Community Action for Endangered Species

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Epiphytic Lichens: Going Down With the Trees

by Trevor Goward

My subject this afternoon is lichens, or more specifically the lichens that live in B.C.'s oldgrowth forests. Over the next few minutes I will attempt to develop three propositions: 1) when you cut down an oldgrowth forest, you destroy, among other things, an assemblage of lichens that has taken hundreds of years to develop; 2) these lichen assemblages will not exist in the plantation forests of the future, even with 200- or 300-year rotations: and 3) present forestry practices, if allowed to continue, will lead to the extirpation or extinction of some of the species contained in three assemblages.

Because this symposium is about endangered species, you might reasonably expect me to focus this talk on rare and endangered lichens. Unfortunately, not enough is known about the status of B.C.'s rare lichens to comfortably fill a twenty-five minute presentation. Our level of ignorance can be gauged from the fact that roughly half of the lichen species thus far known to occur in B.C. have been reported from five or fewer localities. It is difficult to guess which of these species have simply escaped notice by the collectors, and which are genuinely rare. That is why I prefer, for now, to discuss oldgrowth-dependent lichens as individual species. And that is also why I will restrict my attention to the macrolichens, which in general are much better known than the crusts.

THE NATURE OF LICHENS

Let me begin with a few words about lichens themselves: what they are and what they are not. Lichens are not mosses, nor liverworts, nor algae. Nor, for that matter, are lichens a mere symbiotic relationship between a fungus and an alga; to say they are is a bit like saying vegetarians are a mere symbiotic relationship between human beings and tofu.

Lichens are fungi that have taken up agriculture

A better way of putting it is that lichens are fungi that have taken up agriculture. Different from most other fungi, which feed on things larger than themselves (e.g. trees, dead fish, and so on), lichen fungi feed on tiny algal cells which they envelop in a sort of living fungal greenhouse. When we look at a lichen, we are therefore looking at something we rarely see in other fungus groups: the vegetative portion of a fungus. In other fungi, all we usually see is the ephemeral fruiting portion, or mushroom.

Where do lichens grow? Over rocks, soil, decaying logs, clam shells, even over leaves in some instances. The lichens I intend to talk about today grow over the trunks and branches of trees, and are collectively called epiphytic lichens.

Epiphytic lichens, it should be stressed, don't feed on trees. Nor are they usually in the least harmful to trees. To an epiphytic lichen, a tree is simply a place to live without having to compete for space with more vigorous members of the local flora. Though some lichens are important nutrient recyclers, and others provide a source of carbohydrates for various forest animals, it is probably fair to say that a majority of lichens merely fill the empty spaces in the vegetation. They are, as it were, a form of biological chinking.

Mr. Goward is honorary curator of Lichens at the University of British Columbia and is currently working on a booklet outlining the lichen flora of BC. He is a member of the International Association of Lichenologists and has published several papers on BC lichens.

A lichen, like a marriage, is nothing without the working cooperation of its partners. When working cooperation fails in a marriage, the result is usually divorce. When a working cooperation fails in a lichen, the result is invariably death.

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A lichen, like a marriage, is nothing without the working cooperation of its partners. When working cooperation fails in a marriage, the result is usually divorce. When working cooperation fails in a lichen, the result is invariably death. This is the key to understanding why many lichens are so particular about where they grow. Add a little too much humidity, or shade, or heat, or whatever, and the lichen partnership dissolves. And so dissolves the lichen with it.

And epiphytic lichen, for example, usually doesn't colonize all parts of its host tree equally; it may thrive only at the very base of the tree, or on bark that is protected from rain, or in the lower branches, or again in the crown of the tree. To put it tautologically, everything hinges on the availability of the particular set of microclimatic conditions for which the lichen has evolved.

In general, however, one of the fundamental requirements of most lichen partnerships is that the lichen be wetted and dried at rather frequent intervals. Just how frequently depends on the species involves, but it's safe to say that very few lichens tolerate continuous high humidity.

LICHENS OF OLDGROWTH FORESTS

A majority of B.C.'s oldgrowth-dependent lichens are restricted primarily to coastal lowland forests. Partly for this reason, and partly because coastal oldgrowth forests are disappearing faster than oldgrowth forests elsewhere, I give special emphasis to coastal oldgrowth lichens in this talk. It should be stressed, however, that oldgrowth-dependency among lichens also occurs in other parts of the province.

