

3.10 Habitat Specificity and Morphological Variation in two Antarctic *Usnea* species

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Summary: *Usnea antarctica* and *U. sphacelata* occur with overlapping distributions in the Windmill Islands, Budd Coast, Eastern Antarctica. The species exhibit a niche specificity related to moisture availability and shelter. *Usnea antarctica* is muscicolous or saxicolous and occupies wetter, more sheltered sites than the entirely saxicolous *U. sphacelata*. Analysis of species associations in quadrats using a non-metric multidimensional scaling package (KYST) confirms the niche separation of the two *Usnea* species. Stem anatomy, stem papillosity and soralia characteristics are the most useful criteria for taxonomic identification in continental Antarctic populations.

Zusammenfassung: *Usnea antarctica* und *Usnea sphacelata* haben verschiedene aber sich überlappende Verbreitungsareale im Gebiet der Windmill Islands, Budd Coast, Ostantarktis. Das Vorkommen der Arten ist von der Wasserverfügbarkeit und dem Schutz des Standorts abhängig. *Usnea antarctica* besiedelt Moose und Steine und ist in feuchteren und geschützteren Standorten stärker vertreten als die rein epipetrische *U. sphacelata*. Diese Trennung der beiden Arten wird mit einer Computeranalyse der Artenbeziehungen in Quadraten (nichtmetrisches multidimensionales Skalierungs-Programm, KYST) geklärt. Als sehr brauchbare Charakteristika für die taxonomische Bestimmung dieser kontinentalen Populationen erwiesen sich die Achsenanatomie, Papillenbesatz auf dem Thallus und Sorale.

I. INTRODUCTION

The lichen genus *Usnea* subgenus *Neuropogon* was recently monographed by WALKER (1985) who included only two species — *Usnea antarctica* Du Rietz and *U. sphacelata* R. Br. — for Continental Antarctica. *Usnea acromelana* Stirton (sensu FILSON 1974) from the Windmill Islands is referable to *U. sphacelata* (WALKER 1985). WALKER (1985) stated that in Antarctica *U. acromelana* is confined to the northern parts of the Antarctic Peninsula. We follow the taxonomic interpretations of Walker who included in her studies a wide selection of *Usnea* specimens from the Windmill Islands.

In the vicinity of Casey Station (66° 30' S, 110° 30' E) in the Windmill Islands both moraine deposits and country rock outcrops may support dense stands of lichen and moss dominated vegetation. *Bryum pseudotriquetrum* (Hedw.) Gertrn., Meyer et Scherb., *Ceratodon purpureus* (Hedw.) Brid., and *Grimmia antarctici* Card., are the principal mosses while the lichen vegetation is dominated by *Usnea sphacelata*. *Buellia frigida* Darb., *B. soledians* Filson, *Pseudephebe minuscula* (Nyl. ex Arn.) Brodo et Hawksw., and *Umbilicaria decussata* (Vill.) Zahlbr. *Rinodina turfacea* (Ach.) Koerb., is an abundant muscicolous epiphyte. In wetter sites *U. antarctica* may occur as a locally abundant epiphyte on moss.

Usnea antarctica commonly dominates lichen communities in sub-Antarctic regions and in the maritime Antarctic Peninsula (LAMB 1964, SMITH 1972, WALKER 1985). In the Windmill Islands, particularly in the vicinity of Casey Station, *U. sphacelata* is the dominant *Usnea* species, as in many other continental Antarctic localities. Although *U. sphacelata* occupies more exposed habitats, it occurs sympatrically with *U. antarctica* at many sites. Where the two species occur together, one or both species approach the limits of their respective local distribution ranges. Phenotypic variation, particularly in *U. antarctica*, is then common, making field determinations more difficult.

The purpose of this paper is to identify those taxonomic characters which clearly separate *U. antarctica* from *U. sphacelata* and to determine the respective niche of both species in the lichen and moss dominated vegetation near Casey Station. Table 1 summarises the main distinguishing taxonomic characteristics.

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	<i>U. antarctica</i>	<i>U. sphacelata</i>
Soralia	plane to excavate	pulvinate to sublobose
Soredia	unpigmented	pigmented
Stem surface	papillose with papillae unpigmented; stems usually with only small amount of pigmentation, appearing straw colour	stems smooth or with minute pigmented papillae; upper branches and stems very darkly pigmented, appearing black
Stem transverse section	medulla compact; axis usually exceeding 0.5 of stem less	medulla lax; axis usually less than 0.5 of stem diameter
Habit	saxicolous and muscicolous; sheltered and moister sites than those occupied by <i>U. sphacelata</i>	saxicolous; more exposed and drier sites than those occupied by <i>U. antarctica</i>

Tab. 1: Main distinguishing taxonomic characters of *Usnea antarctica* and *U. sphacelata* as they occur near Casey Station, Antarctica.

