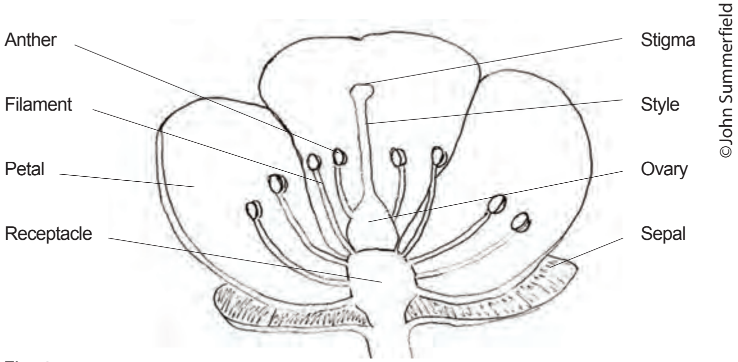

Fig. 1

How plants work – flowers

Gail Summerfield

For most hardy planters, the sheer presence of a particularly stunning plant in their garden is not good enough: they need to know its name, therefore identification is essential. At the present time, plants are classified according to their floral structure; recent developments in DNA mapping could change this, but for now we gardeners are with Linnaeus. It is necessary to have a working knowledge of the morphology, or the structure and arrangement, of the flower and the family to which it belongs. Botanists love to give everything a name, and no more so than when it comes to plant identification, so it helps to be familiar with the specialised terms.

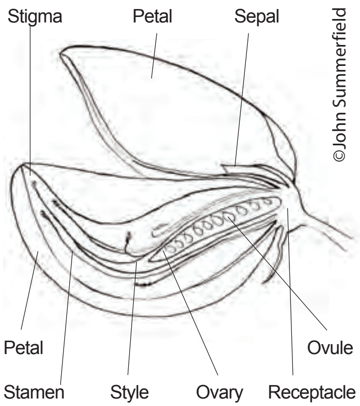

Fig. 2

Like other living things, plants originated in aqueous environments and were dependent on the presence of water for sexual reproduction. The only garden-worthy plants which have this need for water are ferns, which don't have flowers (or seeds) but instead reproduce asexually by spores. The vast majority of the plants we grow are seed-bearing, and they have been subdivided into the Gymnosperms, including conifers – where the seeds are naked, and the Angiosperms – where the seeds are enclosed in an ovary. Evolution has resulted in the Angiosperms' complex and diverse floral structures and pollination mechanisms which makes the task of identification more difficult. We can but try!

A flower is a shoot which has been modified for sexual reproduction. In order to reproduce, plants in each species or cultivar must have male and female organs: these can exist in the same flower (hermaphrodite), in different flowers on the same plant (monoecious), or in different plants (dioecious). The internodes of the shoot have been contracted to produce the receptacle from which the specially adapted leaves, the sepals and petals are borne.

Figs 1 and 2 are diagrammatic representations of a flower cut longitudinally, and although they look quite different they have the same basic parts. Fig. 1 represents those flowers which have radial symmetry (actinomorphic), while Fig. 2 shows a flower with bilateral symmetry (zygomorphic). The flower parts are grouped at the top of the adapted stem, and are arranged in spirals in the more primitive flowers like *Magnolia*, or more commonly in whorls. Each flower is borne on a stalk, the pedicel, and there may be bracts or sepals – leaf-like structures at the base of the flower – which in some cases can be more prominent than the petals.

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Fig. 3

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Fig. 4

Both the sepals, collectively known as the calyx, and the petals, collectively known as the corolla, are modified leaves. Sepals are usually green and protect the rest of the flower while it is developing, whereas petals are predominantly coloured, may be scented, and have evolved to attract insects to ensure cross pollination takes place. A wind-pollinated plant, on the other hand, can flower much earlier in the year when few insects are active, hence many of our trees flower in late winter. They produce copious amounts of pollen to be carried on the wind and have little need for large petals, often grouping their flowers into catkins which can catch the breeze. The collective name for the sepals and petals is the perianth, and in some cases where it is impossible to distinguish between petals and sepals, such as in the tulip, they are known as tepals. In hellebores (fig. 3) the petals are modified to form nectaries, and breeders have used this modification to produce the double forms which many gardeners love. Petals and sepals can be free from one another as in the rose, when the tips are often free, allowing us to count the number of petals or sepals present (fig. 4); or they can be joined together as in the primula. Once the flower is fully developed the sepals may wither, but in some plants such as *Helleborus* x *hybridus* the perianth persists, giving the impression that the flower is still young, and extending its period of interest in the garden.

