Chapter 9

The Botanical Garden - A Tool to Teach Systematics, Physiology and a Lot More

Iain E. P. Taylor
and
Gerald B. Straley

Department of Botany and
The Botanical Garden
University of British Columbia
Vancouver, British Columbia
Canada, V6T 1W5.

Iain Taylor graduated from the University of Liverpool (B.Sc Hons. Botany - 1961, and Ph.D. -1964). He taught high school for 2 1/2 years, held a visiting position at the University of Texas at Austin, and joined the Botany Department at UBC in 1968. His research interests are in plant cell wall structure and extension, and in the physiology of micropropagation in conifers, ornamentals and endangered species. He is Editor of the Canadian Journal of Botany, a past President of the Canadian Botanical Association, and on the Executive of the International Union of Biological Sciences. He was a founding member of ABLE.

Gerald B. Straley, a native of Virginia, has advanced degrees in both plant taxonomy and ornamental horticulture. He is currently Research Scientist and Curator of Collections with the Botanical Garden of the University of British Columbia, and holds adjunct appointments in the Departments of Botany and Plant Science. His primary interests are in taxonomy of horticultural plants, especially herbaceous perennials, floristics of British Columbia and rare and endangered species. He is the Pacific Northwest editor for the Flora of North America project.

INTRODUCTION

A botanical garden is a living collection of plants that is a valuable resource for a wide range of in situ teaching activities. However, the accumulation of plants without some organized biological themes puts severe restrictions upon the value of the collections to teacher, researcher and the general public. Botanical gardens throughout the world seem to find it easiest to serve plant systematists and horticulturalists. Recently, we have explored opportunities for teaching a wide range of biological sub-disciplines from the resources of the University of British Columbia (UBC) Botanical Garden.

ASSESSMENT OF THE RESOURCES IN A BOTANICAL GARDEN

The taxonomic content of each botanical garden can be generally divided into local flora, special collections, ecological groupings, and aesthetic display. The nature of these different components determine the primary opportunities for teaching. Labelling and pamphlets may be adequate for students to gain some understanding of the garden, but a teacher, even one from the Garden staff, must become very familiar with the plants and their significance within the garden theme if the visit or class activity is to be more than a pleasant afternoon's walk to look at plants. The UBC Garden has an alpine garden, a native garden, a winter garden, a physic garden, a food garden, an Asian garden, a separate nursery, and a Japanese garden. The systematic and evolutionary garden remains to be developed. The total area is 45 hectares.

Each component has a particular function. The Physick, Food, and Japanese Gardens are special display gardens. The Nursery is the technical resource for the garden. The Alpine, Native, Winter, and Asian Gardens, with their more ecological emphases, provide opportunities to study form and function relationships. The Systematic and Evolutionary Garden will provide the living collections for the teaching of systematics.

TEACHING OPPORTUNITIES

Systematics

A botanical garden can be a living laboratory to study diversity within the plant kingdom. The native garden, or any natural area, can be used for a 'scavenger hunt', which is a useful tool for students of any age to learn to recognize plants at various levels of taxonomic hierarchy. This will help them to gain an understanding of systematics as well as ecology, and to look closely at a microcosm of the biota that is part of their everyday environment. The UBC Garden, on the wet Pacific coast, contains a small area for growth of plants from the dry interior of British Columbia. Students and public alike express surprise at the success of these species in what seem like very wet conditions. The explanation (fast drainage is the key to gardening success for these plants) directs the student to consider a physiological explanation for the success of this display and for the natural ecological preferences of these species.

Presentation of native grass species in root constraining concrete tubs allows convenient comparison of species that are otherwise easily passed over by non-taxonomists. The maintenance of native habitat also provides good growing conditions for cultivated or spontaneous algae, fungi, lichens, bryophytes and pteridophytes. The outdoor presentation of these plants that seem superficially similar to the lay person seems to have greater impact on beginning students than first exposure in laboratory study. The first experience acts as a catalyst for more penetrating study in later lab work.

