HAMPSHIRE FLORA GROUP WORKSHOPS: DEVELOPING IDENTIFICATION SKILLS

MODULE 1: INTRODUCTION

Recognising Plants

Most of us who have become curious about plants and want to understand and appreciate their diversity will have started in the same way, at least if we are amateurs: by picking up an illustrated field guide, thumbing through the illustrations, and trying to match the live plant to the pictures. As far as it goes, there is nothing wrong with this approach, since humans are rather good at pattern recognition without having to articulate the thought process behind it on every occasion.

However, once you have done this for a while, you come to realise that it has its limitations; and if you come into contact with botanists more experienced than you, you soon realise that it is easy to make mistakes. Here are some of the reasons why.

- Illustrations don't show you all the features of a plant species, and differences between plant species can be subtle.
- Illustrations show an idealised plant, not the range of variation in the species.
- Illustrations sometimes aren't very good!
- Illustrations alone don't tell you anything about the **plausibility** of finding a particular species: its rarity, its specific habitat requirements, its usual flowering times, and so on.

Of course, field guides aren't just collections of illustrations; they are ordered in one way or another to bring together plant species with some similarities, and they have descriptive text that helps you confirm an identification. Sometimes they are ordered by colour; sometimes by habitat preferences; very often they are organised by plant **families**: that is, groups of plants that have been shown to have close relationships within their group, and more distant relationships with plants in other groups. (We'll get on to how this is established later.)

The family-based approach is the most practical one if you want to deepen your ID skills, because it allows you easily to compare the features of similar species and, once you know your families reasonably well, to place something you suspect you've never seen before in its right context. But how do you get to the point of placing something in the right family?

To answer this question, let's consider three of the most popular **comprehensive** field guides to the British flora (all of them organised around plant families).

- ***Wild Flowers of Britain and Ireland***, 2nd edition, by Richard and Alastair Fitter, illustrated by Marjorie Blamey (Bloomsbury Press 2013). I'll refer to this in future as "Fitters". For each family there is a very brief family description. Within some families there are headings that help to group plants with similar features together, and some tables that show shared features of several species.
- ***The Wild Flower Key***, 2nd edition, by Frances Rose and Clare O'Reilly, with various illustrators (Warne 2006). I'll refer to this in future as "Rose". The title of this book leads to the answer to both questions. To start from square one with an unrecognised plant, one uses a key to families.
- ***Collins Wild Flower Guide***, 2nd edition, by David Streeter, with various illustrators (Collins 2016). I'll refer to this in future as "Streeter". This also presents a key to families, then to genus and/or to species. Again, where a small number of species is involved, the reader is left to make comparisons from the descriptions and the illustrations.

When I say 'comprehensive', I mean that they cover all of the native, and many of the introduced, species you are likely to want to identify in the wild without becoming an expert in some obscure and difficult groups. There are many guides that present only a selection of our wild plants, but if you want to progress you will sooner or later become frustrated or make wrong identifications with these. In fact, the *Wild Flower Key* isn't truly comprehensive as it omits grasses, sedges, rushes and ferns which are reserved for a separate book. But what it does cover is covered fully.

Using these books raises two important questions: how do we get to the right family in the first place, without going through all the likely families and comparing their features; and how do we get to the right species without carefully reading the full descriptions of all of them in any group?

There are many ways to present a key, but the principle they work on is this:

- The key presents two or more options giving contrasting plant features.
- Users choose one of the options matching their plant. (If no option matches, they will need to think again.)
- The choice of one option limits the number of matches. Eventually, there should be only one match; but while several remain, the key leads the user to another set of options to narrow things down further, and the process is repeated.
- Once the family key has been used, further keys guide one to a species for all but the smaller families where it is easy to make a direct comparison of descriptions and illustrations.

Using keys will be an important part of the workshop modules, and we'll see how the process works later. Keys are now a standard feature of almost all the more technical and detailed Floras, such as Stace's *New Flora of the British Isles* (Stace (2019)) and its predecessor, Clapham, Tutin and Warburg's *Flora of the British Isles*. It's hard to consider making use of one of these, or many of the other handbooks to particular groups of plants, without having recourse to the keys. But in the early stages of using them, you will probably struggle.

- Because of the variability of plants within the same family (especially in the bigger families), keys to family level are usually long and complex. If you have to start your diagnosis from square one each time, keying out a plant can be time-consuming and tedious.
- For the same reason, they often have to describe rather abstruse features using technical vocabulary. It's easy to go wrong if you misinterpret a particular key item, and because of the way most keys are built, it can be hard to see exactly where you went wrong.
- Keys will sometimes have to use features that won't be apparent at all seasons, when not knowing the answer to one specific question will stop you dead in mid-key.

For all these reasons, and others, it is a very good idea to learn the main features of the most important families of plants at an early stage, as this will often enable you to short-cut the keying-out process. It also means that you will learn some of the most important plant features and the technical terms that describe them in a systematic way.

This is the approach we shall take in the rest of the workshop material, learning not only the attributes of the major families but also the exceptions to

the family "rules", and the similarities to other families that you may need take into account. But first, we need to think a bit more about how plants are classified.

References and Further Reading

Stace, C A (2019): ***New Flora of the British Isles*****, 4th edition, C&M Floristics.**.
The standard handbook for British botanists since 1991.

Putting Plants in Order

WARNING: this section is a bit heavy. It gets better again later.

The Background

How does one decide which plants to bring together and arrange in some sort of meaningful order? In the early days of botany, the main consideration was the human use they were put to. Accordingly, plants with a similar (real or supposed) medical effect or culinary use would be grouped together. But as science developed to take a greater interest in the **intrinsic** properties of plants alongside their uses, botanists sought a way to classify them so that plants with similar observable features could be treated together.

The process of accurate, detailed description and illustration of plant structure really got under way in the early 16th century. By the late 16th and early 17th centuries certain major groupings were being recognised and some sort of "natural order" between them was being hypothesised; descriptions of **genera** and **species** were being published; botanists a little later such as John Ray and Herman Boerhaave were building systems based on the morphology of the whole plant and even on its ecology. Several different systems of **binomial** (two-word) naming had been proposed to replace the long descriptive Latin tags that had previously been used as a species' "handle".

All this meant that when Carl Linnaeus arrived on the scene in the mid-18th century, he was not working in an intellectual void. His major contributions to science included his vast range of survey of the natural world (aided by many students), establishing the identity of many species that are still recognised as such today; and his making the binomial naming system a rigorous one based on the genus (the first name) and the species within a genus (the second).

Although it gained great popularity at the time and remained in currency well into the 19th century, his other major piece of work has not stood the test of time. This was a system of plant classification based exclusively on the counts of sexual parts of flowers. It was a step back from the "whole plant" approach of earlier workers and was (as we now know) a highly artificial method that brought together some very unlikely bedfellows from across the plant world.

Of course, conventional wisdom up to this time was that plant species arose from a single act of creation with species fixed from then on. This meant that groupings of plants into species, genera, families and so on was almost entirely dependent on perceived degrees of similarity in morphology and anatomy, with other aspects of the known species playing a minor supporting role. Early thoughts on evolution were circulating by the middle of the 18th century, and Linnaeus' own views changed from a belief in this dogma to a "half way house" position where God had created an exemplar species in each family, and nature acting over time through the mechanism of hybridisation did the rest. It took another century for the work of Darwin and Wallace to give a solid intellectual foundation to evolutionary theory. And it is still an ongoing project to elucidate the mechanisms by which evolution works.

The significance of evolutionary theory to the classification of organisms is that it introduced the concept of **ancestry**. If plants could be shown to have a common ancestry, then that would provide a more "natural" way to classify them. But there is a problem with inferences made from the fossil record which is particularly acute for plants: not only does the record have gaps, but those fossils which do exist are often fragmentary and damaged. Often when different fossil parts of what is suspected to be the same species are classified, they are to this day given different genus names rather than risk making unverifiable assumptions.

So, inferences from similarities in present-day plants can't simply be done away with. But then there is another issue: the phenomenon of **convergent evolution**, where plants from different ancestries which evolve to adapt to similar environmental constraints come to resemble each other. In groups of widely different ancestry, sufficient differences usually remain in the features that are not under the given adaptive pressure. For instance, botanists have not had problems distinguishing the New World cactus-like plants of the Cactaceae family from the Old World cactus-like plants of the Euphorbiaceae. Plants more closely related by ancestry are not always so straightforward.

This is where DNA analysis (supplemented by more sophisticated methods of observing plant structure and chemistry) comes in. There is now a battery of tools for more precise delineation of relationships, on the assumption that plants with greater similarities in their genetic content will have diverged more recently from a common ancestor and that this will be reflected to a greater or lesser extent in other observable features. DNA analysis is not a

straight replacement for any other means of identifying and classifying species and is never likely to be: and it is an ongoing process. It is also complicated by the growing understanding that the genome of an organism (the DNA sequencing) does not automatically result in the manifestation of the same traits in all organisms that bear it, but is itself pliable (epigenetics). In some groups of plants it has starkly revealed what was already believed, that the very notion of classifying to species level is unsustainable, on any universal definition of "species". But it has led to some major redefinitions of plant families and genera and their relationships, which have been generally accepted.

These changes are enshrined, in the case of flowering plants, in a publication of the Angiosperm Phylogeny Group, designated "APG" for short. We are now at the fourth incarnation of the document, referred to as "APG IV" appropriately enough. Most technical Floras of recent years are aligned either with APG III or APG IV. Similar groups exist for ferns and their allies, and for conifers and their allies, but they haven't yet reached the same stage of general acceptance.

For the amateur and indeed the non-specialist professional, often working from field guides based on earlier classifications yet coming up against the resulting changes in family definitions and scientific names in other sources, these changes can be confusing or even infuriating. But they are not made, as is sometimes said, on a whim or as career-building exercises. The classifications are intended to reflect a deeper underlying truth about evolutionary history, and as our understanding changes it would be perverse to try and freeze them at some earlier state of knowledge. We are now at a stage where much has changed and been accepted, but our knowledge is by no means complete; more change has to be expected. Please remember this when we come to look at individual families in later modules.

How Do We Classify?

Some Principles

The classification of plants is **hierarchical**: it starts with a small number of broad groupings and proceeds to break these down successively into a larger number of ever narrower groupings. What is this meant to convey?

- All plants within a grouping will have **some** characteristics in common, without exception.
- Plants within two different groupings that are members of a higher grouping will have the common characteristics of the higher grouping, without exception.

But with the advent of phylogeny ("plant origins") as a study, it also carries an extra payload.

- Plants within two different groupings that are members of a higher grouping should be, wherever possible, traceable to a common ancestor either known or reasonably hypothesised in the higher grouping. (The jargon for this is "monophyletic".)
- No plant in any lower grouping of a higher one should be traceable to an ancestor not part of the higher one.

The assemblage of groupings leading back to one common ancestor is known as a "clade".

Why the "wherever possible"? Well, as it turns out, this isn't as straightforward as it might seem, especially in the case of plants, where many groupings considered for instance as species (probably approaching half of all species) have arisen through a process involving hybridisation as a step on the way. (The jargon for this is "allopolyploidy".) That means that while the parent species exist (and may show genetic variation over time or geographic range) there is the opportunity for the new species to arise multiple times, perhaps with some observable differences.

In these cases practicality often comes into the equation; for instance, if these potential differences aren't easily recognisable, or go against long-accustomed usage, or result in ridiculously many and small subgroupings or ridiculously large and unwieldy ones, they may be ignored.

An important aspect of this dual approach is something that might not be at all obvious. Indeed, it's not always been obvious to some of the professional

workers in taxonomy. That is, that one cannot make assumptions about common features of two groupings just because they happen to be at the **same level** of the hierarchy. The hierarchy merely expresses how things are related through the levels above and the levels below. The fact that two different plant groupings appear in different parts of the hierarchical tree at the same level, as "genera", doesn't enable one to say what properties a "genus" has, in such a way that both groupings **must** have those properties.

At this point, then, you may be wondering what a species is. And that is a very poignant question. Much effort has been expended in trying to define an all-embracing definition of "species" that works for plants, and the more one learns about the range of plant reproductive strategies the less likely this enterprise seems. In the end, practice comes down to a mixture of current knowledge, convenience and past usage. Since this can involve subjective judgements, there are always likely to be differences of opinion among experts.

Levels of the Hierarchy

The hierarchy of classification for plants splits into two ranges. The upper levels (the higher groupings) are not defined formally in the same way as the lower levels. That means that they tend to have different naming conventions in different books, and even different names for the levels themselves, as they are not bound by international standards.

However, there's general agreement on how vascular plants ("higher plants" - plants that aren't algae, mosses or liverworts) should be classified, as follows.

