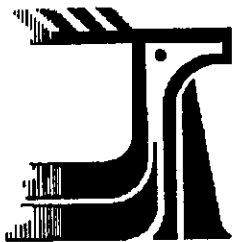


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COMMITTEE ON THE  
STATUS OF ENDANGERED  
WILDLIFE IN CANADA

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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 CRYPTIC PAW LICHEN  
*NEPHROMA OCCULTUM***

**IN CANADA**

**BY**



**TREVOR GOWARD**

**STATUS ASSIGNED IN 1995  
VULNERABLE**

**REASON: WIDESPREAD AND RARE WITHIN SPECIALIZED HABITAT OF  
HUMID OLD GROWTH FORESTS; SUBJECT TO CONTINUED  
LOGGING.**

**OCCURRENCE: BRITISH COLUMBIA**

**COSEWIC - A committee of representatives from  
federal, provincial and private agencies which  
assigns national status to species at risk in  
Canada.**

**CSEMDC - Un comité de représentants d'organismes  
fédéraux, provinciaux et privés qui attribue un  
statut national aux espèces canadiennes en péril.**

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# **STATUS REPORT ON ENDANGERED WILDLIFE IN CANADA**

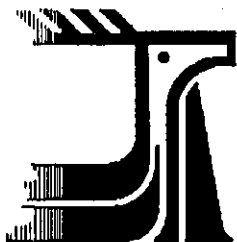
## **Cryptic Paw Lichen**



**COMMITTEE ON THE STATUS  
OF ENDANGERED WILDLIFE  
IN CANADA**



**COSEWIC**



COMMITTEE ON THE  
STATUS OF ENDANGERED  
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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.
NOT AT RISK: (NAR)	A species that has been evaluated and found to be not at risk.
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**STATUS REPORT ON THE CRYPTIC PAW LICHEN**  
***NEPHROMA OCCULTUM***  
**IN CANADA**

**BY**

**TREVOR GOWARD**  
**CURATOR OF LICHENS, UBC**  
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**STATUS ASSIGNED IN 1995**  
**VULNERABLE**

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## ABSTRACT

*Nephroma occultum* (Cryptic Paw Lichen) is a member of the Nephromataceae (or Peltigeraceae) known to occur in Canada only in the humid, primarily oldgrowth forests of British Columbia. Twenty-one localities are recorded here for this western North American endemic, 18 of which were detected during field work for this report. Of the others, one is now known to have disappeared, owing to logging.

Approximately 75% of the total known range of *N. occultum* occurs in Canada. The present study reports on about 150 thalli occurring within a total area of probably less than 100 ha. The total potential distribution of this species is, however, much greater than currently documented.

Throughout most of its range, *N. occultum* is an obligate epiphyte restricted to oldgrowth forests. In Canada it is currently known to occur only at elevations below about 1200 m within the Coastal Western Hemlock and Interior Cedar - Hemlock Zones. Its narrow ecology, especially within the latter zone, appears to reflect a strong requirement for high humidity and moderate summer temperatures. Only in the (climatically anomalous) Nass Basin does it regularly, though never abundantly, colonize younger forest types.

The author recommends a status of vulnerable for *N. occultum* in recognition of its primarily Canadian distribution, its specialized habitat ecology, and its continuing extirpation through logging.

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## SECTION I: SPECIES INFORMATION

### 1. Classification and Nomenclature

(1) Scientific Name: *Nephroma occultum* Wetm.

(2) Bibliographic Citations: Bryologist 83: 243 (1980).

(3) Type Specimen:

Oregon, Lane County, 11.2 km NE of Blue River, H.J. Andrews Experimental Forest, 19 Feb 1978, SUNDBERG 120.

Holotype: University of Minnesota (MIN).

Isotypes: National Museums of Natural Science, Ottawa (CANL).

Oregon State University, Corvallis (OSC).

Swedish Museum of Natural History, Stockholm (S).

Smithsonian Institution, Washington, D.C. (US).

(4) Synonyms: None.

(5) Common Names: "Cryptic Paw Lichen".

(6) Family Name

The genus *Nephroma* is often treated within the Peltigeraceae (e.g., Henssen & Jahns 1974), though more recently it has been recognized by some authors as belonging in a separate family, the Nephromataceae (e.g., Eriksson 1982).

Common Family Name: "Nephroma Family", "Peltigera Family".

(7) Major Plant Group: Lichens (lichenized Ascomycetes).

(8) Current Alternative Taxonomic Treatments

The specific distinctness of this species was obliquely questioned by Wetmore (1980) who, noting that *N. occultum* is very similar in chemistry to *N. arcticum* (L.) Torss., posed the question: "Could the same fungus be combining with *Coccomyxa* [a green alga] to form *N. arcticum*, and with *Nostoc* [a cyanobacterium] to form *N. occultum*"? If so, *N. occultum* would lose its taxonomic distinctness, and would be viewed merely as the blue-green morphotype of *N. arcticum*. Tønsberg & Holtan-Hartwig (1983), however, subsequently described the blue-green morphotype of *N. arcticum*, showing that it is unrelated to *N. occultum*.

If a green morphotype of *N. occultum* does exist, it probably resembles *N. "skottsbergii"*, i.e., the green morphotype of *N. papillosum* F.J. White & P. James (White & James 1988).

## (9) History of Taxon

The earliest collection of *N. occultum* was made in Oregon in 1970 (Wetmore 1980). The species has remained taxonomically stable since its description in 1980 (but see the discussion under D, above).

## 2. Description

### A. Non-technical Description

This is a rounded, loosely appressed, foliose (leaf) lichen averaging to about 3-7 cm across. The upper surface is dull, naked, pale yellowish grey to greenish or bluish grey, and is distinctly net-ridged throughout. The lower surface is also dull and naked, but is finely wrinkled, and varies in colour from pale tan at the margins to blackish toward the centre. The lobe margins are even and distinctly rounded in outline. Soredia are present along the lobe margins, and later develop also on the ridges of the upper surface. The medulla is white, and is UV+ pale yellow. The photobiont is a cyanobacterium (*Nostoc*). Apothecia and pycnidia are unknown in this species.

Note: As mentioned by White & James (1988), a fine, whitish, inner reticulum is present over the upper surface of *N. occultum*, especially toward the margins. Contrary, however, to their assertion that this reticulum is "only visible when wet", in most British Columbia specimens it can be observed also in the dry condition.

Note: Wetmore (1980) described the vegetative propagules in this species as "soredia", but White & James (1988) later commented that they actually originate as "corticate, nodulose isidia" that may later erode to produce soredia. In fact, powdery soredia appear to be produced throughout in most specimens; and although isidia do occur initially in a few specimens (especially in those derived from less humid sites), soredia are clearly the dominant propagules in this species. For convenience, this term will be used henceforward in the following report.

Chemistry: according to White & James (1988), *N. occultum* contains nephroarctin, phenarctin, usnic acid, zeorin and an unidentified triterpenoid lying just above a T1 control in solvent G. These results are based on material from the holotype locality, in west central Oregon. Six further specimens from different parts of British Columbia have now been tested with two-dimensional chromatography, and have yielded two additional accessory unidentified triterpenoids. On the TLC plates, in solvent G, these substances run at: 1) between T2 and T3; and 2) between T4 and T5.

Technical descriptions will be found in Wetmore (1980), and White & James (1988).

## B. Local Field Characters

*Nephroma occultum*'s foliose habit, net-ridged upper surface, sorediate ridges, pale yellowish grey to bluish grey colour, and naked lower surface distinguish it from all other bark-dwelling lichens. Some forms of *N. parile* (Ach.) Ach. are similar, but in that species the upper surface is usually brownish, and is at most weakly wrinkled, never net-ridged.

## C. Illustrations

In addition to Figures 1 and 2, illustrations of *N. occultum* will be found in Wetmore (1980: holotype) and White & James (1988: isotype).

## 3. Biological and Economic Significance

### A. Biological

*Nephroma occultum* is a Pacific Northwest endemic of rather limited distribution (see Figure 3) and ecology (see § A, below). It is the only North American representative of a group of *Nephroma* species otherwise endemic to southern South America. Like other lichens containing a blue-green photobiont, *N. occultum* has the ability to fix atmospheric nitrogen, which it ultimately releases into the surrounding ecosystem (Denison 1975). Unusual among such lichens, however, is the presence of usnic acid in this species.

