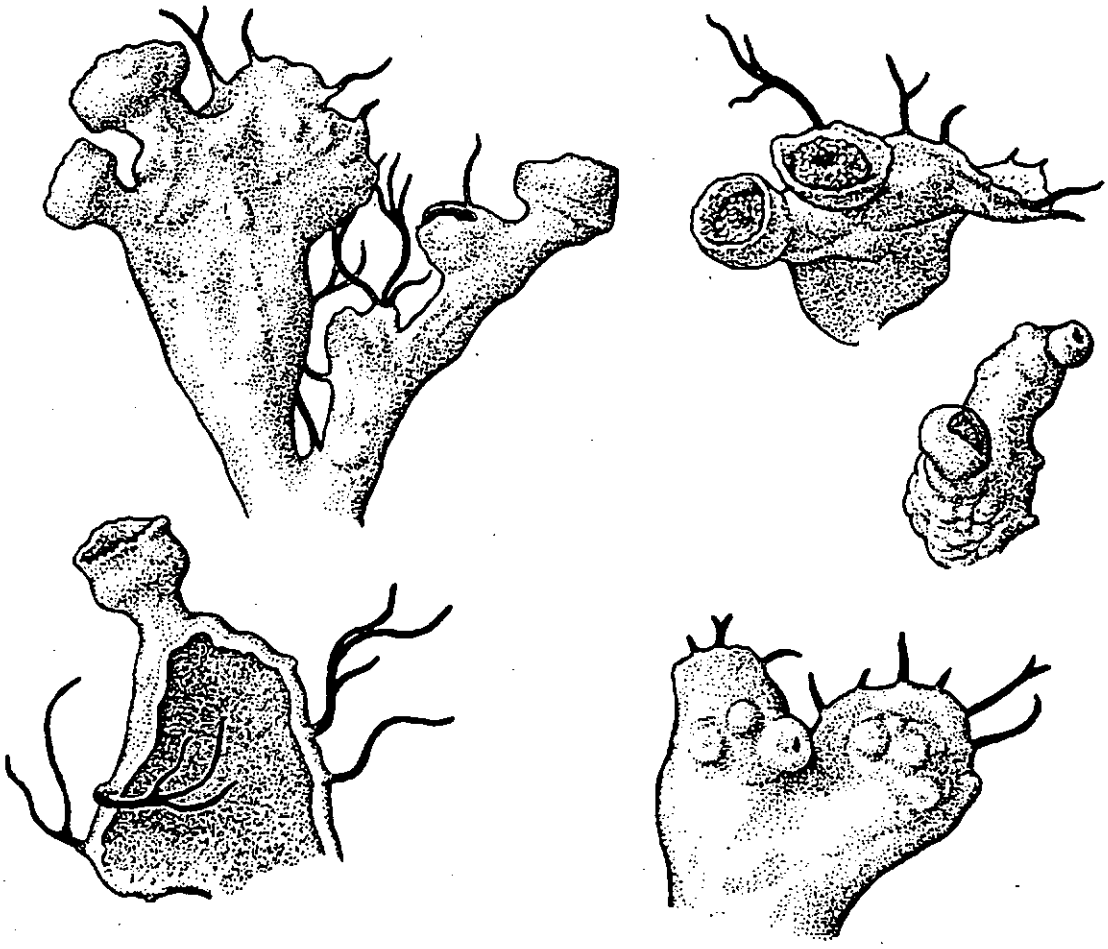

Figure 1: Heterodermia sitchensis: Habit (from Goward et al. 1994).

3. Biological and Economic Significance

A. Biological

H. sitchensis is a Pacific Northwest endemic of unusually restricted distribution (see Figure 2) and ecology (see 4 B 4, below). In North America, it is the most northerly member of a group of *Heterodermia* species more characteristic of tropical and semi-tropical latitudes. Of special interest are the apothecia, which apparently no longer produce spores, but instead act as highly specialized structures for the production and dissemination of soredia.

B. Economic

No economic use has been made of any species of *Heterodermia* to the present time.

4. Distribution

A. Summary

H. sitchensis is endemic to the Pacific Northwest of North America, and appears to be further restricted to British Columbia. Only two localities have been reported for it to date, both of which are situated along the west coast of Vancouver Island (Figure 2).

Figure 3 presents the approximate potential range of *H. sitchensis* in Canada. Given that intensive floristic studies in the Queen Charlotte Islands (Brodo, unpublished) and southeast Alaska (Geiser et al. 1994) have failed to detect this species, its absence from these regions is probably real, and not a mere artifact of undercollecting (see also 4 B 4, below).