Domesticated plants

The Botanical Garden is a good place to learn of the effects that humans have had on selection of naturally occurring subspecies, varieties and forms. A vegetable, fruit, food or economic garden is especially useful for teaching morphology, because the various plant parts that are edible or useful are things to which students can relate, or with which they may already be familiar. One variable species, Brassica oleracea, shows how selection and breeding, over a long time, can cause certain parts of the plant to become exaggerated - enlarged terminal buds in cabbage, lateral buds in Brussels sprouts, flower bud variations in cauliflower and broccoli etc. The challenge to students is to find food or useful examples representing as many different plant parts as possible.

The food garden also provides a useful tool to teach both the public and the horticultural trade about potentially new food plants and to display a variety of growing strategies (raised beds, espaliered trees etc.). The systematics of plants both for ornamental and other uses usually requires a substantial commitment to a special collection if enough variety is to be available to make the study critical enough for advanced students, although a small collection can be focussed if the material is suited for the study of a particular classification problem. The Physick Garden at UBC is designed and planted in the form of a 16th century European garden. The labels in such a collection provide much more information than name, family, and origin. The teaching value of the label is enhanced if the simple rules of presentation are followed; the label must be clearly visible, legible from a standing position, brief, informative, and interesting. The information must be accurate.

The recent emphasis on pesticides and drugs of natural origin has led to renewed interest in the 'herbals'. Plant secondary compounds, particularly the alkaloids, are known to have a wide range of pharmacological and toxicological activity. Well known plants, such as Digitalis sp., continue to provide medically useful compounds, but there is increasing interest in ethobotanical uses as clues in the continuing search for new drugs and pesticides.

A relatively infrequent collection in botanical gardens is a grouping of plants that were used by indigenous peoples. A major opportunity exists, especially in regions where the indigenous culture is becoming submerged. In areas of North America, for example, much ethnobotanical information, which was passed on by word of mouth in pre-colonial times, will be lost when the present generation of elders and medicine men die.

The identity and chemistry of the active principles is relatively easy for teaching purposes. Solvent extraction, followed by thin-layer chromatography and detection with spray reagents or UV light, is well within the grasp of the teenage high school student. So much work remains to be done in the area of useful plant chemicals, that small research projects abound for high school and undergraduate students, as well as their teachers, with some aptitude for chemistry.

Environmental and Physiological Adaptations

The ecological groupings within a botanical garden provide excellent opportunities to study adaptations. The most obvious examples emerge in a desert garden or in an alpine collection. The particular adaptive structures or morphological forms usually survive transplantation, although the favorable growing conditions provided by cultivation may enhance growth to sizes that exceed those found in Nature. Demonstration of physiological adaptations may require collection and transfer to the laboratory. It is sometimes disappointing to find that resources that are readily available from the Botanical Garden are overlooked in favour of greenhouse or lab-grown material that is more convenient but provides no better illustration than plants that students can also study outdoors. The growth of ecophysiology, and the development of several portable versions of physiological measuring devices, for example to measure leaf gas exchange, nitrogen fixation, and photosynthetic carbon fixation, provide new opportunities to study plant physiology using plants that are growing in the Garden. The introduction of hydroponic technology in nursery practice is yet another opportunity for the Botanical Garden to contribute to the teaching of plant physiology.

Micropropagation and Biotechnology

The increasing activity of botanical gardens in collection and study of endangered species requires the availability of the tissue culture technology that is referred to as micropropagation. The plant production industry has embraced the technology, and the need for botanical gardens to produce plants, even if only for their own use, can be directed to teaching not only for plant physiologists, but also for rare plant workers and for amateur and professional orchid growers.

Other Uses

The largely unrecognized resource of most botanical gardens is the animal life. The absence of major disturbance and the regulated pattern of human activities are opportunities for birds and butterflies. Teaching of taxonomic ornithology and entomology can be extended into behaviour and reproductive biology. The study of horticultural and pesticide management can also be superimposed in comparative studies between the garden and comparable spaces outside.