The stamens or androecium are the male reproductive organs of the flower, and consist of the pollen-bearing anthers fixed to the stalk or filament. In many insect-pollinated flowers some of the petals are joined together in the form of a tube, and the stamens are fused with the petals so that pollen falls on the back of pollinating insects when they're searching for nectar. The female reproductive organ is the ovary; the style arises from it and terminates in the stigma(s) which receives the pollen.

Pollination is the transfer of pollen from the anther to the stigma. Fertilisation occurs when the pollen grain produces a tube down which the male gametes pass to enter the ovule situated in the ovary. The whole process takes place within the plant, and as the presence of water is no longer necessary the plant can survive in a much wider range of habitats.

Botanists represent the flower in three ways: a two-dimensional diagram of the flower cut in half longitudinally, a floral diagram which shows all the flower parts and their relationship to one another, and a floral formula which indicates how many of each flower part is present. When examining a flower, the most common pattern is one where the sepals and petals are equal in number. Monocotyledons like the lily have their flower parts in 3s, whereas dicotyledons such as wallflowers and roses have flower parts in 4s or 5s respectively.

The position of the ovary in the flower is also a key identifying factor: if the flower parts are above the ovary, such as daffodils, the plant is said to be epigynous; if they are below the ovary, such as the buttercup, then the flower is said to be hypogynous.

When we describe a flower, most of us do not make a distinction between the individual flower and the terminal group of flowers correctly known as the inflorescence. We are all familiar with the spires of foxgloves (fig. 5), or the balls of the alliums (fig. 6), and we may know the terms racemes, cymes and umbels, but can we recognise these structures in an unidentified flower? It would be tedious to go much further in describing the various types of inflorescence, but it's useful to know that in a raceme (foxglove) the lower flowers open first, but in a cyme (*Geranium pratense*) (fig. 7) the upper flowers are the first to open. Some very simple diagrams and descriptions of inflorescences can be found on www.theseedsite.co.uk/inflorescences: click on *A Bit of Botany*, then find 'inflorescence' in the index.

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Fig. 5

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Fig. 6

In many plants the inflorescence has evolved to suit the plant's method of pollination, hence in the wind-pollinated hazel the male catkins hang from the branches so that the wind can carry the pollen on to the stigmas of the female catkins which are small, sessile (stalkless) structures with a tuft of red stigmas. Grasses have stamens with long filaments so that the anthers can protrude from the inflorescence to catch the wind.

The advantage of a large inflorescence consisting of many flowers is that it provides insects with a copious amount of pollen and nectar in a very small space. This principle has been exploited to the full by the daisy family, the Asteraceae, where what we think of as a single flower is a composite inflorescence (fig. 8). The outer petals, the ray florets, are actually part of individual flowers whose function is largely to attract insects. In the centre of the daisy 'flower' are numerous fertile disc florets which will produce the seeds. Wild members of the family like the ox-eye daisy keep a balance between fertile and non-fertile florets, but many gardeners are attracted to flowers where the ray florets outnumber the disc florets and breeders have responded to this preference. Argyranthemums are a good example of the result: many have large numbers of ray florets and therefore very little pollen or nectar for visiting insects. Perhaps we should take a step back and consider the effect on bees and other insects before we succumb to the attraction of double, showy flowers.

Some of the plants in our gardens have interesting adaptations to their flowers and inflorescences. In the Euphorbiaceae, the flowers rarely have petals and are in saucer shaped structures called cyathia (fig. 9).


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Fig. 7


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Fig. 8

There is a single female flower with one stigma surrounded by numerous male flowers, each with only one stamen. The flower-like structure we see in herbaceous euphorbias is actually specialised bracts which persist after the ovule has been fertilised. In the inflorescences of grasses the petals and sepals are replaced by boat-shaped structures, the lemma and the palea. Within the Poaceae family each inflorescence contains many flowers, all remarkably similar, whatever the genus. The flower is reduced to an ovary with two fluffy stigmas and surrounded by three large stamens. Most grass flowers are too small to view successfully without some magnification although *Stipa gigantea* flowers (fig. 10) can be seen quite clearly with a hand lens.

