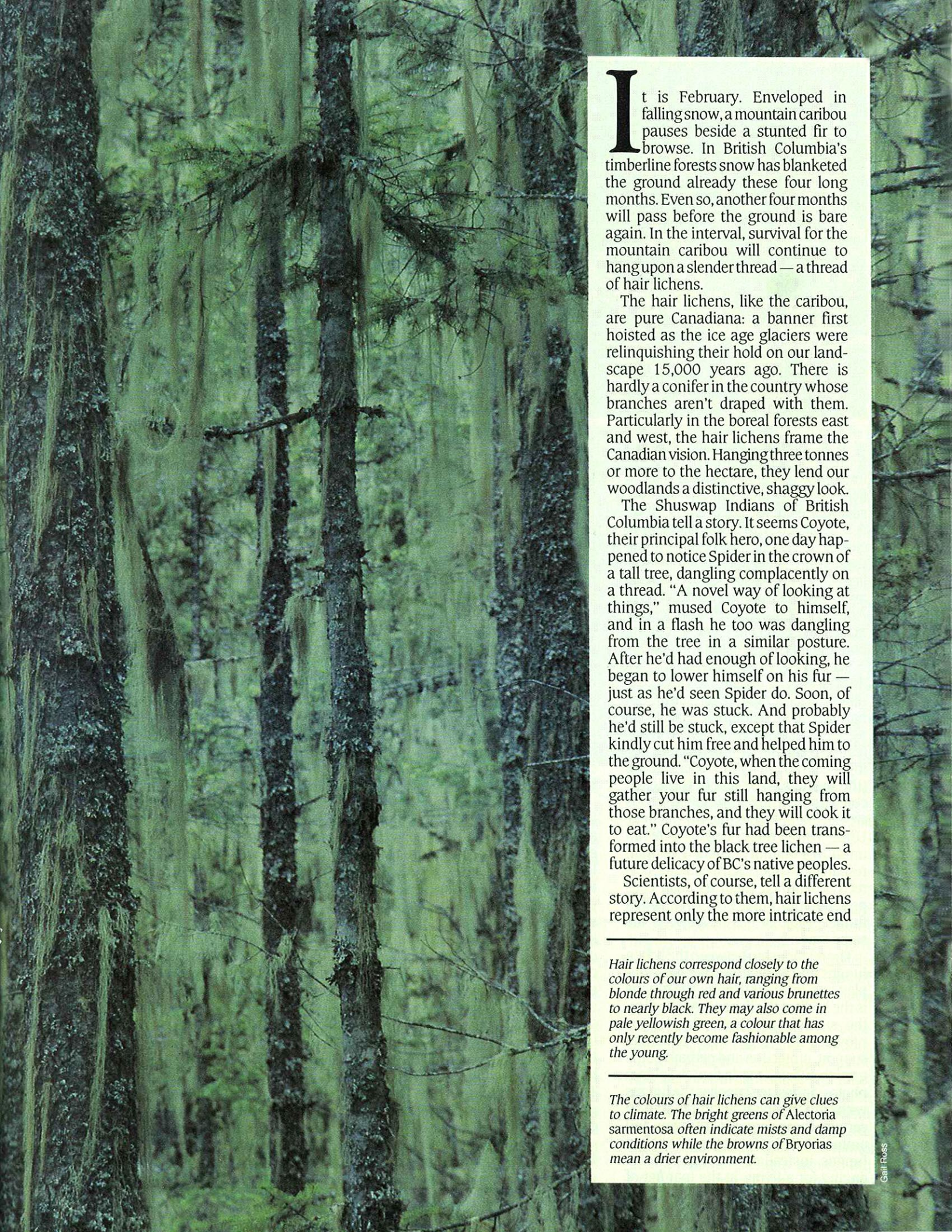

It is February. Enveloped in falling snow, a mountain caribou pauses beside a stunted fir to browse. In British Columbia's timberline forests snow has blanketed the ground already these four long months. Even so, another four months will pass before the ground is bare again. In the interval, survival for the mountain caribou will continue to hang upon a slender thread — a thread of hair lichens.