CONCLUSIONS

The content and arrangement of plant collections in botanical gardens are easily applied to the teaching of plant systematics. This paper points to opportunities that exist to teach other sub-disciplines in Biology. Access to organized collections may not be a complete substitute for field work, but it allows detailed study in controlled situations. It may also remove some of the uncertainties that are inherent in the organization of a field excursion that requires advanced planning with outside agencies. In urban centres, the Botanical Garden may be the only living resource that is accessible within the logistics of educational timetables. For the non-botanist teaching in a botanical garden, there is the added benefit of support from professionals who are actively working with plants. The rate limiting factor is the creativity of the teacher, no matter what sub-discipline is under study.

APPENDIX 1

PLANTS AS CHEMICAL SOURCES

The use of plants for chemicals and medicines seems to have begun well before recorded history. The Physick Garden was also developed as a place of particular value, so much so that early rulers tried to forbid cultivation of such plants having magical powers. Many of the plant names reflect their medicinal properties, e.g. *Papaver somniferum, Lobelia siphilitica*, while others reflect their country of origin, or their use, e.g. *Conioselinum chinense, Matricaria chamomilla*. The Physick Garden at the University of British Columbia is modelled on a typical 16th century herb garden.

Methods are available for the chemical study of the various active, or allegedly active constituents, and in recent years these have come into the financial range of class teaching budgets. In addition, students can be introduced to the simpler methods of phytochemistry because procedures have become relatively quick, easy and sensitive.

The alkaloids are nitrogen-containing secondary compounds that occur in a wide range of plants. Many are known to have pharmacological and toxicological activity. Approximately 6000 alkaloids are known. Two key journals on alkaloids are *Planta Medica* and *Lloydia*, A key reference book is Medical Botany by W. H. Lewis and M. P. F. Elvin-Lewis (John Wiley, 1977). A widely-used, standard reference on alkaloid chemistry and analysis is by F. Santavy in *Thin-layer Chrornatography: a laboratory handbook* (edited by E. Stahl; pages 421-471, Springer-Verlag, 1969).

Collection and chemical preparation

Plant material (2-3 leaves) is extracted with 2 x 25 ml 80% methanol in water and filtered. The pooled filtrate is basified with 0.1M NH_4OH and partitioned into chloroform (the lower layer). Note: There may be some emulsification. This crude material can be concentrated immediately by rotary evaporation until just dry, or it can be 'cleaned up', with some losses, by back extraction into 0.1N HCl, followed by rebasification and return partitioning to fresh chloroform. This chloroform is then removed by rotary evaporation. The solid material taken up in a very small amount of chloroform is now ready for thin layer chromatography on silica gel.

Chromatography

The diverse chemistry of alkaloids requires different TLC solvent systems for high resolution separation. Rf values of alkaloids are very sensitive to solvent composition and to atmospheric saturation in the chamber. Thus, solvents should be kept to 1-3 components, and should be made freshly before use. In addition, opening and closing of the chromatography chamber should be minimized. It is also useful to have known standards as reference compounds Cyclohexane-chloroform-diethylamine (50:40:10), chloroform-methanol-ammonium hydroxide (60:10:1), and chloroform-diethylamine (90:10) are useful first solvents. Detection of alkaloids can be very easy because most fluoresce under UV light (365 nm). Dragendoff s Reagent is still widely used. This is a bismuth-iodide-acetatereagent and there are several variations.

A word of warning

Nicotine is a commonly used pesticide in gardens. Remember that it is an alkaloid, or you will have some very odd results!

APPENDIX 2

NOTES ON PLANTS IN THE UNIVERSITY OF BRITISH COLUMBIA PHYSICK GARDEN

The grouping of plants and the preparation of informative labels or a written guide are teaching tools in themselves. The following are the texts of labels in the UBC Physick Garden. Any small scale planting on a campus can be used for display and education. The Fern and Primitive Angiosperm Garden in the Biology building courtyard at UBC was laid out as a teaching resource and labels provided only scientific identity. A specific-use garden may benefit from labelling with more information. The cardinal rule, however, is that label information must be attractive, informative, but not too extensive. A visitor (even a dedicated student!) has a relatively short attention span. Remember: If you must put a lot on a label, the reader should be comfortable. Make the letters legible from a STANDING POSITION.