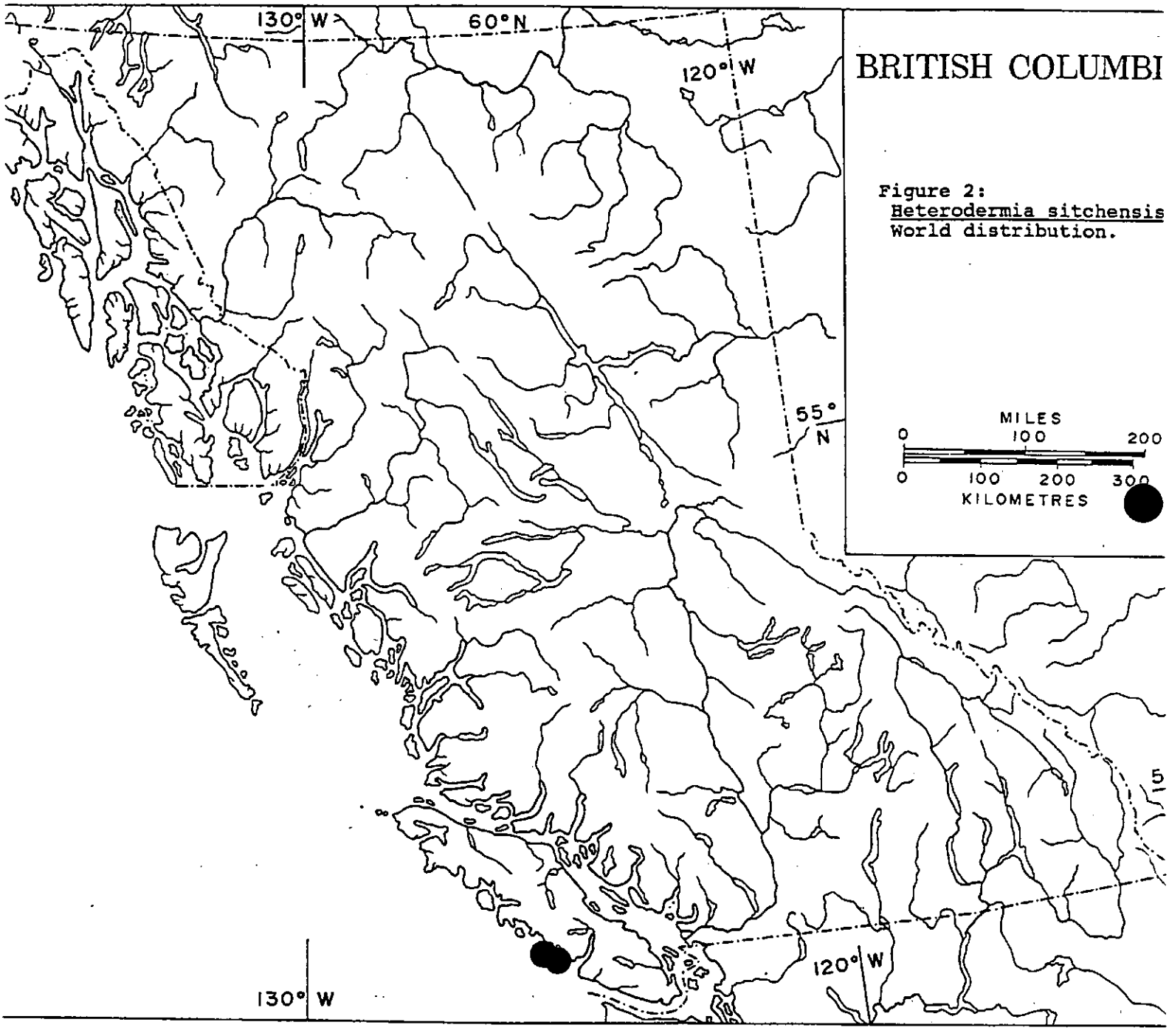

Figure 2:
Heterodermia sitchensis
World distribution.

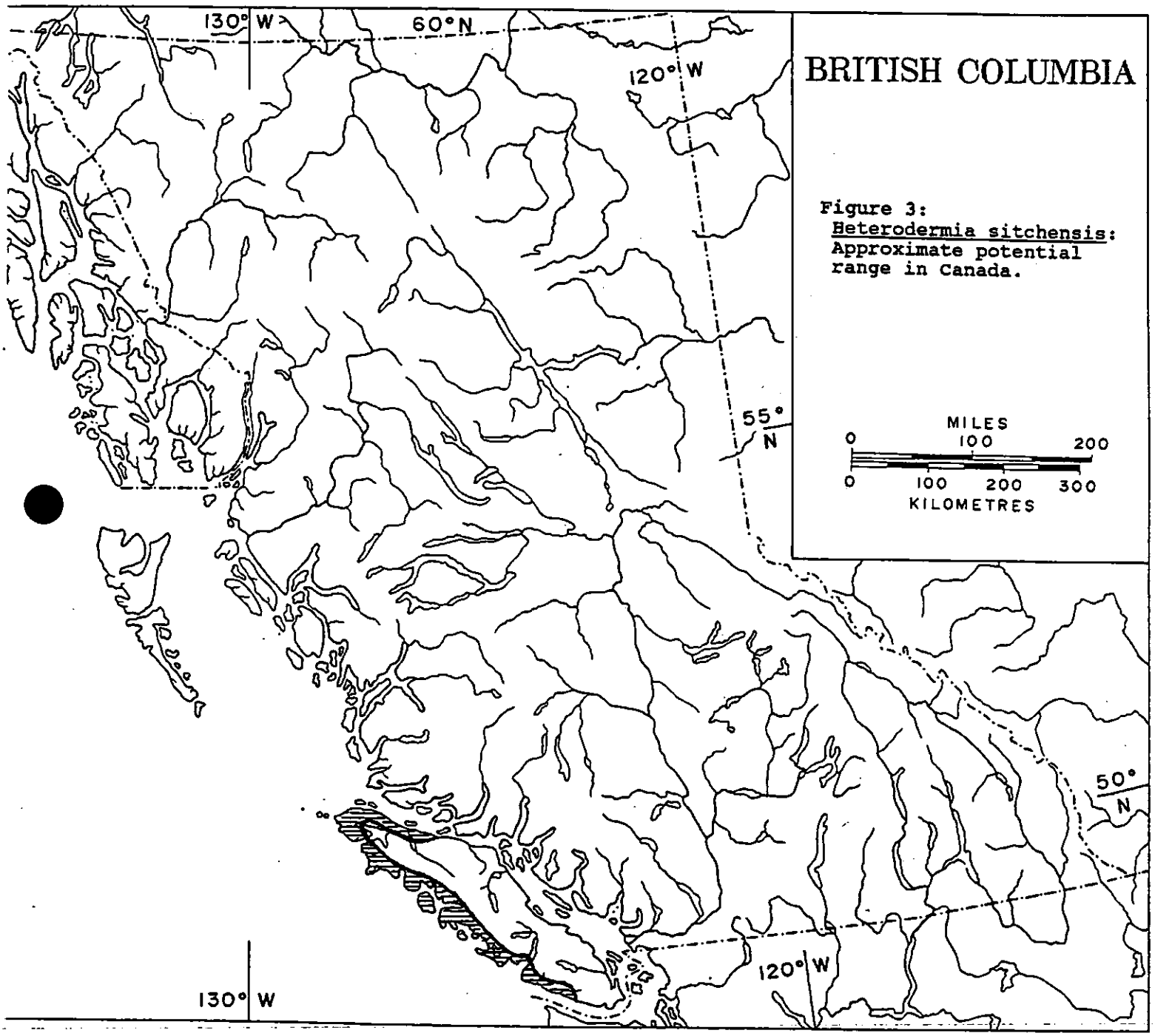

Figure 3:
Heterodermia sitchensis:
Approximate potential
range in Canada.

B. Locality Citations

Precise locality data and land ownership, if known, is on file with COSEWIC and the appropriate provincial jurisdiction. This information is generally available unless the localities are considered to be publicity-sensitive.

(1) Extant Populations Currently or Recently Verified

- Locality 1. Vancouver Island, Pacific Rim National Park, Schooner Cove. (Map: 92 F/4 SW) 49 04'N, 125 48'W. Altitude: 3 m. Last visited by the author on 25 September 1991.

