PREFACE

In this book, the authors present topical research in the study of the morphology, evolutionary diversification and implications for the environments of flowers. Topics discussed in this compilation include the bioactive components from asteraceae flowers; the classification, phylogenetic status and uses as ornamental groundcover of the arachis species; understanding the role of pigments in flowers; flowers as sources of therapeutic molecules; the floral development of sauvagesia (ochnaceae) revealing different origins of presumed staminodes; pollen grain diameter, in vitro pollen germination and regression between grain diameter and in vitro pollen germination in pickerelweed (pontederia cordata L.) and the development of novel pollination techniques to overcome the effects of heteromorphic incompatibility and herkogamy in pickerelweed.

Chapter 1 - Asteraceae is a large family in the Plant Kingdom. The many flowers of Asteraceae have been cultivated for their desirable esthetics all over the world, and are also used medicinally. In particular, their anti-inflammatory properties are considered to be useful. The active components in numerous flowers of Asteraceae have been identified as flavonoids and their glycosides, sterols, triterpenoids and their glycosides and sesquiterpenes. With regard to flavonoids, various compounds have been isolated from pot marigold, wormwood, edible chrysanthemum, mountain arnica and French marigold, and the chemical compositions have been identified. Most have an anti-inflammatory effect. Triterpenoids and their glycosides have been isolated from artichoke flower, pot marigold, edible chrysanthemum, mountain arnica and sunflower, and the chemical compositions have been identified. These compounds show anti-inflammatory activity and cancer-preventive effects. As components in dietary and herbal supplements, these compounds are considered to be relatively non-toxic to humans. Alkanediols are newly discovered compounds and have been confirmed to show anti-inflammatory and cancer-preventive effects. In this chapter, the authors provide an outline of the bioactive compounds present in the flowers of Asteraceae.

Chapter 2 - The *Arachis* genus is divided into 9 taxonomic sections by Krapovicaks and Gregory (1994) based on the most important morphological characters. It is estimated that there are some 100 species within the genus. In the past, phylogenetic relationships were mainly inferred from morphological features, crossability, karyotype analysis and protein markers; in recent years, however, newer DNA markers and *in situ* hybridization techniques have been used in systematic studies of the genus, resulting in findings somewhat different from previously reported postulations. Globally, four wild peanut species have been used as ornamental groundcover. In Florida, USA, rhizoma perennial peanut, *A. glabrata*, is considered a good sod alternative in the urban landscape. In North Queensland, Australia, *A. pintoi* is used for bank stabilization and as ornamental groundcover in shaded and erosion-prone regions; in South China, the species has been extensively planted in orchards and gardens. *A. duranensis* is accepted as a good ornamental groundcover in South China; it also works well when grown in a hanging pot. *A. repens* is widely utilized as an ornamental both along roadsides and in home yards in South America. Up to now, most of the studies related to wild peanut species have been conducted by peanut breeders, rather than workers on flowers and turf science, with aims to enhance the productivity and stress resistances of *A. hypogaea* more often and in some cases to transfer desirable quality traits from wild peanut species. Research on utilization of wild *Arachis* species in breeding ornamental groundcover cultivars should be further strengthened.

Chapter 3 - Betalains, anthocyanins, carotenoids and chlorophylls, are the main pigments present in flowers. Anthocyanins and betalains are mutually exclusive and they are never found together in a plant. The main function of the pigments in flowers is giving them colour and thus to provide an attraction signal to pollinators. The hue of flowers, however, not only depends on the nature of their pigments but it is also influenced by the presence of co-pigments, the cellular pH and the incorporation of metal ions. Other factors like light conditions and temperature also affects the spectral distribution of the light reflected by the pigments and as consequence the flower color. Several auhors have also observed fluorescence emission from betalains in flowers. The reflected light and the light emitted as fluorescence by flowers pigments may be analysed in terms of their relevance in biosignalling towards pollinators. For this survey, not only the spectral distribution of the light given off from the flowers, but also the sunlight spectrum and the sensitive response of pollinators photoreceptors should be considered. Some flowers pigments show also a defensive function acting as toxics to predator insects. It was found that carotenoids are related to flowers flavor as they act as precursors of chemicals which are responsible for the fragrance of some flowers.

Chapter 4 - Innovation, sustainability and safety of drugs have become the main foci of the modern pharmaceutical industry. Consumer awareness of the possible side effects of the use of chemical-based therapeutic agents has compelled researchers to probe and explore natural botanical-based agents that are toxicologically safe, especially when used in the health care system. To this effect, alternative sources of drugs are being probed for novel lead molecules in an endeavour to offer permanent and sustainable solutions to patients. Plants with potential therapeutic value have been used since time immemorial to cure various ailments and it is only during the last past decades that the scientific community has expressed renewed interest in plants as alternative therapeutic sources of lead molecules. Flowers have traditionally been used in cooking in various cultures, such as European, Asian, East Indian, Victorian English, and Middle Eastern. Being an important part of a plant, flower as any botanical source possess secondary metabolites or the bioactive compounds (phytochemicals) which have been reported to be accountable for various observed biological activities and health benefits.

Phytochemicals produced from flowers exhibit pharmacological effects on the body ranging from anti-inflammatory and antimicrobial properties to cardiovascular benefits. This book chapter focuses on providing and updating available information on the therapeutic activities exhibited by common flowers (Saffron, Lavender, Chamomile, Citrus and Calendula), which are envisaged to find potential applications as alternative natural preservatives for foods and/or applications in the pharmaceutical industries to develop new and sustainable botanical-based products for treating/managing various human ailments.