Achillea millefolium Common Yarrow Asteraceae
Achilles used it to staunch his soldiers' wounds. According to Gerard, it grew in churchyards as a reproach to the dead "who need never have to come there if they had taken their yarrow broth faithfully every day while living".

Aconitum napellus Monk's-hood Ranunculaceae
Its roots and leaves are so poisonous that Emperor Trajan forbad its growth, and Anglo-Saxon archers tipped their deadly arrows with it. However, the "hastie poyson" is used today as a cardiac and respiratory sedative, and in treatment of rheumatism.

Alchemilla vulgaris Lady's Mantle Rosaceae
"The little magical one". Alchemists in the Middle Ages believed the dew drops caught on its nine-lobed leaves had strong magical qualities.

Althaea officinalis Marsh Mallow Malvaceae
From the Greek 'althino', meaning 'I cure'. Pliny, Virgil and Diascorides all laud its medicinal virtues. Roots contain a mucilaginous lubricant once valued as a cough medicine and also applied to burns and animal bites. Sometimes still used for intestinal disorders and bronchial conditions. Base of confectionery marshmallows.

Amni visnaga Bisnaga Apiaceae
Long used in folk medicine for asthma and angina pectoris. The infusion of its seeds was used to treat urinary complaints. The flower stalks were sold as tooth picks in ancient Egypt.

Aquilegia vulgaris Columbine Ranunculaceae
This was Shakespeare's "Herb of Venus". It was used in medieval times to cure sore throat and swollen glands. It has been a popular medicinal plant in Germany ever since it was mentioned by St Hildegarde, Abbess of Rupertsberg in her "Physica Sacia", dated 1097 A.D.

Arctostaphylos uva-ursi Kinnikinnick Ericaceae
Its leaves were once used in blood infusions. They also have diuretic and antiseptic effects on the urinary tract.

Argemone mexicana Prickly Poppy Papaveraceae
This plant is poisonous and narcotic. Its milky juice was used for emetic and purgative reasons. It was also used as a sedative, a cough medicine and for cutaneous diseases.

Artemisia absinthium Common Wormwood Asteraceae
Oil obtained from this plant is used as a vermifuge tonic. It is also a cerebral stimulant, dangerous in large doses, for which reason its use in drinks is now prohibited. Originally used as a base for the French drink 'Pernod', wormwood was held in high repute in medieval times, against all forms of infection.

Artemisia dracunculus Tarragon Asteraceae
It is a popular seasoning herb in salads and sauces. Tarragon has a stimulating action on the digestive and urinary systems, and is used in the treatment of gastric and intestinal parasitic infestations.

Asperula odorata Sweet Woodruff Rubiaceae
A medieval strewing herb. Gives off a scent of new-mown hay when dried and trodden. Used in "May Wine" and tea and for scenting linen.

Atropa belladona Deadly Nightshade Solanaceae
Renaissance Italian ladies used this juice to dilate their pupils; hence the name 'belladonna'. Today, atropine, obtained from the roots, is used in eye operations and examinations.

Balsamita Major Costmary Asteraceae
Early uses included the elimination of worms in children, the killing of head lice and the curing of digestive disorders. "It is good for them to have eaten hemlock" (Gerard).

Betula pendula Weeping Birch Betulaceae
Fluids in this plant have a stimulating effect on several glands. It has been used in urological teas for kidney and urinary infections, and rheumatism. "...and in our time also the school masters and parents do terrify their children with rods made of birch" (Gerard).

Centranthus ruber Red Valerian Valerianaceae
This was once thought to be the same as the biblical Spikenard. It was used as a sedative in hysteria and nervous disorders.