### B. Economic

Apparently no economic use has been made of any species of *Nephroma* to the present time, though the presence of a rather distinctive chemistry in this group raises the possibility of future application in biotechnology. Usnic acid, for example, has shown promise in cancer research (Vartia 1974).

## 4. Distribution

### A. Summary

*N. occultum* is endemic to the Pacific Northwest of North America. Although earlier reported from only a few localities in Oregon (Wetmore 1980) and British Columbia (Goward & Ahti 1992), it is now known to be more widely distributed. At latest count, 28 localities have been detected -- i.e. five in Oregon (Bruce McCune, pers. comm.), two in Washington, and 21 in British Columbia.

Figure 3 presents the world distribution of *N. occultum*. An examination of this map reveals that by far the greater portion of this species' range occurs in Canada -- where it spans ten degrees of latitude and eight degrees of longitude, as compared with only five degrees and one degree, respectively, in the adjacent United States.

The localities indicated in Figure 3 probably approximate the total geographic extent of this species. Given that intensive floristic studies in southeast Alaska (Geiser, unpublished), and northwest Montana (McCune 1982, Lessica et al. 1991) have failed to turn up *N. occultum*, its absence from these regions is probably real, and not a mere artifact of undercollecting.

## 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. Chilliwack Lake area. (Map: 92 H/3 SW) 49 03'N x 121 25'W. Altitude: 650 m. Last visited by the author on 25 August 1992.
- Locality 2. Sayward area. (Map: 92 L/7 NE) 50 23'N x 126 40'W. Altitude: 100 m. Last visited by the author on 7 July 1991.
- Locality 3. Upper Adams River. (Map: 82 M/14 NE) 51 50'N x 119 00'W. Altitude: 900 m. Last visited by the author on 17 September 1992.
- Locality 4. Upper Adams River. (Map: 82 M/14 NE) 51 58'N x 119 06'W. Altitude: 750 m. Last visited by the author on 23 September 1992.
- Locality 5. Upper Adams River. (Map: 83 D/3 SE) 52 02'N x 119 06'W. Altitude: 700 m. Last visited by the author on 22 September 1992.
- Locality 6. Murtle Lake. (Map: 83 D/4 SE) 52 04'N x 119 37'W. Altitude: 1170 m. Last visited by the author on 10 September 1992.
- Locality 7. Murtle Lake. (Map: 83 D/4 SE) 52 08'N x 119 07'W. Altitude: 1100 m. Last visited by the author on 9 September 1992.
- Locality 8. Azure Lake. (Map: 93 A/8 SE) 52 23'N x 119 58'W. Altitude: 650 m. Last visited by the author on 5 August 1992.
- Locality 9. Upper Fraser River north of McBride. (Map: 93 H/8 NW) 53 23'N x 120 25'W. Altitude: 800 m. Last visited by the author on 18 August 1992.
- Locality 10. Upper Fraser River north of McBride. (Map: 93 H/11 NE) 53 39'N x 121 12'W. Altitude: 800 m. Last visited by the author on 17 August 1992.
- Locality 11. Upper Fraser River north of McBride. (Map: 93 H/10 NW) 53 40'N x 120 57'W. Altitude: 800 m. Last visited by the author on 17 August 1992.

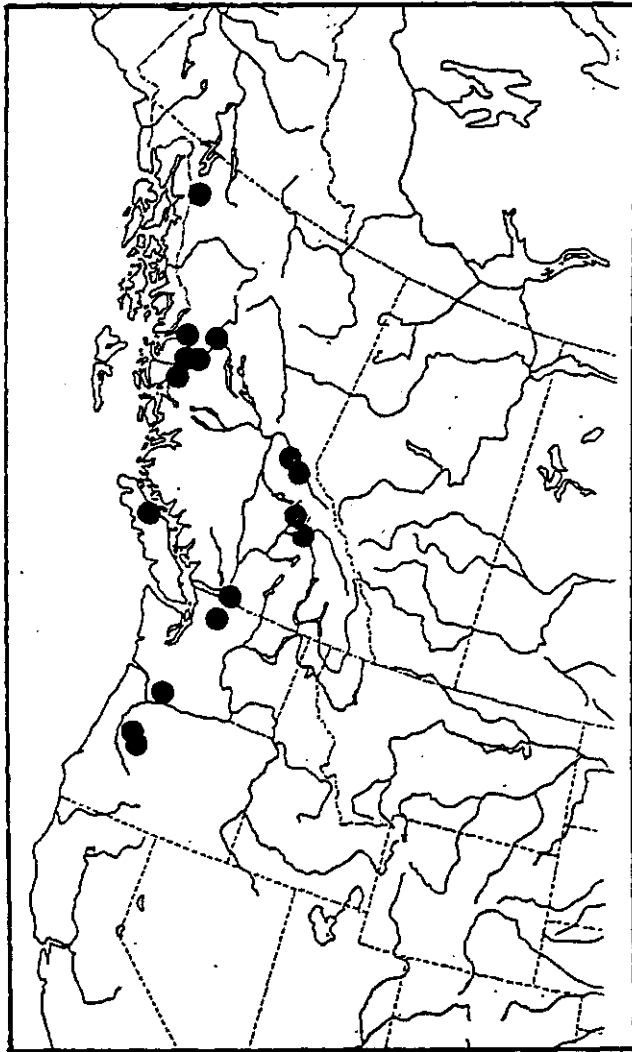


Figure 3. *Nephroma occultum*: world distribution

- Locality 12. Upper Fraser River north of McBride. (Map: 93 H/11 NE) 53 43'N x 121 06'W. Altitude: 750 m. Last visited by the author on 17 August 1992.
- Locality 13. Kitimat Village. (Map: 103 H/15 NE) 53 59'N x 128 40'W. Altitude: 0-10 m. Last visited by the author on 28 August 1991.
- Locality 14. Shames Creek. (Map: 103 I/7 NW) 54 30'N x 128 58'W. Altitude: 700 m. Last visited by the author on 31 August 1991.
- Locality 15. Terrace area. (Map: 103 I/9 SW) 54 35'N x 128 16'W. Altitude: 375 m. Last visited by the author on 25 August 1991.
- Locality 16. Terrace area. (Map: 103 I/10 NE) 54 41'N x 128 41'W. Altitude: 200 m. Last visited by the author on 26 August 1991.
- Locality 17. Aiyansh area. (Map: 103 P/2 SW) 55 06'N x 128 59'W. Altitude: m. Last visited by the author on 24 August 1981.
- Locality 18. New Hazelton area. (Map: 93 M/4 NE) 55 11'N x 127 35'W. Altitude: 730 m. Last visited by the author on 19 August 1981.
- Locality 19. Extirpated: see below.
- Locality 20. Kispiox area. (Map: 93 M/5 NE) 55 25'N x 127 48'W. Altitude: 510 m. Last visited by the author on 19 July 1992.
- Locality 21. Taku River. (Map: 104 k/12 NE) 58 40'N x 133 35'W. Altitude: 150 m. Last visited by the author on 10 July 1982.

## (2) Extirpated Populations

- Locality 19. Hazelton area. (Map: 93 M/5 SE) 55 18'N x 127 37'W. Altitude: 400 m. First visited by the author on 19 August 1981. Last visited by the author on 24 August 1992. Logged.

## (3) Historical Populations of Unknown Status: None known.

## (4) Potential Sites for Investigation

Throughout most of its Canadian range, *N. occultum* is primarily restricted to oldgrowth forests in very humid intermontane districts at lower elevations. Assuming the existence of the appropriate habitats, i.e., oldgrowth forests, potential candidate areas for further investigation therefore include the Revelstoke and Kootenay Lakes areas. Additional areas might be selected with reference to the "approximate potential range" outlined in Figure 4.

