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Project leader	**Dr Virginia Murray**
Location	**National Poisons Unit, Guy's Hospital** **Royal Botanic Gardens, Kew** **Royal Horticultural Society, Wisley**
Project Co-ordinator	**Mr John Hillier**
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Additional information

Information from this project has also been published in the following forms:

Horticultural Trades Association
'Code of recommended retail practice relating to the labelling of potentially harmful plants'
'The display and sale of potentially harmful plants. Guidance note 010.'

Contact: 01734 303132

Royal Botanic Gardens, Kew. Poisons Unit, Guy's and St Thomas' Hospital Trust
'Poisonous plants in Britain and Ireland' on CD-ROM.

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HAZARD ASSESSMENT OF POISONOUS PLANTS

IN THE

UK HORTICULTURAL TRADE

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SUMMARY

Over the last few years (1991-93) there has been growing public concern for improved labelling of plants, at the point of sale, in respect of their potential to cause adverse effects on ingestion or handling. Indeed, of the approximately 5,000 enquiries of suspected human poisonings received every year from emergency medical professionals by the National Poisons Information Service, London, a large proportion involve cultivated garden or house-plants.

To address this problem, the Royal Horticultural Society convened a meeting with the Horticultural Trades Association and, as result, commissioned an independent toxicological review. This work has been undertaken by specialists from the National Poisons Unit, Guy's Hospital and the Royal Botanic Gardens, Kew, with horticultural support from the RHS, Wisley. The attached report is the result.

The report contains toxicological reviews for over 100 plants/plant groups, indicating that of the several thousand different plant species or cultivars sold in the UK, a few hundred are potentially harmful if ingested or handled under certain conditions (an exact figure is not possible due to the scores of cultivars for sale, whose toxic status is not known).

Each review comprises information on *Ingestion*, *Skin contact*, *Eye contact*, *Toxins*, *Mechanisms* (i.e. physiological action) and *Other species* (i.e. the toxicity of other species or cultivars in that plant group). Wherever possible, information on individual toxic parts of the plants involved and expected clinical effects has been included together with examples of validated cases of human poisoning. The *Conclusion* of each review aims to summarise and conclude the potential toxic ***hazard*** associated with each plant/plant group and its constituent plant parts.

The horticultural trade plan to use this report as an authoritative source document that will provide the scientific basis for the development of a nationwide Code of Practice for warning labels on potentially harmful plants (including bulbs and seeds). By developing such a Code of Practice, the consumer will be better placed to make a more informed decision about the choice of plants to be purchased and their subsequent handling. In this way, it is hoped that the number of accidental poisonings and adverse contact reactions associated with commercially grown plants can be reduced.

INTRODUCTION

AIM OF THE REPORT

This report was commissioned by the Royal Horticultural Society, on behalf of the Horticultural Trades Association and other horticultural trading agencies, following growing concern about the sale of toxic plants from many retail outlets in the United Kingdom, their potential poisoning hazard to the consumer and the inadequacy of warning labels.

The purpose of this report, therefore, is to provide an independent, scientific review of the potential hazards of such plants available from nurseries, garden centres and other major horticultural retail outlets throughout the United Kingdom.

The horticultural trade plan to use this report as an authoritative source document that will provide the toxicological basis for the development of a nationwide Code of Practice for warning labels on potentially harmful plants (including bulbs and seeds). By developing such a Code of Practice, the consumer will be better placed to make a more informed decision about the choice of plants to be purchased and their subsequently handling. In this way, it is hoped that the number of accidental poisonings and adverse contact reactions associated with commercially grown plants can be reduced.

BACKGROUND

Many plant species are known to contain a wide range of chemicals (alkaloids, glycosides, phenols, etc.) that have the potential to produce detrimental effects in humans if eaten or handled; these constitute the poisonous plants. Of the many thousands of plants introduced into cultivation for ornamental purposes in the United Kingdom, it is inevitable that at least some may retain such chemicals and therefore have the potential to cause mild or, in some cases, serious poisoning. Over the last two years, this has become an area of growing concern amongst the general public, the National Poisons Unit and the horticultural trade itself.

Children are most at risk from accidental poisoning, especially the under-5 age group, who often find berries and other plant parts attractive to eat. In addition, some plants may give rise to skin reactions on handling. Symptoms often include dermatitis-type reactions, local inflammation, itching and blistering. In some cases these reactions can be very severe.

More than 5,000 cases of suspected poisoning involving cultivated or native plants are reported every year to the National Poisons Information Service at Guy's Hospital (NPIS figures based on calls from emergency medical professionals, *NPIS, 1993*).

A recent article (Anon. 1991) drew attention to the fact that while some horticultural retailers have made efforts to ensure their plant produce carries appropriate warning labels, others have been less vigilant and many potentially hazardous plants continue to be sold without any such advice to the consumer; furthermore the article indicated many inconsistencies in the quality of information provided and coverage of plants so far labelled.

In December 1991, the Royal Horticultural Society (RHS) convened a meeting with the primary UK trade organisation, the Horticultural Trades Association (HTA), to finance an investigation to address this issue. It was agreed that a scientific review was justified to assess the potential hazard to the consumer. As a result, the National Poisons Unit, Guy's Hospital and the Royal Botanic Gardens, Kew, were commissioned to prepare such a paper, with horticultural input from the RHS. This collaborative approach has brought together expertise in toxicology, botany and horticulture and has made possible the preparation of an independent yet authoritative source document to be used as a basis for joint action by the trade. The accompanying report is the result.

The collaborators acknowledge the financial support and assistance of a number of organisations associated with horticulture, namely the Horticultural Trades Association (HTA); the Horticultural Development Council (HDC); the Land Settlement Association (LSA) Charitable Trust; J. Sainsbury plc/Sainsbury's Homebase; Notcutts Nurseries Ltd; Marks & Spencer plc; the Royal Horticultural Society (RHS).

SCOPE OF THE REPORT

The report contains toxicological reviews for 109 plants or plant groups and represents many hundreds of the most commonly sold cultivated plants. Clearly, it has not been practical to review the toxicological status of the several thousand species and cultivars believed to be available in the trade; instead, existing toxicological literature, case reports and expertise of the three collaborating institutions has been used to highlight potentially harmful species.

Although the report aims to be as comprehensive as possible, it does not include potentially poisonous plants sold from highly specialist nurseries only. It is, therefore, inappropriate to assume that plants not mentioned in this report are non-toxic.

Furthermore, it is important to note that because of variations in different individuals' susceptibility to different plants, the authors cannot be held responsible for omitting plants that may give rise to harmful reactions only in those individuals who are unusually sensitive.

Contact problems examined include those arising from occasional or accidental contact, as in gardening exposures, and problems arising from occupational exposure (i.e. chronic use). The range of contact reactions covered includes irritant contact dermatitis, allergic contact dermatitis, urticaria and photo-sensitive reactions.

With the exception of the ***Brugmansia*** investigation (*see Appendix I*), poisoning that may result from inhalation (e.g. of allergenic volatile oils) has not been researched in this report unless such information has been readily available.

METHOD

The criterion used to select a plant or plant group for review was that there must be sufficient scientific evidence, either in the toxicological literature and/or case data held by the National Poisons Information Service (NPIS) at Guy's Hospital, to suggest that there may be a toxic *hazard* associated with that plant/plant group, following either ingestion and/or contact.

Defining *hazard* and *risk*

The term *hazard* is defined in this study as the **chemical potential** of a plant to cause harm to an individual as a result of any of its parts being eaten or contacted. The toxic *hazard* of a plant is, therefore, determined by a number of factors: the presence, identity, concentration and distribution of toxins within that plant. For example, the more potent the toxin(s) present and the higher their concentration, the greater the *hazard*. In addition, the degree of *hazard* associated with a plant may vary according to whether the plant is eaten by an adult or a child; the severity of symptoms is likely to be greater in children. The enclosed *hazard* assessments attempt to reflect such discrepancies in toxic effect.

The term *risk* is defined in this study as the **likelihood** that an individual may suffer harm from ingestion and/or contact with all or part of a plant. To determine the *risk* of poisoning associated with a plant, it is first necessary to undertake a *hazard* assessment, then, if a *hazard* exists, determine the *likelihood* of the toxic parts of the plant being eaten or contacted. For example, a widely cultivated plant containing a highly toxic substance in all parts and bearing attractive fruit is not only potentially very *hazardous*, but it also carries a high *risk* of poisoning since it is **likely** that the fruits will be eaten, especially by children. Alternatively, a *hazardous* pot-plant containing toxins in its underground parts only, e.g. the bulb, represents a low *risk* of poisoning since it is **unlikely** that the plant will be uprooted intentionally, even by children, and the bulb eaten.

It is the purpose of this report to provide *hazard* assessments only. *Risk* assessments are best determined by the horticultural trade itself since sales of each plant will need to be assessed, and the way and frequency with which the plant is likely to be handled (e.g. regular dead-heading of flowers; pruning; etc.).

Information sources

Most of the data presented in this report has been drawn from the wealth of toxicological, horticultural and taxonomic literature held by the National Poisons Unit (Guy's Hospital), the Royal Horticultural Society (Wisley) and the Royal Botanic Gardens (Kew).

Every year, over 5,000 cases of suspected poisoning due to plants are handled by the National Poisons Information Service (NPIS), part of the National Poisons Unit. NPIS provides a 24 hour service to medical professionals around the country and advises on the management of patients who have been seriously poisoned by plants; the severity of some such poisonings have proven fatal. Access to these case data, mostly involving ingestions, has proved particularly valuable in ensuring that the accompanying reviews are as medically accurate and up-to-date as possible.

With respect to poisoning problems arising from contact with plants, be it intentional or unintentional, the medical recognition of such conditions is often limited. As a result, under-reporting of such cases is suspected. Recognising this information gap, the project team, in addition to searching the literature and using case data from NPIS, adopted two additional methods of information retrieval.

Firstly, the project team issued a press release in the national papers during 1992 inviting the public to report personal experiences of garden/house-plants causing skin reactions. This resulted in over 200 new cases being reported; those with medical confirmation were incorporated into the report.

Secondly, the project sought additional advice from a consultant dermatologist (Dr C. Lovell, Royal United Hospital, Bath and author of the book *Plants and the Skin*, 1993). Dr. Lovell was invited to undertake a review of the draft species accounts from a dermatological perspective. This provided a most worthwhile verification of the plants identified by the project team as potentially hazardous on contact and ensured the dermatological quality of the accompanying accounts.

Format and interpretation of the reviews

The information aims to reflect the current state of knowledge about the toxicity of the plants covered. The final format and information coverage adopted for each review was agreed with the horticultural trade at an early stage in the work.

Each review comprises information under separate sub-headings: *Ingestion*, *Skin contact*, *Eye contact* (where data available), *Toxins*, *Mechanisms*, *Other species* (i.e. the toxicity of other species or cultivars in that plant group) and *Conclusions*. Wherever possible, information on individual toxic parts of the plants involved and expected clinical effects has been included together with examples of validated cases of human poisoning. For those plants or plant groups whose scientific names have undergone recent change due to a review of their nomenclatural status, a *Taxonomic note* has also been added at the beginning. Information about poisoning in animals was considered irrelevant in all but a handful of reviews.

The *Conclusion* of each review aims to summarise and conclude the potential toxic ***hazard*** associated with each plant/plant group and its constituent plant parts. These stand-alone *Conclusions* are intended to enable the trade to design a labelling scheme that will accurately reflect the potential hazard associated with each plant/plant group and its respective parts.

A scheme showing comparative toxicity of the plants covered is not possible due to many naturally-occurring and variable parameters: maturity of the plant or plant part, quantity ingested, age and health of the plant, degree of human susceptibility, soil and other environmental conditions.

In general, reviews focus on individual species (e.g. *Nerium oleander*). Where many different species or cultivars are sold of a particular plant, as in the case of *Berberis*, the review has been written from the generic level (e.g. *Berberis*) rather than the species level (e.g. *Berberis vulgaris*). In this way, the hazard associated with all species and cultivars of *Berberis* can be accommodated within a single review. For these *generic reviews* a lead species is usually chosen for which the toxicity information is most well-known. Because of the absence of toxicity information for every cultivar, some extrapolation to determine their toxicity has been unavoidable. In all cases, however, any such interpretation has been clearly stated within each review under the sub-heading *Other species*.

Where toxic principles are present across entire plant families, e.g. irritant toxins are present in all members of the Aroid family (Araceae), a review is likely to be presented at the family level rather than the genus level (e.g. *Dieffenbachia*) or species level (e.g. *Dieffenbachia picta*). The family Boraginaceae, which includes *Symphytum* (Comfrey), *Pentaglottis* (Alkanet) and *Pulmonaria* (Lungwort), has been reviewed in this way.

Latin family and generic names follow those accepted by the Royal Botanic Gardens, Kew and as published in Brummitt (1992). The vernacular names given are those considered to be in widest usage across the country. Botanical descriptions have not been included since these can easily be obtained from the numerous popular gardening and house-plant publications.

Investigation of *Brugmansia*

Drafting a review for the genus *Brugmansia* presented something of a challenge. Although the toxicity by ingestion of this genus was well-documented, special effort has been given to clarifying the taxonomic status of the genus since a recent nomenclatural change has resulted in considerable confusion over its naming in the horticultural world.

More importantly, concern was expressed by the project's Steering Group, after presentation of the first draft report of the project, about the potential systemic toxicity of *Brugmansia*'s volatile oils after inhalation. Two case reports described in the draft were considered by the Group to provide inconclusive evidence for labelling action.

In order to pursue this further, the Royal Botanic Gardens, Kew, agreed to undertake a biochemical investigation of the volatile oils of the plant. A detailed report on the findings of this research are presented in Appendix 1 and the conclusions incorporated into the species review for that plant (*pp. 20-22*).

Excluded species

Some plants initially considered for inclusion were found, after examination of the literature, not to meet the criterion (described above) owing to their low or non-toxic nature on both ingestion and contact. A full review of each was therefore considered unjustified, but it was felt appropriate to list them (*see Table I overleaf*).

TABLE I **Non-toxic and low toxicity plants/plant groups**	
Begonia spp.	(Begonia)
Chlorophytum spp.	(Spider plants)
Cotoneaster spp.	(Cotoneaster)
Lonicera spp.	(Honeysuckle)
Mahonia spp.	(Mahonia, Oregon Grape)
Quercus spp.	(Oak -pedunculate, sessile and holm)
Pyracantha spp.	(Pyracantha, Firethorn)
Saintpaulia spp.	(African Violet)
Tradescantia spp.	(Tradescantia)

CONCLUSION AND FUTURE DEVELOPMENTS

This study shows that, of the several thousand plants believed to be commercially available in the UK from garden centres and other retail outlets, many hundred present a potential toxic hazard to the consumer (an exact figure is not possible due to the scores of cultivars on sale).

The report has identified 109 plants/plant groups worthy of hazard assessment according to the criterion described in the *Method*. An analysis of the *Conclusions* of these reviews would be inappropriate to provide here since it would pre-empt their interpretation by the horticultural trade who plan to use this document to develop a Code of Practice for a nationwide labelling scheme of potentially hazardous plants.

In summary, of the 109 plants/plant groups studied, 94 indicate the presence of a potential toxic hazard, be it minor, moderate or severe. Of these 94, over a third indicate potential toxicity associated with both ingestion and skin or eye contact; just under a half indicate potential toxicity associated with their ingestion only; the remainder comprise those with potential toxicity via skin or eye contact.

The research team emphasise the fact that even though a plant may be sold at a non-toxic stage in its life-cycle (e.g. when in leaf or flower only), the plant may produce toxic parts (e.g. fruits or seed) at a later stage. The trade should take this into account when developing warning labels.

Recommendations for the future

A UK-wide Warning Label Scheme for commercially-grown plants

Early drafts of this report provided the Horticultural Trades Association (HTA) with sufficient information to begin the design of a proposed Code of Practice for a nationwide *warning label scheme* covering whole plants, bulbs and seed. With this completed report, the HTA is now in a position to refine and develop this Code of Practice to ensure that its scope and recommendations accurately reflect the potential dangers associated with a number of commercially grown plants.

By increasing public awareness of such potentially harmful plants, the research team hope that the proposed Code of Practice will reduce the number of children and adults suffering adverse health effects following exposure to such plants. The research team also believe that this work will establish a European, possibly international, precedent in this area.

Monitoring a hazard-warning labelling scheme

The role of the National Poisons Unit: An important part of any prevention programme is monitoring. Monitoring is needed to evaluate the effectiveness of the programme adopted; the Code of Practice referred to here is no exception. Poison Centres around the world have considerable experience in monitoring poison prevention strategies (e.g. they advise the International Programme on Chemical Safety, sponsored by the WHO[a], ILO[b] and UNEP[c], on this topic). The National Poisons Unit, one of Europe's busiest Poison Centres is, therefore, well-placed to offer assistance in this field.

For this reason, it is proposed that the NPU offer a monitoring service to help assess the effectiveness of the Code of Practice. For example, after the Code is implemented, NPU could offer a more systematic and thorough surveillance of all enquiries related to the sale of whole plants, bulbs and seeds, and their details of labelling at the time of sale. Furthermore, a statistical comparison of numbers and type of plant-related enquiry before and after the implementation of the Code would provide a valuable indicator of its success.

The role of PLATO: It is likely that the recently developed image-based computer system for identifying poisonous plants, called PLATO (Anon., 1990), designed jointly by NPU and the Royal Botanic Gardens, Kew, might also offer valuable feedback on the success of the Code of Practice.

Covering more than 200 of the plants most frequently implicated in poisoning in the UK, PLATO is designed to support medical professionals in their management of cases of plant poisoning. The system has recently been evaluated in hospitals around the country and is planned to become available for their routine use over the coming year. By using this system, hospitals will provide much more accurate botanical data about the plant material involved in poisonings and as a result PLATO could become a useful tool for monitoring the success of the labelling scheme.

Research on plant poisoning by systemic inhalation

The attached toxicological reviews address the problem of toxicity arising from ingestion, skin or eye contact. However, with the exception of the *Brugmansia* study (*see Appendix I*), little thought has, as yet, been given to toxicity arising from inhalation. We propose that the Code of Practice be developed further to address this topic.

The need for a Periodic Review

As new plants become commercially available, new toxicological assessments may become necessary. For example, in the near future, hazard warning labels may no longer be needed for plants such as *Alstroemeria*, should allergen-free cultivars become available. On the other hand, many species whose toxicity may as yet be undetermined, are entering commercial cultivation for the first time. In order to keep abreast of such developments additional toxicological reviews may become necessary.