Chamaemelum nobile Roman Chamomile Asteraceae
Its seeds came to Britain with invading Roman legions. "oile of cammomill is exceeding good against all manner of ache and paine, bruisings, shrinking of sinewes, hardnesse, and cold swellings" (Gerard). Its foliage and flowers contain aromatic oils; thus it was used as a "strewing herb" on medieval floors. As a tea, it aids upset stomachs.

Chenopodium ambrosoides Wormseed Chenopodiaceae
Oil is made from these flowers and fruit, and consists of ascadole. This has vermifugal qualities; for example, it cures round worms and hook worms.

Chrysanthemum cinerariifolium Asteraceae
Tanacetum cinerariifolium Pyrethrum
Comes from the Caucasus, with bright flowers on straight stems. These may be single or double and are a source of Pyrethrum powder used as an insecticide. Vast quantities are grown for this purpose in the Kenya highlands. It is non-toxic to man and animals.

Chrysanthemum leucanthemum Ox-eye daisy Asteraceae
Native to North America. Often called the Field Chamomile. Employed to relieve chronic cough, asthma, and nervous excitability.

Chrysanthemum parthenium Feverfew Asteraceae
Tanacetum parthenium
In medieval times this plant was used as a cure for "them that are giddie in the head" and "such as be melancholike".

Colutea arborescens Bladder-senna Fabaceae
This plant has similar properties to Senna. It cures ring-worm, destroys insects, acts as a febrifuge and as a laxative.

Convallaria majalis Lily-of-the-Valley Liliaceae
The "May Lily", according to Gerard, restored "speech into those that have the dum palfie". Dried rhizomes of the plant produce the glucoside convallarin. Present day usage includes the treatment of speech slowness in patients recovering from strokes.

Coriandrum sativum Coriander Apiaceae
When crushed, the seeds have a pungent odor and taste. They are stimulative and relieve colic. If used too freely, the seeds become narcotic.

Cynoglossum officinalis Hound's-tongue Boraginaceae
The plant smells of mice. The leaves are narcotic and astringent. It was used by the ancients as an anti-spasmodic. It is also known as the "Herb of Mercury".

Datura stramonium Thornapple Solanaceae
This was used against epileptic fits and madness. All parts are narcotic, and it was once known as "Devil's Apple". In the 16th century, a woman struck by lightening was saved by a *Dature* preparation "when all hope was passed". It is presently used in the treatment of chronic bronchitis and insomnia.

Digitalis laevigata Foxglove Scrophulariaceae
Glycosides, forming in the second year leaves, yield digitoxin and digitalin which regulate activity of the heart.

Digitalis lutea Straw Foxglove Scrophulariaceae
This plant was used for many hundreds of years "to cleanse and purge the body both upwards and downwards" (Culpepper). Since 1775, this plant has been a source of digitalin used in cardiac treatments.

Digitalis purpurea Common Foxflove Scrophulariaceae
The common name is derived from the Anglo-Saxon word "Foxesglew", an ancient musical instrument with hanging bells. This is a source of digitalin used as a cardiac stimulant.

Dipsacus fullonium Fuller's Teasel Dipsacaceae
The leaves of this plant trap water, which was once thought to be a remedy for poor eyesight. The flower heads are hooked, and used to raise the nap on woolen cloth.

Eryngium maritimum Sea Holly Apiaceae
"Roots preserved in sugar have the property of...nourishing the aged and amending the powers of nature in the younger" (Gerard).

Galega officinalis Goat's Rue Fabaceae
Early herbalists used it as a footbath for people tired with overwalking, and to cure smallpox. It can also be used in the place of rennet in making cheeses.

Gaultheria procumbens Wintergreen Ericaceae
The leaves of the plant yield Oil of Wintergreen, and make a drink called "Mountain Tea".

Hamamelis virginiana Witch-hazel Hamamelidaceae
The bark, twigs and leaves of this plant contain tannic acid, which is used to stop bleeding and prevent inflamation. Its common name comes from use in witching. Branches are used as divining rods to locate water in order to dig a well.