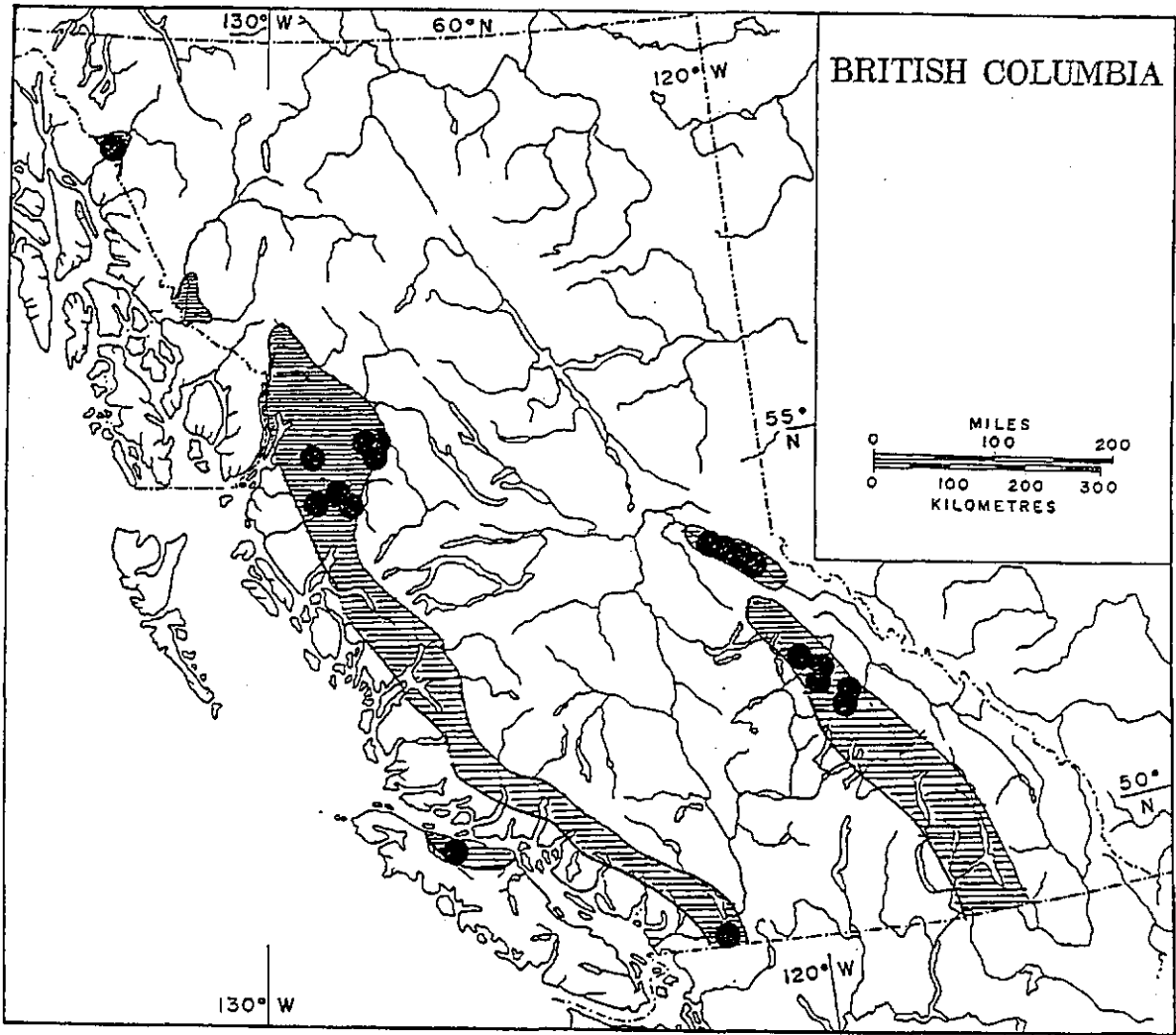


Figure 4. *Nephroma occultum*: known range and approximate potential range in Canada.

(5) Erroneous Reports: None known.

C. Status and Location of Presently Cultivated Material: None known.

#### D. Biogeographic and Phylogenetic History of the Species

The absence of a comprehensive worldwide treatment of the genus *Nephroma* continues to hamper any attempt to assess the biogeography of this group. On the basis, however, of existing scattered treatments, it would appear that this genus, which is comprised of about 40 species worldwide, is more or less evenly distributed throughout the humid temperate and boreal regions of both hemispheres. The lack of any obvious centre of diversity may point to great antiquity in *Nephroma*. Here it can be noted that some species of *Peltigera*, a related genus, appear to have evolved to their present form prior to the break-up of Pangaea, roughly 200 million years ago (Hawksworth 1982). A similar argument might also be made for certain cosmopolitan species of *Nephroma*, e.g., *N. helveticum* Ach., and is almost certainly applicable to the genus as a whole.

Although *N. occultum* appears to be restricted to the Pacific Northwest of North America, its closest relatives -- the "*N. cellulorum* group": *N. cellulorum* (Ach.) Ach., *N. chubutense* Lamb, *N. microphyllum* F.J. White & P. James and *N. papillosum* F.J. White & P. James -- are all endemic to southern Chile and Argentina (White & James 1988). This strongly suggests that *N. occultum* itself has descended, directly or indirectly, from a South American progenitor.

*N. occultum* is primarily sorediate, whereas its closest existing relative, *N. papillosum*, is isidiate. Both of these species appear to be vegetatively reproducing apomicts not known to produce apothecia; they have presumably been incapable of genetic innovation since their loss of sexual characters (Tehler 1982). That these species are chemically distinct from one another (White & James 1988) therefore strongly suggests that they must be derived from different, but closely related, parent species. On the other hand, the possibility that heterokaryosis (the anastomosing of fungal hyphae with an exchange of nuclei) and dikaryotization (the fusing of whole thalli) may occur in lichens should not be discounted (Brodo 1978).

Soredia are considered to be important mechanisms of dispersal in lichens (Topham 1976), and probably more effective than isidia in long distance dispersal (Bowler & Rundel 1975). It has been suggested, for example, that soredia may become attached to the feet and feathers of migrating birds (see Bailey & James 1979), and are thereby dispersed over great distances. It is therefore not surprising that the only sorediate member of the *N. cellulorum* group now occurs 10,000 km from its nearest relatives.

The absence of other members of the *N. cellulorum* group in North America suggests that *N. occultum* must have arrived on this continent as a result of long distance dispersal -- as opposed, for example, to continental drift associated with plate tectonics. Whether this



occurred as a single migratory displacement, or via a series of "mountain hopping" events, is open to conjecture. One possibility is that *N. occultum* (or its precursor) radiated northward along the Andean axis during the Pleistocene, when cooler global temperatures caused a lowering of vegetation zones. In this case, *N. occultum* will have arrived into the northern hemisphere only relatively recently, i.e., within the past two million years. This may explain why it has yet to become established throughout its full potential ecological range, which probably includes portions of Japan and Norway.

## 5. General Environment and Habitat Characteristics

### A. Summary

In Canada, *N. occultum* is confined to moist forested regions at elevations below roughly 1100 m. All populations found to date occur in the Coastal Western Hemlock Zone and the Interior Cedar-Hemlock Zone. No other zones are colonized, nor do extreme maritime (hypermaritime) portions of the Coastal Western Hemlock Zone appear to support this species. Climatic variables common throughout the range of *N. occultum* are: 1) rather continuous high humidity; and 2) moderate summer temperatures. Its absence from the hypermaritime is not easily explained, but could possibly involve either a sensitivity to salt spray or an inability to withstand strong competition from *Isoetecium stoloniferum* and other epiphytic bryophytes (see 5 G 5, below).

*N. occultum* is usually further restricted to oldgrowth forests characterized by long-term environmental continuity. Within such forests, however, trees of all age classes are colonized. Except in coastal localities, where *N. occultum* may inhabit the upper forest canopy, this species is essentially restricted to the lower forest canopy, where humidity is presumably more continuous.

### B. Climate

Note: The following discussion is based primarily on values derived from climate stations adjacent to localities in which *N. occultum* is known to occur. Such stations are rare, and are certainly not representative of the entire range of this species. It is also important to stress that the thermal values given above were recorded at 1.3 m above the ground in Stevenson screens standing in open grassy areas (Environment Canada 1975a). Conditions in the adjacent forests inhabited by *N. occultum* are certainly much different (see for example Canters et al. 1991). In particular, forest ecosystems can be expected to be thermally more oceanic: cooler on warm summer days; and warmer on cold winter nights (Geiger 1975).

