Albersheim (*Biochem. biophys. Res. Commun.* **70**, 729; 1976) have reported that legume lectins interact with the lipopolysaccharide of their 'correct' *Rhizobium* species.

A classic way to examine the importance of cell wall components for antigenicity or phage attachment has been to examine mutants defective in their synthesis. This approach has been taken by Sanders, Carlson and Albersheim who report their findings with *R. leguminosarum* in this issue of *Nature* (page 240). By selecting bacteria after passing cultures through 1.2 μm Millipore filters they obtained mutants at high frequency which did not produce exopolysaccharide. Chemical characterisation of the mutants indicated that there was no exopolysaccharide synthesised and that the capsule and lipopolysaccharide were unaltered. Five of these mutants, otherwise apparently indistinguishable from the parent, were tested for their ability to nodulate their correct host plant, the pea; all five mutants were non-nodulating. Five spontaneous revertants of one of these mutants, selected for the reappearance of exopolysaccharide production, all regained the ability to nodulate the pea. Thus it appears that the exopolysaccharide is essential for nodulation to occur, at least in this strain of *R. leguminosarum*. Whether or not it is involved in lectin binding has not yet been determined.

It now remains for these and other workers to clarify the role of capsular, lipo- and exopolysaccharides in determining the host range of *Rhizobium* species. Indeed it has yet to be shown how complex the host recognition process is. Perhaps lectin binding is only one of a complex series of recognition processes that must occur before a nitrogen fixing nodule can develop. □

Mining triggers earthquakes

from Peter J. Smith

It is almost universally accepted now that, given the right circumstances, earthquakes may be induced artificially by injecting fluids into the ground, by setting of underground nuclear explosions or by filling large reservoirs. Indeed, the idea is so commonplace that there may be some difficulty in believing that less than 7 years ago it was the subject of lively controversy, largely because the evidence in favour of man-made earthquakes, though strong, was then little more than circumstantial. What was lacking in most cases was a detailed record of seismic conditions for the period before the suspect events had become quite obvious even to the least sensitive member of the population. In short, 'before and after' seismic comparisons were generally not available—a data gap

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Animal sounds: coloratura and basso profundo

from John Krebs

Many species of birds and mammals use sounds as threat signals in contests over territory and other resources. Dogs growl, elephants roar, and great tits scold. The remarkable thing is that the threat sounds of most birds and mammals tend to be low-pitched, harsh (broad frequency spectrum) noises. In contrast non-aggressive signals, such as appeasement gestures, tend to be high pitched and contain pure tones. E. S. Morton (*Am. Nat.* **111**, 855; 1977) now suggests an explanation.

Threat signals in the animal world to some extent replace out-and-out fighting, presumably because it is less dangerous for an individual to settle a dispute in this way. But obviously the loser of the contest, which might be for example over a piece of food, does less well than the winner and so one might expect, anthropomorphically speaking, losers not to give up easily when faced with a threat signal unless they are sure that they would lose eventually. The inescapable conclusion is that at the beginning of a contest animals try to assess the fighting ability of their opponent without actually engaging in a scrap. What sort of cues therefore would give reliable information about an opponent's fighting ability? A totally arbitrary cue would be easily faked, but some body features are inevitably correlated with strength, an obvious example being body size.

The significance of low pitched threat sounds should now be apparent: on the whole, larger individuals are capable of producing lower pitched sounds. The pitch of a threat call depends on the tension, size and thickness of the vibrating membrane on the voice box, and at least in mammals, on the volume of the nasal and oral cavities which act as resonators. In other words, depth of voice gives a quick, rough indication of how big an opponent is, and so it is not surprising that low pitched sounds have, during evolution, become an effective way of threatening a rival. Harshness is often an inevitable by-product of low frequency sounds, since a vibrating membrane under low tension will tend to produce harmonically unrelated tones.

Why should appeasement and non-aggressive sounds be high pitched? One possibility is Darwin's Principle of Antithesis—signals conveying opposite kinds of information tend to be very different to reduce confusion —but Morton also suggests that high pitched appeasement calls have, so to speak, parasitised the fact that animals respond in a non-aggressive way to the high pitched begging calls of their young.

Coloratura, according to my dictionary, refers to 'incidental trills introduced to make a song or other piece of music more agreeable.' The song of our common or garden wren (known across the Atlantic as the winter wren) has enough coloratura to make Rossini's' *Una voce poca fa* sound like a Gregorian Chant, but does this make it more agreeable to other wrens? D. Kroodsma (*Am. Nat.* **111**, 995; 1977), suggests that it does. He studied song recordings of the nine species of North American wren, which show a considerable range of complexity. Virtuosi such as the long-billed wren have over 100 different song types for each individual male, while the less ostentatious male Bewick's wren has between 9 and 20 song types. Kroodsma calculated for each of his nine species an index of song virtuosity, including information about the number of song types and the complexity of each type (for example our own wren has few song types but each one is very long and complex, so this species scores high on overall virtuosity.)

One conclusion of this analysis is that wren species with the most complicated songs are those species in which males are most polygynous. In polygynous species, the males compete intensely for females to add to their harems, and as the females have a choice of mate, they exert powerful sexual selection on males. Any male trait which increases his attractiveness to females will be favoured, and it seems that coloratura singing in wrens is just such a trait. It is an auditory peacock's tail.

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