Palaeontology

Questions of flower power

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THE flower is often seen as an object of beauty, but for the plant kingdom it is a source of great power. Its success as a reproductive organ is one of the main reasons why so many of the world's floras are now dominated by angiosperms. When viewed on a geological timescale, however, flowering plants have played a relatively minor role. During a total history of about 400 million years for land vascular plants, the angiosperms appeared probably no more than 200 million years ago and did not become dominant until less than 100 million years ago. How the group achieved this dominance is one of the most interesting stories in plant evolution and, on page 344 of this issue[1], Lidgard and Crane report their attempts to document the pattern of change.

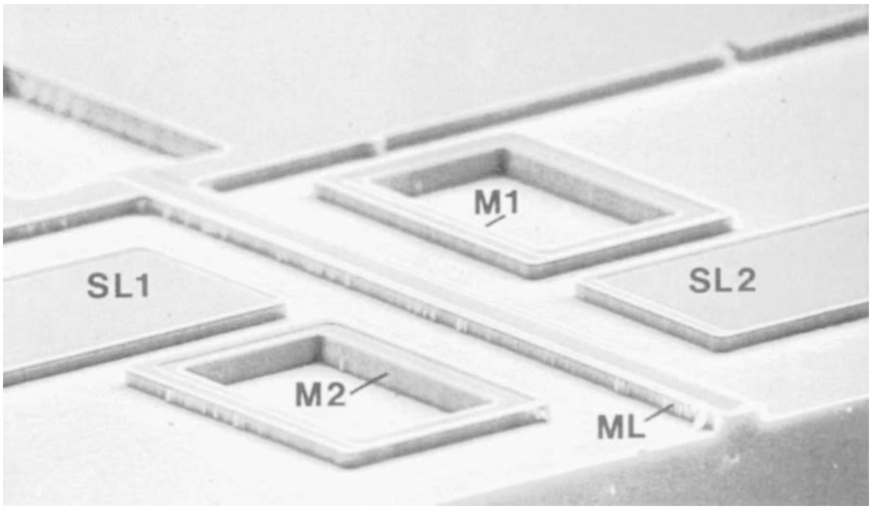
Until recently, the best available evidence[2] was from the Potomac Group of North America, in which a significant increase in angiosperm species diversity was found in the mid-Cretaceous (about 90 million years ago). This evidence represents only a restricted geographical area and a few habitats, and does not necessarily reflect the global pattern of change. Palynological studies[3] provided wider sampling and showed a similar pattern, but there remain problems. Pollen and spores are not always reliable means of distinguishing biological species, and differential rates of their distribution can bias the results.

To obtain a more comprehensive picture, Niklas and others[4-6] statistically analysed the compositions of late Mesozoic to Tertiary macrofloras, mainly from North America. Angiosperms appeared to increase gradually in diversity during the Cretaceous, mainly at the cost of cycadophytes and pteridophytes. There are significant difficulties in interpreting this type of statistical analysis of the fossil record and, to their credit, Niklas and his co-workers discuss many of them in some detail. There is a suspicion, however, that they have made the conceptual leap from observing variations in the fossil record to assuming that this reflects global changes in floras. The validity of this leap is particularly difficult to judge as they do not document in their papers which floras they have used for their analysis (these data have to be obtained separately by writing to the authors).

Lidgard and Crane[1] attempt to obtain more refined results by analysing the compositions of nearly 200 Northern Hemisphere macrofloras, ranging in age from late Jurassic to Palaeocene. They perform four different types of analysis to try to overcome some of the difficulties of sampling and taxonomy. Furthermore, they only analyse leaf remains, thereby removing the problem of overestimating diversities resulting from different plant organs being given different species names. They again find that the angiosperm radiation was mainly at the cost of the cycadophytes and pteridophytes but, in contrast to the results of Niklas and co-workers, they conclude that it occurred in a sudden burst during the mid-Cretaceous.

This result seems to be an improvement on the previous studies, particularly in the use of such a large database. It is difficult to judge, however, exactly how much better it really is because details of the data used are not given in the paper (they again have to be obtained directly from the authors). There are also other weaknesses in the study. As with most statistical analyses of this type, it is based on an uncritical compilation of species lists. This is particularly worrying in a study involving angiosperm leaves, which are notoriously vulnerable to taxonomic confusion[7]. It is probably inevitable considering the voluminous literature covered; and Lidgard and Crane do attempt to overcome it, both by using such a large database and by running a separate analysis on the data of W.A. Bell (ref. 8 and references therein). Nevertheless, one feels uncomfortable with a study in which the data used are potentially unreliable. Another criticism lies in Lidgard and Crane's ranking of the data into time intervals which are total artefacts: ranking of sequential data in this way has to be very carefully done, and can introduce a bias into an analysis.

But the most serious weakness lies in the absence of any palaeoecological or palaeogeographical input. Meyen has argued[9] that the late Cretaceous change to angiosperm-dominated floras was asynchronous in different regions. It can also



LOGIC in a flash. Future computers could be based on elements like the one shown above. This optical logic gate, built by W.J. Grande and C.L. Tang (*Appl. Phys. Lett.* 51, 1780–1782; 1987) uses the 'on' and 'off' states of its semiconductor lasers as the raw material of its digital operations. Grande and Tang demonstrate that it can be used in continuous mode for the logic operations NOR, NAND and invert.

The inputs for the gate are the two side lasers consisting of an active medium (SL1, SL2) and a mirror (M1, M2). The output comes from the main laser (ML). The mechanism was first developed in the 1960s. The main laser is coupled to the two side lasers, because its active medium falls within their optical cavities. If either is on, it depletes the population inversion, necessary for laser action, in the crossing zone. For a NOR gate, either laser alone is sufficient to quench the main laser; for NAND, both need to be on. The main laser is continually powered up, and is always on unless quenched. This means that switching times depend primarily on the 'cavity lifetime' of the main laser, and could eventually be as little as 10 ps. Other proposed optical logic devices use nonlinear optical effects, requiring high laser intensities and hence high powers. Others use changes of optical wavelength or polarization and require additional external components. Grande and Tang argue that their gate uses less power, is smaller (the micrograph above is about 60 μm across; individual lasers could be as little as 20 μm long) and does not require external components, and so could be used more readily in integrated monolithic chips using current technology. Each gate could be driven, and its output detected electronically; or an entire device could be based on optical logic and communication, with the output of one gate driving the input to one or several other gates. □