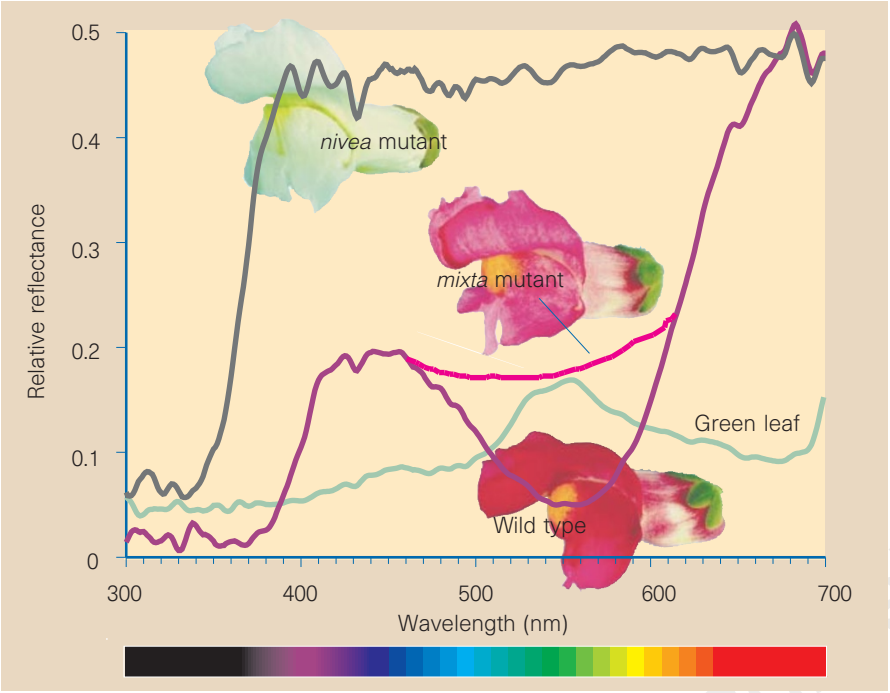

Figure 2 **Reflectance spectra of *Antirrhinum majus*. A colour shift from purple to pink (as in *mixta* mutants) is generally mediated by an increase in green reflectance[5] (pink curve). Ultraviolet-reflecting white flowers (such as the *nivea* mutants) usually reflect all light above 360 nm (grey line), whereas ultraviolet-absorbing white flowers cut off at 420 nm. Mutant spectra are inferred from flowers of over 1,000 other plant species[5].**

and shapes attract different pollinators and, indeed, that they often represent adaptations of plant species to specialize on different pollinators. This is the idea of 'pollination syndromes', which Glover and Martin refer to throughout, and which underlies other studies of floral evolution.

For example, the mapping by Bradshaw *et al.*[9] of quantitative 'speciation genes' in monkey flowers, genus *Mimulus*, assumes that differences in flower colour and shape erect reproductive barriers between lineages, transforming them into separate biological species. This requires that different colours and shapes automatically confer specialization on different pollinators, but the evidence[10] suggests otherwise — different insects and other pollinating animals possess colour vision with broad spectral sensitivity, and colour is mainly an advertisement rather than an innate attractant for experienced pollinators. In the case of monkey flowers, Sutherland and Vickery[11] had earlier shown that, from direct observations of pollinators, bumble-bees and hummingbirds do not specialize on different colours and shapes. So, we may have to look beyond pollinators to explain reproductive isolation between plant species[12].

Whether a bee or other pollinator prefers one flower over another is a result of many factors: innate preference (if any); past experience of one flower as more rewarding than the other; familiarity with one or the other flower; ease of handling of one or the other; and sensory limitations that may make one flower more detectable. These components have been dissected for honey bees and other bees, but we are just beginning to merge these advances with pollination ecology, and to explore the implications for plant fitness. This merger is an exciting prospect — it should allow us to transform the traditional framework of pollination syndromes into a more satisfying picture of the interactions between flowers and pollinators, and their evolutionary consequences. □

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Daedalus

Total protection

Immunization, that brilliant medical invention, is a way of arming the body's defences in advance of an attack. You inject a foreign protein characteristic of the disease organism; the immune system raises antibodies against it, and acquires expertise in detecting the protein and neutralizing its threat. Any pathogen bearing that protein is thereafter rapidly overwhelmed by primed and practised immunological defences.

Daedalus now wants to generalize this technique. The immune system seems to be able to produce antibodies to any protein, or any number of proteins. So DREADCO biologists are devising a universal immunization. At first they planned to exploit modern combinatorial chemistry to synthesize a mixture of all possible proteins, and inject it into test subjects. But the combinatorics defeated them. With 20 possible amino acids at each link in a protein chain, an immunization containing just one molecule of all possible 20-link chains would weigh well over a kilogram. And much longer chains are common.

However, life uses only a small subset of proteins, those with useful foldings; many of them are common to several species. So Daedalus's team is now scouring farms, zoos, botanical gardens, and culture archives to acquire samples from, or a specimen of, every known living thing. They plan to mix and homogenize the specimens, and extract their proteins. The resulting mixture will still be wildly complicated, but should be a feasible immunization.

DREADCO's 'Noah's Ark Vaccine' will be powerful indeed. An injection of it will bring a horrific feverish reaction as the subject's immune system is challenged simultaneously by millions of foreign proteins. A graded series of shots will be needed, starting with very tiny doses and only gradually building up to the full prophylactic dose. The subject will then be immune to absolutely everything.

Given to the whole population, Noah's Ark Vaccine will transform medicine. Colds, 'flu, infections, all the bacterial and viral diseases will vanish. Even if the baffled organisms mutate, they will simply hit another component of our fully primed immune systems. Even a pathogen protein not in the vaccine may still be close enough to one that is, to trigger its response. Medical costs will be cut right back. Only diseases of the immune system itself, such as AIDS, will remain to plague us.

David Jones