Hyoscymus niger Black Henbane Solanaceae
This plant is lethal to poultry; hence its common name. The leaves contain lyiscine, a drug used as a sedative in child birth. This was used by Dr Crippen to murder his wife.

Hypericum perforatum St John's-wort Hypericaceae
This beneficial herb is also called "Grace of God". It has a long Anglo-Saxon history of protecting houses and churches. Large bunches were hung over doorways to ward off evil powers.

Hyssopus officinalis Hyssop Lamiaceae
A holy herb of ancient times. "Purge me with hyssop and I shall be clean" (Psalms 51:7). Persians used it in lotions to help the skin. Flavors liquers.

Ipomoea purpurea Morning Glory Convolvulaceae
This plant is known in Mexico as "badoh negro". It is hallucinogenic when used in large quantities, and a purgative when used in small doses.

Inula helenium Elecampane Asteraceae
Helen of Troy was said to have been digging this plant when she was abducted by Paris. It has cough easing properties when taken internally. It can also be used to treat wounds.

Iris spuria Iris Iridaceae
Dried rhizomes of certain Iris species are the source of the violet-scented "orris root". Orris was included among the rare spices of the Egyptians. Romans and Greeks esteemed it for its medicinal uses, as well as for its perfume. Orris was used to cure ulcers, induce sleep, and as a sovereign remedy for a "pimpled or saucie face".

Juniperus communis Common Juniper Cupressaceae
The leaves and fruits are carminative, used as an antiseptic and to stimulate diuretic action. It was also used in "healing leprosy and strengthening the brain" (Culpepper).

Lavendula vera Lavender Lamiaceae
Lavender oil is an insect repellent. It has been used as a rub for rheumatic complaints, aches and pains. The dried blossoms are used to enhance teas. They make beautifully scented sachets which will keep moths from damaging clothes.

Leonurus cardiaca Common Motherwort Lamiaceae
"There is no better herb to take melancholic vapours from the heart, and to strengthen it; it makes mothers joyfull, and settles the womb, therefore it is called MOTHERWORT" Culpepper). Today, it is used as a nerve tonic, and after childbirth.

Liatris spicata Blazing Star Asteraceae
A North American native, used by pioneers in treatment of venereal diseases and as a gargle. Powdered leaves act as an insect repellent.

Lobelia siphilitica Great Lobelia Lobeliaceae
Linnaeus gave this blue-flowered lobelia its name of 'siphilitica' because Peter Kalm, returning from the New World in 1747, reported that the Indians used this plant as a cure for syphilis.

Lobelia tupa Devil's Tobacco Lobeliaceae
This plant was used by American and Chilean Indians as tobacco. The leaves contain lobeline, which has a narcotic effect. It is used for treating bronchitis and spasmodic asthma, and the resuscitation of newborn babies.

Marrubrium cylleneum Horehound Lamiaceae
This plant was listed by Hippocrates in 500 B.C., and has been used ever since for bronchial and digestive complaints. It was known in ancient Egypt as "the seed of Horus". It is used as one of the five bitter herbs for the Feast of Passover.

Matricaria chamomilla German Chamomile Asteraceae
This plant is the source of tisane, made from the leaves and used as a remedy for pain. The plant possesses the same soothing qualities as *Anthemis nobilis* - Roman chamomile.

Melissa officinalis Lemon Balm Lamiaceae
This plant is a beloved of bees.

Mentha x gentilis Red mint Lamiaceae
Mentha requieni Creme-de-menthe
Mentha spicata Peppermint
These plants are used as peppermint flavoring in medicines and food, and also in creme-de-menthe.

Mentha pulegium Pennyroyal Lamiaceae
"...a garland of pennyroyal worn about the head is of great force against swimming in the head" (Gerard). Used as a medicinal, this plant prevents seasickness, and acts as an insecticide. It is also used as a peppermint flavoring in medicines and food, and also in creme de menthe.

