Pacific Science (1984), vol. 38, no. 3


# Hawaii's Alectorioid Lichens[1]

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ABSTRACT: Four species of alectorioid lichens are reported from Hawaii. *Bryoria smithii* (= *Alectoria sandwicensis*) is the most common. Two species, *B. furcellata* and *Pseudephebe minuscula*, are new records to the islands. The presence of *B. lanestris* is confirmed. *Alectoria altaica* and *A. jubata* are not present as previously reported. All species are confined to elevations above 2000 m on Maui and Hawaii. Their ecologies are discussed and a key to their identification is provided.

THE ALECTORIOID LICHENS ARE a group of green to black, terete, generally dichotomously or pseudo-dichotomously branched, fruticose lichens. They are, therefore, similar to the genus *Usnea* but lack the characteristic wiry central strand. There are also significant differences in the structure of the apothecia. The taxonomic position of the alectorioid lichens is still uncertain but the recent monograph on the North American species (Brodo and Hawksworth 1977) has gone a long way toward resolving some of the problems. Only two genera of this principally boreal group are represented in Hawaii: *Bryoria* and *Pseudephebe*.

The earliest account of these lichens from the islands was by Magnusson and Zahlbruckner (1945) in which *Alectoria sandwicensis* Magn. was described and *A. jubata* (L.) Ach. was listed. In 1956, Magnusson added *A. altaica* (Gyeln.) Räs. to the flora. In 1964, Motyka mentioned *A. smithii* DR. in a note to his study of the North American *Alectoriae*. Jørgensen (1972) placed *A. sandwicensis* in synonymy with *A. smithii* which was later confirmed by Hawksworth (1972). Brodo and Hawksworth (1977) transferred *A. smithii* into *Bryoria*. They also stated that a "collection from Hawaii ... appears to belong to *B. lanestris*." The status of *A. altaica* and *A. jubata* was not considered by any of these latter authors though Brodo and Hawksworth (1977) preferred to reject *A. jubata* as a *nomen confusum*.

## METHODS

All material mentioned in the literature except that in herb. Klement was examined. Over 100 specimens have been studied, most of them mine and currently located in the Botany Department, University of Hawaii, Honolulu (HAW). Field Studies were conducted from 1975 until the present. Type and other materials were borrowed from or examined at the following herbaria: B. P. Bishop Museum, Honolulu (BISH); British Museum (Natural History) (BM); Duke University Herbarium, Durham, North Carolina (DUKE); Naturhistoriska Riksmuseet, Stockholm (S); Institute of Systematic Botany, Uppsala (UPS); Smithsonian Institution, Washington, D.C. (US); and Naturhistorisches Museum, Vienna (W). The key and abbreviated descriptions apply only to Hawaiian collections. Detailed descriptions of species can be found in Hawksworth (1972) and Brodo and Hawksworth (1977).

Para-phenylenediamine (Pd) was the only chemical spot test used in this study. Segments of thallus were soaked in Steiners's solution (Brodo and Hawksworth 1977). The treated fragments were then discarded.

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KEY TO THE HAWAIIAN SPECIES

1. Thallus less than 3 cm long. Growing directly on rock above 3300 m ..... *Pseudephebe minuscula*
1. Thallus more than 3 cm long. Corticolous or if saxicolous always among mosses. Found below 3000 m ..... 2
2. Soralia common, tuberculate, much wider than thallus, white. Soralia and medulla Pd + red ..... *Bryoria furcellata*
2. Soralia uncommon to rare, always narrower than thallus, minute, concolorous with thallus. Medulla never Pd + red ..... 3
3. Thallus robust, up to 1 mm diameter at base. Pd- throughout. Soralia fisural, rarely with short spinules ..... *Bryoria smithii*
3. Thallus delicate, less than 0.3 mm diameter, fragile, generally fragmenting in herbarium packets, diameter uneven. Soralia tuberculate, Pd + red ..... *Bryoria lanestris*

SPECIES ACCOUNTS

*Bryoria furcellata* (Fr.) Brodo & D. Hawksw.

This species is yellowish-brown but may be black in old or damaged areas. The branching pattern is isotomic-dichotomous but almost squarrose and occasionally distinctly obtuse. The soralia and medulla are always Pd + red. This is the only species in Hawaii with large (up to twice the diameter of the thallus) tuberculate soralia. Apothecia have not been observed in Hawaiian specimens. Both this species and *B. smithii* have spinules in the soralia, but the latter is clearly distinguished by the Pd − reaction in the soralia, the larger size of the branches, and the much darker color of the thallus.

*Bryoria furcellata* is common in the Hawaiian Islands and known from all three high mountains. It is found with other fruticose lichens among the shaded branches of subalpine shrubs such as *Styphelia tameiameia* and *Vaccinium reticulatum* between 2000 and 3000 m in dry areas inundated in orographic cloud. It is particularly abundant in Kipuka Ainahou on Mauna Loa where it grows on the shaded branches of the alpine shrubs. Hawaiian specimens previously ascribed to *Alectoria jubata* by Magnusson (1956) belong here.

Representative specimens examined: Maui. Higashino 1063, Haleakala Crater. Hawaii. 4816, Mauna Kea; 7856, Mauna Loa.

*Bryoria lanestris* (Ach.) Brodo & D. Hawksw.

This species is characterized by its generally concolorous olivaceous brown thallus which reacts Pd + red only in the soralia. The uneven diameter of the fine branches is obvious in most Hawaiian specimens. The branching pattern is anisotomic-dichotomous. The thallus tends to fragment in herbarium packets.

