

If you've smelled one ladybird...

Nobody sniffs ladybirds or butterflies. Nobody, that is, except entomologists interested in finding out about the function of insect odours.

For years it has been known that many poisonous insects use bright colours to warn predators of danger, and, as a result, some species — like wasps and bees — look alike. Now scientists are finding that many toxic insects smell alike, due to the presence of a group of chemical compounds called pyrazines.

Pyrazines are found in tiny amounts in various toxic plants and animals. They are among the most odorous substances known, and little is needed to make their presence felt. The seed-heads of opium poppies contain pyrazines, but more accessible exponents of the odour are dandelions or green peppers.

Dr Miriam Rothschild of Peterborough, England, was the first researcher to notice the similarity of the odours of many brightly coloured toxic insects. In the early 1960s, she suggested that these odours form part of elaborate warning systems, and pointed out that one particular type of warning odour — the characteristic smell of ladybirds — was widespread in the insect world.

Twenty years later, Dr Barry Moore and Dr Vance Brown, of the CSIRO Division of Entomology in Canberra, showed that the odour of one of Australia's brightly coloured but toxic beetles was due to the presence of three pyrazines. They detected these same substances in several species of Australian ladybird beetles.

The two scientists have recently collaborated with Dr Rothschild to study the odour components of the well-known orange and black monarch, or wanderer butterfly, and two types of moth.



An adult monarch butterfly that has just emerged from the pupal stage — it is still clinging to the old cocoon.

To the trained noses of the scientists, all three species gave out a pyrazine-like odour. Using coupled gas chromatography-mass spectrometry, the researchers were able to identify the presence of three pyrazines, balanced in varying ratios between species. Depending on the mix of pyrazines present, the butterflies studied had either a predominantly 'ladybird' or a 'green pepper' smell.

The results showed a wide variability in the pyrazine content of monarchs — many Australian monarch butterflies are, indeed, odourless. Dr Rothschild, Dr Moore, and Dr Brown found that pupae of butterflies raised on an imported species known as swan-plant — so-called because it produces enormous swan-shaped seed-capsules — were, like the plant, pyrazine-free.

Pupae raised on the rarer red-head, which belongs to the same plant genus as swan plant, did, however, have pyrazines. So variation in odour between butterflies is related to the choice of food-plant by the female parent. Since findings elsewhere have shown that female monarchs prefer to lay

eggs on red-head, it seems that pyrazines may be one of the factors involved in the choice.

The researchers found no evidence of pyrazines in the bright yellow 'blood' of butterflies, but deduced that the insects store the smelly substances near the easily damaged membranes around the neck and wing bases. Entomologists have observed pyrazine-smelling fluid mixing with yellow blood on the



Two monarch larvae on the stem of a milkweed plant.

surface of the body of butterflies. Some butterflies release a pyrazine smelling of crushed pea pods, which flows around the mouthparts and head. When further disturbed, toxic 'blood' oozes through the neck region and mixes with the fluid.

Many harmless species take advantage of the reputation of toxic ones, and adopt the same bright colours to warn off predators. For example, the viceroy butterfly looks exactly like the monarch, but is harmless to birds and other predators. Dr Rothschild is interested in finding out whether the viceroy also mimics the pyrazine odour of monarchs.

Apart from being first-rate warning smells that can alert colour-blind or nocturnal predators, pyrazines have wider uses in nature. They occur in many plants, and ants have developed them to lay trails — the smell orientates fellow ants and repels other organisms; bees have used them for similar ends.

Dr Rothschild, Dr Moore, and Dr Brown suggest that pyrazines may also enhance other signals — for example, heightening the attractive smell of various animal and plant secretions, such as vanilla. They further suggest that this evocative quality may assist the process of learning, in the same way that bright colours quickly teach predators to steer clear.

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Pyrazines as warning odour components in the Monarch butterfly, *Danaus plexippus*, and in moths of the genera *Zygaena* and *Amata* (Lepidoptera). M. Rothschild, B.P. Moore, and W. V. Brown. *Biological Journal of the Linnean Society*, 1984, 23, 375-80.