To help us identify a particular plant, many reference books contain keys; they are supposed to simplify the identification process, but beware – they are only as good as the people who constructed them and often you need a tame botanist to explain all the technical terms! For gardeners, the simplest way to identify a particular plant may be to work out the family to which it belongs. Always start with the flower where the typical characteristics of the family will appear in most members. For example, in the Ranunculaceae the flowers of *Ranunculus*, *Helleborus* and *Trollius* have a similar appearance but beware of the black sheep of the family, *Delphinium* and *Aconitum*, which on first appearance do not seem to have anything in common with other family members! Even if you don't succeed you will enjoy the process, because looking at the parts that make up the flower is a rewarding experience.

How do plants know when to come into flower? Recent research suggests that a single master gene triggers the reproductive development of a plant. It generates the proteins which switch on over a thousand genes involved in the flowering process. A signal is then sent to the meristems, the areas of actively dividing cells in the shoot tips, to halt leaf production and start producing flowers. The master gene is influenced principally by temperature and light. The duration of the dark period in a plant's 24-hour cycle is known as the photoperiod, a misnomer caused by initial research which concluded that the length of the light period was the critical factor whereas it is now known that it is the length of the dark period which triggers flowering.

Plants are described as short-day, long-day or day-neutral. Short-day plants form flowers when the day length is less than 12 hours: they include chrysanthemums and poinsettias. Long-day plants produce flowers when the day length is more than 12 hours: most of our summer bedding plants fall into this category, along with summer vegetables such as beetroot, lettuce and potatoes. The third group are said to be day-neutral as they flower regardless of day length – they include roses and cucumbers. Tomatoes are day-neutral, so the tomato crop can be grown in an annual cycle producing flowers and fruit for twelve months or more from the same plant. With short-day plants, breaking the dark period with a flash of light will inhibit flowering, so chrysanthemum growers may experience problems caused by street lighting. Poinsettias have been bred to have different response times so that growers can regulate production cycles and ensure a constant supply up to Christmas.

Many plants including hardy annuals, biennials and perennials require a period of cold before flowering can occur. This preference for exposure to cold is known as vernalisation – preparation for spring. It ensures that the plants do not flower when temperatures are low and damage may occur. Vernalisation is often linked to photoperiodism. As weather can be unpredictable, the combination of day-length and temperature acts like an insurance to prevent early flowering. The most common combination is a cold period and long days leading to summer flowering. The effect of the cold period can remain within the plant until day-length reaches the plant's requirement. In some crops, such as broccoli, high temperature combined with long days will cause bolting. Prepared hyacinths are subjected to a period of cold to induce the onset of flowering, but if they are subsequently sold from a warm garden centre, flowering will be inhibited: the moral – buy your hyacinth bulbs from a reliable outside market stall.

It seems amazing just how much we take plants and botany for granted. When you're next in your garden, stop and pick a flower or two, take them into the house, pull them apart and examine them closely: they really are quite beautiful. Then perhaps consider some unanswered questions – for example, why do some shrubs flower on last year's wood and others on this year's; or how does the plant detect day-length and temperature. Subjects for future research, perhaps.

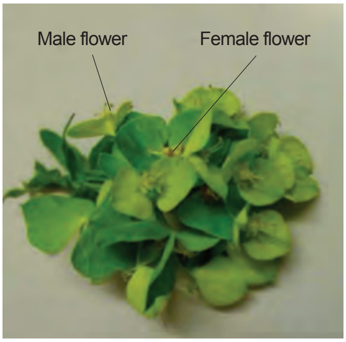

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Fig. 9

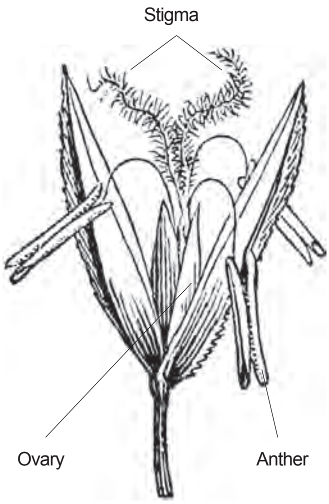

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Fig. 10

Gail Summerfield is a botanist and former lecturer in horticulture. In 1985 she started Westshores Nurseries, which has specialised in ornamental grasses for the past 22 years.