#### (1) Temperature

As outlined by Meidinger & Pojar (1991), the Coastal Western Hemlock Zone might be described as having a cool oceanic climate, with a mean annual temperature of roughly 5-10 C, and an annual mean temperature range of about 15-20 degrees C, depending on latitude

and proximity to the open ocean. At Kitimat (10 m), the average mean January temperature is -4 C, compared with 16 C for July (Environment Canada 1975a). The extreme minimum temperature is -23 C, and the extreme maximum is 36 C.

The Interior Cedar - Hemlock Zone is more continental and, though the mean annual temperature is similar to that of the Coastal Western Hemlock Zone, i.e., 4-9 C, the annual range in mean temperature is greater, varying between 22 and 26 degrees C. At Blue River North (650 m), the average mean January temperature is -10 C, whereas the average mean July temperature is 16 C (Environment Canada 1975a). Recorded extreme temperatures are -46 C and 35 C.

Putting aside the extreme minimum temperatures cited above, the thermal data for these stations are strikingly similar -- notwithstanding that they are intended to characterize the climate experienced by *N. occultum* at opposite (i.e., east-west) ends of its range. This clearly reflects the ecological narrowness of *N. occultum*'s distribution which in British Columbia embraces the more continental subzones of the Coastal Western Hemlock Zone on the one hand, and the more hygrially oceanic subzones of the Interior Cedar-Hemlock Zone on the other hand.

At both extremes of its range, *N. occultum* displays a strong affinity for oldgrowth forests. Franklin et al. (1981) point out that thermal values in such forests, at least when moist, remain below 15 C even when temperatures elsewhere are much higher. They argue that this is of critical significance to the survival, for example, of *Lobaria oregana*, which, like other lichens, is physiologically active when wet but dormant when dry. Below about 70% saturation, this lichen ceases to fix nitrogen, and "is presumably protected against temperature extremes by dormancy."

A similar temperature - moisture relationship is discussed by Kershaw (1985), who stresses, however, that "the thermal operating environment of the dry thallus will define the thermal stress limits which the species must survive, whilst the thermal range during hydration will potentially define the required optimum for net photosynthesis". Thus, given *N. occultum*'s strict association with cool environments in British Columbia, it is reasonable to speculate that this species is sensitive to high temperatures, both when physiologically active and when dormant. This observation, if correct, would account for its close association with oldgrowth forests. (Only in two localities (# 20 and 21) was it observed, very sparsely, to colonize forests younger than 100 years old; and in both of these sites, macroclimatic conditions were decidedly cool, owing to northerly exposure.) On the other hand, *N. occultum* is clearly able to tolerate winter temperatures as low as -40 C.

It is possible that temperatures at the Vancouver Island site (Locality 2), and perhaps also at the Chilliwack Lake site (Locality 1), are less continental than those recorded above, but this seems unlikely, given their position in narrow valley bottoms (Figures 5 and 6) subject to cold air drainage from adjacent mountains (Geiger 1975). Continentality within the range of *N. occultum* therefore probably varies only about 10 units, i.e., between 20 and 30 on



Figure 5. Locality 1: Chilliwack Valley. *Nephroma occultum* is located on the lower branches of conifers adjacent to the river.

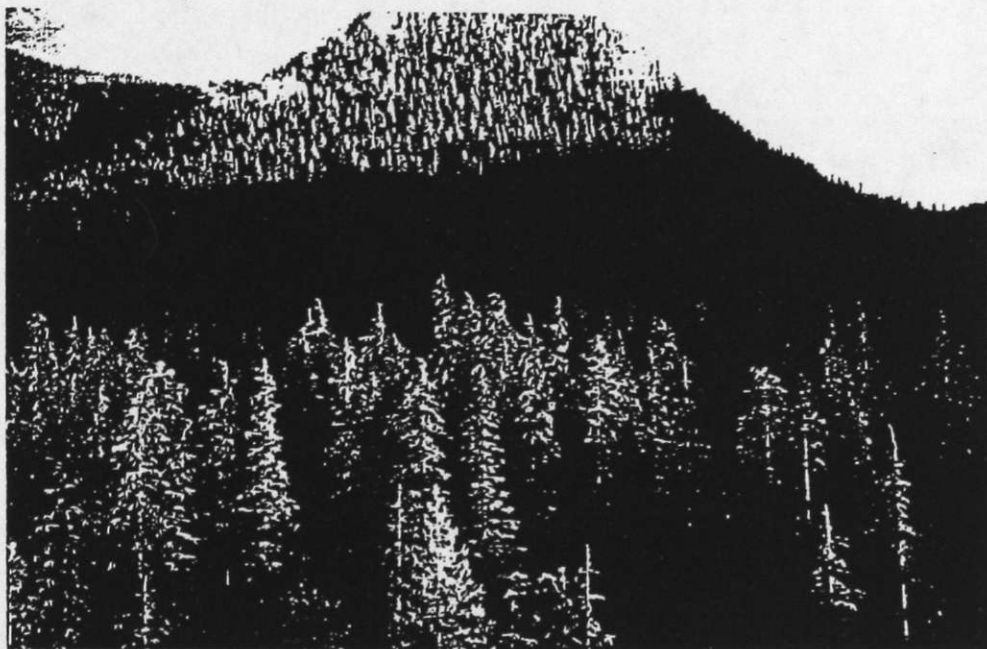


Figure 6. Locality 2: Sayward area. *Nephroma occultum* is located on the upper branches of conifers in the valley bottom.

conifers in the valley bottom.

Conrad's Index of Continentality (Conrad 1946; see also Goward & Ahti 1992). In comparison, continentality in British Columbia as a whole varies by about 50 units, i.e., from 5 at Estevan Point to 55 at Fort Nelson.

## (2) Precipitation

Total annual precipitation values are much higher in the Coastal Western Hemlock Zone than in the Interior Cedar-Hemlock Zone, averaging roughly 2800 mm at Kitimat, versus 1100 mm at Blue River North (Environment Canada 1975b). However, precipitation in the Coastal Western Hemlock Zone is heavily concentrated during the winter months (with approximately 80% of the annual total), whereas in the Interior Cedar-Hemlock Zone it is more evenly distributed throughout the year (Environment Canada 1975b). As a result, precipitation values are similar in these zones during the summer months, when neither station receives less than 75 mm per month. From this it may be concluded that prolonged dry spells are probably infrequent throughout much of the range of *N. occultum*.

Summer drought is much more prevalent in Washington and Oregon, where climatic conditions are essentially mediterranean (Highsmith & Kimerling (1979). Perhaps this accounts for the comparative rarity of the hygrophytic *N. occultum* in the American northwest, as compared to its greater frequency in the Canadian northwest. Interestingly, though the Vancouver Island locality (# 2) is also probably subject to extended periods without rain, summer fog is nevertheless a prominent feature of the climate here (Brian Roth, WCWC, pers. comm.), and doubtless serves as a compensating factor in the ecology of *N. occultum*.

*N. occultum*'s vertical distribution in the forest canopy provides further clues to its physiological ecology. Originally, Wetmore (1980) described this species as being found only "high up in old trees on moderate-sized branches, and never lower on the trunks". In British Columbia, this characterization appears to apply only in coastal localities, where *N. occultum* is indeed often located in the upper portions of the canopy -- often as high as 30 m. In inland localities, by contrast, it occurs much lower, usually within two or three m of the ground. Exceptions, of course, do occur: in open, well-illuminated, well-ventilated coastal localities, the lower trunks and branches of trees may also be colonized. Conversely, *N. occultum* has been found to occur in inland localities as high as 10 m in the spray zones of waterfalls.

These differences in vertical distribution strongly suggest that coastal macroclimatic conditions (which are better expressed in the upper canopy than in the lower canopy) are more favourable to this species than inland macroclimatic conditions. In inland localities, *N. occultum* is able to establish only under special microclimatic conditions associated with the lower canopy of oldgrowth forests. Such conditions are both much more thermally oceanic (see 5 B 1, above) and much more hygric than the prevailing macroclimatic regime.