2. METHODS

Morphology: Overall habit, stem surface and anatomical features were examined, concentrating on sites where the two species occurred together. The ratio of central axis and medulla to total stem diameter was determined from 68 transverse sections of stems of each species. Stem surface characters and internal anatomy were examined using a scanning electron microscope.

Chemistry: Chemical constituents were determined by thin-layer chromatography using the methods of CULBERSON (1972).

Ecology: At a site 100 m by 50 m, embracing a range of habitats from wet moss turf to dry exposed gravels, 210 quadrats, 20 cm by 20 cm, were placed subjectively to include all habitats and sociations. Percentage cover values were recorded for all species in each quadrat. Ordinations were obtained of both quadrats by species and species by quadrats using the non-metric multidimensional scaling package KYST (KRUSKAL et al 1973, CLYMO 1980, MINCHIN 1987).

To elucidate more clearly species habitat differences 13 transects of varying length were studied. Transect sites were subjectively chosen to represent the range of habitats in which one or both species was found. Representative transects are discussed below.

3. RESULTS

3.1 Morphology

While specimens of both *Usnea* species are usually easy to delimit taxonomically in the field, some collections we have made proved difficult to name with certainty. WALKER (1985) has also drawn attention to the occurrence of intermediate thallus forms. The primary characters used to delimit the species are summarised in Table 1. The nature of the medulla, proportional diameter of the central axis, and characteristics of the soralia are taxonomically important.

Stem sections show that in general *U. antarctica* (Figure 1) has an axis less than half the stem diameter. The mean ratio of central axis to total stem diameter of the specimens we have studied is 0.57 for *U. antarctica* and 0.42 for *U. sphacelata*. There is some overlap in axis to stem diameter ratios (Fig. 3) although this ratio is a useful taxonomic character if used in conjunction with other thallus features. While all sections were taken from an equivalent position, just above the holdfast, some variation may be attributed to habitat and age (WALKER 1985).

3.2 Chemistry

Chemical analysis indicated the presence of usnic acid and an unknown ultra-violet fluorescent substance of Rf between 24 and 31 in both species. WALKER (1985) described several chemical races in *U. antarctica* and *U. sphacelata*. The Windmill Islands populations of *U. antarctica* conform to Race 3 and *U. sphacelata* to Race 2 for these species, neither having diagnostic chemistry.

3.3 Ecology

3.3.1 Habitat selectivity

Two transects are presented as being demonstrative of the range of habitats typically occupied by the two *Usnea* species near Casey Station.

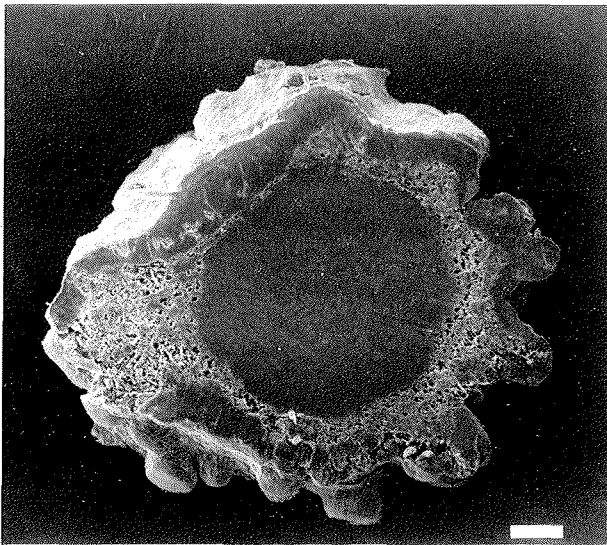


Fig. 1: Transverse section of stem of *Usnea antarctica* with central axis clearly occupying more than half the total stem diameter and with compact medulla. Scale bar = 100 μ m.

