evidence, we maintain that during the middle and late Miocene C4 plants expanded gradually in favourable ecosystems around the world in response to both biotic and abiotic factors.

We do not agree that our use of the word "emergence" caused us to misrepresent the conclusions of Cerling *et al.* regarding the expansion of C4 ecosystems²⁻⁴. We did not intend to interpret our data in the context of the origin or first appearance of C4 plants, and indeed pointed out¹ that we were assessing "the development of modern tropical grassland (C4) biomes".

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No smoking

SIR — Rodu and Cole in Scientific Correspondence¹ report that, by switching to smokeless tobacco, smokers might live 7.8 years longer than by not switching. The authors compare survival rates of smokers, non-smokers and smokeless-tobacco users. The first flaw in this methodology is the assumption that if smokers take up smokeless tobacco, their survival rate will approach that of smokeless-tobacco-only users. No proof is provided for this assumption. The second imperfection is that the amount and length of smoking are not taken into account. Casual smokers will have a very different survival rate from heavy smokers.

Finally, the most disturbing aspect of this study is the conclusion that smokeless tobacco is preferable to smoking on the basis of its only "consequential hazard" being oral cancer. Approximately 30,000 new cases of oral cancer will be diagnosed in the United States in 1994 alone². Of that number, roughly 50 per cent will not survive 5 years from the time of diagnosis. In India, where much of the population uses smokeless tobacco, albeit mixed with leaves of other plants, oral cancer has the highest incidence of any malignancy throughout the body.

In my opinion, Rodin and Cole's advice that health-care providers actively advise patients to switch one addiction for

another is an abdication of our obligation and responsibility to the patient.

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Does diversity beget stability?

SIR — Tilman and Downing¹ present data which they argue support the hypothesis that more diverse plant communities are more stable. This finding, if well founded, would shed light on long-standing questions about the relationship between the diversity and stability of ecological communities²⁻⁴, and provide added motivation to conserve biological diversity. But this finding may be premature.

Tilman and Downing studied grasslands that developed different levels of vascular plant species richness (number of species per 0.3 m²) largely as a result of different amounts of nitrogen fertilization. Fertilization decreases species richness in this system⁵, paralleling a general tendency for grassland diversity to decrease with increasing soil fertility^{6,7}. Community stability in response to drought was measured using the proportional rate of change in total above-ground biomass ($1/B \times dB/dt$), estimated from the logarithm of the ratio of single harvests in successive years. More diverse quadrats showed greater resistance to drought, with less reduction in *B* heading into the drought year 1988; and greater resilience to drought, with faster recovery in *B* after 1988.

As expected from various economic models⁸⁻¹⁰, greater soil fertility generally favours plants with lower allocation to roots versus leaves, higher stomatal con-

ductance, and greater photosynthetic capacity. But plants with low allocation to roots and high stomatal conductance usually have low drought resistance, and plants with high photosynthetic capacity often do. Hence, the fact that quadrats with low species richness had the greatest drop in above-ground biomass during the 1988 drought may be a result of such quadrats having been those most heavily fertilized, and consequently those most likely to be dominated by drought-sensitive plants. The correlation of community resistance to drought and species richness may thus be illusory, reflecting the indirect effects of high soil fertility (in promoting drought-sensitive species or phenotypes) more than the effects of low diversity itself. A similar argument might apply to community resilience, which increased with species richness¹. Plants adapted to low-diversity, high-fertility sites may have been most damaged by drought, and hence the slowest to recover.

Tilman and Downing¹ did attempt to control for possible shifts in the functional groupings of plants caused by shifts in soil fertility along their 'diversity' gradient by examining partial correlations of resistance and resilience with the number and abundance of C4 versus C3 species. But C4 grasses comprise only a small fraction of species richness in Tilman's experimental grasslands⁵, and controlling for their abundance would not screen effectively for systematic shifts in other drought adaptations along the fertility gradient. Furthermore, given that diversity and nitrogen levels are so closely related across plots^{5,10}, it seems highly probable that some within-plot (among-quadrat) variation in diversity is tied to within-plot variation in nitrogen levels and root:shoot ratio; the latter were not measured. Thus, attempts to control for among-plot differences in nitrogen, C3 versus C4 abundance, or 1993 root:shoot ratios (see reply from Tilman *et al.*) are unlikely to eliminate completely the confounding effects of fertility on drought sensitivity.

Some of the variation in species richness among the Tilman-Downing plots reflects a difference in successional age: older fields tend to be more diverse^{5,10}. These older, more diverse fields are known to be dominated by plants with a higher root:shoot ratio than those seen in younger fields^{10,11} (perhaps reflecting more intense competition for nutrients in older fields), which may account for some additional portion of the apparent correlation between stability and diversity.

The underlying problem in the Tilman-Downing study is that diversity, community biomass, soil fertility, and (presumably) species sensitivity to drought are inter-correlated along the experimental gradient. It will require considerable in-

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