- **Lycopods** include Clubmosses and Quillworts. These used to be thought of as "fern allies", but they are now known to form a different line of evolution from Ferns.
- **Ferns** now include not only those plants traditionally thought of as Ferns, but also the Horsetails which were previously considered "something else".
- **Gymnosperms** include all those plants traditionally described as conifers, with the tropical Cycads, the often-planted Maidenhair Tree (*Gingko*) and the Mediterranean Joint-pines (*Ephedra*) among others. They produce seed like flowering plants but they don't have the enclosing structures that form fruits of one kind or another around the seed in all flowering plants. You may think that a pine cone is an enclosing structure, but it's of a different nature from those of flowers.
- **Angiosperms** include all flowering plants, which have their immature seeds (ovules) enclosed in a structure called the ovary. Flowers include some things that, if you are a beginner, you may not have recognised as such: catkins and grass flowers, for instance.

*Now we come to the flowering plants (**Angiosperms**), and here you'll find that latest thinking about common ancestries has changed the way we classify those. Once the main distinction was a simple one between **Dicots** and **Monocots,** evolving along separate lines from something extinct more primitive than either. Now the evidence points to Monocots having evolved from an existing line that had already spawned several Orders with many representatives living today and traditionally considered as Dicots on morphology. These Orders are sometimes now grouped and referred to as **Basal Angiosperms**. Dicots that evolved after the divergence of the Monocots are known as **Eudicots**.*

Basal Angiosperms are often further divided into two:

- **The A-N-A Group**, named for the initials of its constituent families. The only important family native to Britain is the Water-lilies (Nymphaeaceae). In evolutionary terms they are a bit of a rag-bag grouping and don't form a clade, but they all diverged before:
- **the Magnoliids**, which comprise families none of which are native to Britain, although it includes many important garden plants and a few notable garden escapes.

And last, but certainly not least:

- **Monocots** comprise many familiar families of native and garden plants, including the Lily, Orchid and Iris families and all Grasses, Sedges and Rushes.
- **Eudicots** comprise the majority of our flowering plant families.

Being able to put a flowering plant in its broad group is a useful skill on the way to identifying families, and the table below lists some generalisations about the groups. Because each group covers such a broad set of plants there are many exceptions, some of which will be dealt with in later modules under individual families, but the distinctions work well for many plants.

	Basal Angiosperms	**Monocots**	**Eudicots**
Life form	Woody or aquatic	Predominantly herbaceous	Varied
Seed leaves	2	1	2
Root system	Varied	With roots arising from the stems (adventitious roots)	With fine fibrous roots arising from a central taproot
Leaf outline	Varied	Often simple, unlobed, more or less parallel-sided	Varied but rarely simple, unlobed, or more or less parallel-sided
Leaf venation	Varied	Often unbranched and more or less parallel	Mostly branched and/or reticulate (forming a network)
Floral perianth (petals and sepals)	3, many or absent; when many, usually spirally arranged; often little differentiation between petals and sepals	Mostly 3 or 6; when 6, usually arranged in two whorls, often similar	Mostly 4 or 5, often distinct when both petals and sepals present; many with petals fused into a tubular, bell-like or cup-like section at the base with lobes at the apex.

	Basal Angiosperms	Monocots	Eudicots
Stamens	Not well-differentiated into a stalk (filament) and pollen-bearing part (anther)	Well-differentiated stamens	Generally well-differentiated, with some notable exceptions
Fruiting structures	Multiple and whorled, often with many carpels in each whorl	Fruit most commonly 3-chambered or with a multiple of 3 chambers but sometimes fused to a single unit and in some notable cases fused from 2.	Fruiting structures very varied but many with 2, 4, or 5 divisions or multiples.

Table 1: Most typical characteristics of the major plant groupings

One feature that is now recognised as important in distinguishing the Eudicots from both the Monocots and the Basal Angiosperms that also have 2 seed-leaves is the presence of 3 furrows or apertures on their pollen grains. The other groups have 1. This is clearly not much use in the field,

The next groupings beneath these upper levels are formally defined internationally, and go like this, from the more general to the more specific:

- **Order**: you won't usually come across this in field guides, but it appears in technical Floras like Stace. Names of orders are bastardised Latin or Greek usually taken from one of their constituent families, ending in the suffix *-ales*.
- **Family:** this is the first level that will be inescapable for you as a would-be plant identifier. Names of families are based on one Genus in the family, considered the "type genus", combined with the suffix *-aceae*. There are some traditional family names that don't follow these rules and you will still find these in use in some works. They are listed below with their modern equivalents.
- **Subfamily, Tribe and Subtribe:** we're going to skip over these because they are normally used in large families and can be useful simplifiers when dealing with plants on a worldwide or large regional basis. But for identifying plants in a single country or smaller region, they are rarely used for ID although they may be listed in accounts.
- **Genus**: This is denoted by a single noun derived, sometimes a bit fancifully or perversely, from Latin or Greek. There is no standard ending for a genus name.
- **Species:** This comprises two words of which the first is the Genus name, and the second is a **qualifier**. This is most often an adjective which is sometimes helpfully descriptive of the plant and sometimes not. Sometimes it is another noun, and then often denotes a real or imagined affinity with or similarity to another plant.

Traditional Family Name	Current Family Name
Compositae	Asteraceae
Cruciferae	Brassicaceae
Gramineae	Poaceae
Guttiferae	Hypericaceae (you may see these included in Clusiaceae, but this is no longer considered correct)
Labiatae	Lamiaceae
Leguminosae	Fabaceae
Palmae	Arecaceae
Umbelliferae	Apiaceae

Table 2: Traditional and present-day family names

Below the species level there are further divisions into **infraspecific taxa**, including **subspecies**, **varieties** and **formae**. In the international naming code there is a hierarchy imposed on these terms (subspecies at the top and forma at the bottom) but again, no implicit assumption on what they mean biologically, and different authorities will often have differing views on whether a given plant should be named as a species, subspecies, variety or forma. The form in which they are used in scientific names is pretty well standardised, and we'll come to that next.

References and Further Reading

Byng, J W (2014): ***The Flowering Plants Handbook*****, Plant Gateway Ltd.** This has a brief breakdown of the major divisions of flowering plants according to APG III, and a conspectus of all flowering plant families and most genera with many colour photographs and keys.

Chrystenhusz, M J M, Fay, M F & Chase, M W (2017): ***Plants of the World*****, Kew Publishing.** This has some very good introductory chapters on classification and naming, and a world conspectus of plant families that doesn't have as much detail on genera as the above but goes into more evolutionary and other detail about families, again with many colour photographs.

Elpel, T J (2013): ***Botany in a Day: The Patterns Method of Plant Identification*****, 6th edition, HOPS Press.** One caveat: this book was written for a North American audience. Another: it has quite a strong leaning towards herbalism and ethnobotany; but the author knows his stuff and is able to present it in an approachable way, so if you can tolerate the occasional drop into folksiness, there's a lot of good material here. The title is of course only

half serious. The opening sections provide a very accessible introduction to plant evolution, classification and naming.

Gledhill, D (2008): ***The Names of Plants*****, Cambridge University Press.** Some good introductory chapters on the history of classification and naming of plants.

Scientific Naming

Now we come to an aspect of plant ID that beginners often hate - understandably, since scientific names are a mixture of Latin or ancient Greek cobbled together with all sorts of proper names and, sometimes, *jeux d'esprit* of the namers. (If you want to explore the last category, try http://www.curioustaxonomy.net, especially the "Puns" section which is excruciating.) Since not many people these days are fluent in ancient Latin or Greek or can reel off the pantheon of classical gods and heroes, the names may seem like so much gobbledegook. But many names are meaningful, and some are even helpful in describing the organism (while some are just the opposite). This is where a book such as Gledhill (2008) can help, in providing the meanings and derivations of names and making them more memorable.

What do scientific names do for us?

- **They remove ambiguity**. Sometimes different namers have applied the same name to different plants, but as long as you know who the namer is (and that is, technically, part of the scientific name) and what the current accepted name is, these problems can **usually** be resolved. The name, naming authority and source of publication will normally lead to a **type specimen** so that future arguments can usually also be settled.
- **They are international.** Contemplate the problem of having to learn a new vernacular name every time you come to a plant in a region with a different native language. Then consider that the same vernacular name is often applied to different plants even in one language, and that the same plant may have a different vernacular name depending on where you are in a country. "Bluebell", for instance, is commonly applied to four totally unrelated plants in different parts of the world: their only common feature is their blueness; they aren't even all very bellish.
- **They make for stability in naming.** Now at this point I can hear hollow laughter from the back of the room. We are going through a period where name changes are happening quite a lot. But if you've read the previous section, you'll have an inkling of why some plant names are undergoing change. DNA work is redefining family and genus boundaries, and in some cases upsetting our previous notions of species. If a plant is reassigned to a different genus, inevitably the first part of its scientific name will change. If the second part of the name (the species identifier) has already been used in its new genus for a different plant, that will have to change too for the newcomer.

What the rules on naming do ensure is that name changes are not arbitrary and that they follow certain protocols. One important one is that the name that should be used is the earliest one proven to have been used for the plant that is compatible with its current position in the taxonomic tree. But even then, if this early name is so obscure that it has been completely overshadowed by another that has had long usage, common sense can decide that the well-known name continues to be used if it still "works" taxonomically.

- **They tell you something about a plant's relationships.** From the previous section you'll know that a species is a member of a larger grouping called a genus, a genus stands in the same relationship to a family, and so on; and that this represents some aspects of the real world and not just an arbitrary pigeonholing. Vernacular names in general don't do this: although botanists have tried to concoct systems of vernacular naming that do, there is a huge legacy of folk names which are not going to disappear, and rightly so. They can be out-and-out misleading; consider for instance "Burnet Saxifrage".

So, if you want to get serious about your plants and communicate with other botanists, scientific names will become a part of your life.

Anatomy of a Scientific Name

Impatiens glandulifera Royle

Generic **Specific** **Authority**

As you will no doubt already know, the core of a scientific name for a species is made up of two elements: the **generic** name, which comes first, is treated as a noun, and is capitalised; and the **specific** name, which is (in modern times) never capitalised, and is either an adjective or a noun used in a descriptive way (just as we would say 'a metal bucket' in English). You can have more than one word-element in the specific name, but only if the two elements can sensibly be linked with a hyphen, for instance *Acaena novae-zelandiae*.

A taxonomist will tell you that a scientific name is not complete without the **naming authority**, and you will find this appended in technical Floras like Stace, although it's often omitted in popular field guides. There are standard abbreviations for many of the prolific namers of plants, including Linnaeus himself who becomes 'L.'

There are a couple of conventions for handling more complicated situations in the naming game:

- ***Lysimachia terrestris* (L.) Britton**: this means that Linnaeus first named the plant using the specific 'terrestris', but put it in a different genus. Britton then ascribed it to *Lysimachia*. Since taxonomists are allowed to have second thoughts, it's quite possible to see something like '(L.) L.'
- ***Myosotis sylvatica* Ehrh. ex Hoffm.**: this indicates that Ehrhart first used the name but didn't provide the proper documentation for what he was naming. Subsequently Hoffmann turned up, came up with the goods and legitimised the same name. If you know enough Latin to know what 'ex' means, this order will seem counter-intuitive, but it's what botanists do. Zoologists would have said 'Hoffm. ex Ehrh.', which seems more logical. Again, a botanist can amend his earlier ways, so you might see 'DC. ex DC.', for example.

There are other usages too, and if you want to find out about them, try https://en.wikipedia.org/wiki/Author_citation_(botany). Also, should you want to know the botanist behind the abbreviation, refer to https://en.wikipedia.org/wiki/List_of_botanists_by_author_abbreviation.

Ranks Below the Species Level

A subspecies is identified by adding the subspecies name after the species name using either 'subsp.' or 'ssp.' as a prefix: for example:

- *Poterium sanguisorba* ssp. *sanguisorba*
- *Poterium sanguisorba* ssp. *balearicum*

The rules of naming subspecies stipulate that one of the subspecies must repeat the specific name, as in the first example. That will be the subspecies that was used as the type specimen for the species. If you are including authorities in your name, then in the first case you need only include the species authority:

Poterium sanguisorba L. ssp. *sanguisorba*

In the second case, you are only obliged to include the namer of the subspecies:

Poterium sanguisorba ssp. *balearicum* (Bourg. ex Nyman) Stace

When you have an idle moment, you might like to amuse yourself by working out the narrative behind that last naming authority.

Varieties are denoted in a similar way with 'var.', and forms with 'f.' or 'fa.'.

There is a pecking order in these terms, but not a strict hierarchy. That means that you can have, for instance, a variety of a species or a variety of a subspecies:

- *Conyza canadensis* var. *robusta*
- *Aster lanceolatus* subsp. *lanceolatus* var. *hirsuticaulis*

but what you **can't** have is a subspecies of a variety.