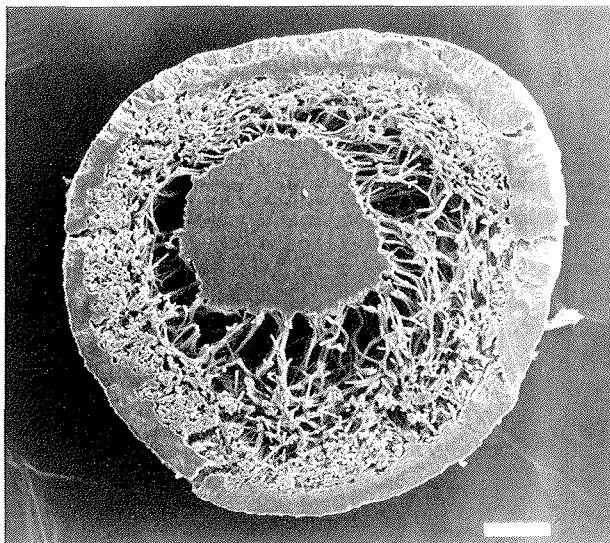


Fig. 2: Transverse section of stem of *Usnea sphacelata* showing central axis occupying less than half the total stem diameter and medulla lax. Scale bar = 100 μ m.

Transect 1 (Fig. 4): Along this 2 m transect *U. antarctica* occurs as an epiphyte on *Ceratodon purpureus*. *Usnea sphacelata* is absent from the moss surface but is abundant on the surrounding rocks where *U. antarctica* occurs as a minor associate in the most sheltered microhabitats. Drift snow collects in the depression occupied by the moss, thus providing a wetter microhabitat than the surrounding moraine during the summer. Median snow depth over the epiphytic *U. antarctica*, from 12 measurements between 25 March 1986 and 22 November 1986, was 80 mm while over the surrounding *U. sphacelata* there was no snow accumulation. This depression site became flooded with meltwater as the snow melted in Spring.

Transect 2 (Fig. 5): In this 12 m long transect *Usnea antarctica* is associated with moss in the lower levels of the transect where increased moisture is provided in summer by drift snow accumulation. In the upper levels of the transect *U. sphacelata* is dominant on the exposed gravels but is replaced by *U. antarctica* as dominant towards the upper end of the transect which is near a boulder. Measurements on snow depth at this site from 26

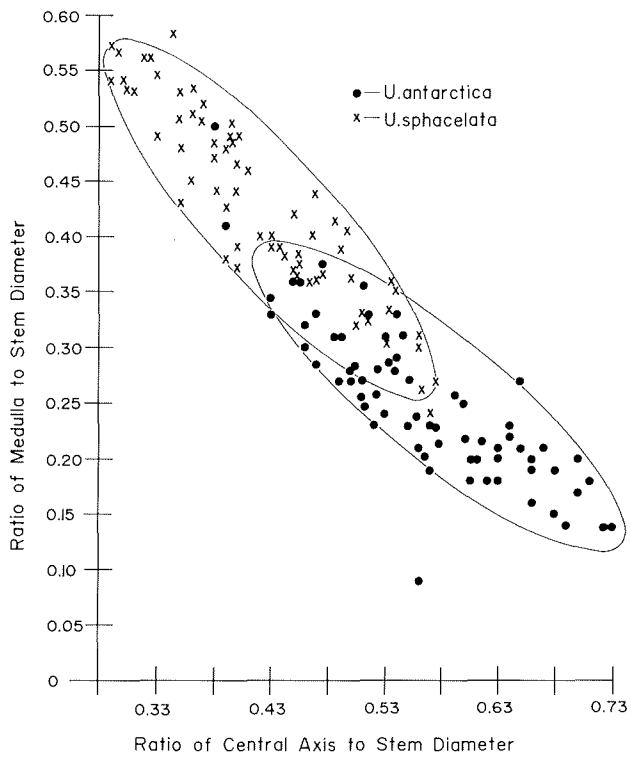


Fig. 3: Ratio of central axis to stem diameter plotted against ratio of medulla to stem diameter for *Usnea antarctica* and *Usnea sphacelata*.