- Locality 2. Vancouver Island, Ucluth Peninsula, Ucluelet. (Map: 92 C/13 NE) 48 57'N, 125 31'W. Altitude: 3 m. Last visited by the author on 3 April 1983.

(2) Extirpated Populations

- None known, but see 10 B, below.

(3) Historical Populations of Unknown Status

- None known.

(4) Potential Sites for Investigation

- The distribution and ecology of H. sitchensis, so far as known, suggest a complex requirement for continuous high humidity, good air circulation, moderate temperatures, and shelter from open exposure. Also apparently requisite are relatively stable ecological conditions of the kind provided by oldgrowth forests. Such conditions are presumably met in a number of coves and bays along the west coast of Vancouver Island. They are not, however, expected to co-occur either along the mainland coast north of Vancouver Island, where arctic outflow conditions during the winter months are probably limiting, or in coastal Washington State, where the coastline is considerably less indented, and where a comparatively more "mediterranean" (i.e. summer-dry) climate prevails.

(5) Erroneous Reports

- None known.

C. Status and Location of Presently Cultivated Material

- None known.

D. Biogeographic and Phylogenetic History of the Species

Kurokawa (1962, 1973) has published a worldwide treatment of Heterodermia (as Anaptychia s. lat.). From this, as well as from Trass' more recent tabular summary of the genus (Trass 1992), it would appear that Heterodermia, with approximately 80 species worldwide, can be characterized as primarily a tropical and warm temperate genus of both the northern and southern hemispheres.

The fact that several Heterodermia species are of essentially pantropical distribution (Kurokawa 1973) would seem to indicate great antiquity in this genus. The strong possibility exists that Heterodermia, in common with other widespread lichen genera (e.g. Hawksworth 1982), had already evolved prior to the break-up of Pangaea, roughly 200 million years ago. On the other hand, Jørgensen (1983), in a discussion of lichen distribution patterns in the Pacific region, stresses the importance of long-distance dispersal.

Within Heterodermia, H. sitchensis belongs to the H. podocarpa group. This is an assemblage of at least 27 species (Trass 1992), all of which have erect or semi-erect lobes, terminal or subterminal apothecia, and a non-corticate lower surface (Kurokawa 1962). Based again on Trass' summary (1992), the H. podocarpa group has two obvious centres of distribution: one in southeast Asia (12 species), and the other in Central America, north to Mexico (15 species). In the United States and Canada, this group is represented by only five species: H. echinata (Taylor) Culb., H. erinacea (Ach.) W. Weber, H. galactophylla (Tuck.) Culb, H. podocarpa (Bél.) Awasthi, and H. sitchensis (see Egan 1987).

As already mentioned, H. sitchensis is an asexual "secondary species" most closely related to the sexual "primary species" H. podocarpa. Assuming that all secondary taxa have evolved from primary taxa (Poelt 1970), then it seems not unlikely that H. podocarpa may represent the evolutionary precursor of H. sitchensis. The fact, however, that H. podocarpa has a rather diverse chemistry (containing, for example, salazinic and norstictic acids, Kurokawa 1973) compared with that of H. sitchensis suggests that the lineage between the two may not be direct. On the other hand, Swinscow & Krog (1976) signal the existence of certain African strains of H. podocarpa containing only atranorin and zeorin; such strains would thus chemically closely resemble H. sitchensis.

If it can be assumed that H. sitchensis has indeed derived from a tropical or subtropical precursor, then the most plausible explanation for its anomalous ecology is that it originally evolved as a species of equatorial cloud forests. This could explain, for example, its present requirement for moderate temperatures and continuous high humidity (see 5 B, below). The possibility should not be overlooked that H. sitchensis may still occur, undetected, in the cloud forests of Central America.

As an epiphyte, H. sitchensis is dependent on the prior existence of trees, specifically Sitka Spruce (Picea sitchensis). Though Lodgepole Pine (Pinus contorta) is now believed to have persisted along portions of the British Columbia coast throughout the Pleistocene (Richard Hebda, pers. comm.), Picea sitchensis appears not to have occurred prior to deglaciation, roughly 14,000 years ago. The ealiest date given for its return to Vancouver Island is 11,500 years (Hebda 1983). Presumably H. sitchensis passed the Pleistocene south of the cordilleran ice sheet in what is now Washington or Oregon.

In most species pairs involving a fertile "primary species" and a sorediate (or isidiate) "secondary species", the asexual species is much more widely distributed than the sexual species (Bowler & Rundel 1975). In the case of H. podocarpa and H. sitchensis, however, the situation is quite the reverse (see 4 A, above): whereas the former species is essentially pantropical, occurring in Africa, Asia, and North and South America, the latter appears to be restricted to the Pacific Northwest. The fertile species is thus here much more widespread than its sorediate counterpart. This may simply reflect the highly specific ecological requirements of H. sitchensis, or it may suggest that this species is of relatively recent evolution, and has not yet become established throughout its full potential ecological range. In either case it is pertinent to reiterate Poelt's observations (Poelt 1963) that recolonization of postglacial landscapes is accomplished primarily by derived asexual species.

5. General Environment and Habitat Characteristics

A. Summary

So far as is known, H. sitchensis is restricted to twigs of Picea sitchensis in the lower canopy of seaside oldgrowth Coastal Western Hemlock forests in somewhat sheltered localities along the Pacific coast. The climate here can be characterized as both highly oceanic and markedly humid.

Its microdistribution appears to be controlled in part by competition from epiphytic bryophytes, especially Isothecium stoloniferum.

B. Climate

(1). Temperature

Both localities from which H. sitchensis is currently known are situated within the Very Wet Hypermaritime Subzone of the Coastal Western Hemlock Zone. As outlined by Meidinger & Pojar (1991), this zone can be characterized as having a cool oceanic climate, with a mean annual temperature range of about 10 degrees C. At nearby Tofino airport, the average mean temperature for the coldest month (January) is 4.4 °C, compared with 14.6 ° C for the warmest month (August) (Environment Canada 1975a). The extreme minimum temperature is -15 °C, and the extreme maximum is 32.8 °C. On average, Tofino recieves only 50 days of frost per year.

Though actual records are lacking, the microsites colonized by H. sitchensis are doubtless even more oceanic than the above thermal values would suggest. In the first place, their position along the outer coast would assure a strong moderating influence from the adjacent Pacific Ocean (Figure 4). And in the second place, their occurrence over the branches of coastline trees of easterly aspect would result in protection from direct sunlight during the warmest part of the day (Figure 5).