A periodic review of potentially harmful plants in the horticultural trade may prove an effective way to reflect these changes; in so doing, the Code of Practice can be kept as up-to-date and accurate as possible.

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On behalf of the Project Team
January 1994

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Key:

a. WHO - World Health Organisation
b. ILO - International Labour Organisation
c. UNEP - United Nations Environment Programme

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Special thanks also go to Stuart Veitch *(formerly Garden Centres Director of Notcutts Ltd)* for his valuable comments for improving the text in order to aid interpretation by the horticultural trade.

CONTENTS

TOXICOLOGICAL PLANT REVIEWS

Monkshood

Aconitum napellus L.

Common Monkshood

Ingestion: All plant parts are highly toxic. The roots have been mistaken for those of Horse-radish and Celery and used for hallucinogenic purposes (Frohne & Pfänder, 1984); the leaves have been mistaken for those of Parsley (Turner & Szczawinski, 1991). The lethal dose of the toxin aconitine for an adult is 3-6 mg; only a few grams of plant material can cause severe or fatal poisoning (Cooper & Johnson, 1988). Clear symptoms of poisoning occur rapidly after ingestion, sometimes within 10-20 minutes (Frohne & Pfänder, 1984). Initially there is a burning sensation in the mouth and throat, with coldness and sweating, followed by vomiting, diarrhoea, paralysis and intense pain. Death is caused by respiratory paralysis or heart failure. Incidents of poisoning, however, are very rare since the plant is extremely unpalatable and its toxicity is generally well-known (Frohne & Pfänder, 1984).

Skin contact: Aconitine is easily absorbed through the skin and mucous membranes; for example, children may be endangered when they play with the flowers (Frohne & Pfänder, 1984) or when cut-flower handlers prepare the plants for sale. A recent case in 1993, involved 2 women who were hospitalised due to various adverse reactions, after removing the lower stem leaves of cut ***Aconitum*** flowers over the course of a single day (Anon. 1993).

If the sap is rubbed into the skin or mucous membranes it gives rise to a prickling and tingling sensation. It also has a vesicant action on the skin and, in pharmaceutical workers, it has produced severe occupational dermatitis (Mitchell & Rook, 1979, using the synonym ***A. neomontanum*** Koelle).

Eye contact: Although no data are available, the effects of eye contact are likely to be similar to those of skin contact.

Toxins: Highly toxic nor-diterpene alkaloids are present (e.g. aconitine); their toxicity is reduced on hydrolysis. Also present are the less toxic diterpene alkaloids. The alkaloid content of a single plant varies considerably with soil type and season, e.g. in winter and spring the roots contain particularly high levels of toxins (Cooper & Johnson, 1988, Frohne & Pfänder, 1984).

Drying or long-term storage may reduce the activity of some of the toxins only, therefore care should be taken with the plant's disposal (Cooper & Johnson, 1988).

Other species: All other species in the genus are likely to have the same toxicity as ***A. napellus***, however, the difference in alkaloid composition determines the variability of toxicity found between individual species. ***Aconitum vulparia*** **Reichb.** (***A. lycoctonum***

auct.) contains the nor-diterpene alkaloid lycaconitine and is reported to have the same toxicity as ***A. napellus***. ***A. ferox*** **Wall. ex Ser.** is reported to be more toxic (Frohne & Pfänder, 1984), a very small dose having caused fatal cardiac depression (Windholz *et al.*, 1983).

Conclusion: All parts of every species of ***Aconitum*** contain extremely toxic chemicals that are potentially fatal on ingestion, may produce severe contact dermatitis, especially amongst occupational workers and, more recently, have been demonstrated to give rise to poisoning through skin absorption after prolonged handling. ***A. ferox*** appears to be the most toxic species and only a few grams have been known to cause fatal poisoning. Reported incidents of poisoning are rare, however, in the UK.

Baneberry

Actaea spicata L.

Baneberry, Herb Christopher

Ingestion: There is considerable conflict in the literature about the toxicity of this plant. According to Lang (1987), all parts are poisonous following ingestion, and may result in violent gastro-intestinal disturbances, headache, dizziness, hallucinations and increased pulse rate; in addition, nausea, vomiting, bloody diarrhoea and colic may also be experienced (Roth *et al.*, 1984). The latter reference nevertheless rates the toxicity as low. In contrast, Frohne & Pfänder (1984) state that the berries contain no highly active constituents and that poisoning after eating the fruits is unlikely. No case data are available.

Skin contact: Some authors state that skin contact may cause reddening and blistering (Roth *et al.*, 1984). Frohne & Pfänder (1984), however, imply that skin contact is unlikely to cause clinical effects.

> **Toxins:** The identity of the toxin(s) has yet to be confirmed. Roth *et al.* (1984) have identified the toxin as magnoflorin, describing it to have "activity like protoanemonin". Lang (1987), however, indicates that protoanemonin itself is the toxic principle present. Frohne & Pfänder (1984) state that protoanemonin does not occur in the plant.

Other species: In general, the genus ***Actaea*** is said to contain a poisonous glycoside or essential oil which causes acute stomach cramps, headache, dizziness and circulatory failure; as few as 6 berries can cause severe symptoms persisting for several hours (Hardin & Arena, 1974).

Conclusion: There are serious conflicts in the toxicological data concerning species of *Actaea*. In spite of the absence of human case data, all parts of the plant should be treated as suspect. There is a possibility of poisoning by ingestion and of irritant contact dermatitis.

Horse Chestnut (including Yellow Buckeye)

Aesculus hippocastanum L.

Horse Chestnut

*This commonly planted tree should be distinguished from **Castanea sativa** L. (**Sweet Chestnut**); the seeds of **A. hippocastanum** are poisonous, while those of **Castanea** are not.*

Ingestion: All aerial parts of ***A. hippocastanum*** contain a toxin, present in highest concentration in the bark; however, there are no reported effects from leaf or bark ingestion in man. Instead, it is the nut or seed (conker), which is almost invariably involved in ingestions. Conkers are regularly eaten either whole or chewed by small children usually with very little adverse effect, although ingestion has been known to lead to gastric upset, with vomiting, diarrhoea, stomach and abdominal pains (NPIS figures). Large ingestions have been reported to cause unconsciousness and paralysis (Poisindex, 1992). It has been suggested that multiple exposures are dangerous (Cooper & Johnson, 1988) possibly because of injury to the lining of the stomach and intestines thereby enabling better absorption of the poison. Given the supposed nature of the toxin it is surprising that, after ingestion, no cases of increased bleeding (anti-coagulation) have been reported in humans or animals.

Skin contact: There are no reports of adverse skin effects arising from contact with any part of this tree; indeed, extracts and purified material have been used medicinally for swelling and bruising (Frohne & Pfänder, 1984).

> **Toxins:** All aerial parts contain a coumarin glycoside called aesculin (Poisindex, 1992) or aescin (Frohne & Pfänder, 1984). This compound is a saponin, 7-hydroxycoumarin 6-glycoside, which readily forms the anti-coagulant 6,7-dihydroxycoumarin (aesculetin) (Poisindex, 1992). An uncharacterised material, or another facet of aesculin, is also believed to be present.
>
> **Mechanisms:** Aesculin forms aesculetin which blocks vitamin K in the clotting cascade leading to potentially life-threatening bleeding. The lack of reports of anti-coagulation after ingestion of ***A. hippocastanum*** suggests, however, that this picture is oversimplified. Another compound believed present *(see Toxins)*, may be responsible for reports of central nervous system depression. It would appear that the toxicity and toxic mechanisms relating to this genus remain poorly understood.

Other species: Many species and cultivars of ***Aesculus*** are available in the UK; these include ***A.* x *carnea***, ***A. flava*** (Yellow Buckeye) and ***A. indica***, all of which should be assumed to be as toxic as ***A. hippocastanum***. Since some cultivars, e.g. ***A. hippocastanum* 'Baumanii'** and ***A.* x *carnea*** 'Plantierensis', do not set seed, the risk of poisoning from these is considerably reduced; the toxicity, however, of the other aerial parts is still a hazard.

Conclusion: All species and cultivars of all aerial parts of the widely grown genus ***Aesculus*** are poisonous. Although they seldom cause any more than mild clinical effects when eaten by children, if sufficient quantity are eaten, the potential nevertheless exists for more serious poisoning, including unconsciousness and paralysis. Conkers may be confused for food, although it is widely known that they are relatively unpalatable. The risk of poisoning from those cultivars that do not set seed is significantly lower since it is the seeds (conkers) that children find attractive to eat. There is no evidence that skin contact is a problem.

AGROSTEMMA GITHAGO L. — Caryophyllaceae

Corncockle

Ingestion: The whole plant is poisonous. When it was formerly a significant weed in cornfields, its seeds would often occur as a contaminant of flour, causing poisoning. With the introduction of improved seed-cleaning techniques over the years and the use of selected herbicides, ***Agrostemma githago*** is now a rare plant in the wild in the UK. Today, however, it is increasingly cultivated and sold in seed form as a "conservation species". Clinical effects of poisoning from eating the seed include disturbances of the digestive system, severe stomach pain, vomiting, diarrhoea, dizziness, weakness and slow breathing (Poisindex, 1992).

Skin contact: There is no evidence that skin contact is harmful.

Eye contact: Under experimental conditions, a saponin from this plant has been shown to be irritant to the eye (Mitchell & Rook, 1979).

> **Toxins:** The toxin present in all parts of the plant, especially the seeds, is a saponin called gypsogenin, sometimes called githagenin or githagin (Roth, 1984; Poisindex, 1992).

Conclusion: All parts of ***Agrostemma githago*** are poisonous, especially the seeds. Historically, because this species was once a common agricultural weed, most cases of poisoning arose as a result of the accidental ingestion of the seeds since they were a common contaminant of flour. Today, the circumstances of poisoning are likely to be different since the plant is only available as a "conservation plant", often sold as seed. No recent reports of poisoning by ingestion have been reported and the danger from contact appears to be negligible.

ALSTROEMERIA L. Alstroemeriaceae

Alstroemeria, Peruvian Lily

Alstroemeria aurea Graham

(synonym: ***A. aurantiaca*** D.Don ex Sweet)

Ingestion: There is no evidence that ingestion of this plant is harmful.

Skin contact: The commonly cultivated species of ***Alstroemeria*** are considered the most frequent cause of allergic dermatitis in wholesale and retail florists. All parts of the plant contain toxins, with the allergen occurring in the greatest concentration in the flowers. Patch tests prove positive for both flowers and leaves (Lovell, 1993). Clinical effects are most likely to occur when they are handled by florists who strip the lower leaves from the stems and detach flowers for use in flower arrangements. This repeated exposure to broken plants encourages sensitization. Cases have also occurred amongst gardeners (Lovell, 1994). With the current increase in the popularity of the genus as an ornamental, both for gardens and the cut flower trade, the level of exposure is likely to rise.

Clinical effects resemble, at least initially, the tulip allergy known as 'tulip finger' in which fissured dermatitis first appears at the fingertips, then progresses to the entire hand or forearm. Eczema, scaling, rashes and blisters have also been reported (Spoerke & Smolinske, 1990).

A 54 year old gardener who cut some ***Alstroemeria*** stems and came in contact with the sap through a hole in her glove, developed symptoms, 48 hours later, of itching and dermatitis-type lesions in her right thumb, index finger and forearm. Within a few days, eczema developed with scaling. Treatment with steroids cleared the symptoms, however, 2 months later, the arm and hand developed a spotty depigmentation covering the zone of the previous dermatitis area (Spoerke & Smolinske, 1990). There appears to be considerable variation in the severity of reaction; usually, those affected are also susceptible to tulip allergens and cross reactions.

> **Toxins:** The major toxin is a glycoside called 6-tuliposide A which is converted to tulipalin A (Spoerke & Smolinske, 1990). The latter is known to be allergenic and to cause various forms of dermatitis. It can penetrate PVC but not nitrile gloves (Lovell, 1993).
>
> **Mechanisms:** The glycosides present are weakly allergenic but are rapidly hydrolysed to tulipalin A, which causes sensitization (Benezra *et al.*, 1985). It appears that the methylene group in the alpha position of the tulipalin structure is necessary for allergenic activity (Spoerke & Smolinske, 1990).

Other species: Many different coloured '*Ligtu* hybrids' (the result of crosses between ***A. ligtu*** **L.** and ***A. haemantha*** **Ruiz & Pavon**) are now available. These contain the allergen and therefore also give rise to allergic dermatitis (Lovell, 1993).

N.B. Research is currently underway in Denmark to breed allergen-free cultivars of *Alstroemeria* (Anon., 1993c).

Conclusion: There is no evidence that members of the genus ***Alstroemeria*** are toxic by ingestion; no cases of poisoning have been reported. It would appear that the main risk from ***Alstroemeria*** is an occupational contact one although cases have also appeared amongst keen gardeners. Repeated contact, frequently leads to sensitization and severe allergic dermatitis. Handling of ***Alstroemeria*** is considered one of today's commonest causes of allergic reactions amongst wholesale and retail florists, however, some individuals are more susceptible to the toxins than others. Although trials are underway to breed allergen-free cultivars, these are at an early stage and all species and cultivars of ***Alstroemeria*** currently grown commercially are believed to contain the allergen.

ANEMONE L. (see also *Pulsatilla*) Ranunculaceae

Windflowers

Anemone nemorosa L.

Wood Anemone

Ingestion: All parts of the plant are toxic but poisoning by ingestion is rare and limited almost entirely to animals (Cooper & Johnson, 1988). Clinical effects to be expected are gastro-intestinal irritation with colic and diarrhoea (Frohne & Pfänder, 1984).

Skin contact: The sap is irritant to the skin, which may become inflamed and blistered. However, most incidents recorded arise as a result of the use of the crushed leaves as a poultice rather than from normal handling (Mitchell & Rook, 1979).

> **Toxins:** The glycoside ranunculin is present throughout the plant and is readily hydrolysed to the skin-irritant protoanemonin. The latter becomes inactive on drying as it is then converted to anemonin (Cooper & Johnson, 1988).

Other species: Reports of skin irritation also refer to several other commonly cultivated species of *Anemone*: ***A. apennina*** L., ***A. coronaria*** L., ***A. cylindrica*** Gray, ***A. hepatica*** L. (***Hepatica nobilis*** Mill.), ***A. multifida*** Poir., ***A. obtusiloba*** Don, ***A. ranunculoides*** L. and ***A. sylvestris*** L. Species here referred to the genus ***Pulsatilla*** (q.v.) are also implicated. Again, most incidents recorded have arisen after the use of the crushed leaves as a poultice and not from normal handling.

> **Toxins:** Ranunculin is present in all species (Frohne & Pfänder, 1984).

Conclusion: All parts of all species of ***Anemone*** are mildly poisonous by ingestion; the plant is very unpalatable. The likelihood of skin irritation arising from the normal handling of the cultivated species is low.

AQUILEGIA L. Ranunculaceae

Columbine

Ingestion: The toxicity of ***Aquilegia*** is considered to be similar to that of ***Aconitum*** (see account), although there have been no reports of poisoning since the early part of this century (Cooper & Johnson, 1988). Likely effects of ingesting any part of ***Aquilegia*** include burning in the mouth, tingling throughout the body, numbness, alternating hot and cold, severe vomiting, diarrhoea and paralysis. In severe cases, death may occur from heart failure or respiratory paralysis (Frohne & Pfänder, 1984).

Skin contact: ***A. vulgaris*** L. is reported to be irritant (Mitchell & Rook, 1979) and the toxins present are likely to have an effect similar to those found in ***Aconitum***.

> **Toxins:** Alkaloids, similar to those found in ***Aconitum*** are present (Cooper & Johnson, 1984).

Conclusion: Since the toxicity of ***Aquilegia*** species is similar to that of ***Aconitum*** species *(see account)*, it can be inferred that all parts of all species of ***Aquilegia*** have the potential to be extremely toxic by ingestion. There are, however, no recent reports of poisoning. Skin contact may cause irritation.

The ARACEAE family

(including Leopard Lily (Dumbcane), Philodendron and Swiss Cheese Plant)

Many genera of this large family are widely available in the horticultural trade, mostly as house-plants; virtually all contain similar toxins. Accordingly, the family is treated here within a single summary. Special attention, however, has been given to those widespread genera for which toxic reactions are most severe.

Dieffenbachia Schott. — Araceae

Leopard Lily, Dumbcane

Ingestion: All parts of this common house-plant contain irritant toxins. The clinical effects include a burning sensation in the mouth, vomiting, severe diarrhoea, salivation, difficulty in swallowing and, possibly, loss of speech (Frohne & Pfänder, 1984). Severe swelling could result in blockage of the airway and impairment of breathing. Physical effects may be complicated by systemic toxic effects causing slow heart rate, muscle twitching, cramps and respiratory failure (Arditti & Rodriguez, 1982). An adult who briefly touched her mouth with a plant cutting suffered oedema, inflammation and superficial ulceration of the upper and lower lips and tip of the tongue; healing began after 3 days (Evans, 1987). Fatalities have been reported (Morton, 1988).

Skin contact: Dermal exposure to the juices or cut stems may produce local inflammation (Spoerke & Smolinske, 1990).

Eye contact: This is likely to cause intense pain, photophobia followed by oedema, eyelid twitching, watery eyes and corneal abrasions (Frohne & Pfänder, 1984; Spoerke & Smolinske, 1992; Grant, 1986).

> **Toxins:** Calcium oxalate needles (raphides) and oxalic acid are present throughout the members of this genus. Other toxins present may include saponins, glycosides, alkaloids, proteolytic enzymes, protein-like substances and cyanogenic glycosides. However, their contribution to the toxicity of the plant is the subject of much confusion (Frohne & Pfänder, 1984).
>
> **Mechanisms:** The calcium oxalate needles (raphides) occur within ejector cells and pressure on these cells causes them to open and the contents to be released. The needles may, in turn, penetrate mast cells leading to histamine release. Some authorities claim that oxalic acid is also present in the ejector cells and is transferred with and ejected by the needles (Frohne & Pfänder, 1984). Walter (1967) suggests that penetration by the proteolytic enzymes enhances the damage caused by the calcium oxalate needles. Despite much study, mechanisms are not fully understood.

N.B. Tissue culture trials of low toxicity cultivars of ***Dieffenbachia*** are currently underway at the Sunki Tissue Culture Laboratory in Brisbane, Australia (Anon., 1991).