Mirabilis jalapa Four-o-clock Nyctaginaceae
The flower of this plant opens at four o'clock in the afternoon, and remains open all night. Its roots contain the drug Jalap, which is used as a purgative medicine.

Monarda menthifolia Bee Balm Lamiaceae
The scented leaves of this plant are made into tea, called Oswego Tea.

Nepata cataria Common Catnip Lamiaceae
This aromatic plant has a curious fascination for cats. "It is much commended of some, if the juice there-of be drunke with wine, to help those that are bruised by some fall, or some other accident" (Parkinson).

Papaver somniferum Opium Poppy Papaveraceae
This plant was mentioned on Sumerian clay labels of 3500 B.C. It induces sleep and turbulent dreams. The family name 'Papaver' is thought to come from the Celtic word 'pap', or porridge, and refers to the custom of mixing poppy juice with gruel to put crying babies to sleep.

Plantago rubrifolia Plantain Plantaginaceae
In ancient days, this plant was used to relieve headaches, and to heal wounds. Alexander the Great used this to cure his raging headaches. Today, it is used to relieve insect bites. One derivative, annodine, soothes earaches and toothaches; the seeds are used for hemorrhoids and dysentery.

Prunella vulgaris Common Self-heal Lamiaceae
Tea made from the leaves of this plant was used as cure-all for quinsy and stomach cramps.

Pulmonaria officinalis Blue Lungwort Boraginaceae
According to the Doctrine of Signatures, this plant was thought to be a cure for chest ailments, because the leaves resemble lungs. In herbal medicine today, it is used to treat inflammation of the bronchial tubes.

Rhamnus purshianus Cascara Rhamnaceae
The value of this tree lies in its bark, which yields cascara sagrada, a powerful purgative. It was so named by missionaries. The translation is 'sacred bush'.

Rosa gallica Apothecary's Rose Rosaceae
The Romans believed the rose provided a cure against drunkenness, and floated rose petals in their wine. A rose-scented pudding was given to sufferers of sore throats. All parts of the rose were used in ancient remedies. Pliny lists more than thirty cures prepared with roses.

Ruta graveolens Common Rue Rutaceae
Ruta graveolens 'Variegata' Rue
"Herb of Grace" was used by the rich in nosegays to ward off evil airs as they walked in the streets. Rue oil was used to arrest bleeding and calm intestinal spasms. "Rue maketh chaste: And ere preserveth sight; Infuseth wit and putteth flies to flight" (Schola Salernitana).

Salix babylonica Weeping willow Salicaceae
Salix triandra French willow
This plant is the source of salicylic acid, the main ingredient of aspirin. It is used in the treatment of diseases with rheumatic or gouty origin; diarrhea and dysentery.

Salvia officinalis Sage Lamiaceae
"To live for aye eat Sage in May". "Sage is singular good for the head and braine, quickeneth the memorie and senses and restoreth health to those that hath the palsie" (Gerard)

Salvia sclarea Clary Sage Lamiaceae
In the Middle Ages, this plant was used for eye inflammation, hence the name 'Clear-Eye'. "Many men when they have got the running of the reins (kidneys)...run to the bush of clary" (Culpepper).

Sambucus nigra European Elder Caprifoliaceae
This plant was often believed to have been inhabited by witches, so it was never used for firewood, or to make a cradle. Its flowers can be used as an astringent in eye and skin lotions. Elderberry jam is a good, natural laxative.

Sanguisorba minor Salad Burnet Rosaceae
"The leaves steeped in wine and drunken comfort the heart and make it merry..." (Gerard). This plant was frequently called 'Toper's Plant'. Its leaves can be used in soups, salads and cool drinks for a taste of cucumber.

Santolina chamaecyparissus Lavender Cotton Asteraceae
This plant was used in small quantities as a remedy against tapeworms; one which was not to be given to children.

Saponaria officinalis Soapwort Caryophyllaceae
Medieval Arab physicians prescribed this plant for leprosy and various skin ailments. It was also used to make a soapy lather to remove greasy spots from clothing, and to cure skin itches.

