## Remember last winter? The plants do

It seems that it's not just elephants that have long memories. Research by Anthony Gendall and co-workers [*Cell* (2001) 107, 525–535] shows that plants have a remarkable capacity to 'remember' too. Studying the process of vernalization (the acceleration of flowering by exposure to a cold period) in *Arabidopsis*, the team has identified the 'memory' gene, VRN2 (vernalization2). Although VRN2 is not affected by cold treatment, it 'remembers' that the cold treatment has been provided, thus permitting flowering when the plant is returned to warm conditions. Interestingly, VRN2 is similar to a fruit-fly gene, which has a chemical memory role in the insect. *NC*

## More than just a chat room

As more and more traffic speeds onto the global information highway, it is increasingly difficult to keep up with what is happening. In an attempt to try and cut a path through this jungle of 'information', a new website has been launched. Sponsored by, among others, *Nature* and *Science*, SciDev.Net is free and dedicated to reporting on and discussing those aspects of modern science and technology that are relevant to sustainable development and the social and economic needs of developing countries. (http://www.scidev.net/) *NC*

## *Brachypodium*, an alternative grass

The sequencing of the rice genome (*Oryza sativa*) in 2001, seemed set to confirm this extremely important cereal as the model grass species. However, rice is a highly specialized grass and its value as a true model for grasses generally is questionable. To overcome some of these objections, *Brachypodium distachyon* is being promoted as a more suitable alternative model by workers at the Institute of Biological Sciences at the University of Wales (Aberystwyth, UK). In spite of its non-crop status, the genome of *Brachypodium* is closely related to wheat and rye, making it a better model for such important temperate cereal species. (http://www.aber.ac.uk/aberonline/uwa10101.html) *NC*

## Lake Victoria's mess

**Fig. 1.** Water hyacinth (*Eichhornia crassipes*) in bloom. Photograph by Ted Center, courtesy of USDA.

Once thought to be under control, water hyacinth (Fig. 1) is invading and choking Lake Victoria in central Africa. The last time water hyacinth was a problem in the mid-1990s, officials used weevil pests and shredding machines to control the invasion. Now, scientists are declaring that they announced victory against the invader prematurely. Joseph B. Ojiambo, executive secretary of the Lake Victoria Environmental Management Project told reporters, 'We're seeing a resurgence.' The plant is native to the Amazonian basin in South America and was first seen in Lake Victoria in 1989. The invasion damages tourism and fishing in Kenya, Tanzania and Uganda, the three countries that surround the lake. [Lacey, M. (2001) *The New York Times*, 26 November, Section A, p. 10] *TS*

## Transgenic plants, no room to maneuver?

Among the many objections raised against the use of genetically modified (GM) crop plants is the possibility that their pollen might fertilize non-GM plants. Although so-called 'separation' or 'buffer zones' – a minimum distance between GM crops and wild neighbors – have been used, concerns remain. And such concerns are likely to be increased by Canadian reports that pollen from GM oilseed rape (*Brassica napa*) can travel at least 800 m. With the existing Canadian separation zone for rape grown for soil or food set at 175 m, that revelation is certainly food for thought! [Coghlan, A. (2001) *New Sci.* 24 November, p. 14] *NC*

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Letters

# Colour patterns in vegetative parts of plants deserve more research attention

The functional and evolutionary significance of colour patterns in animals has received considerable scientific attention since the studies by Charles Darwin [1–3]. This area of research, which is part of the scientific education of many zoologists (but not as many botanists), has frequently resulted in the formulation of hypotheses and frameworks followed by extensive experiments.

The ecological and evolutionary significance of colour patterns in plants have mostly been studied with respect to the attraction of pollinators to flowers [4] and of frugivors to fruits [5]. Colour patterns of the vegetative parts of plants, especially leaves, were proposed to protect mainly against abiotic factors, such as ultra violet irradiation [6], low temperatures [7], water shortage [8] or oxygen toxicity [9]; and against biotic factors, such as fungal attacks [10] and herbivory [11,12]. Red autumn leaves were thought to indicate tree vigour to parasitic insects, in accordance with Zahavi's handicap principle [13,14], and colourful thorns to act as a warning coloration in the Cactaceae and in the genera *Agave*, *Aloe* and *Euphorbia* [15].

However, plant biologists have not yet formulated comprehensive hypotheses for the function and adaptive value of the colour patterns of the vegetative parts of plants, such as: why are many young leaves red? Why is the abaxial side of leaves of many species white, pink, red or blue? Why are petioles and stems of so many plants red or otherwise coloured? Why are there so many types of variegation and pigmentation in leaves and stems? Why do juvenile plants or young parts of mature plants differ in colour from mature ones? We also do not understand yet why there is such a wide intraspecific polymorphism in stem and leaf colouration in plants? For instance, a large-scale study of the possible function of light versus dark colours in temperature adjustment has not been conducted, although some effort to study such an effect has been made [16].

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Moreover, even with the recent developments in the understanding of gene action, we still know little about the physiology of colouration, the biological functions of pigment molecules unrelated to their optical properties. We need a greater knowledge about the developmental and physiological constraints that either induce or block the production of pigments.

Plants comprise the habitat and food for many herbivores or carnivore animals whose eyes, and their optical analysing components in their brains, co-evolved with plants as food and as a habitat. Because plant visual cues (shape, size and colour) are perceived and used by herbivores [11,13–15,17], understanding the role of plant colouration in herbivore–plant communication should receive higher priority than it has in the past. We suggest that vegetative organ colouration might be of considerable adaptive value because of the selective role of animals that see the coloured patterns and respond. The wealth of knowledge and models available on perception of optical signals within the animal kingdom, and the relationships between plants and animals in the process of pollination and frugivory, should now be used to study the adaptive (or non-adaptive) value of vegetative plant colouration.

Concerning signalling to animals, there is a general question, what is the meaning of a particular colour? Does red, for instance, always mean the same thing? Does it mean something specific only when it appears in a specific combination with a reward or with a damaging factor, or with other colours or odours? Or, does it simply signal, 'pay attention'? It is also possible that some of these patterns have no function and they are neutral in character with no contribution to fitness. However, neutrality (if any) of so many morphological and biochemical patterns should also be proven.

The recent development of molecular genetics has provided much knowledge about the biochemical pathways of plant colouration, the genes involved and their regulation. Colour manipulation in transgenic plants is usually aimed at achieving agricultural targets, such as attractive flowers or fruit [18]. Given that there are fewer ethical problems in the experimental study of transgenic plants compared with animals, transgenic plants with manipulated vegetative colour patterns should be produced to conduct experiments designed to test ecological and evolutionary hypotheses. The study of the significance of vegetative colouration in the context of plant–animal interactions, and not just those concerning abiotic or physiological issues, should be pursued. To conclude, it seems that botanists are far behind zoologists in understanding the significance of colours and colour patterns in vegetative organs, but this gap should and could be bridged.

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