The hair lichens, like the caribou, are pure Canadiana: a banner first hoisted as the ice age glaciers were relinquishing their hold on our landscape 15,000 years ago. There is hardly a conifer in the country whose branches aren't draped with them. Particularly in the boreal forests east and west, the hair lichens frame the Canadian vision. Hanging three tonnes or more to the hectare, they lend our woodlands a distinctive, shaggy look.

The Shuswap Indians of British Columbia tell a story. It seems Coyote, their principal folk hero, one day happened to notice Spider in the crown of a tall tree, dangling complacently on a thread. "A novel way of looking at things," mused Coyote to himself, and in a flash he too was dangling from the tree in a similar posture. After he'd had enough of looking, he began to lower himself on his fur — just as he'd seen Spider do. Soon, of course, he was stuck. And probably he'd still be stuck, except that Spider kindly cut him free and helped him to the ground. "Coyote, when the coming people live in this land, they will gather your fur still hanging from those branches, and they will cook it to eat." Coyote's fur had been transformed into the black tree lichen — a future delicacy of BC's native peoples.

Scientists, of course, tell a different story. According to them, hair lichens represent only the more intricate end

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Hair lichens correspond closely to the colours of our own hair, ranging from blonde through red and various brunettes to nearly black. They may also come in pale yellowish green, a colour that has only recently become fashionable among the young.

The colours of hair lichens can give clues to climate. The bright greens of Alectoria sarmentosa *often indicate mists and damp conditions while the browns of* Bryorias *mean a drier environment.*

Gail Ross

Adrian Dorst

Birds are important to lichen reproduction. While flitting from branch to branch, they often carry torn fragments of hair lichens to new habitats.

Trevor Goward

Of the 35 species of Alectoria *and* Bryoria *occurring in North America, two-thirds are centred in Canada, making ours the shaggiest nation on earth.*

of a continuum of lichen growth forms — which includes, in descending order of complexity, the shrub lichens, the clubs, the leaves, the scales, the crusts and even the powders. Canada, with 2500 lichen species to its name, is warehouse to all these forms, but especially so to hair lichens. Of the 35 species of *Alectoria* and *Bryoria* occurring in North America, fully two-thirds centre mostly or entirely in Canada, making ours the shaggiest nation on earth.

Seen in cross-section under the microscope, a lichen is obviously nine-tenths fungus. Every strand of hair lichen, for example, consists of a tight-knit sleeve of fungal threads (collectively called the cortex) enclosing a central cavity of looser threads (the medulla). The rest of the lichen consists of a few tiny green beads woven like spangles into the medulla. Until 1867, these beads were an unknown quantity. Then, a German researcher, Simon Schwendener, correctly identified them as algal cells pressed into service by the lichen fungus. Biology has never been the same since.

The relationship between the lichen fungus and its algal partner is a complex one. In general terms, the fungus is the body of the lichen, and the alga, the sustenance. While the fungus provides the alga with structural support, protection and perhaps some growth substances, in turn the alga, a photosynthesizer, supplies the fungus with carbohydrates, vitamins, and, in certain cases, organic nitrogen and ammonia. This means that the lichen fungus, instead of invading or scavenging for a living in the manner of other fungi, has evolved a more agricultural tact. Cultivating its foodstuffs within itself, it might be called a living greenhouse.

This symbiosis, or intimate exchange of advantages between fungus and alga, permits the lichen to function as if it were a single plant. In reality, however, a lichen is not a plant at all, but a self-sufficient community of organisms, a kind of microecosystem. The hair lichen that hangs from the branch of a spruce does not directly derive its food from that branch as a parasite would; instead it satisfies its energy requirements and completes its entire life cycle, all on a wonderful economy of air, water, sunlight and dust. Hang your laundry out on a line, and it dries; hang a piece of hair lichen, and it grows.