According to the Biogeoclimatic maps recently published by the British Columbia Ministry of Forests (1988), virtually all of the lowland forests of coastal B.C. belong to the Coastal Western Hemlock-Cedar Zone. The CWH Zone is, however, climatically very heterogeneous, and has been subdivided into ten subzones ranging from the Very Dry Maritime Subzone to the Very Wet Hypermaritime subzone. I stress that the patterns outlined below are best expressed in the intermediate subzones of the CWH Zone, and may not fully apply to the wettest and driest subzones.

From a lichenological perspective, the CWH Zone is remarkable in at least two respects: first for the comparatively meager macrolichen flora associated with its young and maturing forest types; and second for the comparatively rich macrolichen flora associated with its mature and oldgrowth forest types. It is not uncommon, for example, for a 100 year-old CWH forest to contain only eight to ten epiphytic macrolichen species, while a 250 year-old forest often contains 25 species or more. Table 13, below, documents this pattern. Age-related floristic differences are not nearly so pronounced in other BC forest zones.

Table 13 Comparison of Epiphytic macrolichen species in different-age forests

Common CWH zone macrolichens on young and maturing forests (preliminary list)

Alectoria sarmentosa	*Hypogymnia tubulosa*
Bryoria capillaris	*Lobaria pulmonaria*
Bryoria fuscescens	*Nephroma bellum*
Cavernularia hultenii	*Nephroma helveticum*
Cetraria chlorophylla	*Nephroma parile*
Cetraria orbata	*Parmelia hygrophila*
Hypogymnia enteromorpha	*Parmelia sulcata*

Hypogymnia imshaugii	*Parmeliopsis ambigua*
Hypogymnia inactiva	*Parmeliopsis hyperopta*
Hypogymnia metaphysodes	*Platismatia glauca*
Hypogymnia occidentalis	*Platismatia herrei*
Hypogymnia physodes	*Platismatia norvegica*

Macrolichens restricted in the CWH zone in old growth forests (preliminary list)

*Bryocaulon pseudosatoanum**	*Nephroma occultum*
Bryoria bicolor	*Nephroma resupinatum*
*Bryoria carlottae**	*Pannaria leucostictoides*
*Bryoria cervinula**	*Parmelia kerguelensis*
*Bryoria pikei**	*Parmelia squarrosa*
*Bryoria subcana**	*Parmotrema arnoldii*
*Bryoria tenuis**	*Parmotrema crinitum*
Bryoria trichodes	*Platismatia lacunosa*
Cavernularia lophyrea	*Platismatia stenophylla*
*Cetraria californica**	*Polychidium dendriscum*
*Dendriscocaulon intricatulum**	*Pseudocyphellaria anomala*
*Erioderma mollissimum**	*Pseudocyphellaria anthraspis*
*Heterodermia leucomelos**	*Pseudocyphellaria crocata*
*Heterodermia sitchensis**	*Pseudocyphellaria rainierensis**
Hypogymnia oceanica	*Ramalina menziesii*
Hypogymnia vittata	*Ramalina subleptocarpha**
Hypogymnia sinuosa	*Sphaerophorus globosus*
*Leioderma sorediatum**	*Sphaerophorus melanocarpus**
Lobaria hallii	*Stricta fuliginosa*
Lobaria linita	*Stricta limbata*
Lobaria oregana	*Stricta weigelii**
Lobaria retigera	*Usnea longissima*

*few specimens on record

If lichens are to become established in such forests at all, it is usually in the upper crowns of the trees that they do so, for here sunlight and wind exert a strong drying effect.

As a rule, lichen colonization in a maturing forest follows a fixed pattern. The more ubiquitous species tend to become established early on, while most of the remaining species do not become established until the forest is 150 to 200 years old, or often much older still.

The key to understanding this prolonged delay in lichen establishment is the fact, already mentioned, that most lichens are unable to tolerate continuous high humidity. Very few species, therefore, are adapted to thrive within the damp, shady canopies of the CWH Zone. If lichens are to become established in such forests at all, it is usually in the upper crowns of the trees that they do so, for here sunlight and wind exert a strong drying effect.

Lichens, however, are usually very slow to become established at the best of times. In order to successfully colonize a site, they need not only the correct microclimatic conditions, they also require a high degree of environmental stability. The fact that young, vigorously growing forests are environmentally highly unstable makes them unsuited for lichen colonization. For in the time it would take for most lichens to become established at a particular site, the upward and outward growth of the trees has already altered microclimatic conditions beyond the tolerance of most lichens.

