first, the density of the host in the current and previous generations; second, a series of measures of forest fragmentation consisting of estimates of forest cover over successively largely circular areas centred at the sampling site (the estimates being obtained from satellite photographs involving GIS (Geographical Information System) technology).

Parasitism by the three largest parasitoids showed significant positive dependence on host density while the smallest species showed negative density dependence. The extent of forest fragmentation influenced parasitism by all flies. But the spatial scale at which parasitism and fragmentation were most highly correlated differed between species, with larger species being influenced by fragmentation measured over the greatest area. Moreover, whereas the three largest parasitoids showed reduced rates of attack in fragmented forests, parasitism by the smallest species was increased in small woods.

This study is significant for two reasons. First, it illustrates spatial patterns of positive and negative density dependence on a scale never previously studied. There is some controversy over exactly how density dependence in parasitoid attack influences host dynamics, and data such as these are invaluable in guiding new theory. Second, it shows how habitat change can alter host–parasitoid population dynamics. In a fragmented forest, the larger species that are probably most important in regulating the host perform poorly, something that might explain the longer outbreaks of *M. disstria* observed in such woodland. Further studies will need to try to disentangle the joint effects of the four parasitoids on host dynamics (here treated independently), as well as developing techniques for dealing with possible statistical non-independence of samples collected from a spatial grid.

In a highly fragmented landscape, individual populations may be destined to become extinct in a relatively short period of time. However, the ensemble of populations may persist if they are loosely coupled by migration and if colonization is able to balance extinction. Such a population structure is known as a classical, or 'blinking lights', metapopulation.

One of the best examples of a classical metapopulation is provided by the work of Hanski and colleagues on *Melitaea cinxia*, the Glanville fritillary butterfly, in the Åland archipelago in Finland. The butterfly exists in small scattered populations in areas where its food plant grows, with each population having a relatively high probability of extinction. Previous studies had shown that extinction rates were correlated with population size, but Lei and Hanski[2] have demonstrated that parasitoid attack also influences extinction.

Melitaea cinxia is attacked by a parasitoid wasp, *Cotesia melitaearum*, which in this region appears to be specific to this host. Host populations of a particular size are more liable to become extinct if they are attacked by parasitoids. Cases of parasitoid, but not host, extinction, and parasitoid colonization of host patches have also been documented. The picture is complicated by the presence of other parasitoids in the system, including a further primary parasitoid that does best in patches where *C. melitaearum* is absent, and a hyperparasitoid with a very wide host range which shows a strong density-dependent response to *C. melitaearum* cocoons.

It is interesting that the father of parasitoid population biology, A. J. Nicholson[3], anticipated host–parasitoid metapopulations 50 years ago. The Nicholson–Bailey equations, the ur-model of parasitoid population dynamics, predict unstable local population dynamics and Nicholson suggested that persistence may occur through a dynamic process of colonization and extinction exactly as in a modern metapopulation.

A more curious example of spatial processes is provided by the work of Harrison and colleagues on the moth *Orgyia vetusta*, which forms persistent outbreaks on certain patches of its host plant (*Lupinus*) along the coastal strip of north California. Why do outbreaks persist in patches of contiguous bushes for many years without spreading? Experiments have excluded differences in host-plant quality, leading to the suggestion that parasitoids dispersing from the outbreak area might cause a halo of intense parasitism in the surrounding bushes that prevents the spread of an outbreak.

Earlier this year, Brodmann, Wilcox and Harrison[4] published the results of experiments showing that parasitism is highest in the areas surrounding the outbreak, as the parasitoid hypothesis predicts. But why should parasitoids disperse away from outbreaks and so presumably lower their reproductive fitness, and why do parasitoids not reduce population densities within the outbreak? Interference between searching parasitoids is a possible solution. Like the other two studies discussed here[1,2], this work shows the importance of thinking spatially — but it raises as many questions as it answers. ☐

H. C. J. Godfray and M. P. Hassell are in the Department of Biology and the NERC Centre for Population Biology, Imperial College at Silwood Park, Ascot, Berkshire SL5 7PY, UK.

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Daedalus

Radical nutrition

Waste disposal is an intractable problem. Solid organic wastes give the worst trouble: paper, plastics, food residues and so on. Ideally, we should burn them to generate power. But garbage burns poorly, giving an acrid smoke. Liquid-phase combustion would be better, but needs daunting temperatures and pressures, or expensive reagents such as excited silver ions. Yet nature has two separate processes for destroying organic waste; and both use the same simple, room-temperature reagent.

Organic matter in the atmosphere is degraded by hydroxyl radicals. Generated by the action of ultraviolet light on ozone, they oxidize or decompose almost every organic molecule. And in our own bodies, the immune response attacks foreign invaders with this same deadly weapon. So Daedalus wants to recruit hydroxyl to the cause of waste disposal. The radical is perhaps most easily made by irradiating water with gamma rays, which suggests a new use for radioactive waste. But it may be wiser to make it by irradiating wet ozone or hydrogen peroxide solution with UV light.

Daedalus's pilot process illuminates an aqueous slurry of organic waste with intense UV light, and pumps in ozone or hydrogen peroxide. The waste is forcefully degraded and broken down by irresistible radical chemistry. But even the strongest UV cannot produce enough hydroxyl to oxidize tons of waste completely to carbon dioxide and water. Fortunately, it doesn't have to. Daedalus's process needs merely to degrade and oxidize the molecules of the waste sufficiently to render them soluble in water. A little oxygen forced into every molecule, breaking up long chains and terminating them with hydroxyl or carboxyl groups, should suffice.

The resulting clear soup will contain some volatiles — simple aldehydes, ketones, and the like — which could be distilled off for use as solvents. The residual solution will contain the involatiles: long-chain fatty acids, polyfunctional alcohols, saccharides, and so on. The mixture, says Daedalus, should be quite nutritive.

Even DREADCO's ever-optimistic Marketing Department has small hope of selling partly oxidized rubbish as a human food product. Fortunately, the practice of feeding rubbish to animals is already well established. So Daedalus will incorporate his oxidized rubbish into pet foods, cattle feed, and so on. Hydroxyl radicals are utterly deadly to viruses and bacteria, so these products will be quite sterile. There is no danger of another BSE crisis.

David Jones