More than half of the species of hair lichens occurring in Canada are long and pendent: falling tresses are sometimes half a metre or more in length. The rest have a shorter, more wiry appearance, some growing erect on the ground in the manner of shrubbery. The growth pattern is a strong clue to identification, as is colour. Although a few species vary considerably in hue from place to place, most are remarkably true to chroma. The colours of the hair lichens agree well with the colours of our hair; like us they can be sorted into the blondes, the redheads and the various brunettes, grading nearly to black. They may also come in pale yellowish green — until recently not a popular colour with beauticians.

To the botanist the name "hair lichen" might apply to any of a half dozen different genera. The layman is usually content if he can distinguish between "old man's beard", which includes the greenish ones, and "witches' hair", which accounts for most of the others. Actually it is possible for the amateur naturalist to split the hairs at least a little more finely. Dr. Irwin Brodo, chief botanist with the National Museums and a world authority on the hair lichens, would like to see the term "old man's beard" restricted to species of the genus *Usnea*, and "hair lichens" used for the others. (The strands of all *Usnea* species possess a somewhat elastic central cord; test for this by tugging the lichen as though it were a party cracker.) Species of *Alectoria* are almost all yellowish green and pendent; *Bryoria* ("witches' hair") comprises the grey-brown to black, tufted or pendent species, growing mainly on trees; and *Pseudephebe* is the name given to the short, tangled, rock-dwelling species, always black in colour, that thrive at high latitudes and altitudes.

The colours of hair lichens do more than distinguish the genera. Sometimes they also provide unexpected, and vivid, insights into the natural

world. A mountain woodland decked out in the bright greens of *Alectoria sarmentosa*, for instance, indicates that it is more prone to mists and damp weather than one dominated by the browns of the *Bryorias*. Forests of intermediate humidity often bear green hair lichens in the lower branches, and brown witches' hair above, where drying winds have greater purchase. To move from these drier environments to wetter sites, as from a ridge into a draw, is to watch the *Alectorias* climb higher into the canopy, like a delicate green mist rising. But take care to apply this rule only to the *Alectorias* and *Bryorias*. In the mountains, the *Usneas*, although green, thrive in humid and relatively arid habitats alike.

In some parts of Canada, particularly in the mountains of the west, the hair lichens often fail to grow near the ground. Their lower trimline, in fact, may lie two or three metres above the forest floor, so that in summer it is impossible to reach them except by shimmying up a tree. The cause of this phenomenon is not at first apparent, and one might easily conclude that the lower limbs have been browsed bare by a famished band of moose.

Actually it is the winter's snow which is the active agent. Although snow provides the flowering plant with a protective blanket against the January gales, to the hair lichen a prolonged snow cover means death. In regions of heavy snow, therefore, the lower trimline of the *Alectorias* and *Bryorias* provides a rough estimate of the average winter snow pack — making it possible to gauge the full extent of winter even in the height of summer.

No one is quite sure why the hair lichens are so sensitive to snow cover. One educated guess comes from Dr. Kenneth Kershaw, Canada's leading lichen physiologist, who suggests it may be a lack of light which is responsible. According to this hypothesis, any lichens buried in the melting snows of early spring are bound to be wetted, and thereby roused to physiological activity: they breathe; they begin to put on new growth; but in the absence of sunlight, there is one thing they cannot do — manufacture new foodstuffs. Eventually they exhaust their reserves, and so die.