After about 100 to 150 years, however, conditions improve dramatically for epiphytic lichens. By then, most trees have begun to slow in their growth rates, and vertical growth may be measured in centimetres, not decametres. At the same time, a gradual increase in windthrow thins the canopy, leading to increased air circulation throughout. Moreover, as new trees spring up to take the place of the fallen giants, the forest takes on a heterogeneous character, being comprised of

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In my experience, such forests are invariably older than about 300 to 350 years.

Fire has acted to return forest succession to early stages at more or less regular intervals. For this reason, antique forests have probably never been very abundant in most portions of the province.

trees of different age classes. The net effect of these structural modifications is that the aging forest gradually acquires a full complement of microsites suitable for colonization by epiphytic lichens – a process essentially complete by the time the forest has achieved oldgrowth status, at between 175 and 250 years.

As a rule, lichen colonization in a maturing forest follows a fixed pattern (Figure 36). The more ubiquitous species (Type A) tend to become established early on, while most of the remaining species (Type B) do not become established until the forest is 150 to 200 years old, or often much older still. Many of the latter species, moreover, remain rare at a site even once they do become established, and it is worth noting that roughly one-third of them may be considered rare in B.C. as a whole. From these observations, we may conclude: that the epiphytic flora of a forest tends to become richer over time; and that a disproportionate number of rare epiphytic lichens in the CWH Zone are restricted to very old forests.

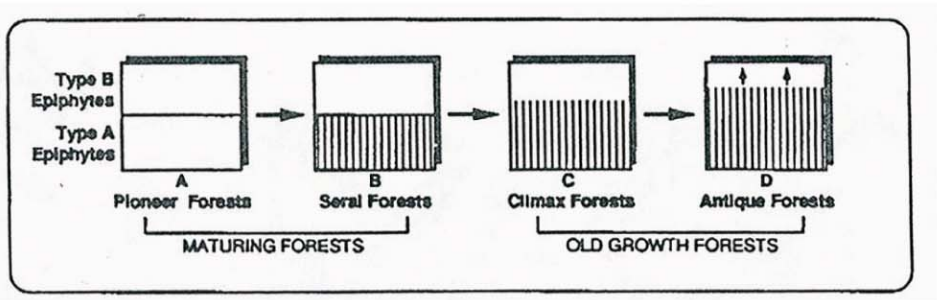

Fig. 36 The relationship of CWH Zone Macrolichens to forest age.

These phenomena are by no means peculiar to the forests of British Columbia. Similar patterns have already been amply documented in Britain by lichenologists Francis Rose (1976). In the mid '70s, Rose conducted inventories of the lichens of 102 Oak and Beech woodlands in different parts of the British Isles. When he later compared his species lists against existing land use records, he found a definite positive correlation between lichen diversity and forest age. Forests known to have been undisturbed for many hundreds of years usually contained between 120 and 150 lichen species per square kilometre, and often many more. By contrast, British woodlands that had been disturbed less than 200 years ago tended to contain fewer than 50 lichen species per square kilometre.

Using these observations as a base, Rose constructed what he called his "Revised Index of Ecological Continuity" or "RIEC". This index is intended to give a rough numerical indication of the extent of ecological continuity in a given woodland. The equation is a simple one:

$$\text{RIEC} = \frac{N}{20} \times 100$$

Here "n" is the number of oldgrowth indicator lichens present at the site being examined; in Britain, this number is drawn from a list of 30 of the most widespread epiphytes that nevertheless seem to be restricted to ancient woodlands. For example, if n = 20, then the RIEC is 100, whereas if n = 2, then the RIEC is only ten. Thus, the higher the RIEC value, the older the forest, and vice versa. Though the RIEC has yet to be adapted to North American forests, there is no reason to suppose it could not be.

The fact that a 200-year-old forest will probably not acquire a full complement of epiphytic lichens for at least another couple of centuries obliges us to think again about what we mean when we speak of "oldgrowth" or "climax" forest. Thus, though

the usual distinction between pioneer forests, seral forests and climax or oldgrowth forests may be adequate to embrace the ecological requirements of forest-dwelling birds and mammals, it is certainly not adequate for epiphytic lichens. For this reason I now propose a fourth category of forest succession: the "antique forest".

