greater the heat (that is, entropy) it would have produced. For example, if dissipation occurred as early as the so-called Planck era (10^{-43} s) when quantum gravity effects were important, then even a minute amount of initial anisotropy would have produced too much entropy.

Without a detailed understanding of the dissipative mechanisms in the very early stages, it is impossible to place precise numerical constraints on the permitted degree of primaeval turbulence, but the authors conclude on general grounds that an initially highly chaotic cosmology can be ruled out. There is still the problem of accounting for the existence of galaxies in this quieter scenario, a phenomenon about which only rudimentary understanding has been gained.

If Barrow and Matzner's ideas continue to hold for more elaborate models of the big bang, it seems that we shall inevitably be obliged to face the mystery that the Universe has been created in a remarkably orderly and highly special state after all. One possible approach to this mystery is through the anthropocentric—that if the cosmos were not so regular we could not be here to know about it. A highly turbulent big bang would overproduce entropy and the cosmic background radiation would then be too hot for life to evolve until it had cooled below, say, the boiling point of water. But the temperature of this radiation takes billions of years to diminish appreciably, and if it were substantially hotter than now then the stars would have burnt out before conditions became cool enough for life to form. Without stars such as the Sun there would be no life anyway. This is not, of course, an explanation for the orderly Universe, but it provides an intriguing comment on how lucky we are that the big bang was so well-behaved. □

Red deer or takahe?

from Peter D. Moore

THE conservation of a species normally demands an active management of its habitat in order to increase its carrying capacity for that particular species. Where a species requires a habitat in its early stages of succession, this may mean extensive and frequent modifications of the habitat to prevent its maturation. Generally the amount of management effort declines in situations requiring more advanced successional stages, and for climax ecosystems the major problems are often ones of prevention of destruction of the habitat, or the control of exotic, invasive predatory or competitor organisms. Experimentation, based upon sound and detailed ecological survey and rational extrapolation, is often necessary before the best available management techniques can be devised and implemented.

Such an experimental approach to conservation is most hazardous where one is dealing with an organism on the brink of extinction. Here one cannot afford to make mistakes. Take, for example, the takahe (*Notornis mantelli*), a flightless gallinule endemic to New Zealand. Subfossil remains of the bird suggest that it once had a fairly extensive range in the south-western tip of the South Island of New Zealand, but the European settlers of the nineteenth century found few specimens and during the first part of this century it was considered extinct. Then, in 1948, it was dramatically rediscovered in the high, alpine and subalpine tussock grassland of the Murchison Mountains. It is now known to occur in an area of less than 1,000 km^2 in these mountains and its population in some parts of this area may still be declining.

Obviously, in such a situation, considerable information is required concerning the environmental requirements of the takahe, before management can be applied. One adverse influence in the area may be the introduced red deer (*Cervus elephas*). Questions such as whether these two species are in competition and whether the deer are modifying the habitat in a manner unfavourable to the takahe, need to be answered.

Mills and Mark (*J. Anim. Ecol.* **46**, 939; 1977) have attempted to provide the information needed to answer these questions. They studied a series of 10 m × 5 m plots in tussock grassland within takahe territory which were situated among the four major dominant tussock-forming plants, *Chionochloa pallens, C. flavescens, C. teretifolia* and *C. crassiuscula*. Usage of the plots was assessed by counting the droppings within them, which can be expected to reflect the amount of time spent by takahe in each. Damage to plants (the bird is herbivorous) could also be estimated directly since tussock tillers are pulled off, the base eaten and the remainder discarded in a pile.

This type of study has led Mills and Mark to conclude that the preferred food of the takahe consists of *C. pallens* and *C. flavescens*, their relative proportions varying seasonally. Plots dominated by these two species were also richer in deer faeces, particularly *C. flavescens*. Chemical analyses of the tillers of four *Chionchloa* species showed that the preferred two species exceeded the others in their concentration of N, P, K, Ca, Mg and soluble sugars (P and K statistically significant). This was not the case for S, Na and starch content. *C. teretifolia* was the species with the lowest overall food value and this species was not recorded as eaten by takahe in the study plots.

From this study it is evident that the two species, *C. pallens* and *C. flavescens*, are more nutritious and are preferred as food sources by the takahe. The red deer, however, has similar food preferences and this fact, together with the limited abundance of the two plant species (20% and 10% cover respectively) indicates that competition for food may be taking place between the two species. Analyses of individual tussocks which had been selected for grazing suggest that both takahe and red deer selected plants rich in phosphorus for their attention. Overall, the red deer had a more varied diet, including more dicot species, but the coincidence of their preference for phosphorus-rich *C. flavescens* tussocks confirms an overlap of niche and hence a competitive interaction. Severe competition, however, may be avoided by the fact that deer take the leaf blades whereas takahe take the basal sheaths.

The impact of the competitive interaction is likely to be most severe when some other factor, such as prolonged snow cover in a severe winter, causes harder grazing by the deer and consequent damage to the structure and composition of the alpine grasslands. Under such conditions, of course, the first plants to suffer will be those with the highest phosphorus content, thus depriving the takahe of their nutrient resource.

The New Zealand Forest Service is currently conducting deer population control operations in the area and the work of Mills and Mark suggests that this could have beneficial effects not only for forestry but also for the alpine grasslands and the takahe. For this endangered species, the removal of red deer is likely to do nothing but good.

Peter D. Moore is a senior lecturer in the Department of Plant Sciences, King's College, London.

Order in amorphous polymers

from Paul Calvert

THE problem of whether there is long range order in liquid and glassy polymers has long been troubling polymer science. The 1975 Shrivenham Meeting on Polymer Physics followed closely after a symposium on 'Physical struc-

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