It's a bad idea to try and read too much meaning into these terms. Attempts have been made to define 'subspecies', but the definitions frequently break down for plants and there is an argument for doing away with the term altogether in botany because of the baggage it carries. 'Forma' tends to be used for minor single-attribute variation such as flower colour.

References and Further Reading

Gilbert-Carter, H (1964): *Glossary of the British Flora,* 3rd edition, 1964. Less comprehensive than Gledhill but still very useful. It can sometimes be picked up second-hand cheaply.

Gledhill, D (2008): *The Names of Plants*, 4th edition, Cambridge University Press. Gives the rules by which scientific names are made and has a very full dictionary of the meanings and derivation of generic and specific names.

Stearn, W T (2004): *Botanical Latin,* 3rd edition, David & Charles / Timber Press. Will tell you more than you probably want to know about Latin usage in botany and has a two-way dictionary and several special glossaries.

Examining a Plant

There are several pathways and stages to identifying a plant: fitting it to a family, keying it out to genus or species, or cross-checking it against a full description. They all rely on a careful examination of the plant. For this you need:

- at least one eye;
- a hand lens (10x is usually fine but occasionally 20x helps);
- a pen or pencil and a notebook or scrap of paper;
- a brain switched into "methodical" mode.

If you read one of the larger Floras or handbooks with comprehensive descriptions of plants, you'll see that they tend to follow a common pattern, which can be summed up as "from the ground (or below) up". This is a good practice to copy, as it helps to ensure you don't miss anything. So, let's go through this. I'm not going to discuss the features exhaustively; that will need too much space. Be guided by the identification tool you're using, and look up the terms as you meet them in a glossary. But there are a few features that often give problems, and these I will mention.

In this process you will come across a lot of terminology that you've maybe not met before, both for naming parts of plants and for describing them. This is bewildering at first, but the more you do it with a real plant to hand, the more it will become second nature. In the first instance it's a good idea to go to the glossary in the guide or handbook you're using, as not every botanist uses terms in exactly the same way, and there's often more than one word to describe the same feature. Presumably, authors will know what they meant in their own work, but sometimes they aren't that good at communicating it. If you are left puzzled, the "Further Reading" at the end of this section will give you some good well-illustrated alternatives to turn to.

One word of warning: I've mentioned that the biggest Floras give a complete account of all features of the plant in each plant description. This can obviously take a lot of space. More often, the features common to all members of a family are summarised in the family description and those common to a genus in the genus description, so that only the distinctive and exceptional features are described under the species account. Stace's Floras work like this, and so do the three field guides. It's important in these cases to be careful to read **all parts** of the description.

The field guides tend to be sketchy on ground-level features and below, and the Fitters guide is often a bit sketchy overall.

Here's a worked example taken from our biggest modern Flora, Sell & Murrell's 5-volume *Flora of Great Britain and Ireland*. Don't worry too much about technical terms you don't recognise yet. Just observe how the account is organised.

(1) Perennial (2) monoecious (1) herb (4) with stolons. (6) Stems up to 100cm and 10mm wide, pale green, (5) erect or decumbent, (6) hollow, grooved, glabrous, branched, leafy. (7) Leaves medium yellowish-green on upper surface, paler beneath, submerged leaves remaining green all winter; (8) basal and lower cauline, 10-30 x 4-11cm, broadly oblong in outline, pinnate, with 5-9(-14) pairs of segments, the segments up to 5 x 2 cm, oblong-lanceolate to ovate, acute at apex, 1- to 2-serrate, sometimes lobed, the teeth acute, cartilaginous or sometimes rounded with a cartilaginous mucro and cuneate to rounded and somewhat unequal at the base, long-petiolate with a ring-mark below the lowest pair of leaflets; (9) upper cauline similar, but smaller with shorter, sheathing petioles; (7) all glabrous. (10) Inflorescence of compound umbels with 7-18 rays which are 5-25mm and smooth, the peduncle as long as or somewhat longer than the rays and usually leaf-opposed, the umbels all (2) with bisexual flowers; (11) bracts 4-7, lanceolate, 3-fid or pinnatifid; bracteoles usually 4-7, lanceolate or 3-fid. (12) Sepals 5, triangular, sometimes unequal. Petals 5, white, smooth beneath, the outer not radiating, obcordate, the apex inflexed. (13) Stamens 5, recurved, with enlarged base forming the stylopodium which is a little shorter than the style; stigma capitate. (14) Schizocarp 1.3-2.0mm, globose, somewhat compressed laterally; mericarps with slender ridges; constricted at the commissure; carpophore present; vittae sunk in the pericarp; pedicels 3-5mm, smooth. (15) Flowers 7-9. 2n=12, 18.

(1) General life form and growth form	***Annual, biennial or perennial?*** This is often not a straightforward question to answer, especially as many plant species can adopt more than one life strategy. The stock answer for whether it's an annual is "Does it uproot easily?", but I hope you will not want to test this against an unknown plant that isn't numerous. And some annuals can have quite tenacious root systems. Some hints: ● If the population is made up of scattered plants and has withered early in the season, it's likely to be an annual. ● If the plant has rhizomes or stolons (see later), it will be a perennial. ● If the plant is a tree or shrub, it will be a perennial. But be careful: some large annuals or biennials can be surprisingly woody at the bottom. ***Tree, shrub or herb?*** In most cases this won't be too difficult to work out, but beware of herbs with woody bases to the stems.
(2) Distribution of sexual parts on individual plants	You'll need to understand what the terms "hermaphrodite" (or "bisexual"), "monoecious" and "dioecious" mean – and be aware that the usage can differ slightly among authors!

(3) Root system	***Taproot with finer roots coming off it, or fibrous roots coming off the stem?*** If you read earlier chapters of this module, you'll know that this is a major feature for separating **monocots** from other flowering plants. But some plants (particularly aquatics) don't help by hardly having roots at all, while others perennate through rhizomes, which are actually modified stems. Some (for instance some members of the Buttercup family) do have taproots but manage to conceal the fact pretty well, having multiple rather thick rootlets not unlike Onions and Leeks.
(4) Rhizomes and stolons	***Rhizomes and/or stolons present?*** Rhizomes occur below the ground surface; stolons are above it. Neither of these structures has anything to do with roots; they are modified stems. They have **nodes** like ordinary stems and roots and leaves can grow from these, although in the case of rhizomes the leaves are usually reduced to scales. You probably won't want to dig up plants to see whether they're rhizomatous, but in many cases you don't have to: you can infer it from the plant above ground. If it forms a dense patch with leafy stems arising, and you can't see stolons, it's likely to be rhizomatous. But rhizomes have two modes of growth, one of which continually extends the rhizome outwards and so makes for a widely creeping plant; the other tends to aggregate branches in a smaller area, so that the plant over time forms a **tuft** or **tussock**.
(5) Stem branching and position relative to the ground	
(6) Stem dimensions, ridges, hairs, colouring etc.	
(7) General leaf attributes (including stalks)	***Stipules present? And in what form?*** The presence or absence of stipules is often an important determiner up to family level, so it pays to get a clear understanding of these.
(8) Basal leaves (if any): attributes	
(9) Stem leaves (if any): attributes	
(10) Inflorescence shape	This is a feature that is important but often challenging, and not only for beginners, since there is a plethora of obscure names for specialised forms. In the field guides, Rose and Fitters don't do a particularly good job of it, as the different terms are only discussed separately (and in the case of Fitters, illustrated poorly). Streeter does better with a diagrammatic comparison of the different forms and a mercifully straightforward approach. Stace (1999 -2019) has a page of diagrams that tell you pretty well everything you need to know. The other books in "Further Reading" - Hickey & King (2000), Beentje (2016) - also have good diagrams on one or more consecutive pages but introduce a lot of terms you probably won't meet often.
(11) Floral leaves (bracts)	
(12) Perianth (epicalyx, calyx and corolla)	
(13) Sexual organs at flowering	

(14) Fruiting body	An important feature which often helps to pin down the family is the disposition of the embryos in the ovary, and subsequently the seeds in the fruiting body. It is easy to overlook this because it may involve making a cross-section of the fruit and often that isn't easy in the field. Sometimes the outward appearance of the fruit will help to make things clear.
(15) Other details (e.g. flowering time, chromosome number)	

References and Further Reading

Beentje, H (2016): ***The Kew Plant Glossary*****, 2nd edition, Kew Publishing.** It has a dictionary section which itself contains many line illustrations, and in my view does a better job of getting definitions down to ordinary language than Hickey and King. This is followed by topic-oriented pages of illustrations: a bit less comprehensive and detailed than Hickey and King, but admirably clear.

Hickey, M & King, C (2000): ***The Cambridge Illustrated Glossary of Botanical Terms*****, Cambridge University Press.** A large-format book that has both a dictionary-style glossary and a large section of terms organised by topics and features, with abundant line illustrations.

Stace, C A (1999): ***Field Flora of the British Isles*****, Cambridge University Press**.

Stace, C A (2019): ***New Flora of the British Isles*****, 4th edition, C&M Floristics.**

Getting to Know Major Families

What is a "major family"?

There are rather more than 400 plant families in the world, and between 150 and 176 of them occur in Britain either as natives or as introductions, depending on whom you're asking. But most of our plants occur in a much smaller set of "major families".

The criteria for this aren't too difficult to define: how many species does it have? How important a part of the vegetation is it? But the answers aren't always straightforward and will depend on where you're standing on the earth. That will straight away introduce another criterion: what proportion of the species of the local flora does it comprise? In the past there was a tendency to concentrate on native species at the expense of non-natives, but does that make any sense in a world where species are moving around so rapidly and sometimes becoming a major part of the flora?

There's a practical side to this too: the families one wants to get to grips with and carry around in one's head are big and often quite diverse in their most obvious features. Families with just a few members tend to have a few distinctive features that one either remembers intuitively or can look up easily. In practice it's not too hard to decide on the major contenders in temperate parts of the world, and it's striking how many of the same families will crop up in lists from Europe, temperate Asia and temperate North America.

The problem lies in where to stop, and how to decide on the "fringe" families. In the *Collins Wild Flower Guide* edition 2, David Streeter has a nice approach where he lists 20 families worth getting to know because of the number of native species, and 5 because they are distinctive and often met with. They are as follows, with the "Top 20" shown bold. If you can get to know these, you will know how to place about 75% of the British flora. (Detail on the groupings of Dicots follows shortly.)

MONOCOTS

- **Potamogetonaceae (Pondweed family)**
- **Liliaceae, including several other families (Lily family)**
- **Orchidaceae (Orchid family)**
- **Juncaceae (Rush family)**
- **Cyperaceae (Sedge family)**
- **Poaceae (Grass family)**

BASAL EUDICOTS

- **Ranunculaceae (Buttercup family)**

ROSIDS

- **Fabaceae (Pea family)**
- **Rosaceae (Rose family)**
- Euphorbiaceae (Spurge family)
- Violaceae (Violet family)
- Hypericaceae (St John's-wort family)
- Onagraceae (Willow-herb family)
- **Geraniaceae (Geranium family)**
- **Brassicaceae (Cabbage family)**

OTHER CORE EUDICOTS

- **Polygonaceae (Dock family)**
- **Caryophyllaceae (Pink family)**
- **Amaranthaceae (Goosefoot family)**

ASTERIDS

- **Ericaceae (Heath family)**
- Rubiaceae (Bedstraw family)
- **Boraginaceae (Borage family)**
- **Scrophulariaceae, including Veronicaceae (Figwort family)**
- **Lamiaceae (Dead-nettle family)**
- **Apiaceae (Carrot family)**
- **Asteraceae (Daisy family)**

This is as good a selection as any, and I shall use it in subsequent modules for workshops, while also treating a few "confusable" families for comparison with the major ones. The fact that it's based on counts of native species doesn't matter much, because in our temperate climate most new arrivals occur in the same families in similar proportions.

Streeter has a comparison table and key for his "Top 20" families, followed by a comparison table for the "Distinctive 5". If you can't make your plant fit any of these, then there is a key for the rest which helpfully includes signposts back to these 25, in case you missed a feature or you have a plant that's an exception to the family rules. If you own a copy of Streeter, then I recommend this to you because it is one of the least intimidating ways into family ID that I've seen.

I don't intend to present a complete comparison table for all the families here, but instead we shall look at a few families in detail in each workshop session. However you'll notice that I've arranged the families in a different order from that currently found in British books, and if you've read the earlier sections you'll see that this corresponds to the taxonomy now laid down by APG III and IV - although the family definitions don't in all cases. Let's not make life too confusing and stick for the moment to what our national handbooks provide, as far as possible. Also, there are a few new groupings, with some new group names in the headings; these are taken from Byng (2014). This allows us to make some generalisations about groups of families that can sometimes be helpful; these apply to plants found in Britain and may not hold true worldwide.

