Biodiversity from Darwin on

WHILE applauding the experimental connection between biodiversity and grassland sustainability forged by Tilman and co-workers[2] (discussed in the main article here), it pays to recognize the long history of ideas about biodiversity. In the *Origin of Species*[5], Charles Darwin wrote:

"It has been experimentally proved, if a plot of ground be sown with one species of grass, and a similar plot be sown with several distinct genera of grasses, a greater number of plants and dry herbage can be raised in the latter than in the former case" (page 85).

It is not evident what experiments Darwin was referring to, but it is clear that he had a mechanism in mind for the connection between diversity and productivity. In particular, Darwin seems to have anticipated Tilman and colleagues' hypothesis of greater efficiency through niche diversification and more complete usage of a limiting resource:

" ... the truth of the principle that the greatest amount of life can be supported by great diversification of life, is seen under many natural circumstances" (page 85).

Experiments on biodiversity and ecosystem function also rest upon ideas advanced by some distinguished ecologists. For instance, the hypothesis that diversity begets stability was eloquently advanced by Charles Elton in 1958 (ref. 6). Elton thought that the balance of simple communities was more easily upset than that of richer communities — but he did not propose any clear mechanism for this effect. A turning point in diversity–stability research occurred with the publication of Robert May's theoretical monograph examining the dynamics of model ecosystems[7]. May irrefutably showed that, in itself, diversity provides no guarantee of stability, and that diversity must be arranged in special ways to promote stable communities. Unfortunately, experimentalists seemed to misinterpret May's monograph as the final word on diversity–stability, and tended to abandon experiments aimed at contrasting the properties of diverse communities with those of simple communities.

It is only with the popularity of conservation biology and the awareness of worldwide threats to biodiversity that experimental ecologists are returning to the study of biodiversity's function. Further progress will require combining experimental expertise, as typified by the analyses carried out by Tilman's group, with Darwin's appreciation of natural history and the kind of theoretical insight exemplified by May's work. Simple experiments, by themselves, will not be sufficient to resolve the services and functions of biodiversity. It will pay to look to the past in tackling the relevant issues in the future. P. K.

about preserving those first ten species of prairie plant, but not to bother once that quota has been satisfied? Obviously, there are other types of ecosystem function (resistance to drought or to pathogens, for instance) that could reveal a value to biodiversity in excess of the ten species seemingly needed for efficient nitrogen use.

Rather than viewing Tilman and colleagues' results as definitive documentation in favour of protecting biodiversity, we should see them as a call to develop more experiments of the same sort. We need to be especially conscientious about reporting experiments that fail to find any effects of biodiversity, and at finding ways to study systems such as forests that do not lend themselves to such elegant manipulative experiments. It is hard to be a biologist and not appreciate the diversity of life forms — but it is even harder rigorously to assess the ecosystem function of biodiversity in a manner that speaks plainly to the concerns of the public and policy makers. The new work is a milestone on the road to ecological research whose results can be directly related to debates about the preservation of Earth's variety of life forms.

There is currently great enthusiasm among biologists for using modern experimental approaches to identify potential values to biodiversity. But we need to keep this scientific evidence in perspective. No matter how the evidence weighs in with respect to the function of the variety of species in different ecosystems, there will remain many alternative reasons for preserving biodiversity. For example, some believe it is unethical to extinguish species forever, and several religious leaders have supported the Endangered Species Act in the United States on moral grounds. Perhaps most important of all, many people value biodiversity as a legacy to be passed on to future generations — no one wants to tell their grandchildren that they passively watched as ignorance and greed led to the loss of richness of the world's flora and fauna. The ecological value of biodiversity is of course a scientific issue — but it is not the only route towards delivering commitments to preserve the diversity of living things. □

Peter Kareiva is in the Department of Zoology, University of Washington, Seattle, Washington 98195, USA.

PARTICLE PHYSICS

A glimpse of the antiworld

John Eades

THE *Physics Letters* article "Production of antihydrogen" by Baur *et al.*, published earlier this month[1], will not surprise any *Nature* reader who does not live at the bottom of a very deep mine. Indeed, the experiment made headlines from Bangkok to Toronto, and in most large villages in between. Why antihydrogen? Did, as *Le Figaro* implied, the CERN press service jump the gun in issuing a pre-publication announcement? Was there a European–American antihydrogen race? How significant is the experiment scientifically?

The electron's antiparticle, the positron (e^+), was found in 1932, but the antiproton ($\bar{p}$) only appeared on the scene in 1955. The possibility of binding these together to form an antihydrogen atom was immediately raised, in semi-popular articles[2,3] as well as technical ones. However, there was no pressing reason to address the enormous problems of doing so until lasers revolutionized the practice of atomic spectroscopy, making it possible to measure transition frequencies between atomic energy levels with almost unimaginable precision. At the 1992 Antihydrogen Workshop in Munich, it was suggested[4] that the energy of the transition from the 1*s* to the 2*s* spectral state might ultimately be measured in ordinary hydrogen and antihydrogen to one part in 10^{18}.

Such comparisons test the world for its symmetry properties. A washing machine assembled from left-handed screws, coils and springs would work just as well as a right-handed one — together, the two form a left–right symmetrical system. However, the kit of parts for making a working, mirror-symmetrical model of the whole world is defective. Some essential screws and springs, like right-handed neutrinos, are missing. When physicists complained about this, nature pointed out that she had supplied a complementary kit of antiparticles (containing, for example,