These observations suggest, but of course do not confirm, a pronounced sensitivity to extremes of either heat or cold. Indeed, continentality values within the range of H. sitchensis are among the lowest in Canada, i.e. approximately 5 on Conrad's Index of Continentality (Conrad 1946; see also Goward & Ahti 1992). By comparison, continentality is 55 at Fort Nelson.

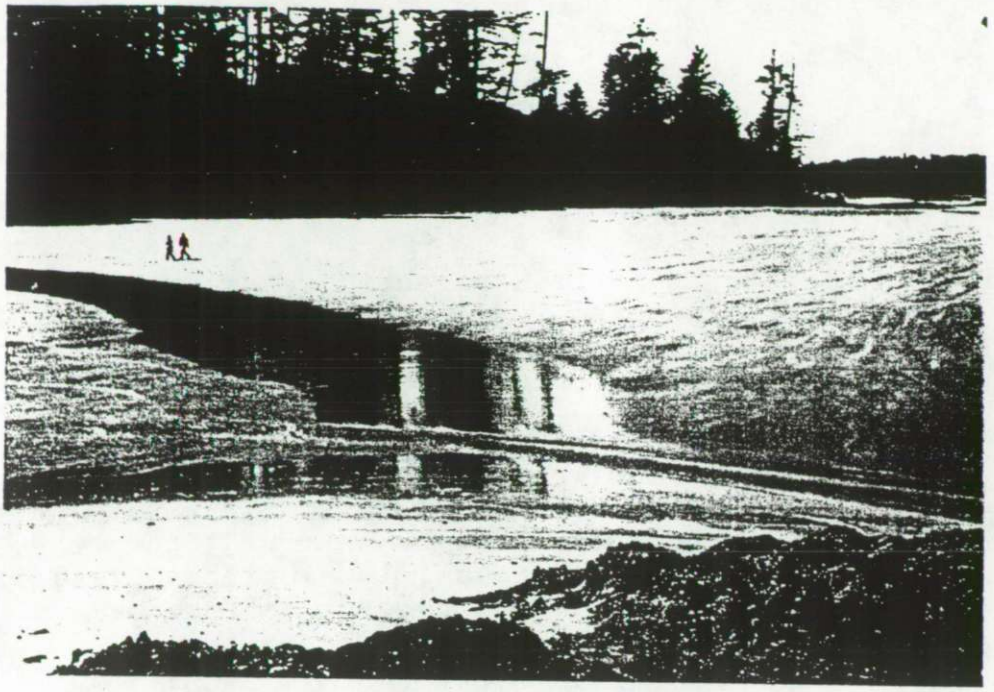

Figure 4: Schooner Cove is the holotype locality of Heterodermia sitchensis.

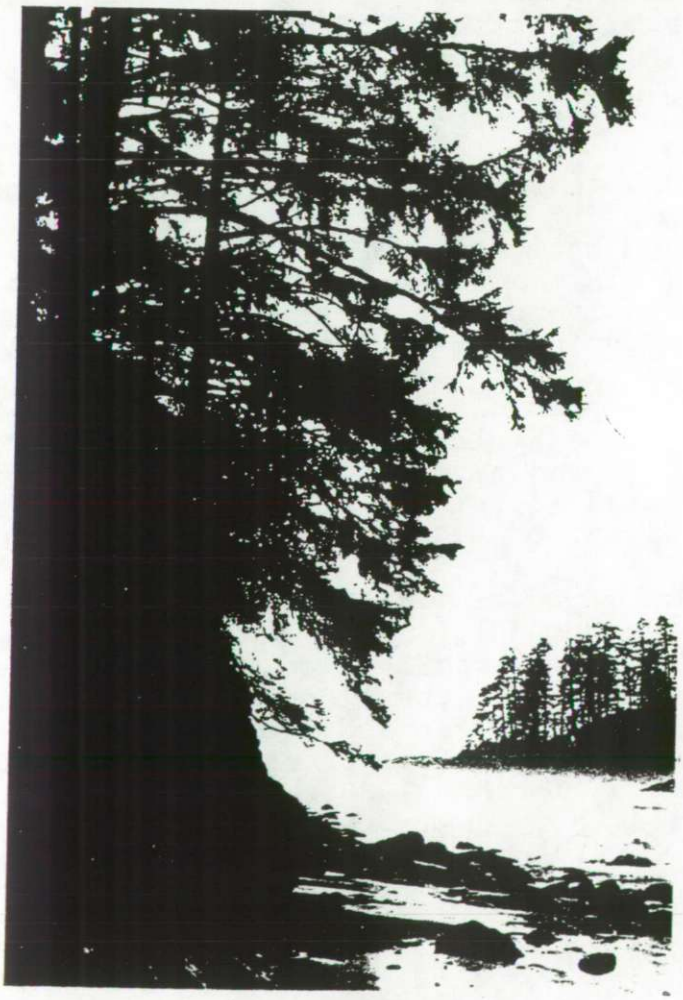

Figure 5: Heterodermia sitchensis colonizes the foreshore branches of Picea sitchensis.

(2). Precipitation

H. sitchensis is apparently restricted to one of the wettest lowland regions of Canada. Tofino, for example, receives a total annual precipitation of approximately 3060 mm, nearly all of which (3020 mm) falls as rain. Precipitation, moreover, is heavily concentrated during the winter months, such that in December, the wettest month, precipitation values are 450 mm, compared with only 80 mm in July, the driest month. It should not be inferred from this, however, that summer is necessarily a period of relative physiological drought (see 5 B 5, below).

(3). Solar Radiation

Yorke & Kendall (1972) give solar radiation values for British Columbia ranging from 1030 hours per year at Prince Rupert, to 2180 hours at Victoria. Tofino is estimated to receive roughly 1600 hours of sunshine per year, with approximately 1000 hours of this occurring from May through September.

Fog is an important environmental factor along this portion of the Pacific coast during the summer months, though its duration and intensity may vary considerably from place to place. While no data on fog are available for the localities colonized by H. sitchensis, local residents report that fog is much more frequent here (i.e. in Ucluelet and along the middle portions of Pacific Rim National Park) than it is, for example, at Tofino. This would have the effect both of reducing the number of hours of bright sunshine reported above, and of enhancing ambient atmospheric humidity.