MONOCOTS	● Single cotyledon (seed leaf) ● Mostly herbs; when trees or shrubs, lacking the specialised cells (vascular cambium) that allow trunks and branches to grow out sideways ● Roots fibrous and not arising from a taproot. ● Mostly leaves with parallel veins ● Stipules absent ● Perianth most often 3-merous (3 or 6), when 6, often with little difference between the two ranks (then all referred to as "tepals" rather than sepals and petals) ● Stamens usually 3-merous, sometimes 2 ● Ovary superior or inferior (above or below the perianth)
BASAL EUDICOTS	Transitional between the Basal Angiosperms (none of which come in our top family list) and other Eudicots. As a result, families such as Ranunculaceae show a confusing mix of ancestral features, such as many whorled floral parts, of varying numbers and not always well differentiated) and more advanced features like fewer floral parts, more fixed in number and better differentiated. ● Two cotyledons ● Herbs, shrubs or climbers ● Roots arising from a taproot, not always very obviously ● Mostly branching leaf veins ● Stipules rare ● Petals most often 2-5 or many or absent ● Stamens usually 6-many ● Ovary superior (above the perianth)

ROSIDS	This group includes many of the major families with free petals (not joined at the base), and a few minor families with petals joined at the base and thus confusable with Asterids. Usually the number of stamens equals or exceeds the number of petals. Other than that it is hard to generalise about the group, and best to examine the features of individual families. ● Two cotyledons ● Herbs, shrubs, climbers or trees ● Roots arising from a taproot ● Branching leaf veins ● Stipules often present (but never in the Brassicaceae family!) ● Sepals and petals usually 4 or 5, with notable exceptions (e.g. Euphorbiaceae) ● Stamens mostly 4-many ● Ovary inferior, superior or sometimes in a mid position with a fleshy outgrowth (hypanthium), e.g. in some Rosaceae members
OTHER CORE EUDICOTS	This group sweeps up most of the other families with free petals, but it also includes plants with petals fused at the base, and therefore confusable with the Asterid group. In the 3 major families we are concerned with, floral structure is very varied and best treated by individual family. There are some plants with floral parts 3-merous, but on other features they are unlikely to be mistaken for Monocots. ● Two cotyledons ● Herbs, shrubs, or hemiparasites ● Roots arising from a taproot ● Branching leaf veins ● Stipules sometimes present and sometimes very distinctive ● Perianth segments most commonly 3-6, in 1 or 2 whorls ● Stamens most commonly 1-6, 10 or many ● Ovary mostly superior
ASTERIDS	This group embraces most of the plants whose petals are fused into a tube, bell or cup shape at least at the base, the ghost of the petal count then being revealed by lobes on the resulting corolla; but among these, it also includes two-lipped plants where the lobing is divided up unequally between the lips and sometimes obscured. However there is one major family where all members have the petals free (Apiaceae). ● Two cotyledons ● Herbs, shrubs or trees ● Roots arising from a taproot ● Usually branching leaf veins ● Stipules present or not ● Petals fused but most often representing 4- or 5-lobed flowers ● Stamens usually equal to or less than the nominal petal count ● Ovary inferior or superior

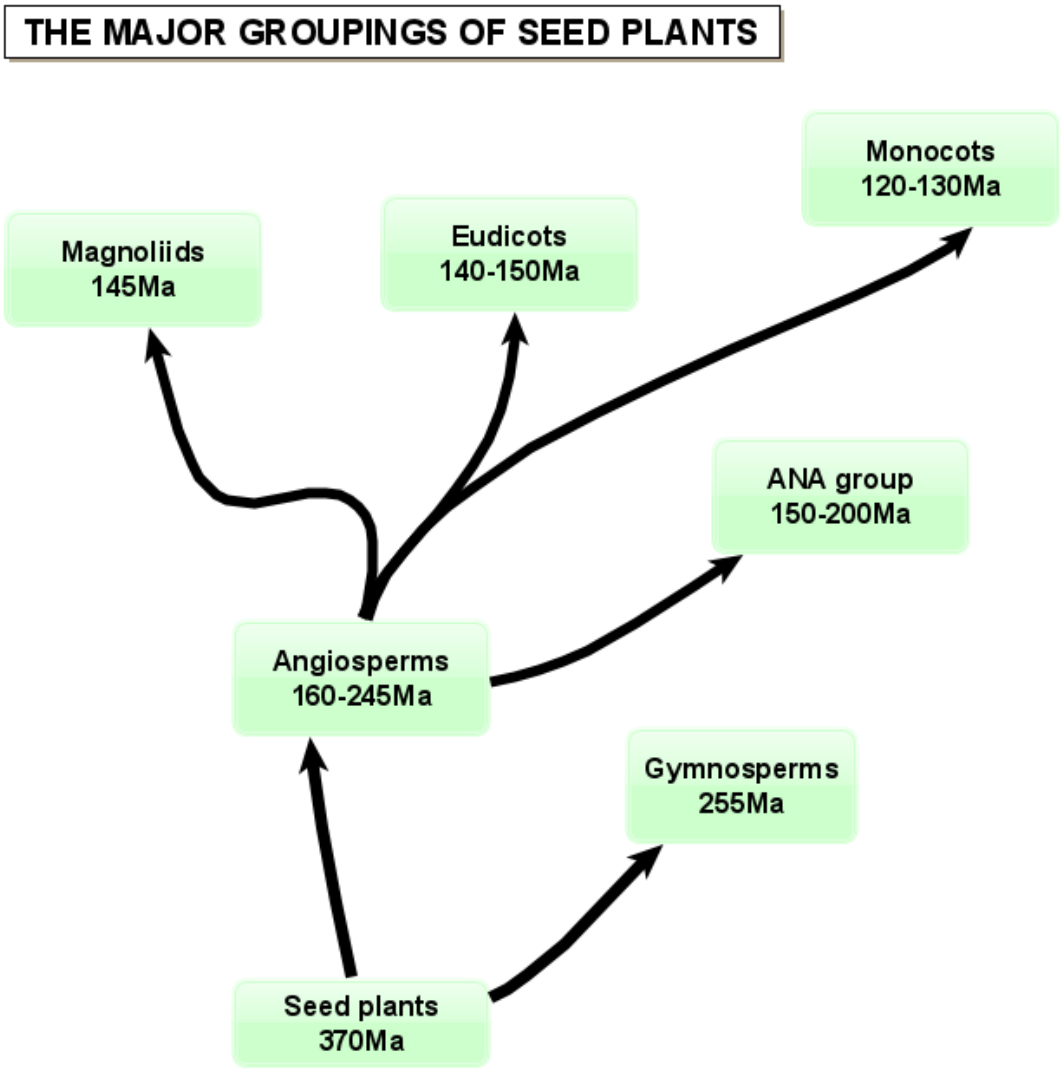
We shall look at the distinguishing features of the families a few at a time, in modules for specific workshops.

Nature's business is evolving, not cataloguing

If you have managed to follow through the sections so far, I hope you will appreciate that when trying to classify or identify plants we are dealing with a process, not a structure. Classification is useful not to the process, but because we humans have found uses for it. Scientific classification, remember, is useful because it tells us something of what to expect of the classified object and its development and ancestry; and it allows us to communicate with others with a reasonable chance that we are talking about the same plants.

With that in mind, this section will show you how the "top 25" for Britain fit into the evolutionary process.

An Overview



The numbers show the ages of the different lineages in approximate millions of years. There is a very wide margin of tolerance on the first emergence of flowering plants (angiosperms) because, although we can see clear genetic and developmental separation between the gymnosperms and the angiosperms at the present day, it's still not possible to delineate the early developments of the latter and say that these should really be characterised as flowering plants. In similar fashion, there is much divergence of opinion about the dates when particular groupings arose, and the dates shown in later diagrams and text are often little better than "best overlap" drawn from many researchers.

Primitive or Basal Angiosperms

Two of the early evolutionary branches of the angiosperm tree are the **A-N-A group** (so called because its three orders are **A**mborellales, **N**ymphaeales, **A**ustrobaileyales) and the **Magnoliids**. Although they form two separate evolutionary strands, some authors lump these for classification purposes as 'Basal Angiosperms' (Byng (2014) or 'Primitive Angiosperms' (e.g. Stace 2019). This super-grouping does tend to share some characteristics considered to be primitive, but there are many exceptions in present-day plants.

- There is often little or no differentiation between perianth segments into sepals and petals, and even the stamens can look more like modified petals.
- The perianth segments are most often either in 3s, or numerous and indeterminate in number, arranged in spirals.
- Fused petals and zygomorphy (mirror symmetry in the flowers) are rare. Leaves are mostly simple and alternate.
- Fruits are often made up of a mass of individual carpels, fused or free.

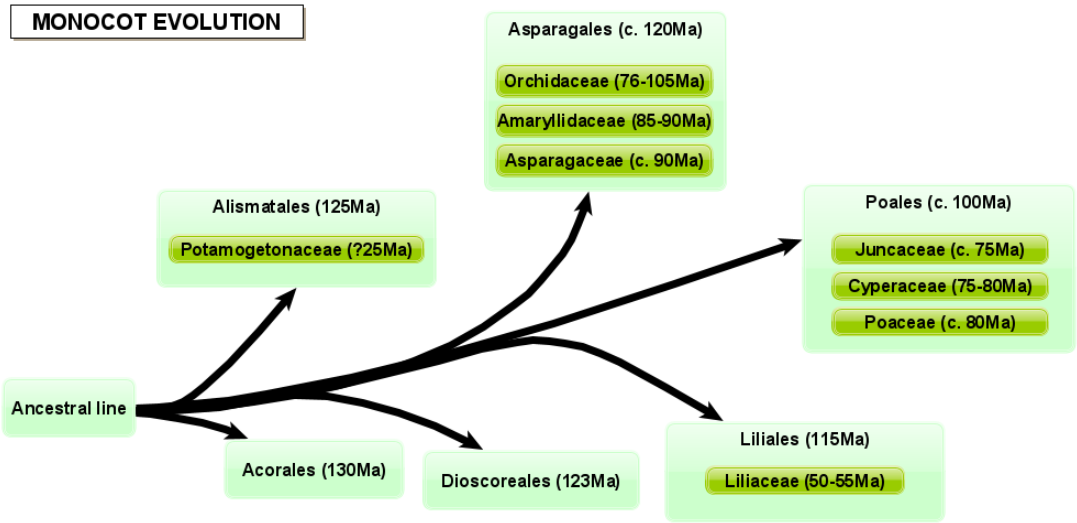
However, the A-N-A group is more homogeneous in these respects than the others. The only A-N-A family one will encounter frequently in Britain is the Nymphaeaceae (Water-lilies). There are no native British plants in the Magnoliids and many are New World and/or tropical, but Magnolias (*Magnolia* species) and Bay (*Laurus nobilis*) will be familiar garden plants, and the European species of Aristolochiaceae (uncharacteristically with a fused perianth and in the case of *Aristolochia*, zygomorphic flowers) will be known to some of you.

Monocots

The **Monocots**, as their name implies, have a characteristic that distinguishes them from almost all other angiosperms, both the Basal Angiosperms we have just been considering or the Eudicots ("True" Dicotyledons) ; the possession of only one seed leaf. You may have noticed that a prevalent character shared with **some** of the basal orders is having perianth segments in 3s. One thing that the Basal Angiosperms and the Monocots do have in common is the presence of a single opening or furrow on pollen grains; the Eudicots have three.

The known Monocots have their lineages traced back 120-130 million years, but a segregation between them and the Eudicots must have occurred earlier.

The following diagram, for the sake of simplicity, shows the evolutionary pathways to just the orders found in the British flora and the families in our "top 25".



Many genera that we used to consider as members of Liliaceae as recently as 20 years ago are now separated out on molecular evidence into a separate evolutionary line in the families Amaryllidaceae and Asparagaceae (along with some familiar garden plants in Asphodelaceae), often showing similar but parallel morphological traits. A few genera have gone into other families in the Liliales, and one (*Narthecium*) into the Dioscoreales. Just a handful of genera and only one native genus (*Gagea*) are left in Liliaceae, which appears to have diversified more recently than its former genera.

On the other hand, Orchidaceae were thought to be a relatively recent evolution through lack of fossil evidence, but they are now believed to date back at least 75-85 million years.

It's time to recap on some of the features that are characteristic of the Monocots and most useful in day-to-day identification. Inevitably in such a large grouping (over 1 in 5 of all angiosperm species) with a long evolutionary history, there is a lot of variation and many exceptions to the "rules". But once you know where the exceptions are found, they don't present too much difficulty in temperate-climate botany.