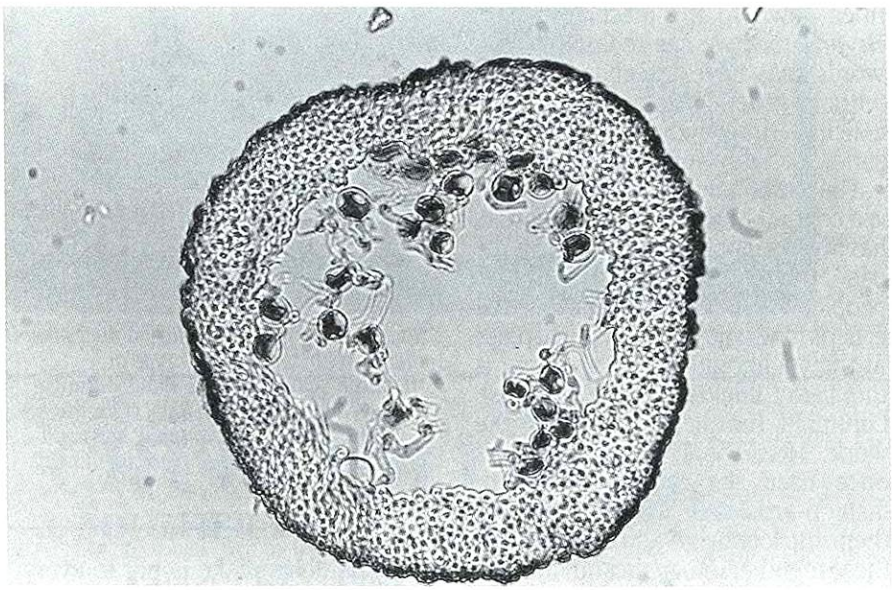
Snow cover notwithstanding, the hair lichens are a hardy lot. Many of the arboreal species push north to the limit of trees, while from there the rock-dwelling *Pseudephebes* continue flush to the shores of the Arctic Ocean. Faced with the rigours of an arctic climate, the *Pseudephebes* grow with painful slowness, often increasing at less than four centimetres in 100 years. The Arctic, however, provides a stable environment; change is measured not in decades but in centuries. Freed from the vicissitudes of plant succession, lichens here tend to be extraordinarily long-lived — a fact which has lately been put to good use by geologists.

The technique of dating rock surfaces by means of lichens is called lichenometry, and was first developed into a science some 25 years ago by the Austrian researcher, Dr. Roland Beschel. Simply stated, lichenometry assumes it is possible to determine the age of some arctic lichen colonies through a comparison of their size with their annual rate of growth. Since lichens tend to establish soon after a surface becomes available for growth, in many cases the age of the oldest lichens provides a direct measure of the time that has elapsed since deglaciation. It is intriguing to reflect that some of the lichens seen in the Canadian north may represent first generation colonizers dating back to the close of the last ice age.

Growth rates among lichens vary both from species to species and, of course, from region to region, depending on climate. The key to a successful application of lichenometry lies in establishing accurate regional growth curves for each species. This can be a difficult undertaking in a land that offers few historical points of reference. One study used bright orange *Xanthoria* lichens growing on the grave markers of Sir John Franklin's tragic third expedition to the eastern Northwest Territories in 1848: 100 years later the largest colonies had reached a diameter of 4.4 centimetres.

Lichenometry is particularly useful in the study of existing glaciers, whose latest advances and retreats can in this way be both mapped and dated, often in surprising detail. In this context the *Pseudephebes* sometimes provide a record of climatic continuity dating back to about the time of Jacques Cartier. Other lichen species are even longer lived: in one study on Baffin Island, for example, a maximum age of 9600 years was estimated for the map lichen, *Rhizocarpon geographicum*. Extrapolating from data of this kind, researchers are able to reconstruct the recent glacial history of the Canadian Arctic. Is it any wonder that geologists have lately come to think of lichens as a kind of minute hand on the geological clock of the north?

Hair lichens have begun to colonize other disciplines as well — including phytogeography, the study of plant distribution through space and time. The geography of hair lichens is quite remarkable: of the 35 *Alectorias* and *Bryorias* inhabiting North America, roughly half are circumboreal, found in appropriate habitats across the northern world. Thus, while the



Irwin M. Brodo

A strand of hair lichen, seen in cross-section under the microscope, consists of a tight-knit sleeve of fungal threads enclosing a central cavity of looser threads that are woven through with tiny green beads of algal cells.