(4). Wind

At Tofino, where average annual windspeeds are 12 km per hour, the prevailing winds during the summer months are from the west and southwest (Environment Canada 1975c). Wind has a pronounced dessiccating effect on lichens (Kershaw 1985). It is therefore not surprising that H. sitchensis, an obvious hygrophyte, is apparently restricted to rather sheltered sites, though its forest-edge ecology ensures at least some degree of ventilation.

(5). Humidity

As might be expected along the Pacific coast, relative humidity remains high throughout the year. During the summer months at Tofino, for example, average humidity values vary from 95% at 04:00 PST to 72% at 16:00 PST (Canada Department of Transport 1968). During the rest of the year, humidity averages between 80% and 90% even at 16:00 PST. Humidity values are expected to be even higher along the coastline sites inhabited by H. sitchensis, particularly during the summer months, when fog is common.

Many lichen species are able to sustain some degree of physiological activity when hydrated by water vapour (see Kershaw 1985). On the other hand, net positive photosynthesis is normally achieved only through wetting and drying at more or less frequent intervals (Farrar 1973). Judging from its occurrence in one of the most humid regions of Canada, as well as from its tendency to colonize rather sheltered sites, H. sitchensis is obviously adapted to surviving prolonged periods at partial or full hydration.

To date, H. sitchensis has been detected only in the lower forest canopy, notwithstanding that it was repeatedly searched for among the middle and upper branches of recently wind-thrown trees. This may further reflect a requirement for continuous high humidity; even under open forest conditions, a three-fold increase in evaporation rates has been demonstrated between the lower forest canopy and the upper canopy (see Kershaw 1985).

C. Air and/or Water Quality Requirements

Wetmore (1988) estimates that quantitative studies of lichen sensitivity to sulphur dioxide and other atmospheric pollutants have been performed on only 157 lichen species known to occur in North America. Unfortunately, H. sitchensis is not among the species tested to date. Nash (1976) did, however, find significant reductions in total chlorophyll content in H. "neoleucomelaena" (= leucomelos) in fumigations with nitrogen dioxide at levels as low as 4 ppm. Though this suggests that H. sitchensis may indeed be sensitive to some forms of atmospheric pollution, air quality along western Vancouver Island is excellent and, given the proximity of the Pacific Ocean, is likely to remain so into the forseeable future.

D. Physiographic and Topographic Characteristics

The fact that H. sitchensis is currently known from only two localities makes it difficult to generalize its physiographic and topographic requirements. So far as is known, however, this species can be described simply as a species of lowland regions along the outer Pacific coast.

E. Edaphic Factors

European phytosociologists (e.g. Barkman 1958, James et al. 1976) classify members of the genus Heterodermia in alliances that can be described as weakly calciphilic. To judge from its co-occurrence with Physcia tenella, Ramalina farinacea and other moderate calciphiles, H. sitchensis would appear to be dependent on, or at least tolerant of, some degree of calcium enrichment. Possibly it benefits from salts precipitated from the sea spray to which it is incessantly exposed. Sea spray is at any rate an important environmental factor in such localities (Fletcher 1976).

F. Dependence on Dynamic Factors

In common with Cavernularia hultenii and C. lophyrea, with which it grows, H. sitchensis appears to be entirely restricted to young twigs. This may reflect a requirement for certain anomalous chemical or physical properties of the young bark. On the other hand, it could equally reflect an inability to compete with various bryophytes, especially Isothecium stoloniferum, that inevitably become established on the older branches in this habitat (see 5 G 5, below).

G. Biological Characteristics

(1). Vegetation Physiognomy and Community Structure

Community structure among epiphytic lichens is not strongly correlated with community structure in the adjacent shrub and herb layers (McCune & Antos 1981, Canters et al. 1991). H. sitchensis is therefore not expected to be associated with any obvious repeating clusters of vascular plants.

(2). Regional Vegetation Type

Both localities are situated in the Pacific Coast (C. 3) Forest Region of Rowe (1972). Alternatively, in the terminology of the British Columbia Ministry of Forests (Meidinger & Pojar 1991), H. sitchensis is restricted

to the Very Wet Hypermaritime subzone of the Coastal Western Hemlock Zone. This is the wettest and most oceanic expression of this zone.

(3). Frequently Associated Species

Vascular Plants
The following species are present in the immediate vicinity of both localities: Picea sitchensis, Thuja plicata, Tsuga heterophylla, Gaultheria shallon, Polystichum munitum and Vaccinium alaskaense/ovalifolium. Other vascular species characteristic of this subzone are listed in Meidinger & Pojar (1991).

Cryptogams
Numerous epiphytic lichens and bryophytes are associated with H. sitchensis. Those marked with an asterisk (*) in the following list are of frequent occurrence in both localities: Alectoria sarmentosa, Cavernularia hultenii, C. lophyrea, Cetraria chlorophylla, Frullania franciscana, Heterodermia leucomelos, Hypogymnia apinnata*, H. enteromorpha*, H. oceanica, Isothecium stoloniferum*, Lobaria oregana, L. pulmonaria, L. scrobiculata, Normandina pulchella, Pannaria leucostictoides, Parmelia hygrophila*, P. sulcata, Parmotrema arnoldii*, P. crinitum*, Physcia tenella, Pseudocyphellaria crocata, Ramalina farinacea, R. minuscula, Shaerophorus globosus, Ulota phyllantha*, and Usnea wirthii*.

(4). Dominance & Frequency of Interesting Associated Species

Associated with H. sitchensis are a few lichen species considered to be of rare or infrequent occurrence in British Columbia (Goward et al. 1994): Heterodermia leucomelos; Parmotrema crinitum; and Pseudocyphellaria crocata.

(5). Successional Phenomena

The most obvious successional phenomenon affecting the microsite distribution and, perhaps, occurrence of H. sitchensis at both localities from which it is known is the development of competing epiphytic bryophyte communities. Especially competitive is Isothecium stoloniferum, which frequently excludes epiphytic

lichens altogether from the lower and mid canopy. On this account, and probably others (e.g. microclimatic conditions), the richest epiphytic communities in the Very Wet Hypermaritime Coastal Western Hemlock Zone are restricted to sites having good to strong ventilation.

(6). Dependence on Biotic Dynamic Factors

No such factors have been discerned, though H. sitchensis' obvious inefficiency at colonizing new habitats doubtless imposes a requirement for oldgrowth forest ecosystems (see 10 B, below).

(7). Other Endangered, Threatened or Rare Species Present

No official status has yet been accorded to cryptogams in Canada. See, however, the species listed in 5 G 4, above.