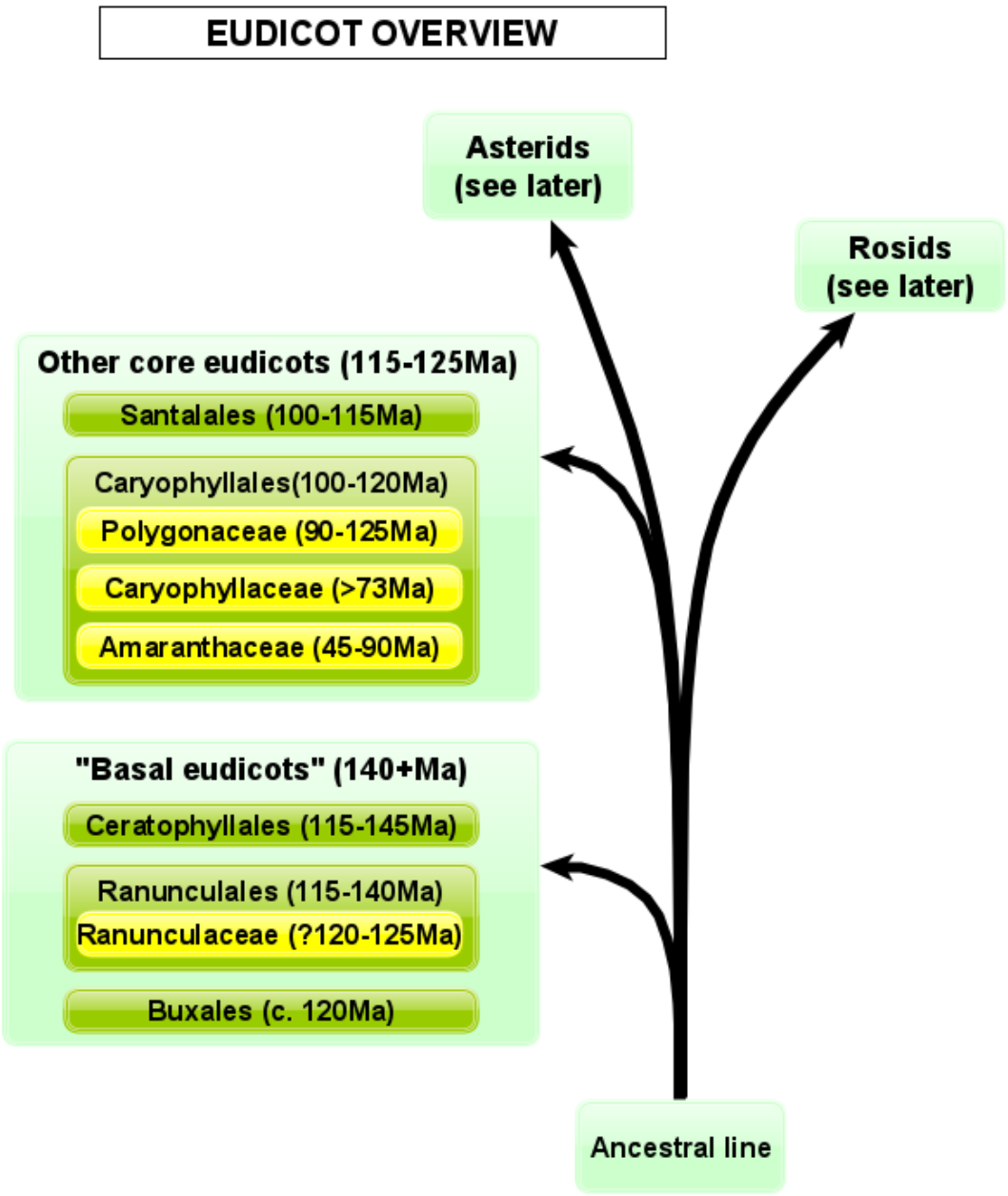
Trait	**Exceptions: examples found in orders covered here**
Single seed-leaf (monocotyledonous)	
Mostly herbs	**Asparagales** (*Ruscus*)
Fibrous roots springing not from a tap-root but from the base of the stem other parts of the stem, leaves in some cases, or from modified stems or shoots (rhizomes and stolons)	
Leaves mostly with parallel or subparallel venation, not reticulate (networked)	**Alismatales** (*Arum*) **Dioscoreales** (*Tamus*) **Liliales** (*Paris*)
Floral parts usually trimerous (in multiples of 3). The most important exceptions here for a temperate botanist are the Cyperaceae and Poaceae, which have very "non-standard" flowering morphology that needs to be learned.	**Alismatales** (*Arum*, Zosteraceae, Potamogetonaceae, Ruppiaceae) **Liliales** (*Paris*) **Asparagales** (*Maianthemum*) **Poales** (Typhaceae, Eriocaulaceae, Cyperaceae, Poaceae)

Eudicots in General

Like the basal angiosperms we have already met and unlike the Monocots, Eudicots have paired seed leaves. Unlike both these groups, however, their pollen grains are **tricolpate** (each grain has three grooves or pores rather than one). Floral parts are most commonly 4- or 5-merous, but there are many exceptions to this.

Eudicots comprise 75% of all angiosperm species on earth, with enormous diversity (and again, a long evolutionary history) so that it is hard to generalise about characteristic traits for the whole group. However, there are certain patterns in their morphology that allow us to classify them into a few sub-groups. On the whole, they work both as an aid to identification and for understanding their place in evolution.

c



"Basal eudicots"

This term is in quotation marks because it's not used universally, and some authors think that at least one order (Ceratophyllales) shouldn't be grouped here at all; but it does appear in Byng (2014). In various ways they show transitions between the more primitive basal angiosperms (many, free, weakly differentiated floral parts) and more advanced traits (regular numbers of floral parts; fused floral parts) and this diversity appears even in individual families, particularly the Ranunculaceae.

The Order Ranunculales holds most of the European temperate species.

- Flowers tend to have perianth segments (petals and sepals) in 2s to 5s, but numerous stamens.
- Stipules are mostly absent or minute, and this helps to distinguish them from several other groupings which have small numbers of perianth segments but many stamens.
- Carpels are usually free, less commonly fused, and sometimes 1.
- Ovaries are almost always superior; an exception is the California Poppy (*Eschscholzia*) in the family Papaveraceae.

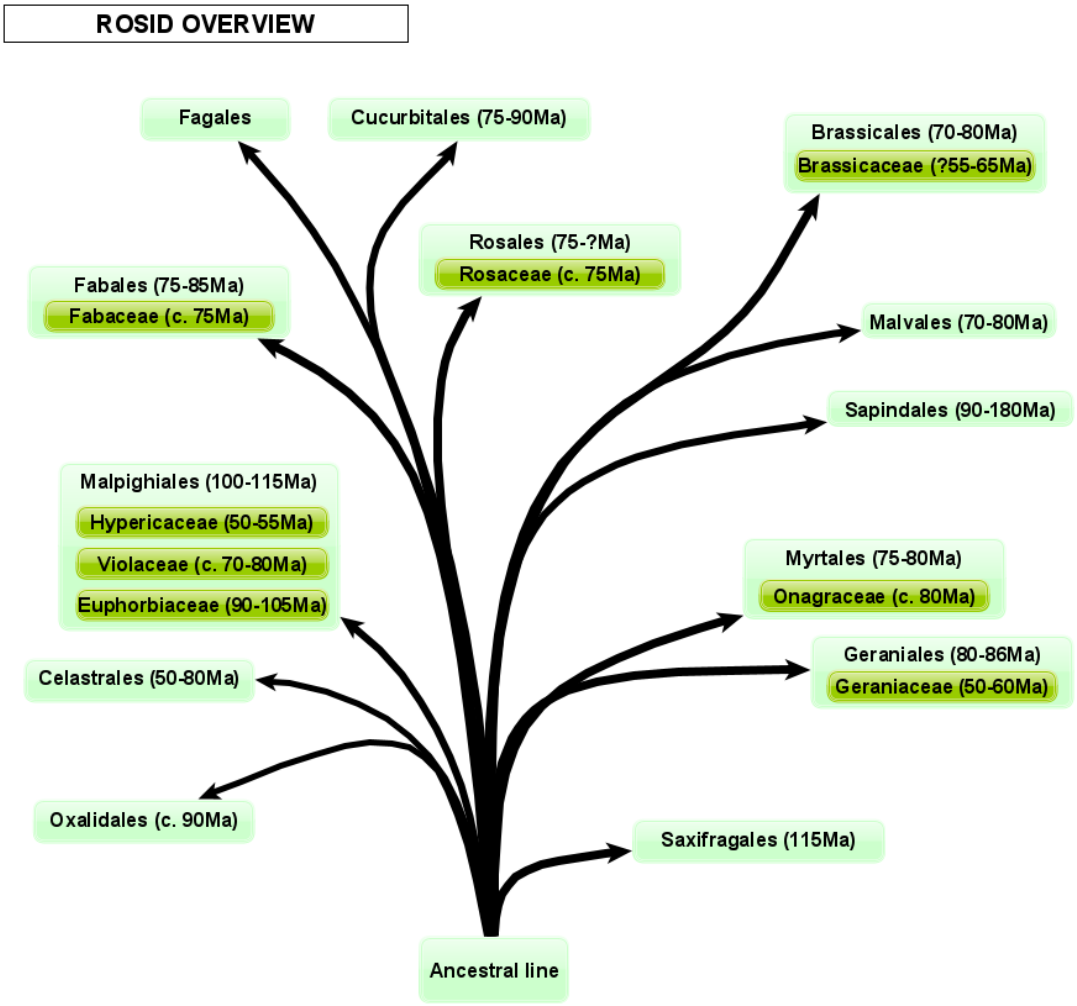
Papaveraceae and Ranunculaceae are the two main British families in the order; they can be distinguished by having latex or stem exudate (Papaveraceae) or lacking it (Ranunculaceae). Both families have members with actinomorphic (radial) symmetry and zygomorphic (mirror) symmetry in their flowers. All Papaveraceae members have fused or partially fused carpels and the fruit is a capsule; a minority of Ranunculaceae have single or fused carpels, and the fruit is typically a cluster of single-seeded achenes or many-seeded follicles opening along their inner face.

Considering common traits is difficult because of the wide spread of the group, but here are a few relating to British plants, with exceptions.

Trait	**Exceptions: examples found in orders covered here**
Leaves opposite or alternate	**Ceratophyllales:** (Ceratophyllaceae: whorled)
Stipules absent or minute	
Stamens numerous	**Ranunculales:** (*Ceratocapnos, Fumaria*: 4-6; *Berberis*: 6; *Actaea*: 1) **Buxales** (Buxaceae: usu. 4)
Ovary superior	**Ranunculales:** (*Eschscholzia*)

Rosids

The Rosid group is a large one, and it includes many of our familiar native plants spread across 31 families. They probably diverged from the other groupings we have yet to consider about 120 million years ago. Most of the datings on the diagrams should be taken as rough estimates at best, but it is particularly true of this grouping where many of the clades are still under investigation.



One of the most characteristic features of this grouping is that the petals are free, but it is not unique in this as many of the "other core Eudicots" and some important families in the Asterids also have free petals. A useful feature to apply in combination is that most Rosids have the number of stamens equal to or more than the number of petals, while most Asterids have the number equal or less. But there is an obvious overlap there, and as usual there are exceptions: the "other core Eudicots" also confuse the picture. There are also a very few British plants that have fused petals in this group.

A notable feature of some Rosids is the **hypanthium** – a fleshy extension of the floral receptacle that wholly or partially encloses the ovary. If you have come across this before, it is probably in connection with the Rosaceae, but other families also possess it.

Most Rosids have actinomorphic (radially symmetric) flowers, but the order Fabales is largely zygomorphic (with mirror symmetry).

Many Rosids have stipules, and this can sometimes help to distinguish them from families with a superficially similar floral structure. Here is a table of "majority" traits.

Trait	**Exceptions: examples found in orders covered here**
Petals free	**Cucurbitales** (*Bryonia*)
Petals 0 or 4-5	**Myrtales** (*Lythrum*, 6); **Brassicales** (*Reseda*, up to 6)
Flowers actinomorphic	**Fabales** (most Fabaceae, most Polygalaceae) **Malpighiales** (Violaceae) **Geraniales** (some Geraniaceae)
Stamen count >= petal count (excluding apetalous plants)	**Cucurbitales** (*Bryonia*)

Some traits are common and characteristic in some parts of orders and families, but not characteristic of the whole group. Here are some features that may be helpful in considering the "top 25". Families with unadorned names on a yellow background have it in **all native** and long-established members in Britain; those in brackets have it in **some** native or long-established members in Britain.

