A. PAUW

Figure 1 **Probing for pollen — the lesser double-collared sunbird *Nectarinia chalybea*. Anton Pauw[2] has found that *N. chalybea* pollinates one member of the milkweed family, *Microloma sagittatum*, by transferring pollen between plants on the tip of its tongue as it probes for nectar. This association is surprising because, from its morphology, *M. sagittatum* was not predicted to be bird pollinated.**

of plants have been classified according to their pollination syndromes and then surveyed for the actual pollinators. But I suspect that such an exercise would result in the correct prediction of only a small number of species from some of the more extremely specialized syndromes (such as 'sphingophily' — hawkmoth pollination). Most species would be difficult to classify. Tellingly, the main pollinators of many species vary between seasons and populations[8], making it difficult to infer the adaptive regime that is experienced by plants in the face of temporally and spatially variable natural selection[9].

Pauw's finding — that *M. sagittatum* is bird pollinated — strengthens this argument because it goes against all predictions. Although some South African flora are bird pollinated, these plants usually dispense powdery pollen which dusts the plumage of the visiting birds. But *M. sagittatum* is a typical member of the family Asclepiadaceae and, as such, it does not possess free pollen. Instead, it has compact accretions of pollen that attach to the pollinator through mechanical clips ('pollinaria'). These pollinaria are tiny (typically 0.25–1.25 mm in length[10]), and were previously thought to take part only in insect pollination[11]. As Pauw now describes, however, the pollen masses attach to the tongue tips of the sunbirds as they probe the flowers for nectar, and can be transferred between flowers in this way.

The short floral tube, small entrance holes and, perhaps most significantly, presence of pollinaria previously excluded *M. sagittatum* from being recognized as a bird-pollinated plant[2] — these characteristics did not fit preconceived ideas of what such a plant should look like. Based on a comparative survey of the floral traits of *M. sagittatum*, Pauw suggests that six of the nine species of *Microloma* ought to be bird pollinated. Further field observations and experiments are required to test this prediction because, as Pauw himself has shown, knowing the flower may not be enough to know the pollinator.

Previously unknown examples of plant–pollinator interactions are constantly being reported, and I would not even be surprised to read of a fish-pollinated aquatic plant. However, these relationships are more than just entertaining diversions — pollination is an ecological process that is vital to the preservation of diverse plant communities[12], so it may indirectly affect local primary production and ecosystem stability[13]. Studies of biodiversity all too often deal with species at the expense of interactions between those species, which are, after all, the driving force of ecosystem function. The more we know about such interactions, the better equipped we are to conserve them and to predict the outcomes of their disruption. □

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Daedalus

When a dead creature is fossilized, its organic remains are replaced by a mineral. Many fossils preserve the structure of the original organism with microscopic fidelity, as if the tissue had been replaced molecule by molecule by precipitated mineral — silica, calcium carbonate, or whatever. The dead organism is presumably permeated by a slightly supersaturated solution of the mineral. As each organic molecule is decomposed to soluble matter, its place is taken by deposited mineral. The process goes so extremely slowly that Daedalus sees it as an example of thermodynamic reversibility. Each organic molecule exchanges with an equivalent volume of mineral only when the process can go with no rise in entropy. The deposited mineral will adopt a crystal habit or microstructure whose strain-energy or grain-boundary density corresponds to, and therefore encodes perfectly, the free energy of the dissolving organic.

So Daedalus wants to reverse the process. Imagine, he says, a silica or carbonate fossil immersed in water quite free of mineral, but saturated with a wide range of biological substances: fats, sugars, proteins, DNA, and so on. The mineral will dissolve very slightly in the water. Its place will be taken by whatever biological molecules are best fitted to undertake the exchange deposition. These, of course, will be the ones originally replaced by the mineral. Keep the solution circulating round the fossil, remove the mineral from it as fast as it dissolves, top up the biochemicals as fast as they are deposited; and the whole process of fossilization will be gradually reversed. It may take years; but ultimately the original specimen will be exactly reconstituted.

This audacious process will require extreme biochemical subtlety. If the right substances are not present in solution, the defossilization mechanism will accept the closest available but incorrect match — especially if the process is hurried, thus losing reversibility. The next layer of organic, influenced by this mismatch, will be more mismatched still, and the reconstruction will deviate more and more from the original. Many fossils of the same type will have to be sacrificed upon the learning curve before a flawless specimen is finally recovered. But Daedalus dreams of the day when a perfectly reconstituted ancient frog or crab or fish opens it eyes in wonder, wiggles its body, and swims off into the solution.

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