Plant pollination

Beetle vectors

from Peter D. Moore

THE reward most frequently offered to a potential insect pollinator by a flower is that of an available food resource, though there are many variations on this theme^{1,2}. Some flowers encourage visitors by possessing parabolic forms that focus solar radiation in their centres; others avoid the energy expenditure and pollen losses involved in the provision of free meals for pollinators by resorting to deceptive techniques, the most extreme of which is the offer of fake pollen in the form of yellow hairs on the lips of some orchids³. Such strategies are regarded as evolutionary advancements, but also entail a degree of risk if the foraging vector were to learn that its food-seeking efforts are in vain. Flowers that rely specifically on beetles as pollination vectors have evolved a variety of enticements for their insect visitors, ranging from the more usual food source to something more exotic — a concealed boudoir for mating activities.

The involvement of beetles as pollinators is in itself intriguing for, although this group of insects is not of great significance for pollination in moist temperate regions, it is much more important in semi-arid areas⁴ and in tropical regions¹. The antiquity of the beetles as a group and their frequent association with primitive flowers has led to the suggestion that beetle pollination represents one of the earliest types of insect vector pollination in flowering plants⁵.

An interesting example is provided by *Calycanthus occidentalis*, a shrub found along streams and in shaded gullies in California. Its attractive dark red flowers are considered to be primitive, in an evolutionary sense, and consist of a spirally arranged series of bracts and petaloid structures (tepals) that merge gradually into one another and eventually lead into stamens and carpels. In many ways the flowers resemble those of *Magnolia*, but they differ in that instead of the parts being arranged on a conical receptacle, they form a hollow cup, with the carpels seated at its base. Grant⁶ listed a number of insects, such as bees and flies, which visited these flowers, and regarded one particular beetle, *Colopterus truncatus*, as critical for pollination. Attracted to the flower by scent, the beetle enters the developing flower only to find itself trapped by the inwardly pointing bracts and tepals which are equipped with a series of stiff bristles. As many as ten beetles may be trapped in a single flower and are forced to remain there, feeding on various floral parts. They become covered by sticky pollen when, a little later, the anthers dehisce but their release does not come until the opening of the flower itself.

The food available to the beetles while they are trapped in the flower comes from specialized cells which accumulate rich resources of proteins in vacuoles⁷. The existence of such highly specialized tissues indicates close co-evolution between the host plant and its pollinator.

A rather more advanced, subtle and energy-conserving technique for recruiting the services of beetles in the transport of pollen has recently been described by Beach⁸, working in the rain forests of Costa Rica on a rhizomatous shrub, *Cyclanthus bipartitus* (Cyclanthaceae). This plant is regarded as phylogenetically close to such families as Lemnaceae and Araceae and, like the latter, has spikes of small unisexual flowers wrapped in fleshy bracts; unlike the arums, however, male and female flowers are mixed. The female flowers mature first and on the evening of the first day the inflorescence becomes invaded by night-flying beetles of the genus *Cyclocephala* (Scarabaeidae). What attracts them is uncertain, since no odour can be detected, but once within the inflorescence cavity they remain there overnight. By the afternoon of the second day, many can be observed in the act of copulation. At this stage the anthers dehisce, releasing masses of pollen into what is by now a moist and sticky environment among the enveloping bracts. Many of the beetles are apparently too engrossed in their activities to notice, on the evening of the second day, that the bracts have opened and exposed them, plastered in pollen, to the night air.

Undoubtedly some feeding goes on during this period, but the prime reason for the clandestine beetle gatherings within the *Cyclanthus* inflorescence is the shelter and protection it provides these rather slow and lumbering insects during their mating activities. Experimental exposure of the beetles by Beach during daylight hours confirmed that predation was intense, since they were rapidly consumed by both lizards and birds, such as toucans. On the other hand, experimental exclusion of beetles from the inflorescence led to its failure to produce seed. Here, then, is a mechanism by which a flower can offer its pollinator a most useful resource which involves very little energy expenditure on the part of the plant. □

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Onco gen

Transcription of c-myc

from Peter Newmark

THREE new reports on the apparent consequences for the cellular oncogene, *c-myc*, of being translocated from its normal chromosome to one that carries the immunoglobulin constant-region locus in mouse plasmacytoma and in Burkitt's lymphoma (see this column, 13 Jan.) have blurred the original picture painted by Shen-Ong *et al.* (*Cell* 3, 443; 1982).

Shen-Ong *et al.* found no evidence of increased transcription of *c-myc* in any plasmacytoma but did detect a new shorter *c-myc* transcript. Now Marcu *et al.* (*Proc. natn. Acad. Sci. U.S.A.* 80, 519; 1983) claim that mouse plasmacytomas usually have a 10- to 20-fold increase in *c-myc* transcripts, a claim independently supported by J. Mushinski, S. Bauer, M. Potter and E. Reddy in a paper in press with the same journal. One possible explanation for the discrepancy lies in the different controls used by the three different groups; Mushinski *et al.* specifically raise the question of the most appropriate control in wondering whether elevated *c-myc* transcription in plasmacytomas might reflect the arrest of the cells at a developmental stage in which *c-myc* is abundantly transcribed rather than being a consequence of translocation of the gene.

Where all three groups are in better agreement is in detecting shorter than normal *c-myc* transcripts in those plasmacytomas where there is evidence of rearrangement of the *c-myc* gene in addition to its translocation. However, Mushinski *et al.* also find a large quantity of a shortened transcript in two plasmacytomas in which there is no evidence of *c-myc* rearrangement; and they note that shorter transcripts and/or rearrangement only occurred in plasmacytomas maintained in the laboratory for several years.

Parallel studies on Burkitt's lymphoma cell lines are included in the paper of Marcu *et al.* (op. cit.) and extended by J. Erikson, A. ar-Rushdi, H. Drwinga, P. Nowell and C. Croce in a paper soon to appear in *Proc. natn. Acad. Sci. U.S.A.* They present evidence of increased transcription of *c-myc* (5- to 10-fold), regardless of whether the gene shows signs of rearrangement.

Turning to the *c-ras* oncogene family, K. Shimizu *et al.* have now isolated, by molecular cloning, that gene from a human neuroblastoma cell line which is capable of transforming NIH 3T3 cells (*Proc. natn. Acad. Sci. U.S.A.* 80, 383; 1983). It is not, they report, grossly rearranged from the same gene in normal cells and though different from other *c-ras* oncogenes, it is a member of the family. □

Peter Newmark is Deputy Editor of Nature.