Feature	**Found in**
Leaves alternate	**Fabales** (Fabaceae) **Rosales** (Rosaceae) **Malpighiales** ([Euphorbiaceae]; Violaceae) **Geraniales** (Geraniaceae) **Myrtales** ([Onagraceae]) **Brassicales** (Brassicaceae)
Leaves opposite	**Malpighiales** ([Euphorbiaceae]; Hypericaceae) **Myrtales** ([Onagraceae])
Stipules absent or minute	**Fabales** ([Fabaceae]) **Malpighiales** ([Euphorbiaceae]; Hypericaceae) **Myrtales** (Onagraceae) **Brassicales** (Brassicaceae)
Stipules present	**Fabales** ([Fabaceae]) **Rosales** ([Rosaceae] except for a few naturalised genera) **Malpighiales** ([Euphorbiaceae]; Violaceae) **Geraniales** (Geraniaceae)
Flowers actinomorphic	**Rosales** (Rosaceae) **Malpighiales** ([Euphorbiaceae]; Hypericaceae) **Geraniales** ([Geraniaceae]) **Myrtales** (Onagraceae) **Brassicales** ([Brassicaceae], the vast majority)

Feature	Found in
Flowers zygomorphic	**Fabales** (Fabaceae) **Malpighiales** (Violaceae) **Geraniales** ([Geraniaceae]) **Myrtales** ([Onagraceae], rare and slight) **Brassicales** ([Brassicaceae], rare)
Petals 0	**Rosales** ([Rosaceae]) **Geraniales** ([Geraniaceae] – v. rare) **Brassicales** ([Brassicaceae], uncommon)
"Petals" 3	**Malpighiales** ([Euphorbiaceae])
Petals 4	**Rosales** ([Rosaceae]) **Myrtales** ([Onagraceae]) **Brassicales** ([Brassicaceae], typical)
Petals 5	**Fabales** (Fabaceae) **Rosales** ([Rosaceae]) **Malpighiales** (Hypericaceae, Violaceae) **Geraniales** ([Geraniaceae] – customary) **Myrtales** ([Onagraceae], rare non-natives)
Stamen 1	**Malpighiales** ([Euphorbiaceae])
Stamens 2	**Rosales** ([Rosaceae])
Stamens 4	**Rosales** ([Rosaceae]) **Myrtales** ([Onagraceae]) **Brassicales** ([Brassicaceae])
Stamens 5	**Malpighiales** (Violaceae)
Stamens 6	**Brassicales** ([Brassicaceae])
Stamens 8	**Myrtales** ([Onagraceae])
Stamens 10	**Fabales** (Fabaceae) **Geraniales** (Geraniaceae – incl. staminodes)
Stamens many	**Rosales** ([Rosaceae]) **Malpighiales** ([Euphorbiaceae]; Hypericaceae)
Style 1	**Fabales** (Fabaceae) **Rosales** ([Rosaceae]) **Malpighiales** (Violaceae) **Geraniales** (Geraniaceae) **Myrtales** (Onagraceae) **Brassicales** (Brassicaceae)
Styles 2	**Rosales** ([Rosaceae]) **Malpighiales** ([Euphorbiaceae])
Styles 3	**Malpighiales** ([Euphorbiaceae]; [Hypericaceae])
Styles 5	**Rosales** ([Rosaceae]; [Hypericaceae])
Styles many	**Rosales** ([Rosaceae])
Hypanthium present	**Rosales** ([Rosaceae]) **Myrtales** (Onagraceae, sometimes short and obscure)
Nectar disc present	**Rosales** ([Rosaceae])
Ovary inferior	**Rosales** ([Rosaceae]) **Myrtales** (Onagraceae)
Ovary semi-inferior	**Rosales** ([Rosaceae])

Feature	Found in
Ovary superior	**Rosales** ([Rosaceae]) **Malpighiales** (Euphorbiaceae; Hypericaceae; Violaceae) **Geraniales** (Geraniaceae) **Brassicales** (Brassicaceae)
Carpel 1	**Fabales** (Fabaceae) **Rosales** ([Rosaceae])
Carpels 2	**Rosales** ([Rosaceae])
Carpels 4	
Carpels 5	**Rosales** ([Rosaceae])
Carpels many	**Rosales** ([Rosaceae])
Carpels fused	**Rosales** ([Rosaceae]) **Malpighiales** (Euphorbiaceae, usu. 3; Hypericaceae, 3 or 5; Violaceae, 3) **Geraniales** (Geraniaceae) **Myrtales** (Onagraceae, 4) **Brassicales** (Brassicaceae, 2)
Fruit a single achene	**Rosales** ([Rosaceae])
Fruit a head of achenes	**Rosales** ([Rosaceae])
Fruit a drupe or berry	**Rosales** ([Rosaceae]) **Malpighiales** ([Hypericaceae], rare)
Fruit a pome	**Rosales** ([Rosaceae])
Fruit a capsule	**Malpighiales** (Euphorbiaceae; [Hypericaceae]; Violaceae) **Myrtales** (Onagraceae) **Brassicales** (Brassicaceae, siliqua or silicula)
Fruit a legume	**Fabales** (Fabaceae)
Fruit a follicle	**Rosales** ([Rosaceae])
Fruit a schizocarp	**Geraniales** (Geraniaceae)

Other core eudicots

See p. 34 for the evolutionary tree. This grouping, which really amounts to a few branches on the evolutionary route to the Asterids diverging 100-125 million years ago, comprises just three orders, only one of which (the Caryophyllales) plays an important part in the British flora. Santalales, an order of mostly hemiparasitic plants, has just two British members (*Thesium humifusum* and *Viscum album*) now placed in the one family Santalaceae.

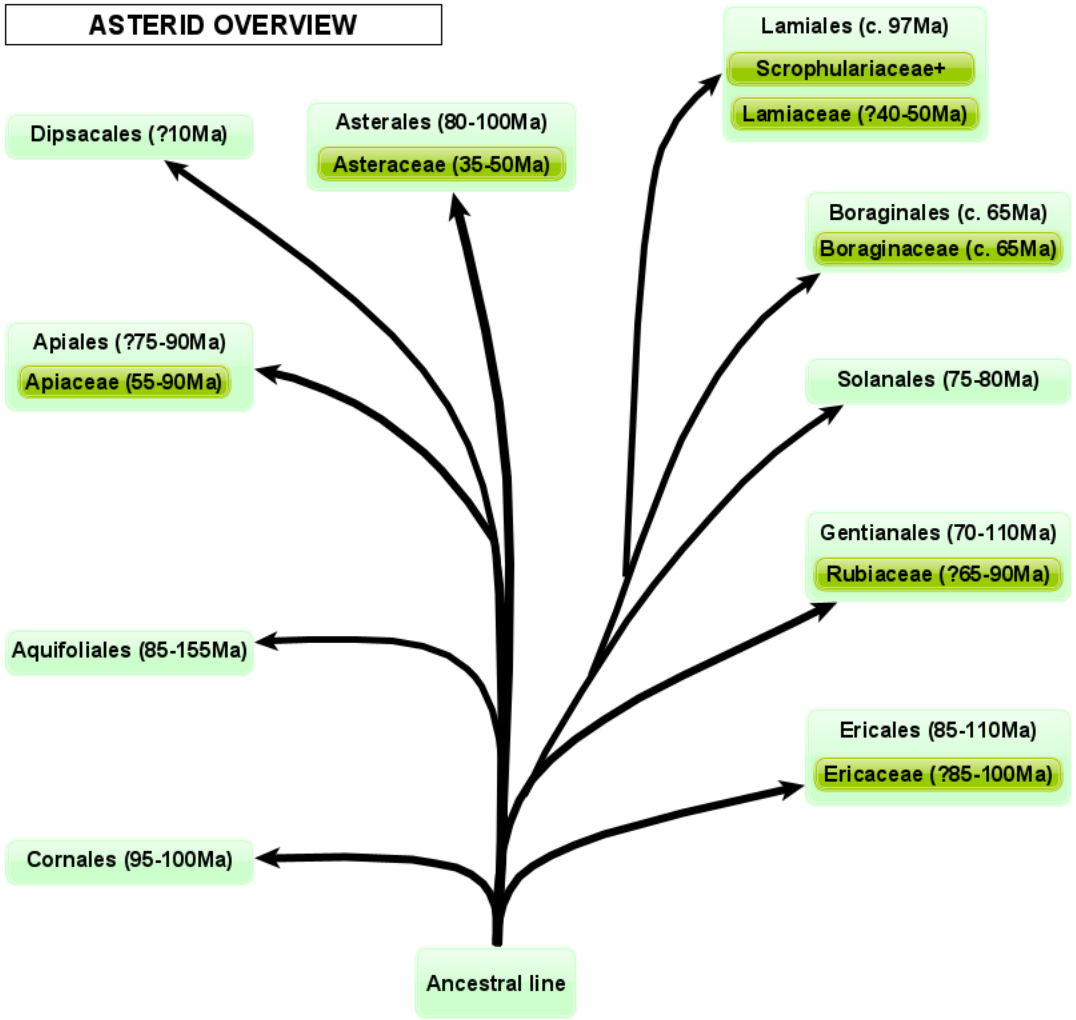
Major features of the Asterids are the preponderance of flowers with petals fused into a tube at least at the base, and the general absence of stipules. With its position in an earlier divergence from the Asterid evolutionary pathway, this group shows a mixture of stipulate and exstipulate plants, with petals free or fused at the base. Both opposite and alternate leaves occur widely,

whorled leaves much more rarely. All have actinomorphic (radially symmetric) flowers, or very nearly so. The distribution of important features in British native and long-established species is shown in the table below, with the same conventions as for Rosids. The table makes it clear that it's difficult to generalise about features of the Caryophyllaceae!

Feature	**Found in**
Hemiparasites (with chlorophyll)	**Santalales**
Non-parasitic	**Caryophyllales**
Leaves absent or much reduced	**Caryophyllales** ([Amaranthaceae])
Leaves alternate	**[Santalales]** **Caryophyllales** (Polygonaceae; [Caryophyllaceae]; [Amaranthaceae])
Leaves opposite	**[Santalales]** **Caryophyllales** ([Caryophyllaceae]; [Amaranthaceae])
Stipules absent or minute	**Santalales** **Caryophyllales** ([Caryophyllaceae]; Amaranthaceae)
Stipules present	**Caryophyllales** (Polygonaceae, usu. as ochreae; [Caryophyllaceae])
Petals / tepals free or almost so	**Santalales** **Caryophyllales** ([Polygonaceae]; Caryophyllaceae; [Amaranthaceae])
Petals / tepals fused at base	**Caryophyllales** ([Polygonaceae]; [Amaranthaceae])
Petals / tepals 0	**Caryophyllales** ([Caryophyllaceae]; [Amaranthaceae])
Petals / tepals 1	**Caryophyllales** ([Amaranthaceae])
Petals / tepals 2	**Caryophyllales** ([Amaranthaceae])
Petals / tepals 3	**Caryophyllales** ([Polygonaceae]; [Amaranthaceae])
Petals / tepals 4	**[Santalales]** **Caryophyllales** ([Caryophyllaceae]; [Amaranthaceae])
Petals / tepals 5	**[Santalales]** **Caryophyllales** ([Polygonaceae]; ([Caryophyllaceae]; [Amaranthaceae])
Petals / tepals 6	**Caryophyllales** ([Polygonaceae])
Stamen 1	**Caryophyllales** ([Amaranthaceae])
Stamens 2	**Caryophyllales** ([Amaranthaceae])
Stamens 3	**Caryophyllales** ([Polygonaceae]; ([Caryophyllaceae]; [Amaranthaceae])
Stamens 4	**[Santalales]** **Caryophyllales** ([Caryophyllaceae]; [Amaranthaceae])

Feature	Found in
Stamens 5	**[Santalales]** **Caryophyllales** ([Caryophyllaceae]; [Amaranthaceae])
Stamens 6	**Caryophyllales** ([Polygonaceae])
Stamens 8	**Caryophyllales** ([Polygonaceae], but often reduced to 3-7 fully-formed)
Stamens 10	**Caryophyllales** ([Caryophyllaceae])
Style 1	**Santalales** (sometimes very short) **Caryophyllales** ([Polygonaceae], but branching into 2-3)
Styles 2	**Caryophyllales** ([Polygonaceae]; [Caryophyllaceae]; [Amaranthaceae])
Styles 3	**Caryophyllales** ([Polygonaceae]; ([Caryophyllaceae]; [Amaranthaceae])
Styles 4	**Caryophyllales** ([Caryophyllaceae])
Styles 5	**Caryophyllales** ([Caryophyllaceae])
Styles 6	**Caryophyllales** ([Caryophyllaceae])
Ovary inferior	**Caryophyllales** ([Caryophyllaceae], rarely)
Ovary semi-inferior	**Caryophyllales** ([Amaranthaceae], rarely)
Ovary superior	**Santalales** **Caryophyllales** (Polygonaceae; [Caryophyllaceae], usually; [Amaranthaceae], usually)
Carpel 1	**Santalales** **Caryophyllales** (Amaranthaceae)
Carpels fused	**Caryophyllales** (Polygonaceae; Caryophyllaceae)
Fruit a single achene	**Caryophyllales** (Polygonaceae; [Caryophyllaceae], rarely; [Amaranthaceae])
Fruit a nut	**[Santalales]**
Fruit a drupe or berry	**[Santalales]** **Caryophyllales** ([Caryophyllaceae], rarely)
Fruit a capsule	**Caryophyllales** ([Caryophyllaceae], usually; [Amaranthaceae])

Asterids



The Asterids are a major grouping of the flowering plants, comprising roughly 25% of their global diversity; the Asteraceae family alone has about 25,000 species. Characteristic features of many families include:

- flowers bisexual, or bisexual mixed with single-sex;
- petals fused (at least at base) into a corolla (note that this needs careful checking in some genera);
- number of stamens equal to, or less than, the petals or corolla lobes;
- stipules absent.