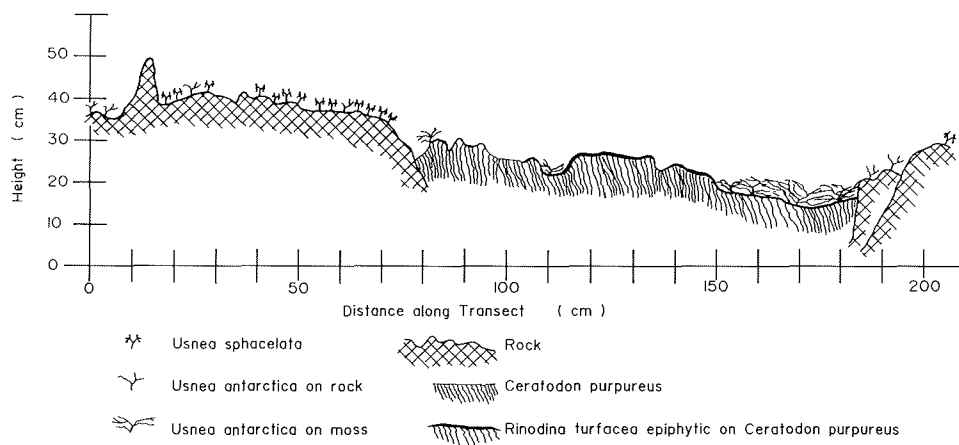


Fig. 4: Distribution of species along a 2 m transect through a moist shallow depression.

March 1986 to 22 November 1986 show that *U. antarctica* predominates closer to the boulder where microtopography results in accumulation of snow and therefore increase in moisture. Further away from the boulder, where *U. sphacelata* is dominant, the snow is quickly blown away. Snow depth records made at weekly intervals from 25 March 1986 to 22 November 1986 (38 observations) in the *U. sphacelata* dominated section show a median depth of 5 mm while at the *U. antarctica* dominated section near the boulder a median depth of 30 mm was recorded. There is also a significant cover of moss close to the boulder.

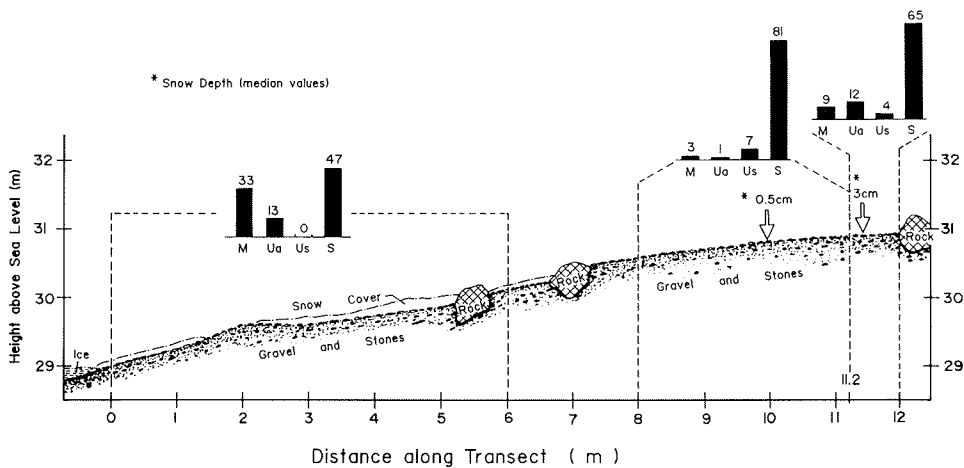


Fig. 5: Moisture influence on species distribution along a 12 m transect. Histograms show the percentage cover of moss and crustose lichen epiphytes (M), *Usnea antarctica* (Ua), *Usnea sphacelata* (Us), and stones, gravel and soil (S) according to their occurrence in 20 cm x 20 cm contiguous quadrats along the transect.

Usnea antarctica grows amongst the gravels with *U. sphacelata* but with very low cover values. Close examination of microrelief and plant association reveals *U. sphacelata* arising from a proliferating holdfast, occurring on the tops of gravel stones while *U. antarctica* is found only on the more sheltered sides of the stones where it is almost monopodial.

Usnea antarctica and *U. sphacelata* occur together on the sheltered side of the boulder at the upper end of the transect. Their growth forms here are similar and stem pigmentation in both species is dark.

3.3.2 Ordination

The ordination of species by quadrats (Fig. 6) further illustrates habitat selectivity of the two *Usnea* species. *Usnea antarctica* is shown to have a greater affinity to the moss species, particularly *Ceratodon purpureus*. Within the study area *Ceratodon* is found more frequently in drier sites than either *Grimmia* or *Bryum*.

A gradient of species moisture preferences is loosely shown in the ordination, with species from moist sites tending to the left, e. g., *Grimmia antarctici* while species from drier sites tend towards the right, e. g., *Usnea sphacelata*.

Both *Usnea* species are closely associated with a number of epilithic lichens such as *Buellia frigida*, *B. soledians*, *Umbilicaria decussata* and *Pseudophebe minuscula*. *Candelariella hallettensis*, which may occur as an epilith but is more usually epiphytic on organic substrates, is positioned closer to *U. antarctica*. Of all the lichens in this group *U. sphacelata* is positioned furthest from the moss species, reflecting its occurrence in drier habitats. While *Buellia frigida*, *Pseudophebe minuscula* and *Umbilicaria decussata* may occur in more exposed and probably drier sites than *U. sphacelata*, they are also more tolerant of wetter more humid sites.