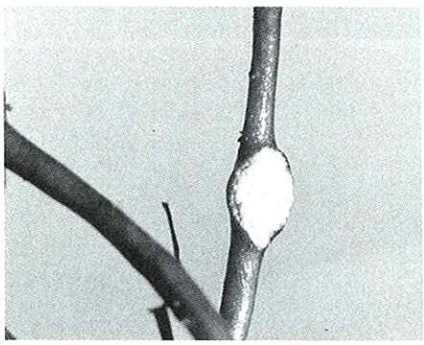
Canadian travelling abroad — whether in China or in Norway — is unlikely to encounter many, if any, familiar flowers or trees, he will at least encounter familiar hair lichens.

To the phytogeographer this raises several possibilities. One of them — perhaps the most interesting — is that lichens may be slow evolvers. According to this view a majority of the modern hair lichens already existed roughly 200 million years ago, before the earth's land mass broke into continents. Since that time the fragments of a once continuous lichen flora have been rafting with their separate continents across the globe. Unlike the flowering plants, which have since evolved into myriad new forms, the lichens, with dynastic reserve, have largely retained their original identities down to the present time. A *Bryoria* that we see today, in other words, may have descended directly, without genetic recombination, from a lichen fungus that existed thousands, possibly millions, of years ago.

The use of hair lichens by scientists is a comparatively recent innovation, having developed largely during the past few decades; to the native peoples of Canada, however, the lichens long enjoyed a privileged place in the traditional ways. Nowhere is this better illustrated than in British Columbia, hair lichen capital of the world. Here the Thompson Indians once used the witches' hairs to fashion articles of clothing, twisting them into loose coils and then binding these together into makeshift moccasins and cloaks. Further south, the Okanagan tribes ascribed medicinal properties to the *Bryorias*, and so mixed them with grease as an ointment for the navels of newborn infants. Meanwhile, the coast Salish discovered the hidden colours which the hair lichens contain, extracting from them a yellow dye for their clothing.

The use of one hair lichen, however, dominated all others. *Bryoria fremontii* was, and still is, widely gathered and processed into a sort of "Indian cake". In view of the importance of this species as an emergency food, it is interesting that the native peoples were adept at distinguishing it from others of its genus long before the professional lichenologist had learned to do so. Their method? Before collecting it, they would always taste it first.

Black tree hair, as it is sometimes called, was usually gathered in the fall. Traditionally it was twisted loose from its arboreal perch with long poles. After sufficient quantities had been collected, they were taken back to camp, and cleaned, soaked and steamed in an underground pit, sometimes for days. Nancy Turner, an anthropologist who has witnessed its preparation, describes the cooked material as "a black, gelatinous mass having the consistency of fresh, stringy dough and the appearance of licorice". Once removed from the pit, the cakes were divided and either eaten fresh (after being sweetened with honey or berries) or stored for future use. Like the pemmican of the Plains Indians, lichen cake would keep almost indefinitely.



Irwin M. Brodo

Some lichens are accomplished hitchhikers that travel by producing a type of "dandruff" called soredia. *Wefts of fungal threads intermixed with algal cells, the* soredia *come loose from the lichens and are carried from place to place by moving animals.*

Black lichen cake is not to everyone's taste. Having once tried it myself, I concur with the judgement of Franchere, a French explorer who sampled it in 1814 while visiting an Okanagan village: "I thought I had put a piece of soap in my mouth."

Given the abundance of hair lichens in boreal Canada, it would be surprising if our native wildlife failed to weave it into their life histories. Flying squirrels, for instance, typically use *Bryoria* as the main building material of their nests. So do various warblers and vireos — although frequently in equal portions with birch-bark, grass, or sometimes, real animal hair. Even the false hemlock looper, an unwelcome forest pest in many parts of the country, has discovered the advantage of laying its eggs within the tangled strands of the witches' hairs.