6. Population Biology

A. Summary

The studies on which this report is based have turned up approximately 20 thalli of H. sitchensis in two localities covering a combined area of less than 2 m^2 worldwide. Notwithstanding its obvious rarity, this species displays good vigour at these localities, probably suggesting that conditions for growth are more favourable here than conditions for establishment. The most likely natural causes of mortality include windthrow of the host trees, and encroaching competition from various bryophytes, especially Isothecium stoloniferum. H. sitchensis appears to reproduce exclusively via vegetative propagules. At the holotype locality, a few small thalli were observed, suggesting that colonization is on-going, though reproductive success must be regarded as extremely poor in this species.

B. Demography

(1) Area of Populations

I have personally examined both sites at which H. sitchensis is known to occur, though only one of them, Locality 1, was located during the course of field work for this report. On the basis, however, of studies dating from 1983 and 1991, the total documented area colonized by this species can be confidently estimated at less than 2 m^2. The population at Locality 1 is much larger than that at Locality 2.

(2) Number and Size Classes of Individuals

Approximately 15 individual thalli were observed in Locality 1 in 1991, whereas fewer than 5 thalli were present at Locality 2 in 1983. The 1991 observations include specimens in all age classes, i.e. ranging to 2 cm across. By far the greater number of thalli, however, are at reproductive maturity.

(3) Density

H. sitchensis occurs on only a single branch at each of the localities from which it is known. Even so, it is comparatively well represented at Locality 1, with a maximum density of approximately 10 thalli per m^2.

(4) Presence of Dispersed Seed

No dispersed soredia noted.

(5) Evidence of Reproduction

Reproduction in H. sitchensis appears to occur entirely asexually, through the production and dispersal of soredia. Soredia are present in the great majority of specimens observed to date, and arise early in the development of the thallus (but see 6 D 3, below), for example in lobes as small as 2 mm long. Virtually all lobes measuring 5 mm or more bear copious soredia.

The presence of small thalli at Locality 1 strongly suggests that successful reproduction is occurring here.

(6) Evidence of Population Expansion or Decline

From 1983, when Locality 1 was discovered, until 1991, when it was revisited, H. sitchensis appears to have maintained itself at this site, i.e. with neither population expansion nor decline.

C. Phenology

Phenological patterns at the macroscopic level are rare in lichens, and were not observed in H. sitchensis. Seasonal changes in thallus physiology, however, have been reported in other lichens of temperate and boreal climates (Kershaw 1985), and can be expected to occur in this species also.

D. Reproductive Ecology

(1) Types of Reproduction

In lichens, reproduction is effected by sexual reproductive organs (apothecia, perithecia, etc.) and by vegetative propagules (usually soredia or isidia). Seldom, however, are both reproductive modes present in the same species (Bowler & Rundel 1975).

Strictly speaking, H. sitchensis is an apotheciate lichen in which, however, the apothecia apparently no longer produce viable spores (Goward 1984); instead, they function as specialized organs for the production of soredia. H. sitchensis could thus be described as a vegetative species in which vestigial sexual traits have been retained.

Goward (1984) has already briefly described the ontogeny of the soredia, which "involves an early dissociation of the inner and outer layers of the exciple [i.e. the thalline material surrounding the apothecia]. The outer layer (i.e., the cortex) soon extends to form a loose-fitting, urnlike sheath that envelops the apothecium. At the same time, the inner excipular layer partially dissolves into a loose mass of granular soredia. These encircle and to some extent spill onto the apothecial disk in a ring-shaped soralium." This process is illustrated in Figure 1, above).

(2) Pollination

Not applicable.

(3) Diaspore Dispersal

Lichen diaspores, including soredia, may be dispersed in three different ways: by wind, by water and by animals (Bailey 1976). In this connection, it is perhaps significant that the soredia in H. sitchensis are enclosed, when young, in urn-shaped soralia, which therefore render them unavailable for effective dispersal. Only once the thallus is fully mature do the margins of the exciple become deflexed, and thus expose the soredia. The resulting delayed availability of reproductive propagules may account in part for the obvious rarity of this species.

On the other hand, the presence of urn-shaped soralia in H. sitchensis may actually enhance short-distance dispersal of its soredia. Brodie (1951) and Bailey (1966) have demonstrated that cup-shaped fruiting structures cause rain droplets to deflect outward, which in turn may carry soredia with them. The highly localized abundance of H. sitchensis at Locality 1 is doubtless related to short-distance dispersal of this kind.

Under some circumstances, of course, long-distance dispersal must also occur, as for example when H. sitchensis first colonized the west coast of Vancouver Island after the Fraser Glaciation. This was most likely effected by migratory birds.

(4) Diaspore Biology

No data available.

(5) Seedling Ecology

No data available.

(6) Survival and Nature of Mortality

The fact that various size classes of H. sitchensis were noted at the holotype locality strongly suggests that once this species has become established at a given site, its chances of reaching maturity are similar to those of any other lichen.

Obvious natural causes of mortality are few. Fire, for example, can be discounted by reason of the humid nature of the habitat. On the other hand, given this species' very localized distribution, windthrow of its host trees may be of importance at some sites. The possibility also exists that exceptionally prolonged periods of wet weather may be physiologically damaging to this species, for example through the establishment of a negative net carbon balance (Kershaw 1985). Competition with epiphytic bryophytes, especially Isothecium stoloniferum, constitutes a third potential source of mortality for H. sitchensis (see 5 G 5, above).

(7) Overall Reproductive Success

Overall reproductive success in this species must be rated as extremely poor. The fact that H. sitchensis is known from only two localities worldwide can almost certainly be attributed to an inability either to disperse or to germinate effectively. Given that dispersal, in the presence of reproductive propagules, is essentially a mechanical problem (and notwithstanding the delayed availability of soredia already discussed in 6 D 3, above), there is no reason to believe that this species should be any less well dispersed than other sorediate lichens. Its rarity is therefore more likely to be controlled primarily by poor germination abilities.

7. Population Ecology

A. Summary

What little is known about the population ecology of H. sitchensis has already been presented in 5 G 5, 6 D 3 and 6 D 6, above. In summary, however, this lichen appears to be obligately associated with Picea sitchensis, and to be restricted to the youngest twigs owing, at least in part, to competition with epiphytic bryophytes.

8. Land Ownership and Management Responsibility

A. General Nature of Ownership & Management Responsibility

The holotype locality of H. sitchensis (Locality 1) is located on federal land within Pacific Rim National Park, and is therefore under the jurisdiction of Parks Canada. Locality 2 is situated on the Ucluth Peninsula on provincial forest land.