Some families are also notable for having strong floral zygomorphy (mirror symmetry) in at least some of their members.

However, there are some important exceptions to these generalisations, and they include a few important families in our British flora. Orders or families

with names on a yellow background are exceptions in **all** native and long-established members in Britain; others have it in **some** native or long-established members in Britain.

Common Feature	**Exceptions**
Bisexual flowers	**Ericales** (Ericaceae]) **Garryales** (Garryaceae) **Lamiales** (Oleaceae; Plantaginaceae; Callitrichaceae) **Aquifoliales** (Aquifoliaceae) **Asterales** (Asteraceae) **Dipsacales** (Dipsacaceae) **Apiales** (Griseliniaceae; Pittosporaceae; Araliaceae; Apiaceae)
Petals fused	**Cornales** (Cornaceae; Hydrangeaceae) **Ericales** (Primulaceae; Diapensiaceae; Sarraceniaceae) **Lamiales** (Oleaceae, petals 0 or free) **Aquifoliales** (Aquifoliaceae, sometimes) **Escalloniales** (Escalloniaceae) **Apiales** (Griseliniaceae, Pittosporaceae, Araliaceae, Hydrocotylaceae, Apiaceae)
Stamens ≤ petals / corolla lobes	**Cornales** (Hydrangeaceae) **Ericales** (Sarraceniaceae)
Stipules absent	**Gentianales** (Rubiaceae) **Solanales** (Solanaceae 'false stipules') **Lamiales** (Scrophulariaceae, only rarely in *Buddleja*) **Aquifoliales** (Aquifoliaceae, small and deciduous) **Dipsacales** (Adoxaceae; Caprifoliaceae) **Apiales** (Araliaceae, sometimes minute; Hydrocotylaceae)

The Asterid grouping comprises many orders; moreover, family and in some cases even order circumscriptions have changed a lot in recent years. The family breakdown given by Stace (2019) still does not go as far in its revisions as many recent taxonomic books. Some notable traits found among at least some members of the families are as follows. The orders or families where the background is highlighted have all members found in the wild in Britain with that trait.

Feature	**Found in**
Predominantly woody	**Cornales** (Hydrangeaceae; Cornaceae) **Ericales** (Diapensiaceae; Ericaceae) **Garryales** (Garryaceae) **Gentianales** (Apocynaceae) **Lamiales** (Oleaceae; Bignoniaceae; Paulowniaceae) **Aquifoliales** (Aquifoliaceae) **Escalloniales** (Escalloniaceae) **Dipsacales** (Adoxaceae; Caprifoliaceae) **Apiales** (Griseliniaceae; Pittosporaceae; Araliaceae)
Some woody members	**Gentianales** (Rubiaceae) **Solanales** (Solanaceae) **Lamiales** (Calceolariaceae; Veronicaceae; Scrophulariaceae; Lamiaceae) **Asterales** (Asteraceae) **Apiales** (Apiaceae)
Full parasites / saprophytes (no apparent chlorophyll)	**Ericales** (Ericaceae) **Solanales** (Convolvulaceae) **Lamiales** (Orobanchaceae)
Hemiparasites (with apparent chlorophyll)	**Lamiales** (Orobanchaceae)
Carnivorous plants	**Ericales** (Sarraceniaceae) **Lamiales** (Lentibulariaceae)
Latex present	**Gentianales** (Apocynaceae) **Asterales** (Campanulaceae; Asteraceae)

Feature	Found in
Lvs all basal	**Ericales** (Primulaceae; Sarraceniaceae; Ericaceae) **Lamiales** (Gesneriaceae; Veronicaceae; Plantaginaceae; Scrophulariaceae; Lentibulariaceae) **Asterales** (Campanulaceae; Asteraceae) **Apiales** (Apiaceae)
Lvs whorled, or appearing so	**Ericales** (Balsaminaceae; Primulaceae; Ericaceae) **Gentianales** (Rubiaceae) **Lamiales** (Hippuridaceae) **Apiales** (Apiaceae)
Lvs opposite	**Cornales** (Hydrangeaceae; Cornaceae) **Ericales** (Balsaminaceae; Primulaceae; Ericaceae) **Garryales** (Garryaceae) **Gentianales** (Rubiaceae; Gentianaceae) **Boraginales** (Hydrophyllaceae; Boraginaceae) **Solanales** (Solanaceae) **Lamiales** (Oleaceae; Calceolariaceae; Veronicaceae; Plantaginaceae; Callitrichaceae; Scrophulariaceae; Acanthaceae; Bignoniaceae; Verbenaceae; Lamiaceae; Phrymaceae; Paulowniaceae; Orobanchaceae) **Asterales** (Asteraceae) **Dipsacales** (Adoxaceae; Caprifoliaceae; Valerianaceae)
Lvs alternate	**Ericales** (Balsaminaceae; Polemoniaceae; Primulaceae; Diapensiaceae; Ericaceae) **Boraginales** (Hydrophyllaceae; Boraginaceae) **Solanales** (Convolvulaceae; Solanaceae) **Lamiales** (Veronicaceae; Scrophulariaceae; Acanthaceae; Lentibulariaceae; Orobanchaceae) **Aquifoliales** (Aquifoliaceae) **Asterales** (Campanulaceae; Menyanthaceae; Asteraceae) **Escalloniales** (Escalloniaceae) **Apiales** (Griseliniaceae; Pittosporaceae; Araliaceae; Hydrocotylaceae; Apiaceae)
Lvs absent or apparently so	**Ericales** (Ericaceae) **Solanales** (Convolvulaceae) **Lamiales** (Orobanchaceae)

Feature	Found in
Flowers actinomorphic (Radial symmetry)	**Cornales** (Hydrangeaceae, Cornaceae) **Ericales** (Polemoniaceae; Primulaceae; Diapensiaceae; Sarraceniaceae; Ericaceae) **Garryales** (Garryaceae) **Gentianales** (Rubiaceae; Gentianaceae; Apocynaceae) **Boraginales** (Hydrophyllaceae; Boraginaceae) **Solanales** (Convolvulaceae; Solanaceae) **Lamiales** (Oleaceae; Plantaginaceae) **Aquifoliales** (Aquifoliaceae) **Asterales** (Campanulaceae; Menyanthaceae; Asteraceae) **Escalloniales** (Escalloniaceae) **Dipsacales** (Adoxaceae; Caprifoliaceae; Valerianaceae) **Apiales** (Griseliniaceae; Pittosporaceae; Araliaceae; Hydrocotylaceae; Apiaceae)
Flowers weakly zygomorphic (mirror symmetry)	**Ericales** (Ericaceae) **Boraginales** (Boraginaceae) **Solanales** (Solanaceae) **Lamiales** (Gesneriaceae; Veronicaceae; Scrophulariaceae; Verbenaceae; Lamiaceae) **Asterales** (Campanulaceae) **Dipsacales** (Caprifoliaceae; Valerianaceae) **Apiales** (Apiaceae, radiating petals)
Flowers strongly zygomorphic	**Ericales** (Balsaminaceae) **Boraginales** (Boraginaceae) **Lamiales** (Calceolariaceae; Veronicaceae; Scrophulariaceae; Acanthaceae; Bignoniaceae; Lentibulariaceae; Lamiaceae; Phrymaceae; Paulowniaceae; Orobanchaceae) **Asterales** (Campanulaceae; Asteraceae) **Dipsacales** (Caprifoliaceae) **Apiales** (Apiaceae, radiating petals)

Feature	Found in
Perianth absent or apparently so	**Lamiales** (Oleaceae; Hippuridaceae; Callitrichaceae) **Asterales** (Asteraceae)
Perianth 2-merous	**Lamiales** (Plantaginaceae)
Perianth 3-merous or appearing so	**Ericales** (Balsaminaceae; Ericaceae) **Lamiales** (Plantaginaceae; Acanthaceae (corolla)) **Asterales** (Asteraceae)
Perianth 4-merous	**Cornales** (Hydrangeaceae; Cornaceae) **Garryales** (Garryaceae) **Gentianales** (Rubiaceae; Gentianaceae) **Lamiales** (Oleaceae; Calceolariaceae; Veronicaceae; Plantaginaceae; Scrophulariaceae; Acanthaceae (calyx); Orobanchaceae (calyx)) **Aquifoliales** (Aquifoliaceae) **Asterales** (Asteraceae) **Dipsacales** (Adoxaceae)
Perianth 5-merous	**Cornales** (Hydrangeaceae) **Ericales** (Balsaminaceae; Polemoniaceae; Primulaceae; Diapensiaceae; Sarraceniaceae; Ericaceae) **Gentianales** (Rubiaceae; Gentianaceae; Apocynaceae) **Boraginales** (Hydrophyllaceae; Boraginaceae) **Solanales** (Convolvulaceae; Solanaceae) **Lamiales** (Gesneriaceae; Veronicaceae; Scrophulariaceae; Bignoniaceae; Lentibulariaceae; Verbenaceae; Lamiaceae; Phrymaceae; Paulowniaceae; Orobanchaceae (corolla)) **Asterales** (Campanulaceae; Menyanthaceae; Asteraceae) **Dipsacales** (Adoxaceae; Caprifoliaceae; Valerianaceae) **Apiales** (Griseliniaceae; Pittosporaceae; Araliaceae; Hydrocotylaceae; Apiaceae)
Perianth > 5-merous	**Ericales** (Primulaceae) **Gentianales** (Gentianaceae) **Lamiales** (Oleaceae; Scrophulariaceae)
Flowers 2-lipped	**Lamiales** (Calceolariaceae; Veronicaceae; Scrophulariaceae; Bignoniaceae; Lentibulariaceae; Lamiaceae; Phrymaceae; Orobanchaceae) **Asterales** (Campanulaceae) **Dipsacales** (Caprifoliaceae)

Feature	Found in
Ovary superior	**Ericales** (Balsaminaceae; Polemoniaceae; Primulaceae; Diapensiaceae; Sarraceniaceae; Ericaceae) **Gentianales** (Gentianaceae; Apocynaceae) **Boraginales** (Hydrophyllaceae; Boraginaceae) **Solanales** (Convolvulaceae; Solanaceae) **Lamiales** (Oleaceae; Gesneriaceae; Calceolariaceae; Veronicaceae; Plantaginaceae; Callitrichaceae; Scrophulariaceae; Acanthaceae; Bignoniaceae; Lentibulariaceae; Verbenaceae; Lamiaceae; Phrymaceae; Paulowniaceae; Orobanchaceae) **Aquifoliales** (Aquifoliaceae) **Asterales** (Menyanthaceae) **Apiales** (Pittosporaceae)
Ovary inferior or semi-inferior	**Cornales** (Hydrangeaceae; Cornaceae) **Ericales** (Ericaceae) **Garryales** (Garryaceae) **Gentianales** (Rubiaceae) **Lamiales** (Hippuridaceae) **Asterales** (Campanulaceae; Asteraceae) **Escalloniales** (Escalloniaceae) **Dipsacales** (Adoxaceae; Caprifoliaceae; Valerianaceae) **Apiales** (Griseliniaceae; Araliaceae; Hydrocotylaceae; Apiaceae)

References and Further Reading

Byng, J W (2014): ***The Flowering Plants Handbook*****, Plant Gateway**. Includes descriptions of every family in the world and most genera.

Chrystenhusz, M J M, Fay, M F & Chase, M W (2017): ***Plants of the World*****, Kew Publishing.** This has some very good introductory chapters on classification and naming, and a world conspectus of plant families that doesn't have as much detail on genera as Byng but goes into more evolutionary and other detail about families, again with many colour photographs.