It may be mentioned here that even under open forest conditions, a three-fold increase in evaporation rate has been demonstrated between the lower trunk and the upper canopy (see Kershaw 1985).

Many epiphytic lichens do not withstand prolonged snow cover, but *N. occultum* does not appear to be particularly sensitive in this regard. In one locality (# 3), for example, it was found growing in a very snowy situation adjacent to *Tsuga mertensiana* -- an extreme chionophile. Under such circumstances, persistent qali (snow clumps) might be expected to develop on the branches of some trees.

### (3) Solar Radiation

According to Yorke & Kendall (1972), solar radiation in British Columbia varies between 1030 hours per year at Prince Rupert and 2180 hours at Victoria. For localities colonized by *N. occultum*, a reasonable estimate of annual sunshine would probably be between 1300 - 1600 hours. Nowhere, however, is *N. occultum* likely to be exposed to this full amount, given that it invariably colonizes microhabitats to a greater or lesser degree sheltered from prolonged unbroken sunlight. That this epiphyte is essentially restricted to evergreen coniferous trees suggests that seasonal variations in light are not modified by loss of leaves during the winter months.

### (4) Wind

Wind is not an important environmental factor in most sites colonized by *N. occultum*. This is especially true in inland localities where, as already mentioned, it is restricted to the lower portion of the forest canopy. On the other hand, increased air circulation in the middle and upper canopies may represent a major factor limiting this species to the lower canopy. In coastal portions of its range, moreover, some degree of ventilation may actually be required to offset the potentially deleterious effects of prolonged continuous wetting (see below). This may partly explain why *N. occultum* is often restricted to the upper canopy in such localities; as it is here that ventilation is most pronounced.

### (5) Humidity

In order to maintain positive net photosynthesis, most lichens require wetting and drying at more or less frequent intervals (Kershaw 1985). Judging from its microdistribution, *N. occultum* must be unusually tolerant of prolonged periods in the wet condition. Assuming, however, that results from studies on other cyanobacterium-containing lichens apply here, *N. occultum* depends on rainfall for hydration, rather than on water vapour (Büdel & Lange 1991), as in many alga-containing species. It can also be speculated that *N. occultum* is highly sensitive to prolonged periods of drought, though the relation between environment and ecophysiology is by no means always straightforward (Green & Lange 1991). See also the discussion in 5 B 2, above.

### C. Air and/or Water Quality Requirements

At latest count, quantitative studies of lichen sensitivity to sulphur dioxide, and other atmospheric pollutants, has been performed on 157 of the approximately 2500 lichen species known to occur in North America (Wetmore 1988). Unfortunately, *Nephroma occultum* is not among the species examined to date. In Europe, on the other hand, *N. laevigatum* is widely considered to be among the most sensitive of lichens to air pollution (Dobson 1981, Wirth 1988). It therefore seems likely that *N. occultum* will also be found to be sensitive to pollution, in common with most other cyanophytic lichens.

None of the localities presently known for *N. occultum* in British Columbia is apparently subject to declining atmospheric quality.

### D. Physiographic and Topographic Characteristics

*Nephroma occultum* has a known elevational range in British Columbia of between 5 m and 1170 m, though a majority of the populations occur between about 400 and 800 m. In coastal localities, valley bottoms and mountain slopes are colonized alike, though in most inland localities only valley bottoms are occupied. Such patterns parallel those already reported for *N. occultum*'s vertical distribution in the forest canopy (see 5 B 2, above) -- an observation perhaps not surprising, given that valley bottom forests are much more humid than mountain slope forests (Geiger 1975).

The strong association with oldgrowth forests also seems likely to assure that a majority of the localities will occur in valley bottom situations, as it is in such topographically subdued sites that forests are most often spared by wildfire.

What factors define *N. occultum*'s upper distributional limits are not clear. One possibility is that the increasing strength of the gradient winds above 1200 m tend to exert a strong drying effect on epiphytic habitats, thereby accelerating the wetting - drying cycle beyond the tolerance of *N. occultum* (see 5 B 5, above).

### E. Edaphic Factors

*N. occultum* is clearly a strongly acidophytic species which colonizes, nevertheless, a rather broad range of host trees. The major phorophytes observed in connection with the present studies are listed below in decreasing order of importance: *Abies lasiocarpa*, *Tsuga heterophylla*, *Picea sitchensis*, *Abies amabilis*, *Picea glauca*, *Tsuga mertensiana*, and *Betula papyrifera*. A few populations in Oregon have also been found growing over *Pseudotsuga menziesii*. Additionally, one population (Locality 11) was found growing over a sheltered, mossy granitic outcrop.

## F. Dependence on Dynamic Factors

Throughout most of its range, *N. occultum* is a marginal species highly intolerant of environmental change.

## G. Biological Characteristics

### (1) Vegetation Physiognomy and Community Structure

Community structure among the epiphytic macrolichens of a given habitat is not strongly correlated with community structure in the adjacent shrub and herb layers (McCune & Antos 1981, Canters et al. 1991). For this reason, as well as by reason of its wide geographic distribution, it is hardly surprising that *N. occultum* is not associated with any obvious repeating clusters of vascular plants.

### (2) Regional Vegetation Type

All Canadian localities are situated in the Columbia (CL. 1 & CL. 2) and Pacific Coast (C. 2 and C. 3) Forest Regions of Rowe (1972). Alternatively, in the terminology of the British Columbia Ministry of Forests (Meidinger & Pojar 1991), *N. occultum* is restricted to the Interior Cedar - Hemlock Zone (ICH) and the Coastal Western Hemlock Zone (CWH), as already mentioned.

Within the ten subzones of the Interior Cedar-Hemlock Zone, *N. occultum* is currently known from only two subzones, namely the ICHmc and ICHvk. These are the wettest and/or coolest expressions of this zone. One population was also detected in the (somewhat less humid) ICHwk, though *N. occultum* is clearly restricted here (Locality 8) to the spray zones of waterfalls. It seems likely that the ICHvc will also eventually be found to support this species.

The Coastal Western Hemlock Zone is also comprised of ten subzones, and *N. occultum* inhabits four of these: CWHms, CWHwm, CWHws and CWHvm. It is not expected to occur in any additional subzones, thus avoiding both the wettest and driest portions of the Coastal Western Hemlock Zone.

### (3) Frequently Associated Species

#### Vascular Plants:

In the 19 plots for which notes on vascular community structure were taken, only seven species were found to occur in 30% or more of the sites. These are: *Oplopanax horridum* (9 sites), *Menziesia ferruginea* (8), *Vaccinium ovalifolium/alaskense* (7), *Cornus canadensis* (6), *Tsuga heterophylla* (young, 6) and *Athyrium filix-femina* (5). An additional 35 vascular species were recorded at lesser frequency.

#### Cryptogams:

In contrast to vascular plants, many epiphytic lichens are regularly associated with *N. occultum*. The following 22 species were found to occur in 30% or more of 17 plots: *Platismatia glauca* (14 sites), *Alectoria sarmentosa* (10), *Lobaria pulmonaria* (10), *Mykoblastus sanguinarius* (10), *Nephroma helveticum* (9), *Parmelia sulcata* (9), *Pertusaria amara* (8), *Sticta fuliginosa* (8), *Cetraria chlorophylla* (7), *Nephroma bellum* (7), *Platismatia norvegica* (7), *Cavernularia hultenii* (6), *Hypogymnia oceanica* (6), *Hypogymnia physodes* (6), *Cladonia coniocraea* (5), *Hypogymnia occidentalis* (5), *Hypogymnia vittata* (5), *Lobaria oregana* (5), *Lobaria retigera* (5), *Lobaria scrobiculata* (5), *Nephroma parile* (5), *Parmelia hygrophila/pseudosulcata* (5). An additional 27 lichen species were recorded at lesser frequency.

#### (4) Dominance & Frequency of Interesting Associated Species

Growing with *N. occultum* are several lichen species that are considered rare and infrequent in British Columbia (Goward et al. 1994). A few of these species are often well represented at these sites, i.e., *Hypogymnia oceanica* and *Lobaria retigera*. Other species are less frequent: *Dendroscopula intricatulum* (+ green morphotype = *Sticta* sp.), *Erioderma sorediatum*, *Hypogymnia rugosa*, *Lichinodium canadense*, *Nephroma isidiosum*, "*Nephroma silvae-veteris*", *Pannaria ahlneri*, *Polychidium dendroscopum* and *Sticta weigeli*.

