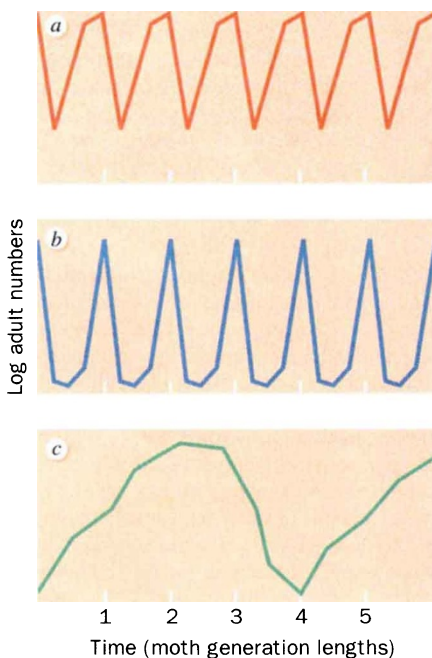


lengths. Of a total of eight boxes, only four lasted two or more host cycles; four others made it through only one cycle. In all but one of the boxes, the three species died out (the other box being terminated for other reasons). So adding a second natural enemy to the boxes destabilized the system, and led to its inevitable collapse.

The non-equilibrium dynamics of these doomed systems are some cause for excitement. Mathematical models⁵⁻⁷ produce their likes, but they have never been so convincingly demonstrated until now. Although the *Plodia* boxes are a far cry from real communities, they do serve as a promising halfway house between abstract theory and the real world.

To better understand the population ecological vehicles behind these results, first consider each single natural-enemy interaction in isolation. Their persistence is promoted, but not ensured, by unequal risks in mortality imposed by the natural enemy in question. In the case of virus addition alone², different pieces of diet carry different virus loads, meaning that hosts feeding on sparsely contaminated patches will be less prone to infection than those consuming pathogen-rich ones. In the case of parasitoid addition alone³, host vulnerability depends on the position of

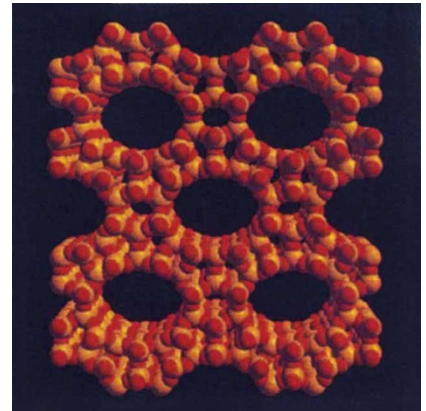


Simplified summary of the results of Begon and colleagues¹⁻³. *a*, Experimental populations of the Indian meal moth *Plodia interpunctella* exhibit cycles with a one-generation period when confined with a granulosis virus. *b*, Cycles with the same period, but much more intense troughs, occur when the moth and a parasitoid wasp, *Venturia canescens*, are confined together. *c*, The picture changes radically when the wasp is added to experimental boxes in which the virus is already present. The cycle is stretched to a period of roughly three to four generations, and the host is eventually driven to extinction, followed by its natural enemies.

Zeolites reach fourteen at last

SYNTHETIC chemists love crystals with holes in. The aluminosilicate zeolites are particularly useful, because their molecular-scale pores absorb organic molecules selectively and the strongly acidic pore walls mean the material acts as a catalyst. Natural zeolite minerals were discovered in the 1800s, and since the 1930s many synthetic versions have been constructed, but all of these contain pores made from rings of no more than 12 aluminium or silicon atoms (each bonded to four oxygen atoms in a tetrahedral arrangement). It is hard to dissuade atoms from minimizing their total energy by packing closely together.

Now this limitation has been overcome, with the material whose crystal structure is shown on the right. On page 295 of this issue, Freyhardt *et al.* describe how they made this zeolite, with its elliptical 14-tetrahedral-atom pore opening, by baking a mixture of



chemicals at 175 °C for two days, bathing the result in hydrochloric acid and then drying it out. The pores in this material are just 0.75 by 1 nm, but they should let larger hydrocarbons through than any other aluminosilicate zeolite, and so allow a range of reactions not possible before. S. B.

the host within the artificial diet — deeply feeding hosts are less likely to be found by roaming parasitoid adult females than surface-feeders. In the two instances, host vulnerability also varies with age, in that early larval stages of the host are more vulnerable to the virus, whereas later ones tend to be sought by the parasitoid.

Now take the full three-species system. The two natural enemies can combine to destabilize the system when the distributions in mortality they each impose differ sufficiently from one another: these can be differences in time or space, or according to host age or phenotype. What is important is that the natural-enemy conglomerate sufficiently imposes itself on the host population (that is, there are few escapees). In the *Plodia* system, larvae escaping viral infection in the first stages of development will always be differentially more prone to attack by the parasitoid in the later stages. So the fundamental difference of the mortality distributions is according to host age.

The intrigue of clever population dynamics aside, Begon and colleagues' study is a poignant illustration of hard upper-limits to natural-enemy diversity: too many natural enemies with overly different exploitation patterns is not a good recipe for maintaining high species richness. These results seemingly run counter to those of Tilman *et al.*⁸, published in February, who showed how the diversity of plants on North American prairies is linked to their productivity and sustainability. But the two conclusions are not really as much at odds as they might seem, in that the nutrient pools adjudicating plant competition in Tilman and colleagues' field plots are evidently more resilient to diverse exploita-

tion strategies than are the moths to the mortalities imposed by their laboratory-bound assailants. Further studies will be necessary to say something more definite about the association between the diversity of natural-enemy complexes and community stability.

The surprise player in the *Plodia* experiments is undoubtedly the granulosis virus. That an organism with such low prevalence (under 5 per cent) can have such far-reaching implications for the structure of a simple community is a potent demonstration of how minor actors in one community can be major ones in another. Arguably, the role of pathogens in community ecology has remained elusive because many of us simply wish to ignore them — they are difficult to observe, to manipulate and to quantify. The elegance with which Begon *et al.* have brought *Plodia* virus to the fore should inspire similar investigations of the effect of pathogens in other systems. □

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