A quiet supernova?

As astronomers continue to train a variety of instruments on SN 1987a, more differences between it and a generic type II supernova are becoming apparent. In particular, its lack of visibility at some wavelengths may be as significant as its prominence elsewhere.

For radioastronomers, the supernova was almost a dud. An Australian link-up between the Parkes Radio Observatory and NASA's Deep Space Network facility at Canberra detected radio emission on 26 February, three days after the explosion, but by 3 March all was quiet again. This is markedly different from the usual type II supernova which, according to Roger Chevalier of the National Radio Astronomy Observatory in Virginia, may take weeks to warm up in radio frequencies, but then remains bright for several months.

In addition, the Japanese Astro-C (Ginga) X-ray satellite has seen nothing, and astronomers at the Institute of Space and Aeronautical Science in Tokyo deduce an upper limit of 4 milliCrabs on the X-ray

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flux. (One milliCrab is one thousandth of the measured flux from the Crab nebula.)

Radio and X-ray emission occur as the supernova shock wave ploughs into surrounding gas and dust. The lack of such emission from SN 1987a points to a lack of circumstellar material, and from this argument and others a clearer picture of the so-far unidentified progenitor star begins to emerge.

From the outset, the comparative faintness of the outburst suggests a smaller than usual progenitor, perhaps of eight or ten solar masses rather than twenty. A possibility that comes to Chevalier's mind is of a highly evolved star which had lost a considerable fraction of its mass; a high-velocity stellar wind could both remove the star's atmosphere and blow away surrounding material, leaving a smaller core in an evacuated region of space.

If true, this model has other implications. Infrared emission is likely to be faint, because that too comes from surrounding material 'lit up' by the outburst. And because the fuel supply is small, explosive nucleosynthesis will yield heavy elements only in small quantities, which means that spectroscopy of the expanding supernova shell may be more difficult and less instructive than might have been hoped.

David Lindley

Population dynamics

Fluctuations in a patchy world

John H. Lawton

AN impressive body of ecological theory now points to heterogeneity, be it spatial, temporal or genetic, as an important stabilizing process in population dynamics¹⁻³. It therefore comes as something of a surprise to discover a field experiment, reported on page 388 of this issue⁴, in which increasing spatial heterogeneity apparently destabilizes the interaction between aphids and predatory ladybirds. Peter Kareiva's simple but elegant field experiment involves carving homogeneous stands of the wild plant *Solidago canadensis* (goldenrod) into long, 1-m-wide strips or into more fragmented plots, each 1 m square. Intuitively, many ecologists would probably predict that the more heterogeneous habitat broken into 1-m squares would yield more stable aphid-ladybird population dynamics. In practice, exactly the reverse happens. The more fragmented habitat impedes dispersal by *Coccinella septempunctata*, the predatory coccinellid (ladybird), making it less able to locate and mop up outbreaking foci of its prey, the aphid *Uroleucon nigrotuberculatum*. The result is higher, inherently more unstable aphid populations in the more fragmented patches of goldenrod.

One clear implication of Kareiva's results is that attempts to conserve populations of plants and animals in small, increasingly isolated habitat patches set aside as nature reserves may generate some unexpected and undesirable population dynamics. Outbreaks of herbivores analogous to those created by Kareiva could do serious damage to vegetation and to the entire fabric of the reserve; indeed they may have already happened in some areas⁵. What Kareiva's experiment and related theoretical models⁶⁻⁹ show is that predator and prey mobility between patches of suitable habitat are crucial to the likely outcome of habitat fragmentation. That outbreaks of herbivores are not an inevitable consequence of such treatment is shown by a general tendency for phytophagous insects to be rarer per host plant (that is, to have lower population densities) in smaller habitat patches^{10,11}. Unfortunately, rather little is known about either prey or predator mobility in most of these examples, so the reason why they seem to be at variance with Kareiva's more controlled experiment is unknown.

In general, the *Uroleucon-Coccinella* interaction may be less at variance with existing population-dynamics theory than initially meets the eye because 'stability' needs to be carefully defined¹². Under one definition, stable populations in models or experiments return to equilibrium after a

disturbance. This is an 'all-or-nothing' definition; a population either is or is not stable. Existing theoretical models (for example, refs 2,3) point to heterogeneity as an important contribution to stability in this particular, carefully defined sense. They also show that changing the relative distributions of prey and predators, and the efficiency with which predators seek out prey, alter equilibrium population sizes and can lead either to an increase or to a decrease in victim populations. For example, reducing predator efficiency raises the equilibrium density of the prey², just as Kareiva observes.

A very different use of the word stability (called variability by Pimm¹²) refers to the amplitude of population fluctuations round some long-term average. With this definition, populations can be more or less stable. Moreover, there is no simple relationship between the two, different uses of stability; populations can fluctuate a lot, or hardly at all, and still be formally stable in the first sense of the word. What Kareiva shows in particular is that habitat fragmentation makes aphid populations less stable in the second sense, that is, they show more variability. Theoretical ecologists have paid rather little attention to the factors that contribute to population variability¹².

Kareiva's simple but illuminating experiment also says something about ecology in the broader context of 'hard' versus 'soft' science. There is no shortage of interesting theoretical ideas and sophisticated mathematical models in population biology, many with important practical implications (predicting the effects of habitat fragmentation is but one example). To test his ideas, Kareiva needed nothing more sophisticated than a field of goldenrod, a mowing machine, notebook, hand lens and a great deal of patience and hard work. This is not to say that ecology can always be done on the cheap, but

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