#### (5) Successional Phenomena

The most obvious successional phenomenon affecting the microsite distribution and, perhaps, occurrence of *N. occultum* in many localities is the development of competitive bryophyte communities over the branches of trees. The most prominent bryophytes in this regard are *Isoetes stoloniferum* (Figure 7) and *Antitrichia curtipendula* (Figure 8). In hypermaritime regions, *Isoetes* is especially competitive, and may often exclude epiphytic lichens altogether from the lower and mid canopy; this may account in part for the apparent absence of *N. occultum* from hypermaritime regions.

In somewhat less oceanic localities, the epiphytic bryophytes are primarily restricted to the larger, older branches. In response, *N. occultum* usually occurs here only on the twigs and smaller branches, though a few colonies were noted on larger branches growing epiphytically over bryophyte communities.

It is interesting to observe that at the hygrially most continental end of *N. occultum*'s range, this species appears to be more common over older branches (Wetmore 1980). This may reflect not only a lesser competitive dominance by epiphytic mosses at such sites, but also a slower colonization rate in *N. occultum* itself, i.e., adjacent twigs and smaller branches may simply be too young.

#### (6) Dependence on Biotic Dynamic Factors: No such factors have been discerned.





Figure 7. *Isothecium stoloniferum* in a humid hypermaritime locality.



Figure 8. *Antitrichia curtispindula* in a humid inland locality.

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

No official status has yet been applied 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 150 thalli of *N. occultum* in 21 Canadian localities covering a combined (but rather diffuse) area of probably less than 100 hectares. In more than half of these localities, only one or two thalli were found -- virtually all, however, displaying good vigour. This may suggest that in most sites, conditions for growth are more favourable than conditions for establishment. On the other hand, in Locality 20 a single *Tsuga heterophylla* branch was found to support 17 thalli. Density therefore varies from distinctly sparse throughout most of the range to (very) locally frequent, e.g., 20 thalli per m<sup>2</sup>. The only observed natural causes of mortality (at the microsite level) are competition by other lichens, and defoliation of the surrounding forests by insects. *N. occultum* reproduces exclusively via vegetative propagules. Evidence of ongoing successful germination was observed at several localities in form of numerous small, incipient thalli.

### B. Demography

#### (1) Area of Populations

During the course of field work, in which a total of 145 localities were examined throughout British Columbia, I visited approximately 35 sites in 18 of the 21 localities in which *N. occultum* is now known to occur in Canada (see 4 B (1), above). I had also previously visited the remaining three localities in the early 80s, though detailed notes on these are lacking. According to present knowledge, the total documented area colonized by this species can be estimated to be less than 100 ha. There is little doubt, however, that *N. occultum* also occurs, albeit diffusely, over a much larger area (see Figure 4: potential range).

#### (2) Number and Size Classes of Individuals

I estimate a total of approximately 150 individual thalli for the 21 localities mentioned above. The thalli range in size from 0.4 cm to roughly 10 cm in diameter, with an average between 4 cm and 6 cm, as measured along the longest axis.

By far the richest localities located to date are those near Kispiox (# 20) and in the Upper Adams River Valley (# 3), where 70 thalli and 30 thalli, respectively, were located.

### (3) Density

*N. occultum* varies in density from a minimum (observed in slightly more than half of the localities) of one or two thalli per site, to an absolute maximum of approximately 20 thalli per m<sup>2</sup>. The latter value was noted on only a single *Tsuga heterophylla* branch in an open, but very humid, oldgrowth forest near Kispiox. A more typical maximum density in favoured sites might be three thalli per m<sup>2</sup>, though even this would usually be restricted to only one or two individual branches.

(4) Presence of Dispersed Seed: No dispersed soredia noted.

### (5) Evidence of Reproduction

Soredia, which are present in all populations of *N. occultum* observed to date, arise early in the development of individual thalli. Indeed, these vegetative propagules are often already present in specimens only 0.5 cm in diameter, and probably less than three years old. Virtually all thalli measuring 1.0 cm across bear copious soredia.

### (6) Evidence of Population Expansion or Decline

In many localities, a few very young thalli were detected. On the basis of growth rates in the supporting twigs, some of these thalli certainly less than three years old. This strongly suggests that *N. occultum* is maintaining itself at these sites. Only in one locality (# 8) were obvious signs of population decline noted (see 6 D 6, below).

## C. Phenology

Phenological patterns at the macroscopic level are rare in lichens, and were not observed in *N. occultum*. However, seasonal changes in thallus physiology have been observed in other lichens of temperate and boreal climates (Kershaw 1985), and can be expected to occur this species as well.

## 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). So far as is known, *N. occultum* reproduces entirely by means of soredia (but see 2 A, above), which in this case arise first along the lobe margins, but are later also produced on the ridges of the upper surface.

Soredia may be defined as tiny, powdery clusters of photobiont cells held together by fungal hyphae. When a soredium lands in a suitable site, it grows out into an "instant lichen" in which both symbionts are carried over from the parent thallus. In the case of *N. occultum*, it is probable (but by no means certain: see Schuster et al. 1985) that each succeeding generation is genetically identical with the last. Given the apparent morphological and genetic homogeneity of this species throughout its range, all existing thalli of *N. occultum* may thus well represent a single genetic "clone", though the possibility that genetic heterogeneity may have been introduced through heterokaryosis or dikaryotization (Brodo 1978) should not be ruled out.

## (2) Diaspore Dispersal

Lichen diaspores, including soredia, may be dispersed in three different ways: by wind, by water and by animals (Bailey 1976). Though few data are available on this aspect of lichen reproduction, it would seem that each of these mechanisms must be more effective in some habitats than in others. It is unlikely, for example, that wind is an important dispersal mechanism in the essentially windless, lower-canopy habitats characteristic of *N. occultum* in inland regions. On the other hand, wind might be of greater consequence in coastal localities, where this species is more common in the upper canopy, though even here it is doubtful that soredia, which are rather coarse in this species, are carried very far in this way.

Rain splash is doubtless effective under some conditions, but would presumably tend to transport the soredia only over very short distances. The extraordinary abundance of this species on some branches might possibly be explained by rain splash. However, it seems unlikely that medium distance dispersal from one oldgrowth forest to another is often effected in this way.

The movements of animals, especially birds in migration, provide the most probable mechanism for medium distance and long distance dispersal in *N. occultum*. Given the strong association of this species with oldgrowth forests, the most important birds in this regard are probably also characteristic of such forests. A list of likely candidate species is provided by Harris (1984).

Finally, the possibility must be raised that the low colonization rates typical of this species throughout most of its range may simply reflect an inherent inability to disperse efficiently. Given, however, that dispersal *per se* is primarily a mechanical problem, and given that sorediate foliose lichens tend to disperse very readily (Bowler & Rundel 1975), this explanation seems unlikely. Colonization in *N. occultum* is much more likely to be limited by this species' obviously highly specific ecophysiology.

## (3) Survival and Nature of Mortality

Given that soredia are effective propagules of dispersal in lichens, and given that such

propagules are produced in great abundance in *N. occultum*, the only plausible explanation for this species' inability to establish large, robust colonies throughout most of its range is that its soredia do not germinate readily. Once germination has occurred, however, the likelihood that the resulting thallus will attain maturity (i.e., in this species, the point at which viable vegetative propagules are produced: probably at age five years or less) is comparatively very good -- at least to judge by the rather equal distribution of small, medium-sized and large thalli noted at many sites.

Obvious natural causes of mortality in *N. occultum* are few. Apparently the most important (apart from wildfire) is the Western Hemlock Looper (*Lambdina fiscellaria lugubrosa* (Hulst)). This caterpillar, which is one of the most effective defoliators of conifers in western Canada, feeds primarily on oldgrowth Hemlock and Hemlock - Red-cedar stands (Erickson 1984). Under outbreak conditions, it may cause complete defoliation in such stands over large areas. The increased desiccation associated with forest defoliation not only renders the affected forests more susceptible to wildfire, it also dramatically alters microclimatic conditions within them, at least in the short term. There is strong evidence that at least some hygrophytic epiphytes may be adversely affected by the resulting shift to drier conditions. In Locality 8, for example, where defoliation had been on-going for two years at the time of investigation, some *N. occultum* thalli had already turned brownish through environmental stress, and no young thalli at all were noted.