Scrophularia nodosa Knotted Figwort Scrophulariaceae
A European native, related to the foxglove, used in folk medicine as an antidiabetic agent, in dermatology and for reducing tumors.

Stachys byzantina Betony Lamiaceae
Anglo-Saxons considered this an important magical plant. A leaf in the purse gives protection from witchcraft. Cure-all for violent blood "chilly need, "fear" and "angry snake bites".

Symphytum asperum Rough Comfrey Boraginaceae
This plant was used as a tonic, and to suppress bleeding. It was also thought to hasten the healing process.

Symphytum officinale Comfrey Boraginaceae
It has many names, including Knitbone and Consoleda, which indicate its usefulness in easing sprains and helping to heal broken bones. Used as poultices or in a tisane. Comfrey is a nutritional herb, rich in calcium, potassium, phosphorus, vitamins and trace elements.

Tanacetum vulgare Common Tansy Asteraceae
The leaves and flowers of this plant contain Tanacelum, which is used as a cure for intestinal worms, and to prevent miscarriages. Charlemagne grew it in his garden in the 8th Century. Worn in the shoe, this plant prevents ague.

Taxus baccata English Yew Taxaceae
This plant is very poisonous - not even safe to sleep under. It was used medicinally for disorders of the spleen. It is mentioned by the third witch in Shakespeare's 'Hamlet'.

Vaccinium myrtillus Low Bilberry Ericaceae
The berries of this plant were listed by Abbess Hildegarde of Rupertsberg, in the 12th Century, as being used as a medicinal drug. The leaves are hypoglycemic - they reduce blood sugar levels. The fruits can be used as a decoction for diarrhea.

Verbascum densiflorum Mullein Scrophulariaceae
A decoction of these leaves is used to alleviate diarrhea. The Romans dipped the tall, flowering stems in tallow and used them as torches.

Verbena officinalis Vervain Verbenaceae
In medieval times, this plant had a reputation as a potent healing aid. Its flowers were used to restore failing vision.

Vinca major Periwinkle Apocynaceae
Astringent properties of these leaves have been recognized and used medicinally since medieval times. This plant is used today in the treatment of leukemia.

Viola tricolor Heartsease Violaceae
This plant is a beloved of herbalists through the ages. According to the Doctrine of Signatures, its heart-shaped leaves were thought to cure heart disease. It was once used as an ointment and cathartic.

APPENDIX **3**

ENVIRONMENTAL AND PHYSIOLOGICAL ADAPTATIONS IN APLINE PLANTS

Any ecologically organized section of a plant collection can be used to study adaptation. In this case the UBC Alpine Garden collection, which is arranged by continental grouping, provides the example. Students, working in groups of 4, are directed to select ten 'alpine' plants and their adaptations. They should each record the name, family, origin and particulars of each adaptation. When the task is completed, they should 'show and tell' their plants to another group. A short competition to identify the greatest number of structural, environmental and physiological adaptations in a group of plants within a fixed time may be a useful teaching tool.

The species chosen will depend on the plants that are showing the adaptations most effectively at the time. This is the major constraint of using live collections either for environmental or physiological study. Key features for alpine adaptations include:

low habit
adaptations for xeric conditions
compressed flowering time
relatively greater resource distribution towards
vegetative propagation.
perennial life form.
narrow leaves that reduce wind force.
thorns.
wax reflective properties.
easily rehydratable.
bright flowers
die-back

Several others can be identified.

Particular collections of plants allow the teaching of particular adaptive strategies without the risks involved in a planned field mp. The Botanical Garden or any small local plant collection is usually close at hand and can be used as the plants provide opportunity. Small display troughs and greenhouse groupings can be used effectively to study adaptations.

NOTE: When teaching about any particular environment in a Garden setting, be sure that plants really are naturally occurring in the environment. For example, in an alpine garden, a naturally low-growing species may be included to provide some visual harmony. It may not be an 'alpine'!