9. Management Practices and Experience

A. Summary

To date, no attempt has been made to ensure the preservation of H. sitchensis in any portion of its range (but see 9 E, below).

B. Habitat Management

None known.

C. Performance under Changed Conditions

No data available.

D. Cultivation

Not tried.

E. Current management policies and actions.

Parks Canada was apprised of the existence of H. sitchensis at Locality 1 shortly after its discovery in 1983. That information has not yet been incorporated into any management plans pertaining to the preservation of this species. The situation, however, is currently under review by Parks Canada management (Barry Campbell, pers. comm.).

F. Future land use.

Locality 1 is situated within 100 m of Schooner Cove Campground, an 80-unit walk-in camping area in which year-round camping has been permitted for many years. Beginning in 1994, camping will be allowed here only from April through October. During these months, however, approximately 200 people use this campground daily (Barry Campbell, pers. comm.).

Roughly 250 m from Locality 1 is the village of the Esowista Indian Reserve. Though apparently dating from about 1930, this small village could not be seen from Locality 1 in 1983, though it is now plainly visible, owing to expansion in 1985.

Locality 2 is located on the Ucluth Peninsula near the north end of Ucluelet. Given that the economy of this community is based primarily on forest harvesting, and assuming that clearcut logging will continue to occur to the edge of salt water, it seems likely that this site will eventually be logged.

10. Evidence of Threats to Survival

A. Summary

H. sitchensis is a rare lichen highly susceptible to extirpation from known localities by inappropriate management practices. Though the holotype locality is situated in a federal park, and is thereby presumably protected by legislation, the presence of a popular walk-in campground within 100 m of it presents an obvious potential

threat to H. sitchensis here. No less critical is the threat of logging at the other known locality. The possibility is raised that this species may have already been extirpated in some areas by logging.

B. Habitat Destruction or Modification

Considering only the two localities at which H. sitchensis has thus far been detected, the greatest threats to this species' survival are: 1) the gathering of twigs and branches for campfires in the campground adjacent to Locality 1; and 2) logging in Locality 2. As regards the threat from logging, H. sitchensis would probably still be at risk in Locality 2 even in the event that a buffer strip of standing trees were to be maintained here. Such a buffer would have to be at least approximately 60 m wide (Harris 1984) to preserve the highly specific microclimatic conditions required by this species.

There is as yet no direct evidence that H. sitchensis is strictly speaking oldgrowth-dependent. Even so, very few ecologically and geographically restricted epiphytic lichens are known to occur in secondgrowth forests. By virtue of their structural homogeneity and especially their environmental instability, secondgrowth forests are unsuited to colonization by most lichens growing at or near the ecological edge of their range (Goward 1994). Oldgrowth forests, by contrast, are structurally much more heterogeneous and environmentally more stable (Franklin et al. 1981), and so permit colonization by a much wider assortment of species, including species with poor disperal abilities (Goward 1993, 1994).

During the course of field work for this report, I carefully searched for H. sitchensis in the forests adjacent to the community of Bamfield, approximately 30 km southeast of the known localities. Though I examined several sites ecologically very similar to Localities 1 and 2, no further specimens were found. It is pertinent to observe that while the Bamfield forest was physiognomically similar to the forests in Localities 1 and 2, it had nevertheless been cut over in the early years of this century, as revealed by the presence of numerous decayed stumps. This raises the possibility that H. sitchensis may have already been excluded from this area by logging.

C. Overutilization of Species

None.

D. Disease or Predation

None observed.

E. Other Natural or Manmade Factors

It is possible that global warming, if and when it occurs, will alter the distribution of H. sitchensis, though whether the coming climatic change will favour or further threaten this species is impossible to predict.

11. Present Legal or other Formal Status

A. Summary

In the Rare Lichen Project of the Smithsonian Institution, H. sitchensis has a received a G1 rating. This is the category reserved for species that are considered to be "globally rare and most endangered" (Pittam 1991). No other formal status has yet been accorded to this species, though Goward et al. (1994) did consider it to be rare. The status of lichens in British Columbia will reviewed by the British Columbia Conservation Data Centre in the near future (George Douglas, pers. comm.).

SECTION II : ASSESSMENT OF STATUS

12. General Assessment

H. sitchensis is known from only two localities worldwide. Both are situated in Canada, on the west coast of Vancouver Island. Though this species displays good vigour at least at the holotype locality, only approximately 20 thalli have been found to date, occupying a total area of less than 2 m^2.

That H. sitchensis is a rare species can hardly be doubted. In 1982-83, I spent 5 months examining the lichen flora of the Ucluelet-Tofino area, and during that period amassed a collection numbering approximately 2,000 specimens. Subsequent to discovering H. sitchensis at Locality 1, I made a concerted effort to find further localities for it, yet could only find one additional site (Locality 2). In the course of field work for the present report, I again searched the adjacent coast for approximately a week, but still found no additional sites. Nor was this species detected in other portions of British Columbia at any of the 145 oldgrowth and secondgrowth forests examined by me during

eleven weeks of field work during 1991 and 1992 (see Figure 6). What is more, other intensive floristic studies along the Pacific coast have failed to turn up H. sitchensis at all: Linda Geiser et al. (1994) in southeast Alaska; Irwin Brodo (in prep.) on the Queen Charlotte Islands; Karl Ohlsson (1973) at various places along coastal British Columbia; Fran Benton et al. (1977) at Bamfield; and Willa Noble (1982) on southeast Vancouver Island (1982).

13. Status Recommendation

I recommend that H. sitchensis be designated as an Endangered Species in British Columbia and Canada, on the basis of: 1) its highly restricted global distribution; 2) its endemic status in Canada; 3) its obviously specialized ecological requirements; and 4) its extreme vulnerability to habitat disruption.

14. Recommended Critical Habitat

During the field studies for this report, I was able to relocate only the holotype locality (Locality 1), which therefore contains the only recently documented population of H. sitchensis worldwide. This locality should therefore receive special status as critical habitat for this lichen.

It is very likely, of course, that further populations do exist. Potential critical habitats include seaside oldgrowth forests in sheltered, bays, coves and inlets along the west coast of Vancouver Island, south perhaps to Port Renfrew (see Figure 3). This region lies within the Windward Island Mountains Ecosection of the Western Vancouver Island Ecoregion (Demarchi et al. 1990).