Antique forests, as I define them, are simply oldgrowth forests that have been around long enough to accumulate a rich assemblage of epiphytic lichens, including several of the less common species listed in Figure 2. In my experience, such forests are invariably older than about 300 to 350 years. I stress that what is important is not so much the age of the trees, as the age of the forest itself. Thus a 150-year-old tree is an antique forest may well support a richer lichen flora than a 250-year-old tree in a forest that is also 250 years old.

The relation between lichen diversity and forest age in the CWH Zone is illustrated schematically in Figure 3. In the pioneer phase of a forest (A), no epiphytic macrolichens at all will be found. Colonization (by the species listed in Figure 1) begins in earnest only once the forest has entered its middle seral phases (B), usually after about 50 years. By the time it has attained oldgrowth status (C), at between 175 and 250 years (Franklin et al. 1981), it usually also supports a few of the more widespread epiphytes listed in Figure 2. The less common species, however, do not generally become well represented until the forest is an antique forest several hundreds of years old (D). Even then, however, the flora may continue to be enriched by the recruitment of additional species.

Until recently, fire has played an integral part in the ecology of most of B.C.'s forests. Specifically, fire has acted to return forest succession to early seral stages at more or less regular intervals. For this reason, antique forests have probably never been very abundant in most portions of the province, including most portions of the CWH Zone.

The fact that steep mountain slopes are especially prone to fire has meant that a majority of B.C.'s original antique forests were restricted to valley bottoms and other topographically subdued locales. Here their relative accessibility made them especially attractive to the logging industry, and it is not surprising that many antique forests disappeared in the early years of this century. Especially hard hit were the antique forests of the lower mainland and eastern Vancouver Island (Stoltmann 1987). These losses imply that many epiphytic lichens may already have been extirpated from large portions of southwestern B.C.

The question of how to maintain biodiversity and forest health in the face of continued cutting has provoked considerable debate. The majority response to date has involved an attempt to set aside representative oldgrowth as parks, ecoreserves and wilderness areas. While this practice will doubtless slow the rate of extinction of epiphytic lichens in B.C., it does not address the related issue of lichen biodiversity in those parts of the province that are not protected. In my view, the existence of a few scattered islands of protected oldgrowth and antique forests in a province-wide "ocean" of secondgrowth forests cannot be adequate to ensure that B.C. will retain its full epiphytic lichen flora into the long term.

A second approach to the problem – one supported by an increasing number of foresters – urges a complete revamping of current forestry practices. Several changes in harvesting techniques have been proposed in recent years, but certainly the most signifcant from the perspective of epiphytic lichens is the proposal (e.g. Harris 1984) that harvesting be scheduled at 320- year intervals, rather than at the current 80 –year intervals. Needless to say, it is important to stress that it would

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not necessarily ensure the long-term maintenance of all epiphytic lichen species. That objective will only be achieved once antique forests are both protected and allowed to develop on as broad a scale as possible.

CONCLUDING REMARKS

In recent years, the word "decadent" has been the usual modifier applied by professional foresters to oldgrowth forests; and if decadent is supposed to mean something like "past their prime" or "on the way out", then I suppose the oldest trees within an oldgrowth forest could arguably be called decadent. But the forest itself should not be called decadent – at least not from the perspective of the many lichens that depend upon it. For these, as probably for other organisms, an aging oldgrowth forest is a dynamic place: its varied and ever-changing microhabitats support and epiphytic flora that becomes richer with the passage of time.

When you cut down an oldgrowth forest, you do more than destroy a stand of old trees. You also destroy forest continuity. Though the individual trees of which the oldgrowth froest is comprised may well be decadent, they are also the bearers of lichen assemblages that exist nowhere else. When you cut those trees, you destroy those assemblages. And if your clearcuts are large enough, and numerous enough, and if your clearcuts are later to be replaced by plantation forests scheduled to be cut again in 80 or 150 or even 300 years, then you will have destroyed those assemblages once and for all.

In recent years, the forest industry has tacitly and sometimes openly asked British Columbians to support the wholesale liquidation of oldgrowth forests over large portions of this province. In addressing this forum today, I have not tried to argue that coastal oldgrowth forests ought to be left standing on account of the lichens that depend on them. What I have tried to argue is simply that public debate about whether and when to cut those forests must include a consideration of the lichens. For no less than Spotted Owls and perhaps Marbled Murrelets, lichens too are going down with the trees.

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