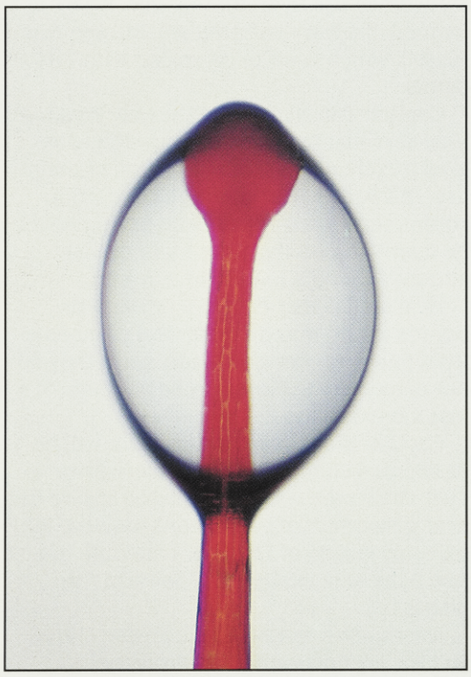
NEW ZEALAND ALPINE PLANTS INSIDE & OUT



A sundew hair with its blob of sticky glue.

During the last three years, Bill and Nancy Malcolm have used photographic and microscopy techniques to look closely at the structure of alpine plants. In this article they describe what some of those structures do for alpine plants.

The delicate and lovely flowers in New Zealand's mountain meadows look utterly peaceful, but in fact they are constantly fending off assaults by the harsh elements, by leaf-eating insects and browsers, and even other alpine plants. They survive those assaults only because their ancestors long ago suffered the same problems, and gradually evolved solutions. The solutions show up in their structures, like the shape and colour of their flowers, the hairs on their leaves and stems, and the beautiful but deadly crystals in their tissues.

For example, the mirror-bright droplets of sticky glue on the leaf-hairs of an alpine sundew are a lethal ambush, luring flying insects to their doom. The glue clings tenaciously to foraging insects unlucky enough to touch it, and the insects' buzzing struggles only mire them further in a tangle of sticky hairs. Quickly subdued, the captive insects are digested by enzymes within only a few hours. When the sundew leaf has absorbed the nutrients from its hapless prey, the hairs cast off the empty insect carcasses, renew the glue droplets, and lie quietly in wait for more victims.

Carnivorous talents

The sundew's carnivorous talents allow it to survive in the sodden soils around alpine tarns, where nitrogen and phosphorus are scarce because high acidity, numbing cold, and water-logging conspire to disable the rot-bacteria that ordinarily release vital elements from dead vegetation. The sundew neatly side-steps that survival problem with its glue-tipped hairs that can snatch out of thin air the nutrients it needs, packaged as insects winging in from distant nutrient-rich areas.

The dramatic stripes on the leaves of the southern heath *Leucopogon suavealens* look merely decorative to us, but in fact the plant could not survive without them – they are bands of dense hairs that shelter the leaves' stomates ("breathing pores") from mountain winds. In spite of frequent drenching rain, alpine plants constantly risk drying out from wind because their open stomates unavoidably lose water vapour while exchanging vital gases during photosynthesis. Many plants solve that survival problem by covering their stomates with matted hairs. The fierce gale that seems to be battering the plants is only a mild zephyr for the stomates snuggled down safely among the hairs.

Botanists from all over the world travel to New Zealand to see cushion plants like our justly famed vegetable sheep. Cushions are made up of a dense mat of branches running along the ground and sending up closely packed leafy shoots. The smooth outer surface of the cushion is made by a fully automatic mechanism that stops their branches from growing any higher than whatever is next to them. Such precise control of their growth allows them to make seamless joins with rocks and with other cushion plants, thus solving several survival problems at once – winter ice-blast, grazing, over-topping, and drought. A cushion is low enough to escape winter winds, hard and slippery enough to frustrate grazers, dense enough to squeeze out competing plants, and water-proof enough to prevent the soil under it from drying out.

Formidable array

Our alpine plants have long suffered the ravages of hungry leaf eaters. For millions of years they were gobbled up by moa, and now with barely a pause after the moa were hunted to extinction, they are a meal for myriad introduced browsers like hares, deer, and goats. But, they defend themselves against their predators with a formidable array of powerful irritants and poisons. For example, the willowherbs (*Epilobium*) lace their tissues with poisonous chemicals and needle-sharp crystals. The needles (called raphides) punch thousands of tiny holes in the soft mouth-lining of grazers, and then the poisons rush through the holes.

Oxalis often is eaten in salads for its pleasantly acid flavour (*oxalis* in Greek means "sour"). That tangy flavour comes from oxalic acid. Oxalic acid is not likely to harm people in only salad quantities, but it can be lethal to grazing animals. Oxalic acid poisons grazers by damaging their kidney tubules and by tying up vital soluble calcium as non-soluble calcium oxalate, causing hypocalcaemia (commonly called "milk fever") with its bizarre symptoms of staggering and convulsions.

Alpine plants face problems in getting enough nitrogen and other elements to build and repair their structures. We humans are inclined to think that those problems must always be caused by the alpines' harsh habitat, but in fact their fellow alpine creatures are often to blame. For example, the eyebrights (*Euphrasia*) look harmless enough, but actually are parasites. Rather than find their own nitrogen supplies, they plug into the roots of other plants unlucky enough to be growing near them, and then mercilessly suck out vital fluids. That root-parasitism solves their own nitrogen problem, but of course it worsens their hosts' nitrogen problem.

An eyebright sucks fluid from its host through thousands of tiny parasitic connections called haustoria that directly connect the inner piping of the two plants. The eyebright doggedly ensures that traffic is strictly one-way through the haustoria by constantly evaporating water from its leaves. It is well-equipped to do that, too – it has far more stomates (pores for gas exchange) on its leaves than its host does. With its myriad stomates, the eyebright is a living wick that steadily evaporates away the host's precious water supply, sucking out at the same time the nitrogen-containing molecules that the parasite uses to build and repair its own structures.

Eyebrights can live on the cheap because they get materials and energy from their host rather than going to the trouble of finding their own supplies. Like human thieves, they get rich quick, but unlike human thieves they run no risk of being caught or even suffering the cluck-clucking of outraged moralists. They get away with anything that works, and the only measure of their success is how many offspring they can leave behind them.

No moral "high ground"

There is no moral "high ground" in the