Other members of the family:

Ingestion: Many other genera within the **Araceae** are popular as ornamentals in the home. All are thought to contain calcium oxalates, mostly in the form of raphides. These play a part in the irritant effects on the mucous membranes. Clinical effects of ingestion include a burning sensation in the mouth, salivation, vomiting, hoarseness and swelling. Large amounts may cause gastric bleeding and cramps and possibly coma or death. Empirical data (Frohne & Pfänder, 1984) suggest that species of ***Monstera*** are unlikely to produce serious effects (NPIS figures), however, Mayo (1993) points out that flowers and fruits are rich in needle-like trichoscleroids and should be avoided. The death of an 11 month old child was attributed to effects secondary to erosions caused by ingestion of the leaves of ***Philodendron*** (McIntire *et al.*, 1990). This is in contrast to the findings of Rita Mrvos *et al.* (1991) who report on 188 cases of ingestion of ***Philodendron*** or ***Dieffenbachia***. Their results showed effects came on rapidly, were of short duration and no long term problems developed.

Skin contact: Most species are irritant to the skin (Frohne & Pfänder, 1984) and even ***Monstera*** may cause a mild dermatitis (NPIS figures; Poisindex, 1992). ***Philodendron scandens* subsp. *oxycardium*** and ***Epipremnum aureum*** are reported to cause occupational allergic contact dermatitis. From the former, a major allergen (resorcinol) has recently been isolated and, accordingly, Reffstrup and Boll (1985) state that "***Philodendron*** species should be screened for resorcinols before considering them as ornamentals".

Eye contact: The sap is likely to cause pain and photophobia with the possibility of corneal abrasions (Frohne & Pfänder, 1984; Grant, 1986).

Conclusion: All parts of all species of the family ***Araceae*** are toxic by ingestion and, on contact, may cause irritant and/or contact dermatitis. The majority irritate the mucous membranes producing unpleasant and potentially life-threatening effects. Many members of the family are widely sold as house-plants and children are often attracted to them. ***Dieffenbachia***, one of the most common house-plants, is also the most harmful. In addition, ***Philodendron scandens* subsp. *oxycardium*** and ***Epipremnum aureum*** have also been known to cause occupational allergic contact dermatitis. One of the least toxic of the genera is ***Monstera***, another very common house-plant, the leaves of which have low oral toxicity and may cause only mild skin irritation; however, the floral parts are irritant and should be avoided.

ASPARAGUS L. Asparagaceae

(including Asparagus and Asparagus Fern)

Asparagus officinalis L.

Wild Asparagus

Ingestion: The only toxicity information available concerns the berries of this plant; according to Cooper and Johnson (1988) their ingestion may give rise to gastro-intestinal irritation. Documentation about the toxicity of the plant is scarce (Poisindex, 1992).

Skin contact: The young shoot tips of ***A. officinalis*** may cause allergic contact dermatitis after prolonged and repeated exposure (Mitchell & Rook, 1979).

Eye contact: The juice of asparagus is an irritant, inducing conjunctivitis when applied to the eye (Benezra *et al.*, 1985).

> **Toxins:** Steroidal saponins are considered to be the most likely cause of poisoning but they are poorly absorbed orally. Asparagine and the glucoside vanillin are also present (Frohne & Pfänder, 1984; Poisindex, 1992). The allergic sensitizer has not been identified (Mitchell & Rook, 1979).

Other species: Detailed references seen are to ***A. officinalis*** but all species are likely to have a similar toxic content. The reference in Cooper & Johnson (1988) is to "***Asparagus*** species"; in the other references, to ***A. officinalis***.

Skin contact: ***A. densiflorus* (Kunth) Jessop 'Myers'** and ***A. setaceus* (Kunth) Jessop (*A. plumosus* Bak.)**, both sold as Asparagus Fern, are also listed as causing dermatitis (Fuller & McClintock, 1986).

Conclusion: The berries are slightly poisonous and give rise only to mild clinical effects. Contact dermatitis due to handling the plant as a vegetable has been reported, but this condition normally arises only after repeated and prolonged contact. Although not common, contact dermatitis has also been reported from handling Asparagus Fern (***A. densiflorus*** and ***A. setaceus***).

ATROPA BELLA-DONNA L. Solanaceae

Deadly Nightshade

*Care should be taken to distinguish **Atropa bella-donna** from other Nightshades (**Solanum** spp.) with which it is frequently confused and only distantly related.*

Ingestion: Toxins are present throughout the plant, but it is the glossy black (or yellow in ***A. bella-donna*** **subsp.** ***lutea***) berry that is usually implicated in poisoning. Many cases have been documented where the attractive berries have been eaten by children (NPIS figures); many adults have also eaten the fruit in mistake for other edible wild berries (e.g. ***Vaccinium myrtillus***, Bilberry), often resulting in serious poisoning. One family ate approximately 150g each of stewed berries resulting in gastro-intestinal symptoms, convulsions and, in one case, coma. All recovered within 6 days following medical treatment (Cooper & Johnson, 1984). As little as one berry can produce obvious adverse clinical effects, known as anticholinergic effects; these include dilated pupils, increased heart rate, hot, dry skin with delirium. Such symptoms are likely to be rapid in onset but may persist for several hours. Fortunately, serious cases are rare.

Skin contact: Contact with the sap may result in soreness and blistering and, possibly, dermatitis (Cooper & Johnson, 1988; Mitchell & Rook, 1979).

Eye contact: The juice of the fruit is used in some countries to produce intentional dilation of the pupils; hence the plant's name (Belladonna meaning beautiful lady). Systemic effects in sensitive individuals may also result from eye exposures.

> **Toxins:** All parts contain a variable mixture of highly toxic tropane alkaloids. The proportions and quantity vary according to season, plant part and growing conditions. The unripe berries contain mostly L-hyoscyamine; ripe berries contain the slightly less toxic atropine. Other toxic tropane alkaloids occur in the roots, stems and flowers.

Other species: According to Frohne and Pfänder (1984), other species of ***Atropa*** may be as toxic or more toxic that ***A. bella-donna***; these include ***A. pallidiflora*** and ***A. acuminata***.

Conclusion: Although ingestion of any part of ***Atropa bella-donna*** has the potential to cause serious poisoning, it is rarely reported to cause fatalities. This may be due to the fact that the plant is not widely grown in cultivation. The berries have been mistakenly eaten for food. Skin contact with the sap may give rise to blistering, soreness and, possibly, dermatitis.

AUCUBA JAPONICA Thunb. Cornaceae

Japanese Laurel, Spotted Laurel

Ingestion: All parts of ***Aucuba japonica*** contain toxins. The attractive fruit is the most likely part to be ingested; this may result in nausea, vomiting, diarrhoea, and fever. Most exposures result only in mild symptoms (Spoerke & Smolinske, 1990) and the plant is generally considered to have a low toxicity. There is no evidence to suggest that the toxicity of the many cultivars is different from that of the species.

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** Aucubin, an acrid labile glycoside, and triterpenoid saponins are present in all parts of the plant (Spoerke & Smolinske, 1990).

Conclusion: All parts of ***Aucuba japonica***, and probably its many cultivars, have a low toxicity by ingestion. It is unlikely that skin contact would cause any adverse effects.

Barberry

Berberis vulgaris L.

Wild Barberry

Although *B. vulgaris* is not sold commercially its toxicity has been well documented in the literature compared to other *Berberis* species. The toxicity of other *Berberis* species can be inferred from this information, since little toxicology is otherwise known about them.

Ingestion: Data from Frohne and Pfänder (1984) show that the root bark contains the highest concentration of the toxins, followed by the stem bark. The toxins occur in small amounts in the wood and are present in the leaves. Unripe berries contain the toxins, however they are absent from the ripe berries, i.e. fruit pulp and seeds (Lang, 1987). The clinical effects of poisoning after eating the leaves are fever and stomach ache (Frohne & Pfänder, 1984). Children have been poisoned by eating the roots (Fuller & McClintock, 1986).

Skin contact: Following occupational handling of the wood, vomiting and diarrhoea have been reported (Cooper & Johnson, 1988).

> **Toxins:** Isoquinoline alkaloids, characteristically berberine, are known to be present (Frohne & Pfänder, 1984) together with small quantities of oxyacanthine and chelidonic acid (Lang, 1987).
>
> **Mechanisms:** Berberine is readily absorbed orally. It stimulates smooth-muscle and also affects the respiratory centre (Frohne & Pfänder, 1984).

Other species: The seeds of the following species have been found to contain isoquinoline alkaloids: ***B. chinensis* Poir. (*B. guimpelii* Koche & Bouche), *B. dielsiana* Fedde, *B. regeliana* Koehne ex Schneid. (*B. hakodate* hort. ex Dippel), *B. hauniensis* Zab., *B.* x *serrata*** Koehne and ***B. virescens* Hook.*f*.** Apart from the presence of toxins in the seeds and their absence from the leaves, these species showed a similar distribution of toxins in the rest of the plant to that of ***B. vulgaris*** (Frohne & Pfänder, 1984). ***Berberis darwinii* Hook.** is considered to have similar toxicity to ***B. vulgaris*** (Poisindex, 1992). The toxicity, especially of the fruit, is considered quite low and few, if any, symptoms are expected unless large quantities have been ingested (Poisindex, 1992). NPIS has recorded fewer than ten cases of poisoning due to ***Berberis***; all involved minor symptoms only (Lang, 1987).

The sharp brittle spines of some species can cause an irritable papular dermatitis; those clipping ***Berberis*** hedges are most at risk. This dermatitis usually resolves in 7-10 days, although one case reports symptoms lasting one month. It is not known whether chemical irritation or a foreign body reaction was responsible. ***Berberis*** species are a source of sporotrichosis (Mitchell & Rook, 1979), a rare chronic subcutaneous fungal infection (Stedmans, 1982). Outbreaks have been reported in nursery workers (Mitchell & Rook, 1979) and, in the USA nursery trade, the condition has been referred to as "barberry poisoning" (Fuller & McClintock, 1986).

Conclusion: Toxins are present in the root and stem bark, wood, leaves and unripe fruit of ***Berberis vulgaris***. The distribution of toxins is also similar in the following cultivated species of ***Berberis***: ***B. chinensis***, ***B. dielsiana***, ***B. regeliana***, ***B. hauniensis***, ***B.*** x ***serrata*** and ***B. virescens***; however, the toxins are absent from their leaves. The berries of ***B. darwinii*** are considered to have a low toxicity. The NPIS have no reports of serious effects following the ingestion of berries of any species/cultivar of ***Berberis***. Pruning may cause dermatitis but reports suggest this is unlikely to be serious.

The BORAGINACEAE family

(including Comfrey, Russian Comfrey, Lungwort, Viper's Bugloss, Borage, Forget-me-not)

Many genera in this family are widely available in the horticultural trade and contain similar chemicals, some of which may be toxic and/or irritant. Accordingly, the family is treated here as a single summary, with special attention being given to those genera for which toxic reactions are most severe. Most cultivated Comfrey refers to ***Symphytum*** x ***uplandicum*** **Nyman** *(Russian Comfrey) which is a cross between* ***S. officinale*** L. *(Common Comfrey) and* ***S. asperum*** **Lepechin** *(Rough Comfrey).*

Symphytum L. Boraginaceae

Comfrey

Ingestion: All parts of ***Symphytum*** species, especially the roots and young leaves, may be toxic by ingestion. No cases, however, of poisoning following acute ingestion have been reported in the UK; it is the chronic ingestion of the plant that may give rise to poisoning. For example, Comfrey has been widely used in herbal preparations; such products (e.g. teas and poultices) are the most common method of exposure and some cases have been reported of liver veno-occlusive disease associated with the taking of Comfrey tablets (Winship, 1991). One 23 year old man died from this disease due to liver cirrhosis after consumption of steamed leaves (Anon., 1993b). The effects of the toxic alkaloids present are accumulative and overt damage may take some time to appear. The toxin has been proven to cause liver damage in man and cancer and foetal abnormalities in laboratory animals. Children and young animals seem to be especially sensitive to this alkaloid (Cooper & Johnson, 1984).

Although data on the toxicity of Comfrey are not conclusive, the UK government believe there is sufficient evidence for concern and, following the recommendation of the MAFF Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment, it agreed to issue a voluntary ban on the sale of all tablets and capsules containing Comfrey (Anon., 1993a.) The use of *leaves* of Comfrey to make herbal teas, however, is not included in this ban since the leaves are considered to have a much lower concentration of the toxins than, for example, the roots. The recommendation also stated that all products for external use containing Comfrey should be labelled accordingly. External use of Comfrey preparations is considered to be safe since the metabolites of the alkaloids are only released following the action of liver enzymes after ingestion (Cooper & Johnson, 1984).

Skin contact: The leaves and stem of most ***Symphytum*** species are covered in coarse bristly hairs which are known to cause mild dermatitis (Lovell, 1993).

> **Toxins:** All species contain pyrrolizidine alkaloids, some of which are very toxic, e.g. lasiocarpine. 13 alkaloids have been identified in ***S. officinale***, and 9 in ***S.*** x ***uplandicum*** (Anon., 1993b). Some species, such as ***S. asperum*** accumulate nitrates, from which toxic nitrites are formed (Cooper & Johnson, 1984, 1988).

The alkaloid concentration of an individual plant may vary widely depending on the age, part of the plant and time of the year. One study indicates that the highest concentration of toxins occurs in the roots; the lowest occur in leaf infusions such as herbal teas (Anon., 1993b).

Mechanisms: The toxic metabolites of pyrrolizidine alkaloids are released by the action of liver enzymes after ingestion (Cooper & Johnson, 1984). These metabolites are hepatotoxic (Cheeke, 1985).

Other members of the family:

Ingestion: Other genera (in sub-families Heliotropioideae and Boraginoideae) contain varying amounts of pyrrolizidine alkaloids but, as for ***Symphytum***, they are unlikely to cause poisoning unless eaten regularly over long periods of time; no such cases have been reported in the UK. The genera of concern in such chronic cases include: ***Borago*** (Borage) and ***Heliotropium*** (Heliotrope).

Skin contact: Many genera within the family are covered in rough hairs which have irritant properties (Mitchell & Rook, 1979). Penetration of the skin typically produces a papular irritant eruption similar to scabies.

For example, species of ***Echium*** (Viper's Bugloss), have short bristly hairs on both leaves and stems; these may give rise to dermatitis with severe inflammation and itching (Frohne & Pfänder, 1984). Other genera in the family most likely to give rise to skin reactions include ***Borago***, ***Myosotis*** (Forget-me-not), ***Pentaglottis*** (Alkanet) and ***Pulmonaria*** (Lungwort); anecdotal evidence detailing reactions to all of these plants has been recorded (Leon, 1992).

Considerable variation exists between individuals as to their susceptibility to dermatitis or other mechanical irritation from handling these plants (Mitchell & Rook, 1979).

Conclusion: Two sub-families of the Boraginaceae family (including ***Symphytum***, ***Borago*** and ***Heliotropium***) contain toxic substances with the potential for serious poisoning but only as a result of chronic ingestion. Such incidents of poisoning are therefore very scarce in the UK. The recent voluntary ban on the sale of certain Comfrey-containing herbal preparations, currently in force in the UK, aims to prevent cases of chronic poisoning arising from ingestion of ***Symphytum*** (Comfrey) since this plant has been frequently included in herbal medications for internal use. The likelihood of poisoning arising following an acute ingestion (e.g. by a child) of a few leaves of ***Symphytum***, or other plants in these 2 sub-families, is very remote since a very large quantity would need to be ingested. Furthermore, the bristly nature of the leaves of most of the plants in these 2 groups is likely to discourage occasional ingestion.

Skin contact with many members of these sub-families, notably ***Borago***, ***Myosotis***, ***Pentaglottis*** and ***Pulmonaria***, may cause minor irritation and/or dermatitis. Contact with species of ***Echium*** may give rise to more severe dermatitic reactions.

Tree Daturas (including Angel's Trumpets)

Taxonomic note: *The genus* ***Brugmansia*** *is the currently accepted scientific name for all shrubby species of plants previously called* ***Datura****. As a result, the taxonomy and nomenclature of the* ***Brugmansia*** *group has become confused in the horticultural and toxicological literature and it is often impossible to determine the correct identity of the species described with any certainty (Everist, 1981). The species most widely documented is B.* x *candida* Pers.

Brugmansia x *candida* Pers.

(This is a hybrid between ***B. aurea*** **Lagerh.** and ***B. versicolor*** **Lagerh.**; the plant is often mis-labelled as ***B. arborea*** the true species of which is seldom found in cultivation. Synonym: ***Datura candida*** **(Pers.) Saff.**)

Ingestion: All parts of the plant are poisonous. Poisoning usually arises in adults when the leaves, flowers or seed are deliberately ingested for their hallucinogenic effects. Accidental poisoning in children may also occur since they sometimes find the flowers and/or seed attractive to eat. Many cases of poisoning in humans are on record (Everist, 1981).

Clinical effects of poisoning are visual hallucinations alternating with violent excitement; in addition, the following may also be experienced: high blood pressure, fast heart-rate, fever, pupil dilation, hyperactive deep tendon reflexes, confusion, coma and sometimes death, resulting from respiratory paralysis (Smith *et al.*, 1991). The onset of symptoms varies with dose and the plant part eaten. In one case, symptoms occurred 5-10 minutes after drinking tea made from the flowers; in another, within an hour after seed ingestion, and another between 1 and 3 hours following leaf ingestion (Spoerke & Smolinske, 1990).

> **Systemic intoxication:** Apparent systemic intoxication has also been reported via inhalation during close contact with the plants, e.g. in a conservatory. In adults, 1-3 flowers have been thought responsible for causing hallucinations, while it is claimed that over 6 flowers have been known to cause fits and flaccid paralysis (Spoerke & Smolinske, 1990). However, a recent biochemical investigation (Kite, in prep.) concludes that the only alkaloid (indole) detected in the volatile compound given off by the flowers or leaves of ***Brugmansia* x *candida***, is also commonly found in the scent of many other widely cultivated indoor and outdoor plants (e.g. ***Narcissus***, ***Syringa*** and ***Philadelphus***) and is present in such a low concentration that its potential toxicity is considered negligible. As such, the presence of indole does not present a toxic hazard on inhalation. Neither were the presence of *non-alkaloid* volatiles, also identified by Kite (in prep.) in the same species, considered a toxic hazard on inhalation; many of these are widely used in the perfumery industry in much higher concentration and to no ill effect.

Skin contact: There is no evidence that skin contact is harmful.

Toxins: Tropane alkaloids, mainly hyoscine (scopolamine) and hyoscyamine (Spoerke & Smolinske, 1990).

