J. C. VOGEL

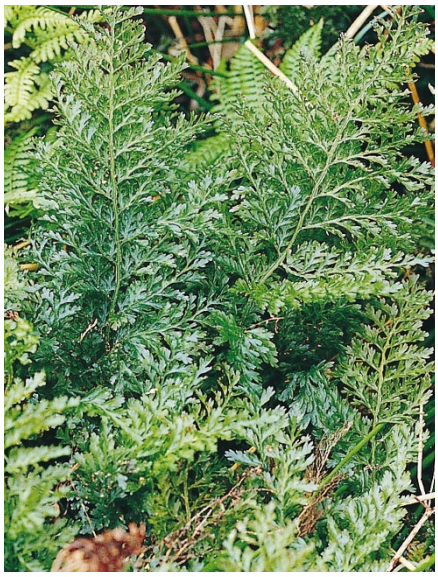

Figure 1 **Alive and well — the Killarney fern, *Trichomanes speciosum*. Left, the sporophyte generation. Right, the gametophyte generation, now discovered by Rumsey *et al.*[1] in areas where the fern was thought to be extinct.**

fern, presumed extinct over its former eastern range, may survive in a gametophyte form in some of its former localities. Rumsey, Jermy and Sheffield now report[1] that the gametophyte has been found alive and well in eastern England (from Yorkshire to Kent), France, Germany, northern Italy and even east into the Czech Republic. The plant has evidently continued its existence in a more occult form, but a desiccation-resistant form which has proved more appropriate for the warmer, drier climate that developed after the Little Ice Age (ending around 1700).

Several lessons, and questions, arise from this discovery. The definition of extinction for a plant must cover all stages of its life cycle. Seeds from plants considered extinct in a locality have been known[5] to germinate from soil seed-banks, often due to physical disturbance, and have re-established an above-ground population. For example, the fen violet (*Viola persicifolia*) reappeared, following some clearance of scrub, after an absence of almost 70 years at a wetland site in eastern Britain.

The seed bank must, therefore, be regarded as part of the population of a higher plant species when considering its conservation and biogeographical status. But this is difficult to survey, and the status of plants that occupy ephemeral habitats — and, as a result, have seeds with long dormancies — is a particular headache. For instance, a rare subspecies of the perennial knawel (*Scleranthus perennis* ssp. *prostratus*), which is endemic to East Anglian heaths[6], shows short-term disappearance but long-term persistence.

Some flowering plants (such as many orchids) may even spend part of their lives in a subterranean form, before emerging and becoming autotrophic. Orchids are notoriously difficult to monitor in population terms, because juvenile plants indulge in symbiotic, saprophytic nutrition. Some orchids, such as the Western Australian *Rhizanthella gardneri*, rarely show themselves above ground[7], and then only for flowering. Such plants could easily become extinct, unnoticed.

Another important issue is that of protection. In the case of the Killarney fern, Rumsey *et al.*[1] point out that strict legislation exists to protect the fern sporophyte, and that this should be regarded as covering the gametophyte. But it may be difficult to enforce such a law, because the gametophyte superficially resembles an algal felting — a green fuzz on a wet rock. Their survey indicates, however, both a widespread distribution and a degree of local abundance for the Killarney fern, so it may be less threatened than was feared. Moreover, its unappealing gametophyte may not need to be legally protected from collectors. The Killarney fern may one day come into its own in the east once more, and develop some fruiting fronds — but it may have to wait until the climate goes into reverse and we have another Little Ice Age. □

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Daedalus

Cleansing fire

The ramjet is an appealingly simple engine, with no moving parts. Its sheer forward velocity compresses the air entering its intake; fuel is burnt in it, and the resulting hot gas expands in the exhaust nozzle to generate thrust. Sadly, it only works at very high speeds. Daedalus once invented a more tractable variant. This was a ground-effect ramjet, or gramjet, which skimmed over a prepared smooth track. As it sped along, its sloping underside compressed the air beneath it against the track. Downward-firing burners raised its temperature, and the hot exhaust gases expanded against its upwardly sloping rear surface to drive it along. Ground-effect compression works at quite moderate speeds, and the upward pressure of entrainment and combustion levitated the craft in hovercraft fashion. Inevitably, however, the fierce unshielded flame beneath it tended to damage its track.

Daedalus now wants his gramjet to travel over water. He sees it as the ideal way of cleaning up oil slicks. Not only would the intense flame from the vehicle burn the oil; the heat of its combustion would help to drive it along. Indeed, a fresh, thick slick loaded with volatile hydrocarbons might even burn fiercely enough to drive the gramjet for free.

Sadly, most aged slicks are too thin and tenuous to burn as strongly as this. In any case, a thin slick is water-cooled too well to burn completely. But Daedalus is undismayed. He recalls that a flame passed over a polyethylene sheet oxidizes its surface (this makes it easier to glue). Even if a slick is only partly oxidized by flame, the resulting oxygenates and fatty acids will act as detergents, emulsifying and dispersing the unburnt portions. So DREADCO engineers are now devising the most chemically active flame for the slick-burning gramjet. Ozone will enhance its reactivity; an electric discharge through the flame will generate active free radicals; oxidants such as sodium peroxide will be sprayed in to encourage the combustion reaction and form detergent from its residues.

Thus a powerful new broom will sweep our polluted seas and waterways. Waterborne gramjets will zoom over oceanic slicks, around dirty harbours and along fouled industrial canals, leaving a sparkling wake behind them. Unless, of course, it is more profitable to keep the water thickly covered in oil, and run slick-fuelled gramjet services over it.

David Jones