*Bryoria lanestris* is rare in the Hawaiian Islands, known only from three collections from Haleakala. It is found between 2000 and 3000 m in areas occasionally immersed in orographic cloud.

REPRESENTATIVE SPECIMENS EXAMINED: Maui. 2901, 3095 Haleakala Crater; Bowler 1645 NW slope of Haleakala near national park headquarters.

*Bryoria smithii* (DR.) Brodo & D. Hawksw.

(*Alectoria sandwicensis* Magn. in Magn. & Zahlbr.)

This robust, predominantly black lichen is the most obvious and unmistakable member of the group in the islands. The main branches reach diameters of 1 mm. It is always Pd − throughout. Hawaiian specimens are somewhat atypical in that the soralia are poorly developed and generally no more than narrow fissures. I have seen similar specimens from East Asia and Japan in BM and W. Jørgensen (1972), however, cites a Degener collection above Pohakuloa, Mauna Kea, having more

typical soralia. He also reported that one of the specimens was fertile.

*Bryoria smithii* is very common on *Styphelia tameiameia* and *Vaccinium reticulatum* in scrubland on Haleakala and Mauna Kea between 2000 and 3000 m in areas frequently immersed in clouds. No collections are known from Mauna Loa but its abundance elsewhere suggests that it should be there. It generally grows among the uppermost branches of shrubs, frequently on twigs that are dead or with few leaves. It is also found growing among mosses on rocks, particularly in shaded gullies. In Haleakala Crater there is a very obvious correlation between the abundance and luxuriance of this lichen and the frequency and duration of cloud immersion.

Representative specimens examined: Maui. Selling 5890, 5894, Haleakala; 1158, 2394, 2601, 2915 Haleakala Crater.

*Pseudephebe minuscula* (Nyl. ex Arnold) Brodo & D. Hawksw.

This species is prostrate, forming black, almost circular thalli in mats up to 1 m broad. Branching is isotomic-dichotomous, infrequent at the center but often very densely so at the tips. They rarely exceed 0.25 mm diameter. There are no lichen substances present. No reproductive structures were seen on any of the specimens.

This species is confined to exposed rocks above 3300 m on Mauna Kea. I have not found it on Mauna Loa but I have only visited the upper elevations of that mountain on a couple of occasions. The summit, however, has a very low coverage of even the most common lichens in this environment (e.g., *Rhizocarpon geographicum*). The sparsity of lichens is probably the result of the recency of the substratum (the mountain erupts every 12 years on an average). There is also a considerable quantity of toxic substances, even in periods between eruptions. In Hawaii, dispersion of this species is almost certainly by thallial fragmentation, an uncertain process even under favorable conditions, and a further impediment to its establishment on Mauna Loa.

REPRESENTATIVE SPECIMENS EXAMINED: Hawaii. 7602, 7647. Mauna Kea, north face at 4400 m.

## DISCUSSION

It is quite unusual that any members of this predominantly boreal group should occur in the tropics. However, the height of the more recent Hawaiian volcanoes exposes their summits above tropical environmental conditions. High montane tropical environments are not strictly comparable with boreal environments because, among other things, daily temperature variations are as extreme as seasonal variations elsewhere or, as Hedburg (1951) put it, "summer every day and winter every night." Why these species have become established and not some of the other widely distributed species (e.g., *Bryoria fuscescens*) is unknown. Their successful establishment appears to be a random event rather than any special adaptation to the Hawaiian environment.

The *Bryoriae* are most abundant in those areas just above the tradewind inversion layer where clouds are driven to higher elevations by the upslope winds during the day. The fruticose habit is ideally suited to capturing water droplets from the clouds. The lichens form a significant biomass where the rainfall measures 50–120 mm/yr, a figure which is substantially increased to an unknown extent by fog interception. The pattern of moisture availability, high around midday and very low at night, is particularly conducive to lichen growth. Above 3000 m there are very few shrubs and either the nightly frosts or the more xeric conditions above this elevation preclude the survival of these species. Below 2000 m either the rainfall is too high and the lichen is overgrown by other species, or in the rainshadow to the lee of the tradewinds the diurnal orographic cloud movements are absent and growth does not occur even though the rainfall is the same as in colonized habitats.

These alectorioid lichens are frequently found in large quantities, yet in other apparently similar areas close by they are absent. In the case of *Bryoria furcellata* and *B. smithii* some shrubs are heavily colonized but neighboring bushes have no thalli. Similarly, rock faces which are colonized with *Pseudephebe minuscula* have numerous individuals but adjacent outcrops of the same lava flow have none. These observations suggest that these species have difficulty getting established but once attached they flourish. Apart from *B. furcellata*, none of these species produce sexual or asexual reproductive structures abundantly, if at all. The major mode of dissemination appears to be irregular thallus fragmentation. High winds, particularly in the winter months, are strong enough to disseminate these fragments over substantial distances.

The record of *Alectoria altaica* from Molokai is based on a specimen of *Hetedermia leucomela* subsp. *boryi* (Fée) Swinsc. & Krog.

ACKNOWLEDGMENTS

The Haleakala collections were made during a plant inventory of the Crater District of Haleakala National Park (NPS contract CX8000 7 0003). The Mauna Kea specimens were collected during a biological survey of the resources above 4300 m on Mauna Kea as part of an environmental impact statement conducted by the Bishop Museum. The support and opportunity to work in these areas is appreciated. I thank D. E. Gardner and C. S. Hodges for their reviews of earlier drafts of this manuscript and I. Brodo, National Museums of Canada, for confirming some of my identifications.

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