Mechanisms: The toxic alkaloids affect the central nervous system (Frohne & Pfänder, 1984).

Other species: In addition to ***Brugmansia* x *candida***, the other species in the genus, according to the authoritative taxonomic review by Lockwood (1973), are:

Current name		Previous name(s)/synonym(s)
B. suaveolens (Humb. & Bonpl.) ex Willd.	=	*Datura suaveolens* Humb. & Bonpl. ex Willd.
B. x *dolichocarpa* Lagerh.	=	*B. dolichocarpa* Lagerh. (*D. dolichocarpa* (Lagerh.) Saff.)
B. versicolor Lagerh.	=	*D. versicolor* (*D. mollis* Saff.) (*D. longiflora*)
B. aurea (Lagerh.)	=	*D. aurea* (*D. affinis* Saff.) (*D. pittieri* Saff.)
B. arborea (L.) Lagerh.	=	*B. cornigera* Hooker (*D. arborea* L.)
B. x *insignis* (B.Rodrigues) Lockwood	=	*D. insignis* B.Rodrigues
B. x *rubella* (Saff.) Moldenke	=	*D. rubella* Saff.
B. sanguinea (Ruiz & Pavon) D.Don	=	*D. sanguinea* Ruiz & Pavon (*D. rosei* Saff.)

Ingestion: Although toxicity varies slightly between species (Lockwood, 1973), all should be regarded as potentially psychotropic.

In 1989, a 76 year-old man ingested 3 teaspoons (15 ml) of a home-made wine made from ***B. suaveolens***. A sample of the wine proved to contain 29 mg of hyoscine/ml, resulting in a total dose of 435 mg. One and a half hours after ingestion the man developed muscle weakness, partial paralysis and restricted breathing (Smith *et al.*, 1991).

Skin contact: There is no evidence to indicate that skin contact is harmful.

Toxins: It is likely that the toxins present in ***B.* x *candida*** are also present in all other members of the genus. For ***B. suaveolens***, the alkaloid content of an individual plant may vary between 0.25% and 0.7%; each flower may contain approximately 0.2 mg of atropine and 0.65 mg of hyoscine (Poisindex).

Conclusion: All parts of all taxa within the genus ***Brugmansia*** are potentially highly toxic. This genus is well-known amongst adults and teenagers for its hallucinogenic properties and it has been reported to have caused serious poisoning and occasionally death from respiratory paralysis. In the main, the greatest risk to adults and teenagers is from abuse, however, children have also been poisoned since they find the trumpet-like flowers, and occasionally the seeds, attractive to eat.

In the UK, where the plants are most likely to be grown in a conservatory, a couple of cases suggest that systemic intoxication may be a problem in such a confined space. A recent biochemical investigation, however, on ***Brugmansia* x *candida***, concludes that such concerns are scientifically unfounded. It is not known whether the same is true for otehr species/cultivars of ***Brugmansia***. There is no evidence of any hazard arising through skin contact.

Box, Boxwood

Buxus sempervirens L.

Box, European Box, Common Box, Boxwood

Ingestion: All parts of the plant contain toxins, especially the leaves and bark (Frohne & Pfänder, 1984). No cases of human poisoning, however, are on record, probably due to the unpalability and unpleasant smell of the foliage. Clinical effects are known only from cases of animal poisoning: nausea, vomiting, diarrhoea, inco-ordination, convulsions and coma; death is usually due to respiratory failure (Spoerke & Smolinske, 1990; Cooper & Johnson, 1988).

Skin contact: One report describes how ***B. sempervirens*** caused irritation and intense itching to the skin after exposure to the sap; however, the plant may have been confused with another plant also called Boxwood (otherwise known as ***Gonioma***); the latter is a member of the family Apocynaceae and is commonly known to cause skin reactions (Lovell, 1993; Mitchell & Rook, 1979). Contact dermatitis from the leaves of ***B. sempervirens*** has been reported but cases are rare (Spoerke & Smolinske, 1990).

> **Toxins:** Steroidal alkaloids have been found in all parts of the plant (Cooper & Johnson, 1988) and an acid juice is also present in the leaves and stems (Lovell, 1993).
>
> **Mechanisms:** The alkaloids act as cardiac and respiratory depressants (Spoerke & Smolinske, 1990), while the acid juice is likely to be responsible for the potential irritant nature of box (Lovell, 1993).

Other species: It is likely that the toxicity of all other species of ***Buxus*** is the same as that of ***B. sempervirens***; no less than 135 different steroidal alkaloids have been found in the leaves of different ***Buxus*** species. A systemic allergic reaction has been reported in a man exposed to the sawdust of one species of ***Buxus***; it is not clear whether this referred to ***B. sempervirens*** or ***B. microphylla*** (Spoerke & Smolinske, 1990).

Conclusion: All parts of ***Buxus sempervirens***, and probably all other species in the genus, have the potential to cause serious poisoning by ingestion in humans; however, no human case data are available. The likelihood of developing contact dermatitis or other irritation from the handling the leaves appears to be low; allergic reactions are rare.

CALTHA PALUSTRIS L. Ranunculaceae

Marsh Marigold, King Cup

Ingestion: An irritant toxin is considered to be present in the sap of this species which may, on ingestion, give rise to the following clinical effects: burning of the throat, vomiting, bloody diarrhoea, dizziness, fainting, convulsions and excessive urination with blood (Tampion, 1977; Westbrooks & Preacher, 1986). If eaten in large quantities, fatalities may result (Hardin & Arena, 1975). According to Mitchell and Rook (1979), sniffing the bruised stems has been known to induce sneezing. The concentration of the toxins is thought to decline as the plant ages (Hardin & Arena, 1975).

Skin contact: One case involved the use of the leaves, in mistake for those of ***Althaea officinalis*** (Marsh Mallow), as a poultice, resulting in skin irritation and the development of watery skin blisters (Westbrooks & Preacher, 1986; Mitchell & Rook, 1979).

Eye contact: Contact with the sap, from crushing the leaves, has been reported to cause conjuctival irritation (Spoerke & Smolinske, 1990).

> **Toxins:** There are conflicting reports in the literature about the identity of the toxin present. Many authorities (Spoerke & Smolinske, 1990 and Westbrooks & Preacher, 1986) indicate the presence of protoanemonin, a derivative of the glycoside ranunculin. According to Spoerke & Smolinske (1990), the concentration of protoanemonin is very small (0.000026% of the leaf). However, Frohne and Pfänder (1984), citing Hagnauer (1962-), state that no ranunculin is present and possible causes of poisoning might be due to the presence of alkaloids and saponins.

Conclusion: The sap of ***Caltha palustris*** is thought to be toxic on ingestion or inhalation and may give rise to serious poisoning. However, no cases of poisoning by ingestion have been found to be reported in the literature. The sap has been reported to cause skin and eye irritation.

CATHARANTHUS ROSEUS (L.) G.Don Apocynaceae

(synonum: ***Vinca rosea*** L.)

Madagascar Periwinkle

Ingestion: All parts of the plant are toxic but no cases of poisoning arising from the ingestion of this plant have been reported (Frohne & Pfänder, 1984).

Skin contact: Although alkaloids from the plant are used medicinally, one report states that contact dermatitis occurred in 18 out of 48 workers involved in the preparation of "vinca" alkaloids (Mitchell & Rook, 1979). In spite of this report there is no reference to this problem having occurred from normal handling of the plant.

Toxins: ***C. roseus*** contains the indole alkaloids vinblastine and vincristine.

Conclusion: ***Catharanthus roseus*** contains toxic substances and therefore the potential for poisoning exists although no cases are known. There appears to be no problem from skin contact arising from normal handling of the plant.

Clematis

Clematis vitalba L.

Traveller's Joy, Old Man's Beard

Ingestion: All parts of the plant are toxic but poisoning by ingestion is rare and cases refer almost exclusively to animals (Cooper & Johnson, 1988). Clinical effects to be expected are gastro-intestinal irritation with colic and diarrhoea (Frohne & Pfänder, 1984).

Skin contact: The sap is irritant to the skin, which may become inflamed and blistered. However, most recorded incidents have arisen as a result of the use of the crushed leaves as a poultice and not from normal handling (Mitchell & Rook, 1979).

> **Toxins:** The glycoside ranunculin is present throughout the plant. It is readily hydrolysed to the skin-irritant protoanemonin. The latter becomes inactive on drying as it is then converted to anemonin (Cooper & Johnson, 1988).

Other species: It is likely that all other species of ***Clematis*** are mildly toxic on ingestion. ***Clematis alpina*** **(L.) Miller**, ***C. florida*** **Thunb.**, ***C. orientalis*** **L.**, ***C. recta*** **L.** and ***C. virginiana*** **L.** have been implicated in cases of skin irritation (Mitchell & Rook, 1979), mostly after their use as a poultice.

Conclusion: All species of ***Clematis*** are considered to be mildly toxic on ingestion, however, reports of poisoning are rare and limited almost entirely to animals. Some cases have been reported of mild skin irritation.

CLIVIA MINIATA Regel Amaryllidaceae

Clivia, Kaffir Lily

Ingestion: All parts of the plant are toxic. No detailed case reports have been seen and human poisoning appears to be rare. Only mild clinical effects are reported, with nausea, vomiting and diarrhoea (Spoerke & Smolinske, 1990). The toxin is present only in small concentrations, therefore serious cases of human poisoning are unlikely (Spoerke & Smolinske, 1990). The Swiss Toxicological Information Centre reported nine cases of ingestion over several years with, at most, only mild symptoms (Frohne & Pfänder, 1984).

Skin contact: There are anecdotal reports among growers of contact dermatitis arising from handling the plant but no case data are available (Lovell, 1993a).

> **Toxins:** Several of the 'Amaryllidaceae alkaloids' are present, including lycorine which has emetic properties (Ieven *et al.*, 1982, cited by Wiseman, in prep.). One study determined the presence of lycorine at 0.43% dry weight (Amico *et al.*, 1979, quoted by Wiseman).

Conclusion: All plant parts of ***Clivia miniata*** have a low toxicity. Following ingestion, only mild clinical effects have been reported. There are anecdotal reports of contact dermatitis from handling the plant, but no case data.

CODIAEUM VARIEGATUM (L.) A.Juss. var. VARIEGATUM

Euphorbiaceae

Croton (not to be confused with the genus ***Croton*** which is more toxic).

Taxonomic note: This is the variety that is in cultivation; ***Codiaeum variegatum var. pictum*** **(Lodd.) Müll. Arg.** *is a synonym. There are seven forms of this variety distinguished by leaf shape; plants in the trade are often cultivars of these forms (Pax & Hoffmann, 1911).*

Ingestion: The literature appears to report a discrepency regarding the toxicity of this plant; old leaves, if eaten, have been reported as being irritant to the mouth, yet young leaves from some of the yellow varieties are reported to have been widely used as a flavouring in food. The bark and roots, if chewed, are known to have caused burning in the mouth (Mitchell & Rook, 1979). According to one report (Frohne & Pfänder, 1984) in which 3 children chewed a number of flowers, burning and slight irritation of the mouth was experienced.

Skin contact: This species does not seem to produce the more immediate type of contact dermatitis so common with other members of the Euphorbiaceae. However, the colourless latex has caused several cases of allergic contact dermatitis especially in people who have frequent contact with the plant (Frohne & Pfänder, 1984). It appears that handling the plant for several months is necessary to induce dermatitis and it has been estimated that 5 to 10% of new greenhouse employees are liable to develop dermatitis from handling this plant. Clinical effects begin on the hands and forearms and are easily transmitted to other unexposed parts of the body. The incidence of rashes is greatest in occupational workers handling the stems and cuttings (Spoerke & Smolinske, 1990).

Toxins: Diterpene esters are reported to be present (Spoerke & Smolinske, 1990).

Conclusion: ***Codiaeum variegatum*** **var.** ***variegatum*** can produce allergic contact dermatitis in those who are exposed to the latex frequently. Ingestion is not reported to be a serious hazard.

COLCHICUM L. Colchicaceae

Autumn Crocus

Colchicum autumnale L.

Meadow Saffron, Autumn Crocus

Ingestion: All parts of the plant are highly poisonous, especially the flowers, corm and seeds, due to the presence of colchicine (Spoerke & Smolinske, 1990). 5 mg of colchicine is a potentially fatal quantity for a child (Lampe & McCann, 1985); 7-60 mg for an adult. Children have been poisoned by eating the flowers and leaves, but the seeds, which rattle within the pods, are also likely to attract their attention. Ingestion of two seeds may be potentially lethal; a 16 year-old girl died after eating 12 flowers (Poisindex, 1992). Drying does not detoxify the plant (Poisindex, 1992).

Clinical effects appear after a latent period of 2-6 hours. They include a burning sensation in the mouth and throat, abdominal pain, vomiting and diarrhoea with blood. In severe cases, which are rare, there may be dehydration leading to hypervolemic shock, very low blood pressure, convulsions, paralysis and death from respiratory failure (Spoerke & Smolinske, 1990). Intoxication may be prolonged because excretion of colchicine is slow.

Skin contact: Fresh corms can be irritant to the skin and mucous membranes; the leaves are also recorded as having caused dermatitis (Mitchell & Rook, 1979).

Toxins: Alkaloids: colchicine and colchiceine (Cooper & Johnson, 1988).

Other species: The toxicity of all other species of ***Colchicum*** is likely to be similar; furthermore, because of difficulties in making precise species identifications within the genus, all species should be considered as highly toxic.

Conclusion: All parts of ***Colchicum autumnale*** are considered to be highly toxic and, therefore, have the potential to cause serious poisoning; fatalities have been reported. All other species in the genus are likely to share this high level of toxicity. Children are likely to find the conspicuous flowers and seed pods attractive. There is some risk of dermatitis for those individuals who handle the corms repeatedly; the hazard is primarily, therefore, an occupational one.

COLUTEA ARBORESCENS L. Leguminosae

Bladder Senna

Ingestion: There are no reports of poisoning following ingestion of this plant, although the seed pods are attractive to children.

Skin contact: There are no reports of harmful effects arising from contact.

Toxins: The amino acid canavanine is present in the seeds (Frohne & Pfänder, 1984).

Conclusion: Although the seed pods of ***Colutea arborescens*** often prove attractive to children, this plant is believed to have a low oral toxicity. No harmful effects from skin contact have been reported.

CONVALLARIA MAJALIS L. — Convallariaceae

Lily-of-the-valley

Ingestion: All parts of this plant, particularly the flowers and the seeds, contain highly toxic poisons. The red berries are attractive to children but are reported to have a foul taste (Fuller & McClintock, 1986); their pulp contains only traces of toxins and these are poorly absorbed after ingestion (Frohne & Pfänder, 1984). Furthermore, the ability of the plant to induce vomiting may reduce the likelihood of poisoning. Clinical effects include vomiting and diarrhoea, flushed skin, headache and an irregular or slow heartbeat. Some reports indicate that hallucinations, coma, convulsions and death may occur (Lang, 1987) but there have been no recent reports of serious poisoning (Frohne & Pfänder, 1984).

There are a number of cases of childhood poisoning, some fatal, which have involved chewing and eating parts of the plant. These have included ingestion of the berries and, allegedly, drinking vase water previously known to contain flowers of *C. majalis* (Turner & Szczawinski, 1991).

Skin contact: Only in rare cases is regular handling of the plant likely to give rise to dermatitis (Mitchell & Rook, 1979).

> **Toxins:** At least 15 glycosides of the cardenolide type occur in all parts of the plant. These include convallarin, convallotoxin and convallamarin (Cooper & Johnson, 1984). Convallotoxin is the major cardenolide to be found in plants of *C. majalis* grown in western and north-western Europe (Frohne & Pfänder, 1984). The concentration of the glycosides is highest in the flowers (0.4%) and the seeds (0.45%), followed by the leaves (0.13-0.2%). Negligible amounts are found in the flesh of the berries (Spoerke & Smolinske, 1990). Steroidal saponins are present in all plant parts except the flesh and seeds of the berries. Essential oils are also present (Turner & Szczawinski, 1991).
>
> **Mechanisms:** The cardenolides are strongly cardioactive but are poorly (<10%) absorbed from the gut. The saponins and essential oils are local irritants (Frohne & Pfänder, 1984; Turner & Szczawinski, 1991).

Conclusion: There is the potential for serious poisoning from ingestion of ***Convallaria majalis***, particularly its seeds. The berries constitute those parts of the plant most attractive to children and it is the seeds of these which constitute the main hazard. The foul taste of the fruit, however, and the likelihood of vomiting after ingestion may help to minimise the number of poisoning cases. There have been no recent reports of serious poisoning. The effects of skin contact are mild and very rare.

Dogwood

Cornus sanguinea L.

Dogwood

Ingestion: The berries are unpalatable when raw but are said to be non-toxic (Lang, 1987) or only slightly poisonous; clinical effects include diarrhoea and gastro-intestinal disturbances (Roth *et al.*, 1984). There is no information on the toxicity of other parts of the plant.

Skin contact: Contact with the leaves may result in reddening of the skin and continuous itching. According to Mitchell & Rook (1979), this is caused by mechanical irritation due to the presence of trichomes.

> **Toxins:** No toxic substances have been identified in the plant other than the presence of trichomes which cause mechanical irritation.

Other species: The fruits of ***Cornus mas*** **L.**, ***C. kousa*** **Hance** and ***C. suecica*** **L.** are recorded as being edible. Most species of ***Cornus*** have hairy foliage and, therefore, it is likely that they contain trichomes with the possibility of giving rise to mechanical irritation and dermatitis.

Conclusion: All parts and all species of ***Cornus*** are considered to have a low toxicity. The fruits are not a serious hazard and those of ***Cornus mas***, ***C. kousa*** and ***C. suecica*** are edible. Contact with the leaves during pruning, or the handling of nursery stock, may result in mild dermatitis.

Hawthorn

Crataegus monogyna Jacq.

Hawthorn, May, Hedgerow Hawthorn

Ingestion: The shiny red fruits of ***Crataegus monogyna*** are attractive to children; however, only unsubstantiated reports exist which describe poisoning resulting from their ingestion. Excitement, fits and respiratory distress have been recorded as the resultant clinical effects but evidence of this is unsupported. Furthermore, the use of the fruits to make jelly and as an additive to various drinks, as described in the historical literature (Lang, 1987), suggests that their toxic hazard is minimal. Fruits, therefore, should be considered as of doubtful or negligible toxicity. The toxicity of other plant parts is not known, with the exception of the bark which is reported to contain the toxin aesculin. No reports of poisoning are known (Cooper & Johnson, 1984).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** The presence of cyanogenic glycosides is unsubstantiated (Lang, 1987). The bark contains the toxic glycoside, aesculin (Cooper & Johnson, 1984).