It therefore seems possible that intense defoliation by the Western Hemlock Looper may lead to the local extirpation of *N. occultum* (and other hygrophytic species) in some oldgrowth forests. This may explain the apparent absence of this species from several oldgrowth forests in which it might otherwise have been predicted to occur. Such comments are of course speculative.

Although it seems very likely, as already mentioned (see 5 G 5, above), that the microdistribution of *N. occultum* is strongly affected by competition from epiphytic bryophytes, yet mosses and liverworts were at no point observed to be actively outcompeting this species. In fact, a few thalli of *N. occultum* were found actually growing over mosses. Apparently, bryophytic dominance operates at the level of deterring colonization, rather than at the level of excluding *N. occultum* once it has become established.

On the other hand, *N. occultum* is not infrequently obliged to compete for space with other foliose lichen species. In many, but not all, such contests, *N. occultum* is apparently the less aggressive competitor, and is ultimately overgrown. *Lobaria oregana*, *Lobaria pulmonaria*, *Lobaria retigera*, *Nephroma bellum*, *Platismatia glauca* and *Platismatia norvegica* were all observed competing for space with *N. occultum*.

Neither grazing by arthropods nor fungal parasites appear to be an important cause of mortality in *N. occultum*. Only one thallus was detected which exhibited any sign at all of grazing. And although an unidentified (nonfruiting) parasitic fungus was found to be present in several thalli throughout British Columbia, none of the host lichens appeared to be

adversely affected by it.

#### (4) Overall Reproductive Success

Given the apparent infrequency of successful germination in *N. occultum*'s diaspores, overall reproductive success in this species must be rated as decidedly poor in most parts of its range.

### 7. Population Ecology

#### Summary

What little information is available on the population ecology of *N. occultum* has already been discussed in 5 G 5, 6 D 3 and 6 D 6, above. In summary, however, *N. occultum* appears to be dependent primarily on the specific microclimatic conditions of its immediate environment; interactions with associated species (apart from the forest trees themselves) appear to be of secondary import. Epiphytic bryophytes do, however, control its microdistribution (and perhaps also its macrodistribution) in many regions. Migratory birds may be important in its dispersal.

### 8. Land Ownership and Management Responsibility

#### General Nature of Ownership & Management Responsibility

All known *N. occultum* localities in British Columbia are located on provincial lands. Three localities (# 6, 7 & 8) occur in a Class A provincial park, and one (# 1) occurs in an ecological reserve. In all of these localities, however, this species is near the ecological limits of its range.

### 9. Management Practices and Experience

#### A. Summary

No attempt has been made to ensure the preservation of *N. occultum* in any portion of its range.

B. Habitat Management: None known.

#### C. Performance under Changed Conditions

Portions of the oldgrowth forest at Locality 20, northwest of Kispiox, were selectively logged in the early 1950s (Allen Banner, pers. comm.). Notwithstanding this, *N. occultum* still occurs here, and is, in fact, apparently no less common than in adjacent undisturbed oldgrowth forests. This suggests that this species may in fact tolerate some degree of

disturbance. Still, it is important to emphasize that comparatively few trees were removed during these logging operations, and that Locality 20 is located in what may be called *N. occultum*'s "ecological epicentre". Similar logging operations in more marginal portions of its range may well result in its local extirpation.

D. Cultivation: No data available.

E. Current management policies and actions.

There is currently no recognition of the importance of oldgrowth forests to the long term survival of *N. occultum* in Canada.

F. Future land use.

In keeping with current policies of the B.C. Ministry of Forests, most *N. occultum* localities are evidently slated to be logged in the near future. Only those localities under B.C. Parks jurisdiction are likely to persist into the long term, though at least one locality (# 3) is currently being considered for protection by the Protected Areas Strategy (Kevin Kriese, pers. comm.).

## 10. Evidence of Threats to Survival

### A. Summary

The continued logging of oldgrowth forests in British Columbia is leading to a steady decline of *N. occultum* throughout most of its range. Such declines appear to be permanent: once this species has disappeared from a given locality, it is unlikely to reoccur in the second-growth replacement forests of the future. It has apparently already been extirpated from some portions of inland British Columbia.

### B. Habitat Destruction or Modification

During the course of field work for this report, I visited a total of 145 forested localities within the range of *N. occultum*. Although half of these localities were inhabited by second-growth forests, virtually all (i.e., 17 of 18) of the localities in which *N. occultum* was detected were oldgrowth forests older than approximately 150 years.

*N. occultum* can therefore be characterized as an epiphyte of conifers in oldgrowth forests. The harvesting of each such forest has the effect of excluding *N. occultum* from yet another portion of its former range. Because future replacement forests are currently scheduled to be harvested at 100 year or less (i.e., much too short a period for *N. occultum* to become established), these local extirpations are likely to be permanent. It is therefore extremely doubtful that *N. occultum* will occur in the plantation forests of the future. Its continued existence depends on the maintenance of oldgrowth forests in at least some portions of the

province.

Inland populations appear to be under the greatest immediate threat of extirpation, owing to their strict occurrence in (readily accessible) valley bottom situations. Bottomland oldgrowth forests have already essentially disappeared from many parts of the British Columbia interior. Those forests which do remain are, with few exceptions, slated for harvesting in the near future.

C. Overutilization of Species: None.

D. Disease or Predation

As already noted previously, *N. occultum* appears to be essentially immune to any deleterious effects from either disease or predation, though the Western Hemlock Looper may indirectly affect its distribution through microclimatic changes associated with defoliation.

E. Other Natural or Manmade Factors

Maass (1980) has raised the possibility that the use of pesticides -- including B.T. (*Bacillus thuringiensis*) -- in forestry management has the potential to jeopardize the survival of some lichen species.

The onset of global warming will probably result in a considerable decrease in *N. occultum*'s range in British Columbia.

## 11. Present Legal or other Formal Status

### Summary

In the Rare Lichen Project of the Smithsonian Institution, *N. occultum* has received a G1 rating. This is the category reserved for species that are considered to be "globally rare and most endangered" (Pittam 1991).

The Oregon Natural Heritage Program list (Oregon Natural Heritage Program 1991) has likewise accorded rarity status to this species. *N. occultum* is, in fact, the only lichen to have been included in ONHP's "List 1", which comprises those species "that are threatened with extinction or presumed to be extinct throughout their entire range".

In neither the Washington Natural Heritage Program, nor the British Columbia Conservation Data Centre have lichens yet been added to any official listing of rare or threatened species. Based, however, on the numbers of localities documented here, *N. occultum* would be accorded a G2 status and S2 status by the latter programme (George Douglas, pers. comm.).



## SECTION II: ASSESSMENT OF STATUS

### 12. General Assessment

Prior to field studies carried out in connection with this report, *N. occultum* had been collected from only six localities in Canada, though only reported from two (Goward & Ahti 1992). At present, it is known from a total of 21 localities, though many other localities doubtless exist (see Figure 4).

Within the 18 localities visited by me during the past two years, *N. occultum* seems to show good vigour, with many young thalli having been noted. The species, however, is apparently rather rare in most localities, and is nowhere very abundant. In total, I counted approximately 150 individual plants in 35 sites, covering a total area of about 100 ha. Apparently somewhat more than 75% of *N. occultum*'s global range occurs in Canada (see Figure 3).

An indication of this species' rarity can be gauged from the work of Ohlsson (1973), who during the early 1970s conducted an intensive inventory of lichens in coastal British Columbia. Though Ohlsson amassed a total of roughly 3,000 lichen specimens, and though most of his work was performed primarily within the range of *N. occultum*, he appears not to have detected this species at all.

There is abundant evidence that this species is in decline in British Columbia. The continued harvesting of the oldgrowth forests upon which it depends may result in its extirpation over a large portion of its present range.

