

the lower rate implies changes in estimates of the relative amounts of elements formed during the explosion of massive stars as supernovae, and therefore in estimates of the rate at which heavy elements are distributed through the Universe. ■

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Conservation biology

Parasite rattles diversity's cage

Peter D. Moore

Grazing and mechanical mowing can increase plant diversity in grassland, probably by weakening dominant species and so allowing others to thrive. A partially parasitic flower can, it seems, have a similar effect.

Diversity is the conservationist's prime goal. Habitats are often evaluated in terms of the variety of different species they can support, and management systems are frequently geared to the enhancement of biodiversity. In the quest for diversity some surprising truths have emerged, such as the fact that predation actually encourages diversity in an ecosystem, and that the seemingly destructive action of mowing can create a grassland sward rich in plant species. The work of Richard Pywell and his associates¹, published in *Journal of Applied Ecology*, reveals that plant parasites are also agents of diversity, and that they too can be used as tools for the management and enrichment of grasslands.

When Tansley and Rankin² first described the vegetation of British chalkland back in 1911, they appreciated that sheep and rabbit grazing over many centuries had eliminated tree and shrub species from some areas, resulting in the development of species-rich grassland. Using exclosure studies to prevent grazing, Tansley and Adamson³ later showed that plant diversity declined when the impact of the grazers ceased — so herbivores, they concluded, have a significant effect on plant diversity. 'Predation' such as this suppresses dominance by robust and productive species, and this frequently leads to the proliferation of less competitive species⁴. It later became clear that the predation–diversity interaction is not confined to herbivores and herbage, but applies at different trophic levels.

The value of applying predation to the management of ecosystems in order to enhance diversity immediately became apparent. Grasslands in Britain have lost much of their plant diversity as a result of management for high productivity, and conservationists are keen to reverse this trend of biodiversity loss⁵ — an aim encouraged by European agricultural policy. Grazing by domestic stock can be carefully manipulated



Figure 1 Diversity generator: *Rhinanthus minor*. This hemiparasitic plant increased plant diversity in grassland plots¹, raising the possibility that it might be a useful tool for managing grasslands.

to produce the required degree of predatory pressure at the most effective time of year, and this has become a widely used method of grassland management. An even simpler, artificial predation involves mechanical mowing, although, despite the attractions of cost-effectiveness and the avoidance of veterinary care, the outcome is not always as satisfactory as that produced by grazing. The herbivore has dietary preferences and varied techniques in trimming vegetation, and also imposes trampling on the plants and soil — all of which add to microhabitat diversity.

But could there be a third option, namely using parasites instead of predators? The yellow rattle (*Rhinanthus minor*; Fig. 1) has been the focus of research attention in the

search for possible parasites. This is an annual plant, regenerating from seed. It parasitizes grasses and clover by means of its roots, but it also has green leaves and conducts photosynthesis, so it is only partially parasitic (it is hemiparasitic).

It is reasonable to propose that the nutritional demands that this acquisitive plant places on its robust and productive hosts may reduce their vigour and permit the diversification of other species in the plant community. Experiments in Swiss grasslands⁶ have confirmed that *Rhinanthus* does indeed reduce host biomass and enhance biodiversity. But can it be routinely used by conservationists as a management tool?

To investigate this question, Pywell and colleagues set up a long-term, randomized block experiment in a species-poor Oxfordshire meadow in 1988; the results of their work have now been published¹. They sowed the experimental plots with varying quantities of *Rhinanthus* seed, and two years later introduced additional grassland species by sowing with a seed mix of ten common herbaceous plants. After four years, the plots with *Rhinanthus* present were significantly richer in plant species than the control plots in which no *Rhinanthus* had been sown. The original sowing density of the hemiparasite seemed to have little effect on the outcome, because this annual species can rapidly build up its population by seeding.

Pywell and colleagues' work has both theoretical and practical implications. Theoretically, it is now clear that parasitism as well as predation can reduce dominance and enhance diversity in an ecosystem. The practical outcome is that grassland managers have a simple and cheap alternative to grazing and mowing. The establishment of the yellow rattle can effectively prepare a meadow to receive a fresh input of seed, and can greatly increase the chances of establishment of new plant species. There is a need for caution, however. *Rhinanthus minor* is toxic to livestock and is very sensitive to heavy grazing⁷. In hay meadows it also needs to shed its seeds in the summer, before the hay is harvested, if it is to maintain a viable population. So those who manage grassland by parasitism will need to ensure that neither mowing nor grazing takes place while the rattle is growing, flowering or setting seed. ■

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