Other species: No cases of poisoning from other species of ***Crataegus*** have been reported with the exception of eye contact problems associated with mechanical damage caused by ***C. laevigata*** **(Poiret) DC. (*C. oxyacantha* auctt.)**. The hairs on the fruit of the latter may cause conjunctivitis (Mitchell & Rook, 1979).

Conclusion: The toxins present in ***Crataegus*** are not well documented, but the fruits are considered to have a doubtful or negligible toxicity. The likelihood of poisoning by ingesting any part of ***Crataegus monogyna*** is very low. There are no reports of human poisoning from ingestion of other plant parts of this species. No occupational or skin hazard is known.

Cape Lily, Crinum Lily, Spider Lily

Crinum x *powellii* Baker

(A hybrid of C. ***bulbispermum*** **(Burm.*f.*) Milne-Redh. & Schweick.** x *C.* ***moorei*** **Hook.*f.*)**.

Ingestion: All parts of the plant should be considered toxic, with the bulb containing the highest concentration of the toxin. However, since the concentration of the toxin is considered low, even in the bulb, it is likely that large quantities would need to be ingested for clinical effects to appear (Lampe & McCann, 1985; Spoerke & Smolinske, 1990). The only reports of serious poisoning by ***Crinum*** species relate to the use of the bulbs in traditional medicine in rural Africa, where fatalities have been recorded (Watt & Breyer-Brandwijk, 1962). Ingestion of the raw bulbs may lead to nausea, persistent vomiting and diarrhoea but there are few reports of human poisoning from Europe or the USA (Spoerke & Smolinske, 1990).

Skin contact: There are anecdotal reports of contact dermatitis arising from handling the plant but no case data are available (Wiseman, in prep.).

> **Toxins:** Wiseman (in prep.) lists 12 alkaloids, including lycorine, from ***C.* x *powellii*** cultivars 'Album' and 'Harlemense'. One authority suggests that the leaves have a lower toxicity than the bulbs (Watt & Breyer-Brandwijk, 1962).

Other species: Various of the 'Amaryllidaceae alkaloids' are reported as present in other species of ***Crinum*** including ***C. bulbispermum*** **(Burm.f.) Milne-Redh. & Schweick.** It is likely that all species are toxic.

Conclusion: All parts of all species of ***Crinum*** should be considered toxic by ingestion with the potential for serious poisoning. However, no cases of human poisoning are reported from Europe; furthermore serious poisoning is unlikely since it is probable that large quantities would need to be eaten. There are anecdotal reports of contact dermatitis but no case data exist.

X CUPRESSOCYPARIS LEYLANDII (Dallim. & Jackson) Dallim. Cupressaceae

(A hybrid of ***Chamaecyparis nootkatensis*** *(Nootka Cypress) and* ***Cupressus macrocarpa*** *(Monterey Cypress).)*

Leyland Cypress

Leyland Cypress is a popular fast-growing evergreen plant widely used for hedging and screening purposes in parks and gardens.

Ingestion: The lack of obvious or attractive fruit reduces the likelihood of the plant being ingested. Ingestion of the foliage, however, may cause gastric upset but cases are more likely to involve animals rather than humans.

Skin contact: Allergic contact dermatitis may follow pruning or burning of the foliage. Individuals previously sensitised to colophony (a substance present in sticking plaster) appear to be particularly vulnerable; skin eruptions can be quite severe. Several cases have been well documented (Hindson *et al.*, 1982; Lovell *et al.* 1985).

> **Toxins:** Gastric irritation may be caused by the presence of essential oils such as terpenes and pinenes (Edwards, 1993). The allergens responsible for the skin reactions have yet to be identified precisely, although terpenes and derivatives of abietic acid may be implicated.

Conclusion: All parts of X *Cupressocyparis leylandii* are likely to contain toxins, although ingestion is unlikely to cause serious poisoning. Pruning or burning of the plant has given rise to mnay cases of contact allergic dermatitis. Individuals sensitive to sticking plaster are those more likely to develop allergic contact reactions.

CYCLAMEN L. Primulaceae

Cyclamen

Ingestion: Poisoning is known to have arisen after ingestion of the tubers (rhizomes) although such cases are rare. The tubers contain toxins which can cause a local irritant reaction resulting in gastro-intestinal problems and a reddish coloration of the urine. In more serious cases, irregular heart-beat, fits, paralysis and possibly death have been reported. It is believed that a small quantity of tuber is needed to give rise to these clinical effects but no clear supportive case data are available. Fortunately, the acrid and rancid taste of the tubers may limit the quantities ingested (Spoerke & Smolinske, 1990); poisoning is, therefore, unlikely (Frohne & Pfänder, 1984). The paucity of information about the toxicity of plant parts other than the tuber suggests they are unlikely to give rise to poisoning on ingestion although, according to one authority (Schneider, 1984), the leaves of ***C. persicum*** **Mill.** have been reported as dangerous (Spoerke & Smolinske, 1990). Very little information is available in the toxicological literature.

Skin contact: Little is known about the likelihood of skin problems associated with this species and lack of case data suggests that the degree of hazard is very low. Studies have been undertaken using ***C. persicum*** **Miller** (Lovell, 1993) but these have provided no conclusive data.

> **Toxins:** Triterpenoid saponins, such as cyclamin, are reported to be present (Frohne & Pfänder, 1984).

Conclusion: What little toxicological information exists about ***Cyclamen*** tends to be general to the genus as a whole. The potential for serious poisoning exists after ingestion of even a small quantity of ***Cyclamen*** tuber but cases are rare, possibly because the tubers are unattractive to eat. The toxicity of other plant parts is not known. No case reports have been found indicating toxicity from handling the tubers or whole plants.

Broom

Cytisus scoparius (L). Link

(synonym: *Sarothamnus scoparius* (L.) Wimmer ex Koch)

Broom

Ingestion: The entire plant may be potentially poisonous due to the presence of toxic alkaloids, however, since these occur in such low concentrations (Fuller & McClintock, 1986) they do not present a real hazard and poisoning in humans is extremely unlikely. Clarke *et al.* (1981) support this view and report that as much as 11 kg of the plant would be required to poison a horse! Children have been attracted to eat the seeds of ***Cytisus scoparius*** which resemble small peas; they have also been used as a coffee substitute, while the flowers have been picked to make wine (Turner & Szczawinski, 1991). If large quantities are eaten, clinical effects of poisoning appear rapidly after ingestion and include nausea and vomiting in humans; paralysis has been reported in animals (Fuller & McClintock, 1986).

Cases of human poisoning are very rare. One fatal, but unsubstantiated, case has been described (Frohne & Pfänder, 1984); this involved a 45-year old farmer who prepared a strong infusion from partly dried twigs of ***C. scoparius***, drank several cupfuls over a 6 day period, then collapsed and died.

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Several toxic quinolizidine alkaloids are present; the major ones being cytisine, sparteine, isosparteine and lupinidine (Turner & Szczawinski, 1991). Others include genistein and sarothamnine (Cooper & Johnson, 1984).
>
> **Mechanisms:** The toxins depress the heart and nervous system and sometimes paralyse the motor nerve endings (Turner & Szczawinski, 1991). Cytisine is rapidly absorbed in the mouth, stomach and intestine (Fuller & McClintock, 1986), while sparteine delays the formation and conduction of the heart impulse and peripherally its effects are like to those of nicotine, leading to paralysis (Frohne & Pfänder, 1984).

Other cultivars/varieties: No information is available about the level of toxicity of the numerous cultivars and varieties of ***C. scoparius***.

Other species: The effects of ingesting ***C. monspessulanus*** L. are similar to those of ***C. scoparius***, since children who have sucked the flowers of the former species have developed nausea and vomiting, while 4 boys were hospitalised in the USA after eating flowers of this species (Fuller & McClintock, 1986). The toxicity of ***C. scoparius*** is likely to be the same or similar for the closely related and widely cultivated species of ***Spartium junceum*** L.

Conclusion: Although poisoning by ingestion of any part of ***Cytisus scoparius*** in humans is rare, the potential for serious poisoning, particularly in children, nevertheless exists due to the presence of several toxic alkaloids. Fortunately, since these occur in very low concentrations, it is likely that a large quantity of plant material would need to be ingested before symptoms developed. It is likely that all other species of ***Cytisus*** have similar toxicity; no information is known about the toxicity of cultivars or varieties. Skin contact does not appear to be harmful and no occupational hazard has been reported.

(including Mezereon and Spurge Laurel)

Daphne mezereum L.

Mezereon

Ingestion: All parts of the plant are poisonous, especially the seeds. The shiny, red fruits are attractive to children, however, their acrid taste may discourage many being ingested. One fruit may produce mild symptoms including a burning sensation in the mouth, nausea, vomiting, stomach pains and diarrhoea. Several fruits may cause more severe symptoms, with weakness, disorientation and convulsions, sometimes followed by death (Cooper & Johnson, 1988). The irritation caused to mucous surfaces is intense, leading to blanching, sloughing and the production of raw ulcers. Lang (1987) states that, for a child, the lethal dose may be as little as 1 or 2 fruits, while for an adult approximately 12 may be lethal. The NPIS describe 5 cases where severe burning in the mouth and throat was reported; more serious symptoms did not develop.

Children are often attracted to the pleasant smelling, pink flowers of ***D. mezereum***. In 1955, a 7-year old boy who ate several flowers developed, in addition to the above symptoms, headache, neurological and psychiatric symptoms, together with meningitis. Although the dose did not prove fatal, the symptoms lasted one week (Frohne & Pfänder, 1984).

Skin contact: The skin may become blistered after contact with the juice of the berries (Lang, 1987) and may result in more serious skin irritation and ulceration; if the skin is broken this allows entry of the toxins into the body (Turner & Szczawinski, 1991). Chewing the bark causes painful blistering of the lips, mouth, and throat (Turner & Szczawinski, 1991). Mezerein, in addition to its skin irritant properties, has co-carcinogenic activity (Frohne & Pfänder, 1984), i.e it promotes cancer in the presence of a carcinogen.

> **Toxins:** The two major toxins present are the diterpene esters mezerein and daphnetoxin; these are not destroyed by drying or storage (Cooper & Johnson, 1988).

Other species: It is likely that other species of ***Daphne*** have a similar toxicity to ***D. mezereum***. This is certainly true of ***D. laureola*** L. (Spurge Laurel) whose black berries are often attractive to children, although they are very bitter (Lang, 1987).

The flowers of ***D. laureola*** are inconspicuous, small, yellow-green and only faintly scented, and thus less attractive than those of ***D. mezereum***. In 1989, a young child who ate a few berries of ***D. laureola*** exhibited typical symptoms of ***Daphne*** poisoning; he recovered, however, after treatment (Turner & Szczawinski, 1991). The NPIS report one case in 1985 of poisoning arising from eye contact; this resulted in conjunctival infection including eye redness and corneal oedema.

Conclusion: All parts of ***Daphne mezereum*** and ***D. laureola*** are toxic and it is probable that all other species in the genus ***Daphne*** have a similar toxicity. Eating the attractive fruits of both ***D. mezereum*** and ***D. laureola*** and the flowers of the former constitute the greatest risk to children, however the unpleasant taste of the berries may act as a deterrent. The sap and berry juice can cause severe dermatitis and one of the toxins, mezerein, is known to be co-carcinogenic.

DATURA L.

(excluding ***Brugmansia*** Pers.; see separate account) Solanaceae

Datura, Thorn-Apple

Datura stramonium L.

Thorn-Apple

Ingestion: All parts of the plant contain toxins; the same as those found in ***Atropa belladonna*** L. (Deadly Nightshade). Their highest levels are found in the flowers and seeds but their concentration may vary greatly according to local environmental conditions and degree of maturity. Poisoning has arisen when the plant has been eaten for its hallucinogenic effects. Children are likely to be attracted to the trumpet-shaped flowers or spiny fruits leading to their possible ingestion (Cooper & Johnson, 1988). Less than 4-5 gm (1/5 oz) of the seeds or leaves can be fatal to a child (Turner & Szczawinski, 1991).

Clinical effects may appear within 1-2 hours and include dryness of the mouth, skin flushing, dilated pupils, nausea, drowsiness and a rise in temperature. According to the amount taken, symptoms may also include rapid or irregular heart beat, hallucinations and, possibly, abnormal behaviour. In serious cases, delirium, convulsions, coma and sometimes death may follow (Cooper & Johnson, 1988). Any visual impairment may last a couple of weeks. One man was poisoned after drinking a herbal tea made from ***D. stramonium*** leaves; it was estimated that 10-15 mg of alkaloids were ingested resulting in blurred vision, hallucinations, thirst, together with unusual and unco-ordinated behaviour (Cooper & Johnson, 1984).

Skin contact: Various cases of contact dermatitis have been reported followpwing skin contact with the Thorn-Apple in an occupational setting (Mitchell & Rook, 1979); but these probably refer to the use of the plant abroad.

Eye contact: Hyoscine can cause allergic conjunctivitis. In those countries where the plant is cultivated as a crop an occupational hazard has been reported in those who harvest the plant since seeds may enter the conjunctival eye-sac (Mitchell & Rook, 1979).

> **Toxins**: The tropane alkaloids hyoscyamine and hyoscine (scopolamine) are present. Heating or drying does not reduce their toxicity. Atropine and nitrates may also be present (Cooper & Johnson, 1988).
>
> **Mechanisms**: Hyoscyamine blocks the parasympathetic nervous system (Cooper & Johnson, 1984).

Other species: Details of poisoning in ***D. stramonium*** apply equally to other species in the genus. The leaves of ***D. meteloides*** DC. were recently implicated in a case of hallucinogenic poisoning; one of the teenagers involved experienced hallucinations for over

48 hours after ingestion of the leaves and continued to have recurrences 3 weeks later (Goodenough, 1992).

Conclusion: All parts of all species of ***Datura*** are highly toxic on ingestion but few cases of poisoning have been reported in this country. The main risk is from abuse of the plant for hallucinogenic reasons. Poisoning is potentially fatal. Although some occupational contact hazard has been reported abroad, it is unlikely in this country unless the plant is grown as a crop. Contact dermatitis may be a problem in sensitised individuals.

DELPHINIUM L.

Ranunculaceae

(including *Consolida* (DC.) S.F.Gray)

Delphinium, Larkspur

Ingestion: All parts of the plant are highly poisonous with the toxins occurring in greatest concentration in the seeds and young growth (Poisindex, 1992). Although no case histories of poisoning have been found due to ***Delphinium*** specifically, plants in this genus are likely to have the potential to produce serious clinical effects similar to those of ***Aconitum*** (*see account*). These include nausea, vomiting, abdominal pain, blurred vision, intense pain and paralysis. These effects may appear rapidly after ingestion (Poisindex, 1992).

Skin contact: The leaves of several species are reported to be irritant (Mitchell & Rook, 1979), however, the problems associated with skin contact are poorly understood.

Toxins: Diterpene and the more toxic nor-diterpene alkaloids, including delphinine and ajacine alkaloids, are present in all plant parts. The annual Larkspur ***Delphinium consolida*** L. (***Consolida regalis*** S.F. Gray) is said to contain aconitine-like alkaloids although its toxicity appears to be lower than that of ***Aconitum*** (Frohne & Pfänder, 1984).

Other species: It should be assumed that all species are toxic by ingestion and contact.

Conclusion: All species of ***Delphinium***, including the annual Larkspurs (sometimes referred to as species of ***Consolida***), contain highly toxic substances which have the potential to cause serious human poisoning. However, accidental human poisoning by ingestion is rare. Many species may cause irritation on contact but such clinical effects are poorly understood.

DENDRANTHEMA (DC.) Des Moul. Compositae
(***Chrysanthemum*** L. in part)

Chrysanthemum

Taxonomic note: ***Dendranthema*** *is an increasingly widely used name for a rather uniform group of c. 18 species which were formerly included in the much larger and more diverse genus* ***Chrysanthemum****.* ***Dendranthema*** *includes the florists' or garden chrysanthemums (also AYR types) -* ***D. x grandiflorum*** **(Ramat.) Kitam.** *(formerly* ***Chrysanthemum x morifolium*** **Ramat.)** *- and* ***D. zawadskii*** **(Herbich) Tzvelev** *(****C. erubescens*** **Stapf***). Hybrids between these two form the group known as Korean chrysanthemums. Other widely-grown species formerly included in* ***Chrysanthemum*** *but now placed in other genera and <u>not</u> therefore included in this account, include* ***Argyranthemum frutescens, Chrysanthemopsis hosmariense, Leucanthemum maximum*** *and* ***Tanacetum parthenium****.*

Dendranthema x ***grandiflorum*** **(Ramat.) Kitam.**

Ingestion: Ingestion of any part may cause mild vomiting and diarrhoea (Spoerke & Smolinske, 1990).

Skin contact: It is widely reported that handling ***Dendranthema*** species can result in allergic contact dermatitis and other allergic skin reactions (Lovell, 1993). However, according to many of the leading growers and cutting suppliers for the UK market, the incidence of cases is negligible; only a handful of individuals who happen to be sensitive to the plant are affected (Oliver, 1993; Plummer, 1994). It would seem that those at greatest risk are keen amateur gardeners who handle the plant regularly outdoors and therefore are exposed to the plant under different environmental conditions from those working in an occuprational setting. Reactions can develop into allergic contact dermatitis in which the eyes and other parts of the face are affected. This may be due to the release of pollen (Frohne & Pfänder, 1984) or fine dust, or that the allergens themselves are volatile (Lovell, 1993).

> **Toxins:** Allergenic sesquiterpene lactones (e.g. Arteglasin A) are present on the surface of the flowers, usually in plant hairs, with less on the leaves and negligible amounts on the stem (Lovell, 1993).
>
> **Mechanisms:** The sesquiterpene lactones may link to sulphydryl groups on proteins to form an antigen (Frohne & Pfänder, 1984). Repeated exposures result in an allergic reaction.

Other species: All other species in the genus ***Dendranthema*** are likely to have a similar toxicity to that of ***D.* x *grandiflorum***. Cross-reactions may occur with other genera formerly in ***Chrysanthemum***, notably ***Tanacetum partenium*** (Lovell, 1993).

Conclusion: ***Dendranthema*** species are of low oral toxicity. Frequent contact with the leaves and flowers, especially by keen amateur gardeners, and sensitive individuals in an occupational setting, commonly result in allergic reactions including contact dermatitis.

(including Bleeding Heart and Dutchman's Breeches)

Dicentra spectabilis L.