4. CONCLUDING REMARKS

Usnea species exhibit considerable morphological plasticity which may pose difficulty in species identification to the field ecologist. In continental Antarctic localities there are only two species, *U. antarctica* and *U. sphacelata* both of which exhibit a strong niche selectivity although they may occur together in many sites. Gross morphological characteristics are usually sufficient to satisfactorily identify the two species in the field. However, where they occur together at the same site morphological similarities may need closer laboratory study to distinguish them. We have found that a combination of soralia characteristics, stem surface rugosity, and ratios

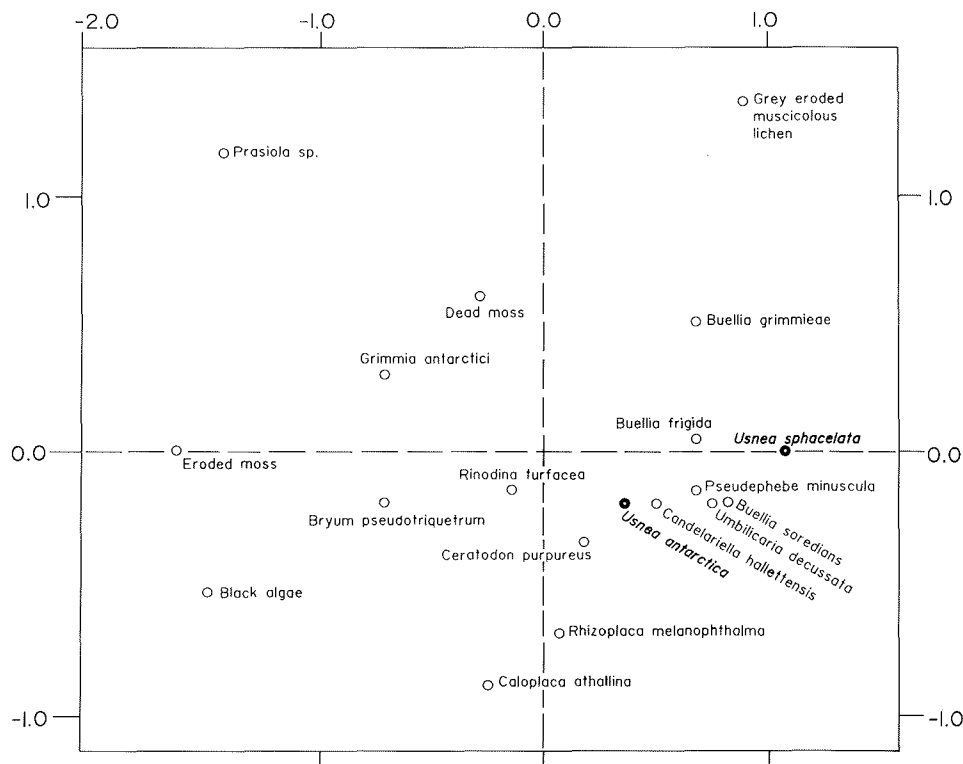


Fig. 6: Ordination of species based on their percentage cover in 210 quadrats placed in a 100 m x 50 m site.

of medulla and central axis to stem diameter permit certain identification of the species. An appreciation of habitat selectivity further aids identification in the field.

In the Windmill Islands area of continental Antarctica *U. sphacelata* occupies drier exposed sites often with minimal snow persistence. It is entirely saxicolous. *Buellia frigida*, *B. soredians*, *Pseudophebe minuscula* and *Umbilicaria decussata* are the principal associated species. These species are also found in wetter sites and appear to have a broader niche width than *U. sphacelata*. Where both *U. sphacelata* and *U. antarctica* are associated in the same habitat there is a microhabitat differentiation with *U. sphacelata* occupying more exposed sites.

Usnea antarctica is generally found in wetter, more sheltered habitats and is saxicolous or muscicolous. *Ceratodon purpureus* is the principal moss species associate of *U. antarctica* in the Windmill Islands. The abundant muscicolous *Rinodina turfurea* is also a common associate. *Usnea antarctica* generally grows in areas where drift snow accumulates.

Habitat differentiation as shown by both *Usnea* species in the Windmill Islands is consistent with observations we have made in other areas of continental Antarctica and those reported by WALKER (1985).

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