15 Conservation Recommendations

The author's recommendations for the conservation of this species have been transmitted separately to provincial and federal jurisdictions. All inquiries regarding these recommendations should be addressed to the appropriate jurisdictions or COSEWIC, and are available at the discretion of these agencies.

SECTION III : INFORMATION SOURCES

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17. Other Pertinent Publications

None.

18. Collections Consulted

The public collections consulted are as follows: Agriculture Canada, Ottawa (DAOM); British Columbia Ministry of Forests, Kamloops; British Columbia Ministry of Forests, Smithers; Canadian Museum of Nature (CANL); Oregon State University, Corvallis (OSC); Royal British Columbia Museum (V); Smithsonian Institution (US); University of Alberta (ALTA); University of British Columbia (UBC); University of Helsinki (H); and Western Washington State College, Bellingham (WWB).

The private collections of the following individuals were also consulted: John Davis (Carson, WA); Trevor Goward (Clearwater, B.C.); Bruce McCune (Corvallis, OR); Jim Pojar (Smithers, B.C.); and Roger Rosentreter (Boise, ID).

19. Fieldwork

During the period 27 March 1991 to 1 October 1992, I spent 77 days in the field in search of five species of rare epiphytic macrolichens, including *H. sitchensis*. I examined a total of 145 localities, including both oldgrowth and second-growth forests; these are summarized in Figure 6. At each of the 18 localities in which one or more of these five lichens was found to occur, I gathered plot data on the size and ownership of the sites, elevation, aspect, slope, bedrock, soil, phorophyte, forest structure, associated plants and lichens, and for the lichens themselves, thallus size, numbers, spacing, vigour, evidence of expansion and decline.

20. Acknowledgements and Knowledgeable Individuals

A. Acknowledgements

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I am also grateful to the province of British Columbia through the Ministry of Forests and the Ministry of Environment, Lands and Parks for financial support for this project.

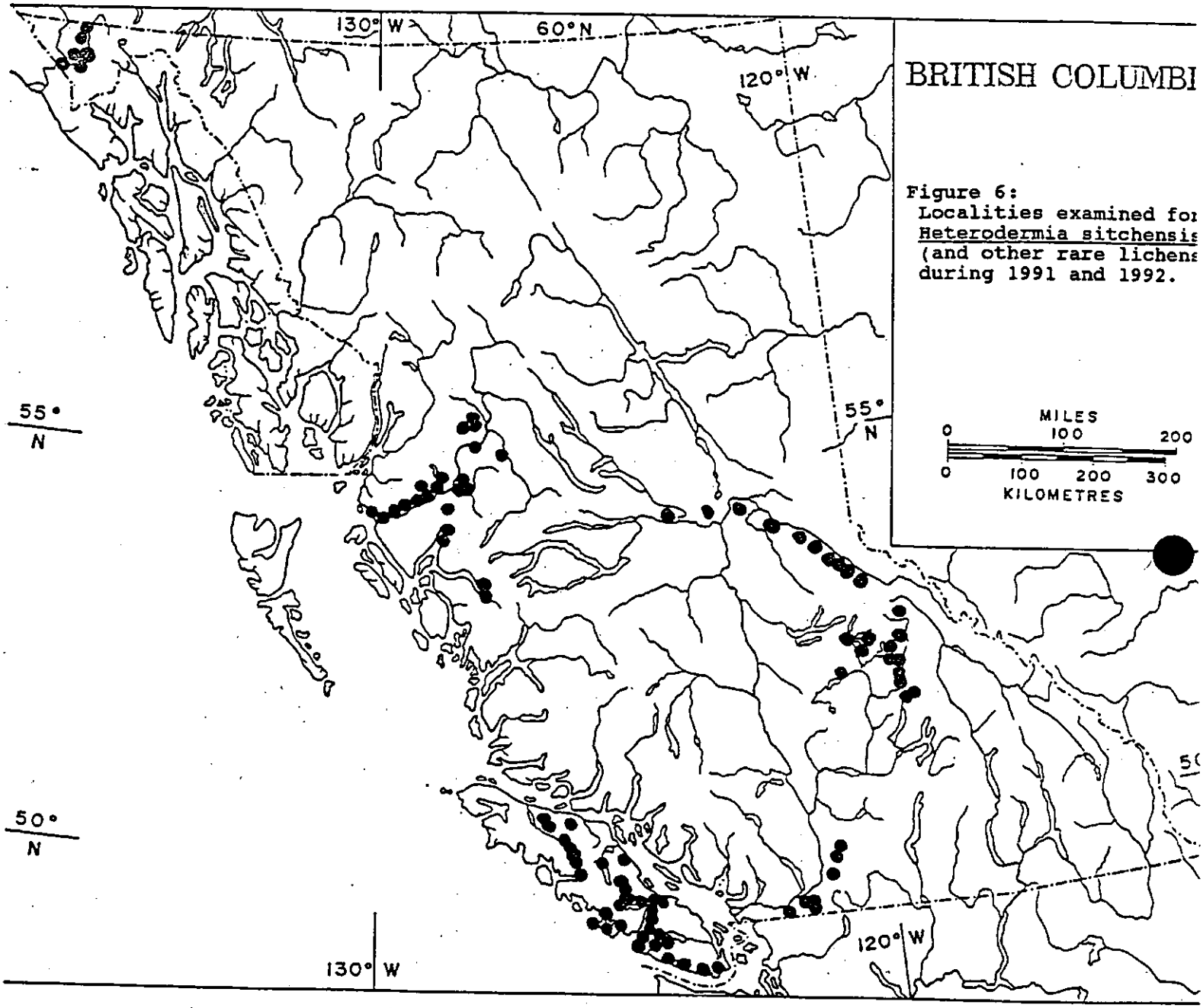

Figure 6:
Localities examined for
Heterodermia sitchensis
(and other rare lichens
during 1991 and 1992.

B. Knowledgeable Individuals

Helen Knight has direct experience with H. sitchensis at the holotype locality. She can be contacted at Box 3383, Clearwater, B.C. V0E 1N0.

21. Other Information Sources

None consulted.

22. Summary of Materials on File

See 16 (above) for a complete listing of all published and unpublished material examined during this project. Letters, maps (including maps of potential new localites), field data sheets, and other notes are all maintained in the author's files at: Edgewood Blue, Box 131, Clearwater, B.C. V0E 1N0. Voucher specimens are for the most part located at UBC.

SECTION IV : AUTHORSHIP

23. Initial Authorship of Status Report

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24. Maintenance of Status Report

The report will be maintained by the author. All corrections and new information will be gratefully received.