Ingestion: All parts of this attractive plant are toxic, particularly the root. Ingestion may produce vomiting and diarrhoea, inco-ordination, trembling, paralysis, convulsions and breathing difficulties. To produce such serious effects, however, it is likely that large amounts would need to be ingested (Spoerke & Smolinske, 1990). No case data are available.

Skin contact: Occupational workers occasionally experience unpleasant but not serious contact dermatitis (Spoerke & Smolinske, 1990).

> **Toxins:** The isoquinolone alkaloid protopine is present at a concentration of 0.76% in the roots and 0.17% in the foliage (Frohne & Pfänder, 1984).

Other species: Effects from ingestion and skin contact are likely to be similar to those produced by ***D. spectabilis***. An allergic skin reaction may occur in some individuals, although the species responsible are not well documented (Turner & Szczawinski, 1991).

> **Toxins:** Various isoquinolone alkaloids such as aporphine, protoberberine and protopine are present in all plant parts, especially the root (Spoerke & Smolinske, 1990).

Conclusion: All parts and all species of ***Dicentra*** are toxic. Large amounts of plant material would need to be ingested, however, for the effects of serious poisoning to occur. The root is the most toxic part but the least likely to be ingested. No human cases of ingestion are known. Frequent handling, as in occupational settings, occasionally produces unpleasant though not serious skin reactions; sensitive individuals have been known to develop allergic skin reactions.

Foxglove

Digitalis purpurea L.

Ingestion: The whole plant is toxic, including the smoke from burning its foliage. Two to three dried leaves are stated to be a lethal dose (Frohne & Pfänder, 1984). Drying, storage or boiling do not reduce the plant's toxicity (Cooper & Johnson, 1988). The non-flowering plant resembles Comfrey (***Symphytum*** L.) with which it has been mistaken, resulting in poisoning after infusions of the leaves have been drunk (Spoerke & Smolinske, 1990). The flowers may be attractive to children.

Serious cases of poisoning are rare; the intense bitter taste normally deters its ingestion. Should the plant be eaten, however, spontaneous vomiting usually occurs minimising the absorption of the toxic glycosides (Frohne & Pfänder, 1984). Symptoms of poisoning include nausea, vomiting (sometimes persisting for more than 24 hours), abdominal pain, diarrhoea, headache and slow irregular pulse. In severe cases, disturbances of vision, trembling, convulsions, delirium and hallucinations may develop (Cooper & Johnson, 1988).

The NPIS report a case in 1985 when a 32 year old man ingested a decoction of ***D. purpurea*** and ***Laburnum*** in a suicide attempt. His symptoms were vomiting, episodes of heart block, slow heart-beat and raised potassium levels; he recovered. Another case (Simpkiss & Holt, 1983) involved a mentally retarded boy who ingested green parts of the plant; his plasma digitoxin concentration was 122 μg/l (therapeutic concentrations are usually below 25 μg/l). His symptoms were vomiting, complete heart block and increased plasma electrolytes. He recovered after 18 days.

Skin contact: This does not appear to be a significant problem, however, contact dermatitis has been known to result from handling the plant and from skin ointment made from the leaves (Mitchell & Rook, 1979).

> **Toxins:** Cardiac glycosides, such as digitoxin and digitalin (Cooper & Johnson, 1988) and saponins (Fuller & McClintock, 1986), such as digitonin, gitonin and tigonin are present (Spoerke & Smolinske, 1990).

Other species: ***D. lanata*** **Ehrh.** also contains cardiac glycosides (Frohne & Pfänder, 1984). It is likely that all species of ***Digitalis*** have a similar toxicity to ***D. purpurea***.

Conclusion: All parts of ***Digitalis purpurea*** and probably all species in the genus are toxic on ingestion and have the potential to cause serious poisoning, even in small quantities. However, the intense bitter taste and spontaneous vomiting that may follow ingestion reduces the risk of poisoning. There is a risk that the leaves may be used in error to make herbal tea. The risk of dermatitis appears to be low.

ERANTHIS HYEMALIS (L.) Salisb.

Ranunculaceae

Winter Aconite

Ingestion: All parts of this species are potentially very poisonous, especially the tuberous roots (Roth *et al.*, 1984). However, no cases of poisoning have been reported. If eaten, clinical effects are likely to include the following: nausea and vomiting, colic, irregular slow pulse, severe visual disturbances, shortage of breath and, in severe cases, heart failure (Roth *et al.*, 1984).

Skin contact: There is no evidence that skin contact is a problem.

> **Toxins:** The furanochromones, visnagin and khellin, are present. Although chemically related to psoralens, they are not photo-reactive (Mitchell & Rook, 1979). The toxic cardiac glycosides, Eranthin A & B, are also present (Roth *et al.*, 1984).

Conclusions: It is likely that all parts of ***Eranthis hyemalis*** are highly toxic, however, no cases of poisoning have been reported. The concentration of toxins in the plant is not known so it is not possible to assess the severity of poisoning that may arise should the plant be ingested. Skin contact does not appear to be a problem.

Euonymus

Euonymus europaeus L.

Spindle Tree

Ingestion: All parts of the plant are toxic and cases of ingestion are frequent. Most cases involve children who are attracted to the brightly coloured ripe fruits or seeds.

Clinical effects of poisoning may not appear until 8-24 hours after ingestion. In mild cases, these include digestive system disturbances with vomiting and colicky diarrhoea. In more severe incidents, there may be drowsiness, convulsions, circulatory disturbances and loss of consciousness. Such severe cases are uncommon and largely confined to the older literature. No fatalities have been recorded in the UK (Cooper & Johnson, 1988; Lang, 1987).

Skin contact: The wood is reported to be "injurious" to woodworkers (Mitchell & Rook, 1979).

> **Toxins:** All parts of the plant contain the cardiac glycoside euonymin, the heteroside euonoside (which is hydrolysed to digitoxin) and glyceril triacetate. Euonymin has an action similar to but less intense than that of the foxglove glycosides (Frohne & Pfänder, 1984).

Other species: Most references relate to ***Euonymus europaeus*** but other cultivated species are thought to have a similar toxin content (Frohne & Pfänder, 1984); examples include ***E. japonicus*** **Thunb.** and ***E. fortunei*** **L. (Turcz.) Hand. Mazz.**.

Conclusion: ***Euonymus europaeus*** contains toxins in all its plant parts and has the potential to cause serious poisoning. Human poisoning from the ingestion of fruits or their seeds, mainly involving children, is frequent but serious incidents are uncommon. Normal skin or eye contact do not appear to be a hazard. It is likely that all other species in the genus have a similar toxicity.

EUPHORBIA L. Euphorbiaceae

(excluding E. pulcherrima; see separate account)

Spurge, including Caper Spurge, Sun Spurge, Snow-on-the-Mountain

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Euphorbia helioscopia L. and *E. peplus* L.

Ingestion: The white latex (sap) present contains several toxic substances and has been known to cause serious poisoning. Clinical effects include a burning sensation and inflammation of the mouth and throat, severe gastro-enteritis, vomiting, colicky diarrhoea and gastritis. In severe cases seizures and coma may occur. The burning sensation in the mouth and throat makes the ingestion of large quantities unlikely (Frohne & Pfänder, 1984) but one fatal case from Greece has, nevertheless, been recorded (Cooper & Johnson, 1988).

Skin contact: Both the latex and the seed oil cause inflammation of the skin and mucosa, sometimes with blistering. Symptoms appear 2-8 hours after exposure and usually subside within a few days, leaving no permanent scarring (Frohne & Pfänder, 1984), although the skin may remain discoloured for a few months (Spoerke & Smolinske, 1990).

Eye contact: The latex may cause a stinging or burning sensation, swelling and serious inflammation of the eyelids, conjunctivitis, punctate staining and ulceration or erosion of the cornea, sometimes with temporary blindness (Frohne & Pfänder, 1984).

> **Toxins**: The toxicity is due to diterpene esters, mainly ingenol derivatives (*E. peplus*) and 12-Deoxyphorbol (*E. helioscopia*) (Frohne & Pfänder, 1984).

Other species: ***Euphorbia*** is a genus of about 1600 species. Although the above information refers to common weed species, many other species of ***Euphorbia*** are likely to have a similar toxicity. One study showed that of 60 species tested, almost all had irritant principles present. Commonly cultivated species known to be toxic include ***E. cyparissias*** L., ***E. fulgens*** **Karw. ex Klotsch**, ***E. lactea*** Haw., ***E. lathyris*** L., ***E. marginata*** **Pursh** ***E. milii*** Desmoul., ***E. myrsinites*** L., ***E. resinifera*** A. Berger, ***E. rigida***, ***E. serrulata*** **Thuill.** (*E. stricta* L.) and ***E. tirucalli*** L. (Spoerke & Smolinske, 1990). Seasonal variation in toxic content has been reported (Frohne & Pfänder, 1984). ***E. marginata*** has also caused irritant dermatitis in flower arrangers (Lovell, 1993a).

> **Toxins**: Diterpene esters are present; in most species these are ingenol derivatives. *E. tirucalli* contains 4-Deoxyphorbol (Frohne & Pfänder, 1984).

Conclusion: Toxic activity is common in the genus ***Euphorbia*** and it should be assumed that any species, with the exception of ***E. pulcherrima*** (Poinsettia), is likely to be toxic by ingestion and by contact. On average, however, large quantities are rarely ingested and skin symptoms are usually mild, however, skin and/or eye contact with the plant's latex has been known to give rise to serious conditions.

EUPHORBIA PULCHERRIMA Willd. ex Klotsch — Euphorbiaceae

Poinsettia

Ingestion: ***E. pulcherrima*** is a common plant in cultivation and there is little documented evidence of toxicity. One study concluded that Poinsettia is non-toxic (Poisindex, 1992), however, one old (1919) and unsubstantiated case from Hawaii resulted in a fatality (Frohne & Pfänder, 1984; Spoerke & Smolinske, 1990). Cases referring to ingestion of the foliage, especially the colourful bracts, are not uncommon but in most cases there are no ill effects. At worst, clinical effects may result in irritation in the mouth with some gastro-intestinal irritation and vomiting.

Skin contact: The data are largely anecdotal and rather confusing. Following tests on the leaves and sap, several authors report contact dermatitis; others record no irritant effects (Spoerke & Smolinske, 1990). Two cases of allergic contact dermatitis have been recorded (Lovell, 1993a, citing Santucci *et al.* 1985).

> **Toxins:** The concentration of toxic diterpenes (usually found in all species of ***Euphorbia***) appears to be small or non-existent (Lampe & McCann). The toxicity of these cultivated plants may have become reduced in the course of horticultural breeding.

Other species: See separate entry for other species of ***Euphorbia***.

Conclusion: The toxicological literature about ***Euphorbia pulcherrima*** is rather confusing. Cases of ingestion are numerous but usually produce only minor symptoms; more serious cases appear to be somewhat anecdotal. Case data arising from skin contact are also confusing; some authorities report no adverse reactions while others report allergic effects. On the whole, adverse reactions are unlikely to arise from either ingestion or contact; further scientific investigation would help clarify the toxicity of this plant.

Beech (including Common Beech and American Beech)

Fagus sylvatica L. and *Fagus grandifolia* L. (synonym: *Fagus americana* Sweet)

There are some 10 species of ***Fagus*** *of which* ***F. sylvatica*** *and its cultivars are the most common in the UK and northern Europe.*

Ingestion: Most concern has been expressed about the fruit (nut) of ***Fagus***. Animals have been seriously poisoned after eating significant quantities of beech nuts or 'cake', made from the husk and other residue of the nut after extraction of beechnut oil (Poisindex, 1992). Humans, however, who eat the roasted or raw kernels in moderate quantities are unlikely to suffer any harm. Large quantities (c.50 according to Poisindex, 1992) of raw nuts may cause unpleasant gastric effects which may include soreness in the mouth and throat. There are no reported clinical effects from eating the leaves or bark.

Skin contact: There are no reports of adverse effects arising from contact with any part of the tree. The leaves have been reported to have medicinal value in the treatment of various skin injuries (Lewis & Elvin-Lewis, 1977).

> **Toxins:** The fruit (nuts) contain oxalic acid and insoluble oxalates (Frohne & Pfänder, 1984). According to Cooper and Johnson (1984) the nut also contains an, as yet, uncharacterised alkaloid, called fagin, together with saponins.
>
> **Mechanisms:** Oxalic acid is a severe irritant. Fagin has an uncharacterised effect, although animals fatally poisoned show swelling of the organs (brain and intestines).

Conclusion: The toxicity of ***Fagus*** is not well understood but there are no reports of serious adverse reactions in humans; the NPIS receives very few enquiries about this taxon. The kernels have been used as food. In animals, however, poisoning has occurred usually due to over-indulgence or inappropriate feeding. There appear to be no problems arising from skin contact with any part of the tree.

FICUS L. Moraceae

(excluding *F. carica* L.; see separate account)

Fig

Ficus benjamina L.

Weeping Fig

Ingestion: Ingestion of the leaves of ***F. benjamina***, a common house-plant grown for its foliage, may produce a slight burning sensation or redness in the mouth (Poisindex, 1992). In large volumes, ingestion may lead to vomiting and diarrhoea (Cooper & Johnson, 1988).

Skin contact: Occupational exposure has resulted in rashes (contact urticaria) and itching (Axelsson *et al.*, 1987a).

Systemic allergic reactions: Allergic reactions including asthma, conjunctivitis and rhinitis (runny nose) have been documented as a result of handling the leaves (Axelsson *et al.*, 1985; 1987a). These effects are most likely to occur in individuals frequently exposed to the plants, however, previously sensitised individuals may develop symptoms in low exposure environments such as a workplace. The effects subside after removal of the plant from the workplace (Axelsson *et al.*, 1987a; 1987b).

It has been suggested that the dust which rises from the plant when it is shaken contains allergens, probably originating from the latex; the allergen may accumulate on the surface through normal transpiration. According to Axelsson *et al.* (1987a; 1987b) humid environments (e.g. greenhouses) appear to lower the risk of allergic reactions developing since there is less evaporation from the plant and so less allergen is brought to the plant surface.

> **Toxins:** Allergens are likely to occur throughout much of the plant; those present in the latex are of particular interest (Axelsson *et al.*, 1987a).
>
> **Mechanisms:** The allergic reactions are Immunoglobulin E mediated (Axelsson *et al.*, 1987a).

Other species: The ripe fruits of all ***Ficus*** species are considered to be non-toxic (Hardin & Arena, 1974) however, ingestion of unripe fruits or other plant parts may cause a mild burning sensation or redness in the mouth and throat (Poisindex, 1992). This is likely to be true for most members of ***Ficus***.

Skin contact: Exposure to the sap of ***Ficus*** species may cause mild skin irritation (Poisindex, 1992); Turner and Szczawinski (1991) suggest that irritant dermatitis as well as photodermatitis may result from contact, although the species of ***Ficus*** are not specificed.

Systemic allergic reactions: Axelsson *et al.* (1991) suggest that individuals allergic to ***Ficus benjamina*** may also develop an allergy to other ***Ficus*** species.

Eye contact: Ficin, found in ***Ficus*** species, is known to be irritant to the eyes (Grant, 1986).

Toxins: Some ***Ficus*** species contain furocoumarins, including ficusin and 8-methoxypsoralen (Fuller & McClintock, 1986); these induce photo-toxic reactions (Lovell, 1993). Ficin, an irritant proteolytic enzyme, is believed to be present in most, if not all, ***Ficus*** species. There may be other unidentified irritant substances in the sap of ***Ficus*** species (Poisindex, 1992).

Conclusion: *Ficus* species are considered to have a low toxicity by ingestion. Skin irritation is possible from handling any member of the genus but it is more likely in occupational exposures. Handling *F.* ***benjamina***, particularly in dry occupational environments, has been reported to cause unpleasant systemic allergic reactions.

FICUS CARICA L. Moraceae

Common Fig

Ingestion: Although the ripe fruits are edible, ingestion of unripe fruits or other plant parts has been reported to cause a mild burning sensation or redness in the mouth and throat (Poisindex, 1992).

Skin contact: The sap is irritant. Handling *F. carica* in bright sunlight may result in photo-sensitivity dermatitis including the development of blistering and redness of the skin (Lovell, 1993); abnormal skin discoloration may develop and which may persist for several years. Some workers who dry, pack or cook figs develop a chronic eczema on the hands (Fuller & McClintock, 1986; Turner & Szczawinski, 1991).

Eye contact: The sap of *F. carica* is highly irritant to the eyes (Turner & Szczawinski, 1991).

> **Toxins:** *F. carica* contains furocoumarins, including ficusin and 8-methoxypsoralen (Fuller & McClintock, 1986), which induce photo-toxic reactions (Lovell, 1993). Ficin, an irritant proteolytic enzyme, may also be present.

Conclusion: *Ficus carica* is considered a low toxicity species; only minor clinical effects have been reported after ingestion of the unripe fruits; ripe fruits are edible. Contact with the sap of the plant in bright sunlight is known to result in photo-sensitisation of the skin and which may have long-term effects; in addition, repeated exposures in an occupational setting may also give rise to chronic eczema. The sap is highly irritating to the eyes.

FRAXINUS L. Oleaceae

Ash

Ingestion: The toxicity of any part of ***Fraxinus***, following ingestion, is not well documented; there are no reports of human poisoning.

Skin contact: Dermatitis may occur (Cooper & Johnson, 1984), however the few reported cases are probably due to lichens present on the wood surface rather than the wood itself. Handling ***Fraxinus excelsior*** **L.** (European Ash) has been associated with hay-fever and occupational asthma (Fuller & McClintock, 1986).

> **Toxins:** Cooper and Johnson (1984) indicate that glycosides are probably present, together with aesculin, a lactone glycoside.

Conclusion: ***Fraxinus*** species are of low oral toxicity but skin contact, particularly occupational, may result in unpleasant skin or systemic allergic reactions.

Fremontodendron

Fremontodendron californicum (Torrey) Cov. x *F. mexicanum* Davidson

Ingestion: There is no evidence that ingestion is harmful.

Skin contact: This hybrid has commonly been found to be irritant. The stems of ***Fremontodendron*** are thickly covered with minute brown hairs reported to give rise to painful and long-lasting itching on contact (Ingwerson, 1985). Surprisingly little appears to be documented about these effects possibly since the symptoms may be relatively minor or short-lived; it is not known whether some people are more sensitive than others. Only one published case is known (Ingwerson, 1985), although anecdotal evidence (Leon, 1992) indicates many recent cases have occurred, possibly due to the rising popularity of this plant within the horticultural world.

