Evolution of the Present Plant Classification

There is a huge number of flowering plants - imagine an Estimated 300,000 species. To begin to understand this amazing biodiversity, we need to break it into manageable chunks. There is a vast amount of information that botanists, ecologists, chemists, farmers, doctors, cooks and craftspeople have learnt about plants, and we need a framework to organise this knowledge. A plant classification acts as a type of database, in which the scientific plant names are the key to unlocking this information.

What is plant classification?

Classification is the process of grouping things together on the basis of the features they have in common. It is a way of summarising what we know - a kind of filing system. The study of plant classification is known as taxonomy ('taxon' means 'group') and it is carried out by specialised botanists called 'taxonomists'.

History

Human survival skills probably generated the need for some form of classification: to distinguish friend from foe, food from poison and usefulness for medicine, magic, clothing, housing and hunting.
The Materia Medica was the first known herbal classification produced by the ancient Greeks (Theophrastus d. 287BC; Dioscorides c. 40-c.90 AD) to categorise medically useful plant properties. Their system survived for over 1,000 years until Linnaeus (1707-1778) proposed a scientific classification based on the similarity of organisms. He divided the animal world into six categories - mammals, reptiles, birds, fish, insects and worms. The last being for anything that didn't fit into the first five! His plant classification was based solely on flower parts.

Although a great scientific improvement and relatively unchallenged for over 200 years, his method was not uniformly applied across the world. Theories on evolution (Charles Darwin and Alfred Russell Wallace) and genetic inheritance (Gregor Mendel) led to a desire to produce a phylogenetic classification (pertaining to race, heritage) - one which reflects evolutionary changes.

Many of the classification systems proposed in the late 19th and early 20th centuries claimed to be phylogenetic. However, the botanists were only using characteristics that they could see (morphological features), and deciding which differences were important and which to ignore was purely speculative and based on the prejudices of individuals.

How do you decide, for example, if the shape of petals is more significant than the number of stamens? Also, as there can only be one truly phylogenetic system (i.e. the one which reflects the actual route of evolution), the many different systems proposed cannot all have been right! There are now more modern approaches to classification. These aim to reduce or remove the botanist's own preference for certain characters. Importantly they are more experimental, hypothesis-testing, and scientific. The ultimate aim is a classification system which accurately

Plant diversity at Myall Park Botanic Garden

represents plant evolution. We are now closer to achieving this with the new classification based on genetics.

Types of classification - and why botanical is best!

Modern scientific plant classifications are very different from artificial classifications (such as grouping by use: weed, fruit, ornamental etc) mainly because they serve a very different purpose.
Botanical classification aims to be 'natural' in that it tries to express the relatedness of plants. This type of phylogenetic classification aims to reflect evolutionary history, so the plants within a group can be considered to have a common ancestor. Although this may seem to be a pointless exercise when there are other more 'useful' ways of grouping plants, a classification based on relatedness has great power in that it is predictive. If you know the natural group to which a plant belongs, you can immediately predict all sorts of other characters for it. If someone tells you they have a grevillea in their garden you can immediately say that it will have fused petals, that it will have spike or spider shaped flowers, that the stamens are well down inside the fused petals, and that the stigma is protruding.

A recent example of the value of this predictiveness was the discovery of an AIDS drug in an Amazonian plant *Alexa*. Taxonomists, working from their classification of the family, were able to predict that this compound or very similar ones, would probably be found in *Alexa* in Australia.

How is plant classification achieved?

To create a classification you need:
1. the objects to be classified

2. identifying features (characters) which can be used to group the objects

3. a logical way of ordering the resulting groups.

The objects to be classified are obviously the plants, specimens of which are still being collected and new species still being found. Any classification system has to be flexible to cope with new additions and discoveries in the plant world.

The huge variety in plant form provides a very diverse range of identifying features or characters which can be used for grouping. One of the oldest and commonly used methods of grouping plants depends on physical characters, or morphology. These characters are mostly visible with the naked eye or a hand lens and many are used, including:

* size, shape, number and arrangement of parts within a flower
* arrangement of groups of flowers
* the way the anthers open
* leaf shape, texture, pattern of veins, arrangement on stem
* type and shape of fruit
* plant habit (tree, climbing annual, aquatic, perennial etc.)
* sap colour and smell

As well as these easy-to-see features, botanists also use other characters. Many structural features are only visible with a microscope, for example the shape of pollen grains and their surface sculpturing. With the correct treatment and staining, cellular structures including chromosomes can be seen under a microscope. Their shape and number can also be important distinguishing characters.

Biochemistry is also useful as some chemicals are only found in certain groups of plants. In many cases this indicates that members of the group are closely related. The most recent addition to botanists' methods of grouping plants is genetic analysis.

Plant genes and the new classification

At the Royal Botanic Gardens in Kew, London, a team of scientists has recently devised a new classification of flowering plant families, based entirely on differences between their genes.
Genes are long strings of instructions for making proteins - the 'building blocks' of life. These instructions are coded by a four-letter alphabet (the DNA bases). Genes are passed down through generations, so if one of the 'letters' changes in a plant, all of its offspring will inherit that change. These changes gradually accumulate, so they can be used to trace plant ancestry. Two species are more likely to be closely related (i.e. to have separated relatively recently in evolutionary time) if they show only a few differences in their gene sequences. If there are more and larger differences, close relationships are less likely.

Research by scientists involved a sample of 565 flowering plant species and three genes found in all plants. For each plant, the three genes were sequenced, and the sequences (long lists of the letters of the DNA bases) were compared using computer analysis. The resulting pattern, similar to a huge 'family tree' of plants, showed all species were interlinked and had evolved into separate groups from the earliest species of flowering plants.

This new classification of plant families represents evolutionary relationships better than any other before it. Taxonomy is forever changing as new information comes to hand so even the 'new' classification based on genetics will not be static. Plant names will continue to change.

Well known Australian groups subjected to taxonomic change

One the recent changes that has created a 'disturbance' to our childhood knowledge was the renaming of some of the eucalypts as *Corymbia*. The well known bloodwoods and a number of the gums were moved from the genus of *Eucalyptus* to the genus *Corymbia*. Genetic studies produced very close heritage for all species of *Corymbia* even though in appearance their form and especially their barks are different.

Another change has been the inclusion of *Callistemon* (bottlebrushes) into the *Melaleuca* genus. When first collected in Australia many of the showy plants producing bottle shaped flowers were described and ordered into a new genus *Callistemon*. For many years it has been known but not accepted that the differences between the plants placed into the two groups were relatively minor.
The current genus under review is *Acacia*. The species first placed into this group were from the Mediterranean. Over the centuries, numerous look alike plants have been grouped together but recently there has been an international agreement to separate the plants into two groups. Australia is hopeful of keeping the name *Acacia* for all but a few of its species. In time we will no doubt see the concluding chapter of this saga.

These three examples are but a few of the changes that have occurred to our Australian species.

Further information:

Baumgardt J.P. (1982) How to Identify Flowering Plant Families. Timber Press, Portland, Oregon.

Jeffrey C. (1982) An Introduction to Plant Taxonomy. 2nd Ed. Cambridge University Press, Cambridge.

Stace C.A. (1989) Plant Taxonomy and Biosystematics. 2nd Ed. E. Arnold, London.

Mabberley D.J. (1997) The Plant Book: A Portable Dictionary of the Vascular Plants. Cambridge University Press, Cambridge.

APG (1998) An Ordinal Classification for the Families of Flowering Plants. Annals of the Missouri Botanical Garden.

http://www.rbgsyd.nsw.gov.au/plant_info/botanical_info/plant_names_and_classifications
This web site provides useful links.