In return, the birds are very important to lichen reproduction. Few lichens ever reproduce in the usual way. Many, indeed, have never been known to bear sexual fruiting structures — a fact reflected in the name *Alectoria* itself, which derives from the Greek, "unmarried". Moreover, even when it does occur, sexual reproduction is the prerogative of the fungal partner alone. The algal partner, for its part, reproduces only by dividing within the lichen. This raises the question as to how the spores of the fungus, once expelled, succeed in locating an appropriate algal partner with which to synthesize a new lichen. Strangely, this question has never satisfactorily been answered. One thing, however, is clear: if left exclusively to sexual reproduction, as humans are, most hair lichens would have vanished long ago.

Actually the most effective dispersal mechanism for hair lichens is probably simple wear and tear. Every time a chickadee flits from branch to branch, or a squirrel catapults from one conifer to another, torn fragments of hair lichens are being carried to new horizons. Those that come to rest in a suitable habitat will eventually develop into a new nest of lichen. The opportunities thus presented are unlimited: for a hair lichen, the peak of the travel season almost certainly coincides with spring and autumn migration, when restless birds are dispersing over great distances.

Some lichens travel better than others, being accomplished hitchhikers. It is not the hair itself, but the "dandruff" that is particularly mobile. The dandruff is really a special reproductive powder peculiar to lichens, and more technically called *soredia*. *Soredia* are best thought of as lichen stuffing — wefts of fungal threads intermixed with one or two algal cells — that has come loose. Lichens which produce *soredia* tend to be more widespread than those that don't, because *soredia* are easily carried by moving animals.

The ungulates, in return, are enterprising users of lichens: the moose, the mule deer and the elk all supplement their diets on occasion with hair lichens. So, of course, do the caribou and the reindeer, whose association with lichens is almost proverbial. A.W.F. Banfield, author of *Mammals in Canada*, once put it thus: "If horses are called 'hay burners', reindeer should be called 'lichen burners'."

Although all reindeer — and caribou — rely on lichens, particularly in winter, the lichen of choice throughout much of their range is the ground-dwelling *Cladina* — the reindeer

lichen. In snowier climates, however, ground forage is unavailable throughout much of the winter, and caribou turn instead to the arboreal species, which they may consume at five kilograms or more to the animal every day. The dependency of caribou on hair lichens is a remarkable, and somewhat disquieting, fact. Without the *Alectorias*, the *Bryorias* and, in some places, the *Usneas*, Canada's southern herds — inhabiting British Columbia, Ontario, Quebec and Newfoundland — would suffer a dramatic decline and, especially in the western mountains, would certainly disappear altogether.

The food value of hair lichens, though low compared with that of more traditional browse species — willow, osier dogwood and falsebox — seems to be rather high in comparison with that of other lichens consumed by caribou. Still, anyone who has ever had occasion to live on bleached white bread for extended periods will have some idea what the caribou must endure in being restricted to an almost pure carbohydrate diet. Many biologists believe that hair lichens offer starvation rations at best: low in fats, low in vitamins, low in protein, their virtue may simply be that they allow the caribou to survive the winter at all. Moreover, they must be a rather bitter pill to swallow, as a majority contain abundant lichen acids.

Hair lichens are not the only thing to grow on trees. So, unfortunately, does money. In the Columbia mountains of southern British Columbia, high elevation logging is currently destroying some of the most productive *Bryoria* habitat in the country, if not in the world. Since the hair lichens, being slow growers, depend on fairly stable forest environments, they seldom thrive in vigorous, second growth woodlands. Only in climax forest types, aged 150 years or older, do they really come into their own, sometimes weighing in at three tonnes to the hectare. As climax forests now begin to disappear, so must the caribou that depend upon them during the winter months.

Someone once suggested that Canadians are a people who sing about the north while living in the south. The maple leaf, after all, derives from a southern tree, not a northern one. Perhaps we could do worse than to adopt the hair lichens, hanging from conifers across the breadth of northern Canada, as our unsung banners.