Eye contact: Only one published case indicates that eye contact may be a problem (Ingwerson, 1985) but see comments under *Skin contact*. This case, reported in 1985, describes intense irritation of the eyes, nose and mouth following pruning of the plant. This painful experience, particularly of the eyes, continued for several days.

Toxins: No information.

Other species: ***F. californicum*** and ***F. mexicanum***: no specific information is available but since these are the parents of the hybrid it is likely that at least one has the potential to cause similar reactions.

Conclusion: No information is available to indicate that ingestion is harmful. Contact with all taxa of ***Fremontodendron***, however, may give rise to irritation of the eyes, mouth, nose and skin. Pruning, usually of mature plants, may lead to irritation.

GALANTHUS L. Amaryllidaceae

Snowdrop

Galanthus nivalis L.

Ingestion: All parts of the plant contain toxic alkaloids with the highest concentration present in the bulb, especially the outer scale leaves. In the rare event that human poisoning may arise from ingesting this plant, the severity of the poisoning is likely to be similar to, but less severe than, that of ***Narcissus*** poisoning (Cooper & Johnson, 1988). Human fatalities are unknown. Clinical effects, which take place soon after ingestion, are nausea and gastric upset resulting in severe vomiting and diarrhoea, possibly accompanied by sweating and salivation (Poisindex, 1992).

Skin contact: The literature is confusing about the likelihood of skin problems arising from contact with this plant. Fuller and McClintock (1986) write that allergic and irritant contact dermatitis has been associated with the genus as a whole, particularly in occupational settings where florists and growers may handle the bulbs regularly (Fuller & McClintock, 1986). Mitchell and Rook (1979), however, report that there are no dermatological reactions associated with this species or others in the genus. More recently, Lovell (1993) indicates that contact allergens have been found in ***G. nivalis*** although their precise identity remains uncertain. Therefore, the level of dermatitis hazard posed by this plant remains to be clarified.

> **Toxins:** Various alkaloids, phenanthridine derivatives, such as lycorine and galanthamine, are present and are unique to the Amaryllidaceae family (Cooper & Johnson, 1984).
>
> **Mechanisms:** Lycorine acts upon the central nervous system and gastro-intestinal tract (Spoerke & Smolinske, 1990).

Other cultivars/varieties: No information is available about the levels of toxicity in the numerous cultivars and varieties of ***G. nivalis***, but it is reasonable to assume that they are similar to those of the species.

Other species: No species-specific information is readily available about the toxicity of other members of the genus, although the literature indicates that information about ***G. nivalis*** is relevant to other members of the genus too.

Conclusion: ***Galanthus*** is a low toxicity taxon. Only minor poisoning is likely to occur from ingestion of any species or cultivar/variety of ***Galanthus***, and only if the bulbs are eaten in large numbers is poisoning likely to become a problem. The hazards of skin contact with the plant are less clear, although even here clinical effects are not likely to be serious.

GAULTHERIA L. (section *Pernettya* (Gaud.) Middleton) Ericaceae

*Taxonomic note: the genus **Pernettya Gaud.** is now included within the genus **Gaultheria** L. where it forms a separate section (Middleton 1991). However, because the toxicity of **Pernettya** is different from that of the rest of **Gaultheria**, it has been treated separately here. The former names within **Pernettya** are given in brackets as these may be more familiar in the horticultural world than the **Gaultheria** names.*

Gaultheria mucronata (L.*f.*) Hook.

(synonym: ***Pernettya mucronata*** (L.*f.*) Gaud. ex Spreng.)

Ingestion: The leaves, berries and nectar (honey) are poisonous (Fuller & McClintock, 1986). Clinical effects of poisoning include a transitory burning in the mouth, followed several hours later by salivation, vomiting, diarrhoea and a prickling sensation in the skin. Headache, muscular weakness and dimness of vision may also occur. In severe cases slow heart rate is followed by hypotension, coma and convulsions (Lampe & McCann, 1985; Poisindex, 1992).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Lampe and McCann (1985) indicate that a grayanotoxin (a toxic diterpenoid) called grayanotoxin I is present.
>
> **Mechanisms:** Grayanotoxins bind to sodium channels in cell membranes, maintaining excitable cells, such as nerve and muscle, in a state of depolarisation. This action is thought to be responsible for the muscular and nervous system reactions reported (Poisindex, 1992).

Other species: Lampe *et al.* (1985) give the above information for all species of *Gaultheria* section ***Pernettya*** with the exception of the fruit to which they do not refer. Poisindex (1992) applies the information from Lampe (1985) to ***G. macrostigma*** **(Colenso) Middleton (*P. macrostigma*** Colenso). Ingestion of the fruit of ***G. furens*** **(Hook.) Hook. & Arn.** (***P. furens*** **(Hook.) Klotzsch**), a Chilean species, can cause mental confusion, madness, and permanent insanity; clinical symptoms resemble those of ***Datura*** poisoning (Schultes 1976). In addition, ***G. myrsinoides*** **Humb., Bonpl. & Kunth.** (***P. prostrata*** **(Cav.) DC., *P. parvifolia*** **Benth.**) is well recognised as poisonous, it can induce hallucinations and other psychic alterations as well as affect the motor nerves (Schultes, 1976).

Conclusion: All the species of ***Gaultheria*** **section *Pernettya*** have poisonous leaves, nectar and fruit and the potential for serious poisoning exists. There is no evidence that skin contact is harmful.

(excluding Section ***Pernettya*** (see separate account); formerly the genus ***Pernettya***).

Ingestion: The berries of ***Gaultheria procumbens*** **L.** are harmless; a tea is made with the leaves (Frohne & Pfänder, 1984). ***G. procumbens*** and to a lesser extent ***G. hispidula*** **(L.) Muhl. (section *Chiogenopsis* Middleton)** contain methyl salicylate, which is closely related to aspirin. It is toxic in high doses and should be strictly avoided by anyone who is allergic to aspirin. However, the berries of these plants and tea made from the leaves is unlikely to be harmful when used in moderation by those with a normal tolerance for them (Turner *et al.*, 1979). The fruit of ***G. shallon*** **Pursh (section *Brossaea* (L.) Middleton)** is edible (Turner & Szczawinski, 1991).

Skin contact: There is no evidence that skin contact is harmful.

Toxins: Methyl salicylate is present in some species.

Conclusion: ***Gaultheria procumbens*** and ***G. hispidula*** are hazardous only to those people allergic to aspirin. The fruit of ***Gaultheria shallon*** is reported to be edible. Other species in the Sections to which these three plants belong are likely to have a similar low toxicity. There is no evidence that skin contact is harmful.

GLORIOSA SUPERBA L. — Colchicaceae

Glory Lily

Ingestion: The entire plant is poisonous, especially the tubers (Turner & Szczawinski, 1991). The latter resemble Sweet Potatoes (***Ipomoea batatas* (L.) Lam.**) and for which they have been mistakenly eaten. Each gram of tuber contains approximately 3 mg of colchicine; the estimated fatal amount of pure colchicine is 7-60 mg for an adult; 5 mg can be fatal for a child. Even a small amount, therefore, of the tuber could cause serious poisoning (Spoerke & Smolinske, 1990). Within 2-12 hours the following clinical effects may develop: cramp, vomiting, diarrhoea, numbness of lips and tongue (Mitchell & Rook, 1979), difficulty in swallowing, dehydration, fast heart rate, and low unrecordable blood pressure and pulse. This may be followed by collapse, fits, paralysis, bone marrow depression and death usually due to respiratory failure (Spoerke & Smolinske, 1990).

There are two case reports where adults have been poisoned by ingesting the tubers. In both cases the tubers were ingested in mistake for Sweet Potatoes. One of the adults died four days after eating a meal of the tubers (no details of quantity ingested available); the other, who ate 125 g of tubers as part of a meal, survived after receiving vasopressors, fluid replacement and steroids. This patient also experienced hair loss during this poisoning episode (Spoerke & Smolinske, 1990).

Skin contact: The tubers are irritant (Mitchell & Rook, 1979).

Eye contact: No data are available but the skin irritants present may present a problem.

> **Toxins:** The tubers contain the alkaloids colchicine (0.3%) and gloriosine, along with salicylic acid and resins. Gloriosine is reported to be more potent than colchicine! The toxin responsible for the irritant properties of the tuber is not known.
>
> **Mechanisms:** Both alkaloids have an antimitotic effect, arresting cell division.

Conclusion: The whole plant of ***Gloriosa superba*** is highly toxic. Ingestion of the tuber is the main hazard and has caused serious poisoning when eaten in mistake for ***Ipomoea batatas*** (Sweet Potato), which it closely resembles. The tuber is a skin irritant which may present an occupational risk.

HAEMANTHUS L. Amaryllidaceae

(including ***Scadoxus*** Raf.)

Blood Lily

*Taxonomic note: in this account, data relate to **Haemanthus** in the broad sense, including species now usually separated into the genus **Scadoxus**.*

Haemanthus multiflorus **Martyn**

(synonym: ***Scadoxus multiflorus*** **(Martyn) Raf.**)

Ingestion: All parts of the plant are considered toxic. The juice of the bulb is considered to be highly poisonous, resulting in dangerous swelling of the lips and tongue (Watt & Breyer-Brandwijk, 1962). However, no case data are available from Europe or the USA; human poisoning mostly having occurred as a result of medicinal use of the plant in rural Africa, from where the plant originates (Spoerke & Smolinske, 1990). Clinical effects following the ingestion of small amounts include salivation, vomiting and diarrhoea. Large amounts may result in paralysis and death (Wiseman, in prep.).

Skin contact: There are anecdotal reports of contact dermatitis associated with handling members of the genus, but no case data are available (Wiseman, in prep.).

> **Toxins:** Wiseman (in prep.) lists nine alkaloids, including lycorine which has emetic properties. Watt and Breyer-Brandwijk (1962) also indicate the presence of chlidanthine, haemanthidine, hippeastrine and haemultine.

Other species: Other species, including ***H. albiflos*** **Jacq.**, ***H. albomaculatus*** **Bak.** and ***H. coccineus*** L. are also said to contain alkaloids including lycorine in all their plant parts (Watt & Breyer-Brandwijk, 1962).

Conclusion: All parts of several species of ***Haemanthus*** contain toxins but there are no case data relating to poisoning by ingestion in Europe or the USA. Similarly, although there are anecdotal reports of skin reactions, there is a lack of case data concerning problems arising after handling the plant.

Ivy

Hedera helix L.

Ingestion: The toxic principles are present in all parts of the plant and are concentrated in the young leaves and berries (Lang, 1987). Poisoning involving ingestion of the berries has been reported. Usually only a few berries are eaten due to their hard texture and unpleasant, bitter taste (Cooper & Johnson, 1988) and clinical effects are, therefore, mainly limited to a burning sensation in the mouth and throat, or infrequently, blistering, swelling and pain (Lang, 1987). A very old case dating back to 1887 resulted in vomiting and violent diarrhoea, together with laboured breathing, excitation, fits and coma (Cooper & Johnson, 1988). Another old case (1925) involved a 3-year-old boy who ingested many leaves; he first developed a rash and later showed further signs of poisoning: fast heart rate, stupor, dilated pupils and fits. He recovered completely (Spoerke & Smolinske, 1990). No recent reports of such severe symptoms have been found.

Skin contact: Contact with Ivy, e.g. when pruning or when children climb walls or trees covered with Ivy, can cause skin reactions of varying severity (Lovell, 1993). Clinical effects range from a mild rash to, in sensitive individuals, blistering and swelling (Cooper & Johnson, 1988); swelling around the eyes has also been described. Sometimes reactions can be so severe that hospitalization has been required. The toxins are known to be present in the leaves of the plant throughout the year; therefore reactions are possible year round.

Both irritant and allergic contact dermatitis may develop; the former being more common of the two. Low concentrations of the irritating compounds have caused direct contact irritation during patch testing and sensitized people can develop symptoms even after handling contaminated clothing (Spoerke & Smolinske, 1990).

> **Toxins:** These include triterpenoid saponins (hederasaponins A and B, or B and C) which undergo partial hydrolysis, with loss of sugars, to form the toxic substances α and ß hederin. The toxic substances rutin, caffeic acid, chlorogenic acid and emetine have also been isolated from ***H. helix*** leaves (Cooper & Johnson, 1984; Spoerke & Smolinske, 1990).
>
> The polyacetylene falcarinol is the major irritant and allergen of ***H. helix*** dermatitis; the closely related, but weaker allergen, didehydrofalcarinol is also present. Falcarinone, a ketone oxidation product of falcarinol, has been detected in ***H. helix***, but its role as an allergen in ***H. helix*** dermatitis is unproven (Lovell, 1993).
>
> **Mechanisms:** Saponins are strong irritants of the mucous membranes of the nose and throat. Polyacetylenes are potent alkylating agents, reacting with amino and protein groups, facilitating binding to Langerhans cells and macrophages. They are direct irritants and also sensitizers (Spoerke & Smolinske, 1990).

Other species: There are no case reports of ingestion of other species of ***Hedera*** but, since the same toxins are present (Spoerke & Smolinske, 1990), clinical effects are likely to be similar.

Severe irritant and/or allergic contact dermatitis have been described after trimming ***H. canariensis*** **Willd.** (***H. algeriensis*** **Hibb.**, ***H. maderensis*** **C.Koch**). Because of the more rapid growth and larger leaves of this plant compared to ***H. helix***, the likelihood of a dermatitic reaction is high. Reactions generally occur 24 to 48 hours after pruning the plant, particularly during the season of rapid growth. The resulting dermatitis ranges from mild cases to moderately severe reactions, characterized by intense itching and "nettle rash". The toxins are present in the leaves throughout the year (Spoerke & Smolinske, 1990).

> **Toxins:** ***Hedera*** species contain triterpenoid saponins and polyacetylene compounds. ***H. canariensis*** contains the polyacetylenes falcarinol and didehydrofalcarinol (Spoerke & Smolinske, 1990).

Conclusion: All species of ***Hedera*** contain toxic, irritant and allergenic compounds in all plant parts; they are especially concentrated in young leaves and fruit. Poisoning has occurred from ingestion of the berries. Severe cases are, however, rare. Since the irritant compounds are present in the leaves throughout the year, contact dermatitis can arise during any month. Most adult cases of dermatitis associated with the plant follow pruning of the plant; this is a potential hazard to professional and amateur gardeners alike. Such reactions can be very severe.

HELLEBORUS L. Ranunculaceae

(including Lenten Rose and Hellebore)

Helleborus niger L.

Christmas Rose

Ingestion: All parts of the plant are toxic. Clinical effects likely to arise after ingestion include excessive salivation, gastro-intestinal troubles, tingling in the mouth and throat. Cases of poisoning, however, are rare (Cooper & Johnson, 1988).

Skin contact: Bruised roots and leaves are irritant (Mitchell & Rook, 1979) and contact with the sap may cause a burning sensation, reddening, swelling, blistering and discoloration of the skin. Extracting the seeds from the still juicy pods frequently causes numbness of the fingers followed by painful blistering.

Eye contact: No information is available but it is likely that the sap may cause severe irritation.

> **Toxins:** The glycoside ranunculin (which hydrolyses on maceration to protoanemonin), is present, at least in above-ground parts of the plant. It is this toxin that is thought responsible for the reported skin, eye and gastro-intestinal irritant effects (Frohne & Pfänder, 1984).

Other species: Most records of poisoning refer to ***H. niger*** but it would appear that other species of ***Helleborus*** share the same toxic properties, although the concentration of these may vary significantly (Spoerke & Smolinske, 1990). Some species have been shown to have the capacity to cause slow or irregular heart-beat (Cooper & Johnson, 1988; Lampe & McCann, 1985).

> **Toxins:** All species contain ranunculin; some species (not specified) contain bufadienolides and saponins (Frohne & Pfänder, 1984).

Conclusion: It is likely that all species of ***Helleborus*** are moderately toxic; few cases of poisoning following ingestion, however, have been reported. Contact with the sap has been known to cause painful dermatitis and the potential exists for serious eye irritation.

HIPPEASTRUM Her. Amaryllidaceae

Amaryllis, Hippeastrum

Ingestion: All plant parts are considered toxic. The bulb contains the highest concentration of toxins, particularly its outer epidermis. The clinical effects of poisoning are mild digestive symptoms, including nausea, salivation, diarrhoea and vomiting. Most poisonings involving lycorine, the main toxin present, result in the early onset of vomiting hours (Spoerke & Smolinske, 1990). One case of childhood poisoning involved the ingestion of a number of bulbs of ***H. vittatum*** **Herb.**; following an episode of vomiting they were subjected to stomach lavage and made a full recovery (Morton, 1988). Serious cases of poisoning have not been reported in humans.

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** Phenanthridine-derivative alkaloids are present; the most common is lycorine which is heat stable (Spoerke & Smolinske, 1990). Narcissine is also reported to be present (Turner & Szczawinski, 1991).
>
> **Mechanisms:** Lycorine affects both the central nervous system and the gastro-intestinal tract. Little is known about the effects of the other alkaloids (Spoerke & Smolinske, 1990).

Conclusion: All parts of all species of ***Hippeastrum*** are believed to be poisonous, especially the bulbs; however, severe poisoning in humans is rare. Ingestion usually produces only minor symptoms. There is no evidence that skin contact is harmful.

HYACINTHOIDES Medik.

Hyacinthaceae

(including Bluebell and Wild Hyacinth)

Hyacinthoides non-scripta **(L.) Rothm.** (also grown as ***Endymion non-scriptus*** **(L.) Dumort,** ***Scilla nutans*** L.)

Wild Bluebell

Ingestion: All parts are poisonous. Poisoning has resulted from mistaking the bulbs for onions. A young child who ate 6-10 seed pods suffered from diarrhoea. Other clinical effects reported include pain in the mouth, abdominal pain, nausea, vomiting and slow heart rate (Cooper & Johnson, 1988).

Skin contact: ***Hyacinthoides*** has been recorded as irritant to the skin, but there are no detailed case data (Cooper & Johnson, 1984; Mitchell & Rook, 1979).

> **Toxins:** Several species of ***Scilla*** L. (referred to here in the broad sense and therefore including ***Hyacinthoides***) contain bufadienolides (Frohne & Pfänder, 1984); these are cardiotoxic glycosides known as scillarens, and which display a toxic reaction similar to that of the glycosides found in ***Digitalis*** (Cooper & Johnson, 1988).

Other species: It is likely that other species of ***Hyacinthoides*** share these toxic properties but no data are available.