Chapter 5 - *Sauvagesia erecta* L. is a small pantropical herb in the family Ochnaceae. Flowers are unusual in that in addition to petals there is an inner whorl of five petaloid structures and clusters of small spathulate appendages situated between the petals and petaloid structures. The petaloid structures overlap to form a cone enclosing the androecium and gynoecium. Both the spathulate appendages and petaloid structures have traditionally been considered to be staminodial in origin.

The floral development and floral anatomy of *S. erecta* was investigated using scanning electron microscopy and light microscopy. The author's analysis shows the late initiation of antepetalous petaloid structures following petals, gynoecium, and antesepalous stamens. This is consistent with the phyllotactic and developmental sequence for a second whorl of stamens. Further to this the vascular traces feeding both the petaloid structures and the stamens split from a common trace low in the receptacle of the flower. These observations confirm the staminodial nature of these petaloid structures. The primordia for the spathulate appendages arise very late in the ontogeny of the flower after all other organs have initiated and are already well developed. The receptacle between the petals and petaloid staminodes expands into a narrow androgynophore and the initial spathulate appendages arise in an antesepalous position below the stamens and staminodes. Further primordia develop around the first-formed appendages in centrifugal sequence, eventually joining neighbouring appendages in a continuous girdle. The vascular traces associated with the appendages are randomly attached to the staminal traces and divide repeatedly before connecting to individual structures.

The nature of a corona is discussed and it is concluded that the generally used definition is not adequately reflecting the homology of structures described as a corona. The author's findings strongly suggest that the appendages are novel organs and could be considered as equating to the corona structures seen for example in Passifloraceae, Velloziaceae or Amaryllidaceae. Therefore the appendages are best interpreted as hypanthial emergences and not as staminodes. Comparison with other Ochnaceae suggests that outer filamentous staminodes found in several genera are best interpreted as a corona, in contrast to inner antepetalous staminodes. However, the function of the appendages in plant-insect interactions is unclear, except for attraction. Flowers of *Sauvagesia* are buzz-pollinated and the cone-like petaloid staminodes would appear to have a dual function in protecting the reproductive organs from damage and in directing the pollen released onto visitors.

Chapter 6 - Pickerelweed (*Pontederia cordata* L.) is a tristylous species that utilizes heteromorphic incompatibility to reduce or prevent self-pollination. Three distinct floral morphs are produced by tristylous species, but each plant always produces flowers of the same morph. Previous reports have suggested that pollen produced by the three sets of anthers in pickerelweed differed from one another in grain diameter and in the length of pollen tubes generated during in vivo germination. A correlation has also been described between these variables, which suggests that pollen storage reserves play a role in compatibility of some combinations. The objective of this experiment was to verify previously reported grain diameter data and to determine whether in vitro pollen tube growth is influenced by grain diameter. Analysis of pollen from 12 plants (four each of S-morph, M-morph and L-morph) revealed that diameters of pollen grains produced by anthers borne by the three filament lengths of pickerelweed were significantly different from one another. Diameters of grains of s-pollen averaged 20.46 ± 0.34 μm, while mean diameters of m-pollen and l-pollen measured

35.04 ± 0.49 μm and 44.97 ± 0.34 μm, respectively. No overlap in grain diameter occurred among the three classes of pollen. Pollen tubes produced in vitro by l-pollen and m-pollen averaged 486.43 μm and 431.14 μm in length, respectively, 240 min after germination, while pollen tubes from s-pollen attained an average length of 265.57 μm. Previous reports suggested that pollen tube lengths produced in vivo by the three pollen diameter classes were significantly different from one another; however, the author found no difference between lengths of pollen tubes from l-pollen and m-pollen produced during in vitro germination. The reason for these conflicting results is unknown but it is possible that other factors influence in vivo germination. A significant positive regression between pollen grain diameter and in vitro pollen tube length was identified; these results are similar to those described by other workers for in vivo pollen germination and suggest that pollen grain diameter has a positive influence on the length of pollen tubes produced during in vitro germination. This research provides evidence that pollen grain size and tube length may contribute to self-incompatibility in some, but not all, morph interactions in pickerelweed.

Chapter 7 - Pickerelweed is a primarily outcrossing tristylous species that utilizes herkogamy to reduce the likelihood of self-pollination. In addition to this physical separation of reproductive organs, pollen grains borne at the three positions within tristylous flowers produce tubes that correspond in length to reciprocally positioned styles. Most genetic studies require that plants be self-pollinated in order to determine gene action controlling traits and inbreeding can also be useful for developing inbred lines that may have utility in cultivar creation programs. The three morphs of pickerelweed have varying levels of self-incompatibility; M-morphs are self-fertile, whereas S- and L-morphs exhibit reduced fertility after normal self-pollination. In this study the author developed techniques to reduce self-incompatibility in the S- and L-morphs of pickerelweed. Seed set in S-morphs self-pollinated using normal pollen transfer averaged 19.7%, whereas corolla removal increased seed production in these plants to an average of 43.6%. Seed set in L-morphs that were self-pollinated using normal methods averaged 2.7%, whereas stylar surgery of these plants increased average seed production to 29.4%. The methods developed in these experiments will be helpful for plant breeders and geneticists interested in studying this and other tristylous species.