### 13. Status Recommendation

I recommend that *N. occultum* be designated a Vulnerable Species in British Columbia and Canada, on the basis of: 1) its rather restricted distribution in Canada; 2) its obvious rarity in the United States; 3) its specialized ecological requirements; and 4) its continued local extirpation due to logging.

### 14. Recommended Critical Habitat

In most of the localities from which it is currently known, *N. occultum* is rare and distributionally restricted, and thus behaves as a species at or near the ecological edge of its range. Only at Locality 20, in the Nass Basin Ecoregion of the Coast and Mountains Ecoprovince (Demarchi et al. 1990), does its level of frequency and ecological flexibility suggest a reasonable adaptedness to local environmental conditions. Here, for example, *N. occultum* has been found to occur, albeit rarely, even in young second-growth forests.

The forest lands of the Nass Basin are classified as belonging to the Interior Cedar - Hemlock Zone (Meidinger & Pojar 1991), though they are ecologically very different from

the main portion of that zone as represented in south-eastern British Columbia. This observation is supported by the fact that several of the epiphytic lichens that occur in relative abundance here are rare in or essentially absent from most other portions of the province (Goward 1993).

It is recommended that a sizable portion of these forest lands, including tracts of oldgrowth forests, be accorded special status as a dispersal centre not only for *N. occultum*, but also for other rare epiphytic lichens. Specific details of location and size must, however, await a more thorough lichenological examination of the Nass River Basin.

Other critical habitats are broadly located in: 1) the Robson Valley (Localities 9-12); 2) the upper portions of the Adams River (Localities 3-5); and 3) the Sayward area (Locality 2).

### 15. Conservation Recommendations

The author's recommendations for the conservation of this species have been transmitted separately to provincial 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

### 16. References Cited in Report

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**17. Other Pertinent Publications:** None.

#### **18. Collections Consulted**

The public collections consulted are as follows: Agriculture Canada, Ottawa (DAO); British Columbia Ministry of Forests, Kamloops; British Columbia Ministry of Forests, Smithers; National Museums of Canada (CAN); 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 *N. occultum*. I examined a total of 145 localities, including both oldgrowth and second-growth forests; these are summarized in Figure 9. At each of the 18 localities in which *N. occultum* 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 *N. occultum* itself, thallus size, numbers, spacing, vigour, and evidence of expansion and decline.

## 20. Acknowledgements and Knowledgeable Individuals

### A. Acknowledgements

I wish to thank the following individuals for assistance with this study:

Allen Banner, John Foster, Alex Inselburg, Dennis Kangesniemi, Kevin Kriese, Dennis Lloyd, Del Meidinger and Fred Nuszdorfer for information on potential sites;

John Christie, John Davis, Bruce McCune, Sherry Pittam, Fred Rhoades and Steve Sillett for details of *N. occultum*'s distribution and ecology in the United States;

Allen Banner, Brian Carruthers, Mark Hobson, John Keslin, Helen Knight, Kevin Kriese, Dave Montgomery, Dave Peerla, Jim Pojar and Fred Rhoades for assistance with transportation to some of the more remote localities;

Allen Banner, Helen Knight, Duncan Henderson, Kevin Jordan\*, John Keslin\*, Ted Lea, Edward Lebrun, Julie Palmer, Brian Roth, Karen Truman and Steve Sillett\* for invaluable help in the field (\*individuals with an asterisk beside their names climbed trees in search of *N. occultum*);

Teuvo Ahti, Ernie Brodo, John Davis, Olivia Lee, Dennis Lloyd, Bruce McCune, John Pindermoss, Sherry Pittam, Jim Pojar, Fred Rhoades, Roger Rosentreter and Pak Yau Wong for data on specimens of *N. occultum* in their care; George Douglas, Ted Lea and Bruce McCune for reviewing an earlier draft of this report; and Ted Lea and Del Meidinger for moral and material support throughout.

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

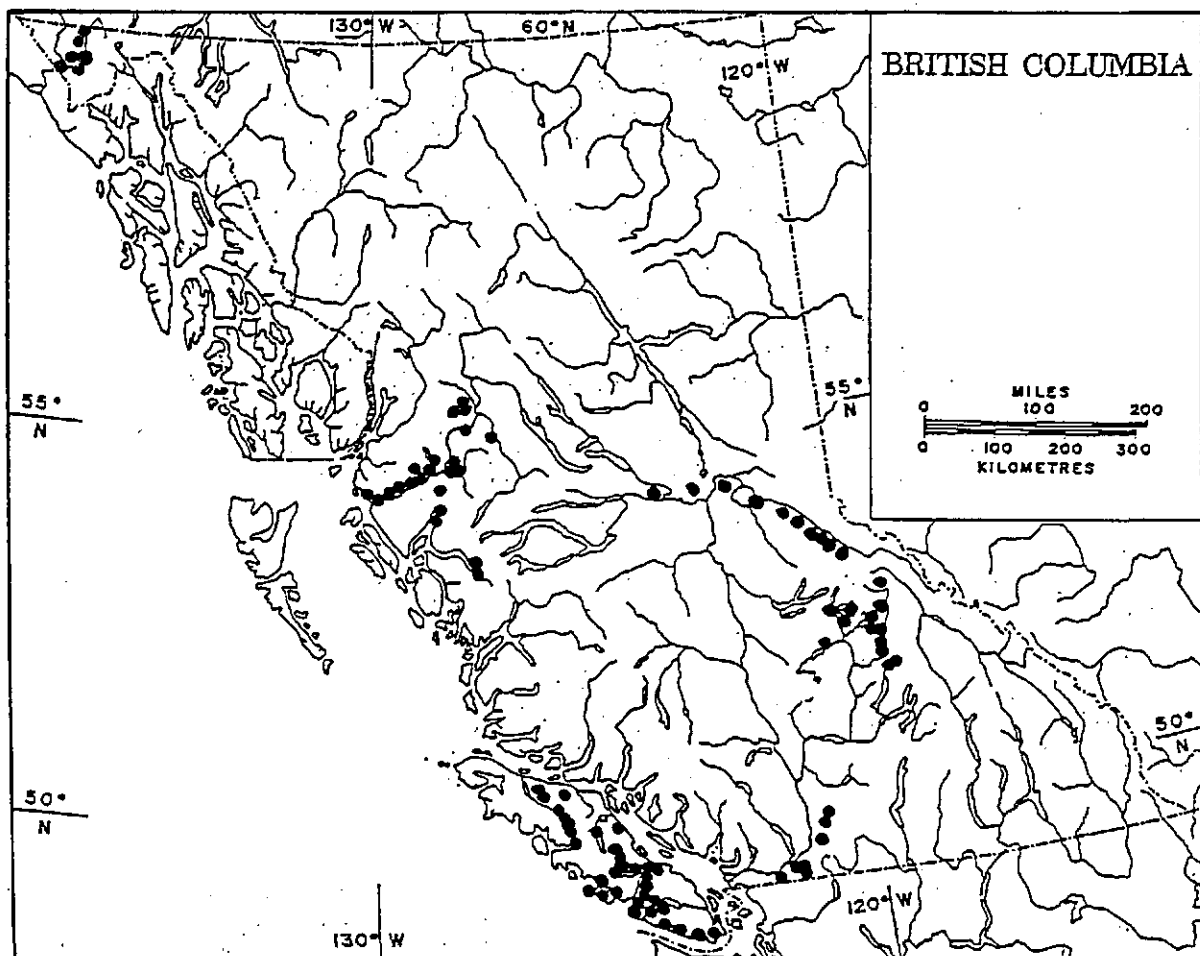


Figure 9. Localities examined for *Nephroma occultum* during 1991 and 1992.

## B. Knowledgeable Individuals

The following people have direct experience with the *N. occultum* localities listed next to their names:

Allen Banner, Research Section, Ministry of Forests, Box 3369, Smithers, B.C. V0J 2N0 (604-847-7555). (Locality 20).

Helen Knight, Box 3383, Clearwater, B.C. V0E 1N0 (Localities 1, 2, 4, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16, and 20).

Kevin Kriese, Box 1875, R.R.#1, Clearwater, B.C. V0E 1N0 (Locality 3).

Steve Sillett, Department of Botany, Oregon State University, Corvallis, Oregon 97331, U.S.A. (Locality 1).

**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 localities), 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 have been deposited 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.