Elpel, T J (2013): ***Botany in a Day: The Patterns Method of Plant Identification*****, 6th edition, HOPS Press.** One caveat: this book was written for a North American audience. Another: it has quite a strong leaning towards herbalism and ethnobotany; but the author knows his stuff and is able to present it in an approachable way, so if you can tolerate the occasional drop

into folksiness, there's a lot of good material here. The title is of course only half serious. Most of the families we are most interested in are here, but you'll also find a few non-Brits.

Hickey, M & King, C (1997): *Common Families of Flowering Plants*, Cambridge University Press. Covers 25 families, including most but not all those we've taken on board as "major". Lengthier family descriptions and excellent line drawings of plant details. There are some succinct but helpful comparison tables of families that people often find hard to separate.

Hickey, M & King, C (1988): *100 Families of Flowering Plants*, 2nd edition, Cambridge University Press. Because why stop at 25?

Stace, C A (2019): *New Flora of the British Isles*, 4th edition, C&M Floristics.

Streeter, D et al. (2016): *Collins Wild Flower Guide*, 2nd edition, William Collins. Particularly for the family keys on pp. 49-71.

Hints on Identification Keys

There are several different ways to help people make an identification decision. One is simply to provide a complete description of every type of plant and let them work out the answer by comparing all the features. This isn't the most helpful approach to starting the process. However, don't lose sight of it - we shall come back to it.

The fact is that in many cases, there is a group of **diagnostic features** that can lead you to the right answer. If these diagnostic features can be compared across different plant species, selecting the right set will get you there.

One way to do this is via a **comparison table**. All the diagnostic features are set out side by side in an orderly fashion. Here's a fragment of one example, where the diagnostic characters are in bold type.

	***Carex divisa* (Divided Sedge) [46]**	***Carex disticha* (Brown Sedge) [44]**	***Carex arenaria* (Sand Sedge) [43]**
General Habit	Shoots **more or less densely clustered** from a creeping branched rhizome, but not tufted; up to 80cm tall	Shoots **singly or in pairs** from a far-creeping rhizome; up to 100cm tall	Shoots **singly and often in easily traceable straight lines** from a far-creeping rhizome; up to 90cm tall **but usually much less (under 30cm**)
Leaf Sheaths and Ligules	Lower sheaths brown; those of sterile shoots forming a false stem; inner face hyaline, apex slightly concave or straight. **Ligule 2-3mm**, obtuse, more or less tubular	Lower sheaths brown, forming false stems in sterile shoots; inner face **green**, becoming hyaline only around **strongly concave apex**. Ligule 3-7mm, obtuse, tubular	Lower sheaths pale or grey-brown, forming false stems in sterile shoots; inner face hyaline, becoming brown and membranous, apex straight. Ligule 3-5mm, obtuse, tubular.
Leaf Blades	15-60cm x 1.5-3mm, stiff; flat or more often channelled or loosely inrolled, overwintering; tip slender but more or less flat; mid- to grey-green	15-60cm x 2-4mm, flat with keeled midrib, gradually tapering to a flat tip, rough on veins beneath and at tip; mid-green	15-60cm x 1.5-3.5mm, rigid, thick, more or less flat but in driest situations channelled, **often recurved**, gradually **tapering to a fine trigonous point**; rough; **dark green and shiny**, persistent when dead and then often dark brown
Stems	Wiry, trigonous with rather blunt angles but rough at top	**Sharply trigonous**, rough	Rather bluntly trigonous (**but often with projecting ribs at the angles**), wiry, rough at top, **often markedly curved**, noticeably variable in thickness

There's an obvious drawback to this; it only really works for comparing a few species at a time. If you'd started with the question "I know this is a member of the Sedge family - but which one?" the table would have needed over 100 columns! So, comparison tables are generally used in circumstances where you've reduced the options to a small number, and where their variability is

such that you need to consider several different features at once. It works well at the lowest level within genera with similar species ("critical genera") or where hybrids are frequent and will have intermediate characters.

Another approach is often used where not all the diagnostic features are readily visible when you need them - for instance, if you really need to see both flowers and mature fruit, or if one feature is best observed in the field and others really need a microscope. This is the **multi-access key**. Here you are given a number of choices for each diagnostic feature. Each choice is given a different code (usually a letter). You work your way through the features assigning codes when you can and ignoring the features where you can't. Eventually you have a string of codes, and a look-up list matching the codes you have will tell you what your options are. You may still have to sort out multiple options, but you now look up descriptions of just a few plants. Examples are the key to Willowherbs (*Epilobium*) and *Cotoneaster* in Stace (2010, 2019).

This looks like a good method but very few people seem to like it when presented in print. On computer, however, it works very well, since the computer can display the reduced set of options as you go along, and alert you to any incompatible entries that result in all choices being ruled out.

The method favoured by most books is the **dichotomous key** (or sometimes the **polytomous key**). This presents a limited set of choices (2 for a dichotomous key; 3 or sometimes more otherwise) at each step, usually involving one feature or a very limited set of features. You make the choice and are told where to go next (either to another step in the key, or to another key, or - hooray! - to the name of a plant). Here's a fragment of an example:

1	Plant fully aquatic	2
1	Plant not fully aquatic (though sometimes appearing in flooded ground)	3
2	Plant free-floating, fronds moss-like, 2-lobed, covering the water surface	***Azolla*** **(Water Fern)**
2	Fronds fine, thread-like, ±upright, with coiled crosiers when young, arising singly from a delicate rhizome	***Pilularia*** **(Pillwort)**
3	Fronds fine, thread-like, ±upright, with coiled crosiers when young, arising singly from a delicate rhizome	***Pilularia*** **(Pillwort)**
3	Not as above	4
4	Fertile frond or portion of frond distinct from sterile frond or portion	5
4	Fertile and sterile fronds all alike	10

People often struggle with dichotomous keys at first, and they can present problems:

- If you have to start from "square one" every time, you will have a very long and tedious journey. That's why learning the features of major families is a good idea early on.
- If you have to check back on the choices you've already made, you may be looking back a long way through the book, with your fingers in several different places. Considerate key builders will deploy one of a number of strategies to make life easier, such as giving you the number of the key couplet you came from when it isn't just above the one you're reading; or laying out the key in blocks with indented couplets so that you can read back previous decisions easily. If your handbook has long keys and doesn't offer any such help, maybe consider an alternative.
- Sometimes you can't make a firm decision. The sample of plant you've got doesn't have the feature you need to observe; or the key compiler has given you a description that's difficult to interpret. You are now apparently stuck, because you need the answer to progress through the key. The answer here is to note the key couplet where this arises. Then choose whatever you think is the most plausible answer and go down that path. If it leads you to a set of options none of which fit, that wasn't the right answer. Go back and try the alternative(s). If it leads you to an answer, it **may** be the right one. The next step is to go through and compare the full plant description with your plant, checking that it fits in every detail: see the previous section on "Examining a Plant". Illustrations may also help. As long as it fits fully, you can be pretty confident, but if there are features that don't really match, go back and try the alternative(s).

  Of course you may go through this process and hit a dead end via all routes tried. In that case, go back progressively to earlier couplets in the key and ask yourself "Did I really make the right choice here?" At some point in the process you may be left with just a small number of options whose descriptions you can compare directly.

Apropos of the last scenario, even if you arrive comfortably at a single determination via the key, **always** cross-check with the plant's full description. It's hard to carry more than a few previous decisions in your head at once, and this check will ensure that you didn't go astray earlier.

I'll finally mention one last format of key, which tries to combine the virtues of the comparison table with those of the dichotomous key. In this format (a

part of which for *Epilobium* is shown below), the decision points are laid out in two-dimensional space rather than in a linear sequence, making it easier to see combinations of decisions. Unfortunately, only one English handbook makes use of anything like this, and it is rather limited and out of date (Hayward (1987). A recently published popular guide in French (Thomas, Busti & Maillart (2016) is laid out in this way, however.

Creeping plant; only tips of shoots ascending	Stigma club-shaped	Stems with lines of short non-glandular hairs	Glandular hairs absent	Leaves with several (3-14)sharp teeth	Leaves with faint lateral veins usually visible only below				*E. pedunculare* Rockery Willowherb
				Leaves with a few blunt teeth		Seeds minutely papillose			*E. brunnescens* New Zealand Willowherb
					Leaves with prominent lateral veins visible above	Seeds smooth			*E. komarov-ianum* Bronzy Willowherb
Greater part of stem ascending	Stigma 4-lobed; stems round	Stems with spreading non-glandular hairs	Prominent glandular hairs on upper parts	Leaves more or less clasping, with line running onto stem	Leaves oblong to lanceolate, rounded at base	Leaves toothed all round	All or nearly all leaves opposite	Petals 12-16mm, shallowly lobed, deep pink	*E. hirsutum* Great Willowherb
			Glandular hairs short, often sparse	Leaves unstalked, not running onto stem	Leaves ovate to oblong-lanceolate, rounded at base			Petals 6-9mm, quite deeply lobed, pale pink	*E. parviflorum* Hoary Willowherb
		Stems glabrous or with non-glandular hairs short, appressed or incurved		Leaf stems often short, not more than 6mm	Leaves ovate-lanceolate to lanceolate, rounded at base			Petals 8-10mm, deeply lobed, pale pink becoming darker	*E. montanum* Broad-leaved Willowherb
				Leaf stems up to 8mm	Leaves elliptical to elliptical-lanceolate, broadly wedge-shaped at base	Leaves untoothed towards base	Upper leaves usually alternate	Petals 6-8mm. shallowly lobed, white becoming progressively pinker	*E. lanceolatum* Spear-leaved Willowherb

References and Further Reading

Hayward, J (1987): ***A new key to Wild Flowers*****, Cambridge University Press.**

Stace, C A (2010): ***New Flora of the British Isles*****, 3rd edition, Cambridge University Press.**

Stace, C A (2019): ***New Flora of the British Isles*****, 4th edition, C&M Floristics.**

Thomas, R, Busti, D & Maillart, M (2016): ***Petite flore de France*****, Editions Belin.**

Next…

The next workshop (July 2020) will look at Ranunculaceae in more detail, then several families in the Rosids, concentrating on the large families Fabaceae, Rosaceae and Brassicaceae.

The following workshop will be scheduled for spring and concentrate on the Monocots and the Caryophyllaceae. Later workshops will look at the Asterids, particularly the Ericaceae; Scrophulariaceae and its recent spin-offs; Apiaceae; and a broad overview of Asteraceae. We shall also examine Polygonaceae and Amaranthaceae from the "other core Eudicots".

Further Study

If you want to improve your practical ID skills with a distance tutor providing one-to-one feedback, I strongly recommend the **Identiplant** course run by the FSC and the BSBI (see https://identiplant.co.uk for details). It comprises 15 modules and submission of practical work between February to August. It can be completed in one year or two. Volunteers who are making significant contributions to the recording and study of flowering plants can apply for a reduced fee. Enrolment is towards the end of the calendar year.

As well as the books mentioned previously in the text, the following make informative reading.

Bell, A.D. (2008): ***Plant Form: An Illustrated Guide to Flowering Plant Morphology*****, 2nd edition, Timber Press.** Much more than a glossary, this gives accounts of all the external elements of plant form: their nature, function and place in the whole plant, and their exuberant variation. Superbly illustrated with photographs and line drawings.

Briggs, D. & Walters, S.M. (2016): ***Plant Variation and Evolution*****, 4th edition, Cambridge University Press.** The latest edition of a classic. A very well-presented and broad conspectus of a big subject: certainly not light reading but rewarding.

BSBI Handbooks. These are a huge resource for better understanding individual plant families. The works that deal with a whole family or the larger part of it are listed here in brief, with the date of their latest edition.

(1) Sedges of the British Isles (Cyperaceae), 2007
(2) Umbellifers of the British Isles (Apiaceae), 1980
(3) Docks and Knotweeds of Britain and Ireland (Polygonaceae), 2014
(4) Willows and Poplars of Great Britain and Ireland (Salicaceae), 1984
(6) Crucifers of Great Britain and Ireland (Brassicaceae), 1991
(8) Pondweeds of Great Britain and Ireland (Potamogetonaceae), 2015
(11) Water-starworts of Europe (Callitrichaceae), 2008
(13) Grasses of the British Isles (Poaceae), 2009
(17) Violas of Britain and Ireland (Violaceae), 2017
(19) Gentians of Britain and Ireland (Gentianaceae), 2019
(22) Broomrapes of Britain and Ireland (Orobanchaceae, part), 2021

The **Angiosperm Phylogeny Group** web site is at
http://www.mobot.org/MOBOT/research/APweb/

and is an exhaustive but terrifying resource for current knowledge.