Conclusion: It is likely that all species of ***Hyacinthoides*** are toxic. Poisoning by ingestion of any species is possible and may be quite serious; few cases have been reported. There is a risk of occupational contact dermatitis resulting from the repeated handling of the bulbs.

Hyacinth

Hyacinthus orientalis L.

Ingestion: The bulb contains the highest concentration of toxins; smaller amounts are present in the flowers, stems and leaves. Since most cases of poisoning do not involve ingestion of the bulb, few cases prove serious. There have been, however, occasional poisoning cases arising from the bulbs being eaten in mistake for onions. Clinical effects have included nausea, vomiting, diarrhoea and stomach cramps, with excessive salivation (Cooper & Johnson, 1984). Although in animals, the ingestion of large amounts have been reported to produce depression of the central nervous system, this has not been reported in man (Spoerke & Smolinske, 1990).

Skin contact: The sap can give rise to contact dermatitis (Cooper & Johnson, 1984). The bulbs have caused irritant dermatitis in bulb planters and sorters (Lovell, 1993).

Other exposure: Handling the plant may induce rhinitis or trigger asthma in susceptible individuals (Spoerke & Smolinske, 1990).

Toxins: Lycorine is reported to be present (Spoerke & Smolinske, 1990).

Mechanisms: Lycorine acts as an emetic (Spoerke & Smolinske, 1990).

Other species: Although no specific information is available it is likely that other species of ***Hyacinthus*** may give rise to similar toxic effects on ingestion and contact.

Conclusion: Ingestion of the bulbs of ***Hyacinthus*** species is likely to cause mild to moderate poisoning; other plant parts may also cause mild poisoning. Handling the plant may produce unpleasant allergic reactions, the likelihood of which is increased through occupational exposure.

Hydrangea

Hydrangea macrophylla L.

Ingestion: Since the plant is not attractive to eat, poisoning by ingestion is unlikely; however, toxins are present and a few cases of mild poisoning have been reported. For example, eating the leaves or flower-buds may result in poisoning since both contain a toxin called hydrangin which can lead to nausea, vomiting and diarrhoea (Hardin and Arena, 1974). Hydrangin is especially concentrated in young leaves, although its concentration falls off to negligible levels with maturity (Fuller & McClintock, 1986). On the few occasions when large amounts have been ingested poisoning has occurred (Cooper & Johnson, 1988), but no fatalities have been reported (Turner & Szczawinski, 1991). One case of poisoning arose when the leaves were used as a tea substitute because of their stimulant properties; the leaves have also been smoked. In another case, a family in Florida experienced nausea and gastro-enteritis when buds were eaten in a salad (Westbrooks & Preacher, 1986).

Skin contact: The likelihood of contracting dermatitis from ***H. macrophylla*** is very low according to Lovell (1993) who states that allergic contact dermatitis may arise only in rare instances, chiefly on the hands. However, Lovell believes consider that such few cases may be due to under-reporting. Those who repeatedly handle the plants in an occupational setting will be most at risk, however, since 1926 only sporadic cases have been reported.

> **Toxins:** Hydrangin, a cyanogenic glycoside (Spoerke & Smolinske, 1990) and the allergen hydrangenol, an isocoumarin. Saponins are also present (Cooper & Johnson, 1988).
>
> **Other cultivars/varieties:** Many cultivated forms of ***H. macrophylla*** are grown in the UK and it is reasonable to assume that their toxicity is similar to that of the species.

Other species: Turner and Szczawinski (1991) report that ***H. paniculata*** contains other compounds known to result in marijuana-like "highs".

Conclusion: ***Hydrangea macrophylla*** is a low toxicity species for which few cases of poisoning either by ingestion or contact have been reported. Although the potential exists for serious poisoning by this plant through ingestion, very large quantities would need to be eaten. Only cases with mild clinical effects have been reported in the scientific literature. Those handling the plant regularly, such as florists and horticulturists, are at risk of becoming sensitised and contracting contact dermatitis but the incidence of contact dermatitis still remains very low. No toxicity information is available about the many cultivars of ***H. macrophylla***. With respect to other species of ***Hydrangea***, only ***H. paniculata*** claims the presence of an additional toxin reported to be toxic on ingestion.

Henbane

Hyoscyamus niger L.

Ingestion: All parts of ***H. niger***, particularly the seeds, contain highly toxic substances. Poisoning has occurred in small children having eaten the seeds, while adults and/or adolescents have been poisoned by eating the flowers for hallucinogenic reasons (Frohne & Pfänder, 1984). A 20 year old man, who had chewed 4 flowers experienced excitability, hallucinations, hot dry skin, a rapid heart beat and sight problems. The roots have also been eaten, with fatal consequences, in mistake for those of Chicory (***Cichorium intybus***), Wild Parsnip (***Pastinaca sativa***) and Horse-radish (***Armoracia rusticana***), with fatal consequences (Westbrooks & Preacher, 1986; Poisindex, 1992). In the 1970s, a case in Turkey resulted in a childhood fatality when a group of children ate a salad made of Henbane leaves (Frohne & Pfänder, 1984). Fortunately, no recent cases of poisoning, hallucinogenic or otherwise, have been reported (NPIS).

Clinical effects include dry mouth, blurred vision, dilated pupils, nausea, mental confusion, excitability, muscular weakness, rapid heart beat and hallucinations. In serious cases, which are rare, coma and death from heart and respiratory failure have been reported (Cooper & Johnson, 1988; Fuller & McClintock, 1986).

Most reports of fatalities are old ones arising from mistaken identity of the roots; while Frohne and Pfänder (1984) report that the flowers are widely used as a hallucinogenic drug.

Skin contact: The sap is reported to be irritant and dermatitis may also appear following skin contact, probably due to the presence of hyoscine (Mitchell & Rook, 1979).

Eye contact: Allergic contact dermatitis may arise from contact with the sap (Mitchell & Rook, 1979).

> **Toxins:** A mixture of alkaloids, mainly the tropane alkaloids hyoscyamine, hyoscine (scopolamine) and atropine are present (Fuller & McClintock, 1986); their toxicity persists after drying.

Other species: No toxicological information has been found specific to ***H. albus*** L. but it is likely to have a similar toxicity that of ***H. niger***.

Conclusion: Ingestion of any part of ***Hyoscyamus niger*** has the potential to cause very serious poisoning. Although no recent cases have been reported to the NPIS, the potential dangers remain, coupled with the possibility of hallucinogenic experimentation. Contact dermatitis or other skin irritation is a potential hazard but insufficient information is available to confirm the possible severity and likelihood of such cases arising. Toxicity information about ***H. niger*** is likely to apply equally to other species in the genus.

ILEX L. Aquifoliaceae

Holly

Ilex aquifolium L.

Holly, Common Holly, European Holly

Ingestion: The whole plant contains toxins. The colourful berries are the plant part most likely to eaten by small children; numerous cases of ingestion have been reported, mostly at Christmas time when the plant is brought indoors. If eaten in small quantity, the berries have a low toxicity, although persistent vomiting and diarrhoea may occur; as little as two berries has produced nausea and mild drowsiness (Cooper & Johnson, 1988; Poisindex, 1992). Serious poisoning is only likely after ingestion of large numbers (Frohne & Pfänder, 1984). There are no reports of the leaves being eaten.

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** Little is known about the toxins responsible for the clinical effects. A saponin has been isolated from the leaves. The berries contain the glycoside ilicin (Cooper & Johnson, 1988), triterpenes and a bis-nor-monoterpene compound (Frohne & Pfänder, 1984). The berries also contain a saponin.
>
> **Mechanisms:** Extracts of the fruit have a digitalis-like cardiotonic activity. The saponin in the leaves has haemolytic activity (Frohne & Pfänder, 1984).

Other species: A pair of 2 year-old twins who ate the berries of ***Ilex opaca*** **Ait.** experienced vomiting; the child eating the largest quantity also experienced drowsiness and watery diarrhoea. Symptoms cleared within 20 hours. Poisindex (1992), however, suggests that a drug used in their treatment may have been partially responsible for their symptoms.

Conclusion: All parts of ***Ilex aquifolium*** and probably ***I. opaca*** contain toxins. These are present only in low concentration in the berries, the part usually eaten. Only minor clinical effects are therefore usually reported. No cases have been reported in which other plant parts have been eaten. There is no evidence that skin contact is harmful.

(including Morning Glory)

Ipomoea tricolor L. (synonym: *I. rubrocaerulea*)

Ingestion: The seeds are highly toxic, containing alkaloids with a strong hallucinogenic potential. The toxicity of other plant parts is not known. All cultivars of ***I. tricolor*** are considered to be hallucinogenic, but their toxin content varies considerably so clinical effects are likely to be very unpredictable. Those most likely include: facial flushing, nausea and vomiting, diarrhoea, low blood pressure, anxiety, mental confusion with long-lasting and frightening hallucination. There may be permanent psychological disturbance (Cooper & Johnson, 1984; Poisindex, 1992).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** The seeds contain lysergamide, erginine, ergonovine and certain clavine alkaloids (Poisindex, 1992). The toxicity of the leaves and flowers has not been studied (Spoerke & Smolinske, 1990).

Other species: Poisindex (1992) recommends that all species in the genus ***Ipomoea*** be treated as potentially harmful.

Conclusion: The seeds of ***Ipomoea tricolor*** are highly toxic and their ingestion has been known to result in serious poisoning. It is likely that all other cultivated species in the genus have a similar toxicity. Accidental ingestion of the seeds is rather unlikely but they may be eaten because of their hallucinogenic properties. There is no evidence that skin contact is harmful.

IRIS L. Iridaceae

(including Yellow Flag and Stinking Iris)

Ingestion: All parts, especially the rhizomes, of wild and cultivated ***Iris*** species are poisonous (Cooper & Johnson, 1984). They are, however, unattractive to eat and *I. **foetidissima*** L. (Stinking Iris), in particular, has an unpleasant odour, hence its name. Ingestion may produce severe irritation to the gastro-intestinal tract resulting in vomiting, diarrhoea and abdominal pain (Spoerke & Smolinske, 1990). Increase in body temperature has been reported in animals and is also likely in man (Cooper & Johnson, 1984).

Skin contact: The sap is irritant and can cause redness, blisters and occasionally dermatitis (Fuller & McClintock, 1986). Handling the seeds of ***I. pseudacorus*** L. (Yellow Flag), however, may result in dermatitis (Lovell, 1993).

> **Toxins:** Many toxic compounds have been identified in the genus ***Iris***; these include myristic acid, found in high concentration in the rhizomes. An irritant glycoside is also present; it is known by various names: irisin, iridin and irisine (Cooper & Johnson, 1984).

Conclusion: All parts of all species of ***Iris***, especially the rhizomes, are toxic on ingestion and may cause poisoning. The potential severity of poisoning, however, is not known since few cases have been reported and little is known about the potency of the toxins present. The handling of ***Iris*** species may cause unpleasant and possibly severe skin reactions.

Juniper

Ingestion: It is the fruit of ***Juniperus*** species which are most likely to be implicated in poisonings. When a sufficient quantity is ingested, gastro-intestinal disturbances are likely to occur due to the presence of essential oils and other compounds present in all members of this genus. Occasionally, irritation of the kidneys and diuresis has been reported. The amounts necessary to produce such effects will vary between species; also, fruits of ***J. sabina*** tend to be more toxic than those of ***J. communis***. In large amounts, the fruits of ***J. sabina*** may be life threatening, with fits and paralysis (NPIS figures). In contrast, the extracted oil of ***J. communis*** is used as a flavouring agent.

Skin contact: Most species of ***Juniperus*** are generally considered to cause only minor irritant effects although contact sensitivity has been reported in gardeners previously sensitised to colophony (a substance present in sticking plaster) (Lovell, 1993). However, the sap of ***J. sabina*** is thought to be potentially dangerous and its historical use as a medical preparation has been known to lead to serious skin injury (NPIS).

> **Toxins:** All parts contain various oils along with other compounds; most notable are terpene essential oils, containing a-pinene, terpineol and juniperine. These are present in ***J. communis*** and are responsible for both the medicinal and flavouring uses to which this species is put; for example, in gin. The presence of podophyllotoxin in ***J. sabina*** accounts for its toxicity, as well as its use internally and externally in the treatment of skin disorders (NPIS).

Conclusion: Within the genus ***Juniperus***, ***J. sabina*** (Savin) presents the greatest hazard since its fruit has the potential to cause serious poisoning and contact with its sap may result in severe skin injury. Cases involving the latter, however, mostly refer to the plant's historical use as a medicine. With regard to other species in the genus, those people previously sensitised to sticking plaster, may suffer contact sensitivity to ***Juniperus*** species as a whole. Ingestion of species other than ***J. sabina*** is unlikely to give rise to clinical effects.

KALMIA L. — Ericaceae

American Laurel

Kalmia latifolia L.

Mountain Laurel, Calico Bush

Ingestion: All parts of the plant are toxic by ingestion but the leathery foliage is unlikely to be eaten by humans. Children, however, have been poisoned in the USA after sucking nectar from the flowers (Hardin & Arena, 1974) and toxic honey has also been produced, but with non-fatal consequences (Fuller & McClintock, 1986). The genus ***Kalmia*** is considered to be the most poisonous genus in the family Ericaceae (Fuller & McClintock, 1986) yet cases of human poisoning are very unusual. Clinical effects common to the family as a whole, may include a burning sensation in the mouth, excessive secretions from the mouth, nose and eyes, vomiting, diarrhoea, slowed heart rate and, in severe cases, coma and death.

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Acetylandromedol (also known as andromedotoxin and grayanotoxin I) is present in all parts (Frohne & Pfänder, 1984). One study concluded that plants cultivated in central Europe had little or no content of active substances (Roth, Daunderer & Kormann, 1984).

Other species: ***Kalmia angustifolia*** L. (Sheep Laurel) is also quite commonly cultivated. It appears to have a similar toxicity.

Conclusion: All parts of ***Kalmia*** species are toxic by ingestion and have the potential to cause serious poisoning. However, the leathery foliage reduces the likelihood of human ingestion and cases are rare. Poisoning has resulted from sucking the nectar from the flowers. There is no evidence that skin contact is a hazard.

LABURNUM Fabr. Leguminosae

Golden Rain, Golden Chain

Laburnum anagyroides Medikus

Laburnum

Ingestion: All parts of ***L. anagyroides*** are toxic, especially the bark and seeds. Most childhood ingestions involve 5-12 years olds who are often attracted to the seeds and pods. Ingestion of whole pods or seeds alone is likely to cause vomiting and possibly drowsiness, headache and a fast heartbeat (Cooper & Johnson, 1984). In rare instances, coma, convulsions and breathing problems have been reported. Few serious cases have been reported in recent years; spontaneous vomiting is likely to be responsible for the rapid discharge of the toxins (Frohne & Pfänder, 1984).

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** The major toxic constituent is the quinolizidine alkaloid cytisine which is present in all parts of the plant particularly the bark and the seeds (Cooper & Johnson, 1984). *N*-Methylcytisine, which is much less toxic, occurs at active growth points (Frohne & Pfänder, 1984).

> **Mechanisms:** Cytisine has nicotine-like effects, stimulating nicotinic receptors (Dale & Laidlaw, 1912, using the name ***Cytinus laburnum*** **L.**).

Other species: It is likely that ingestion of any ***Laburnum*** species may give rise to clinical effects similar to those of ***L. anagyroides***. Since the seeds of the hybrid ***L.* x *watereri* (Kirchn.) Dipp. 'Vossii'** (known as ***L. vossii*** in the trade) do not develop, this plant may present a lower risk of poisoning. However, there is no evidence to suggest that the plant itself has a lower toxicity than other species of ***Laburnum***.

Conclusion: The seeds and pods of ***Laburnum*** species are frequently ingested by older children and there is the potential for serious poisoning. Few recent serious cases have been reported; acute vomiting following ingestion may prevent the toxin entering the system. Skin contact is not believed to be hazardous.

LANTANA L. Verbenaceae

Lantana

Lantana camara L.

Ingestion: The unripe fruits are toxic and are attractive to children. Poisoning by these has been repeatedly described but there have been no cases noted as yet in the statistics of the European toxicological centres. The relative toxicity of unripe and ripe fruits has not been investigated but there is contradictory information in the literature about the toxicity of the ripe fruits: Frohne and Pfänder (1984) report them to be edible, yet Fuller and McClintock (1986) state that the entire plant is poisonous.

Symptoms of poisoning usually develop within a few hours (Cooper & Johnson, 1988), but may be delayed up to 6 hours. The clinical effects of poisoning are vomiting and diarrhoea, muscular weakness, lethargy, cyanosis, visual disturbance, dilated pupils, photophobia, laboured slow respiration and, in severe cases, circulatory collapse and death (Morton, 1982). Acute symptoms resemble those of atropine poisoning (Turner & Szczawinski, 1991).

In Florida, in the early 1960s, four cases involved the serious poisoning of children after ingestion of the berries of *L. camara*. One of the children died of neuro-circulatory collapse after chewing and swallowing the unripe, green berries; another child, swallowed but did not chew the berries and survived. The two other children suffered acute poisoning (Morton, 1982). In 1964, a paper was published in an American journal describing 17 cases of poisoning in children over a 2 year period. The children were all under 6 years old and had eaten an undetermined number of fruits. Three of them had clinical effects and one, who unlike the others, did not vomit, collapsed and died (Frohne & Pfänder, 1984).

Skin contact: Contact with the plant often causes irritant dermatitis and itching (Morton, 1982; Lovell (1992).

Eye contact: There is no evidence that eye contact is harmful, however, the skin irritants may effect the eye.

> **Toxins:** Two pentacyclic triterpenes, lantadene A and lantadene B (Fuller & McClintock, 1986) are present, especially in the leaves. These are responsible for poisoning in animals; studies to compare the effects in humans have not been undertaken but are likely to similar (Everist, 1981).
>
> **Mechanisms:** Experimentally, *Lantana* poisoning causes increases in oxidative enzymes and decreases in enzymes associated with drug metabolism (Fuller & McClintock, 1986). In animals lantadene A and B are broken down in the liver producing phylloerythrin which goes into the blood stream causing poisoning and photo-sensitisation (Morton, 1982).

Other species: Cooper and Johnson (1988) include all species of ***Lantana*** as having ***L. camara*** type properties. ***L. montevidensis*** **(Spreng.) Briq.** ***(L. sellowiana*** **Link & Otto*)*** has been suspected of causing poisonings.

Conclusion: The whole plant of ***Lantana camara*** and possibly that of ***Lantana montevidensis*** is poisonous and potentially fatal. The main risk arises from ingestion of the unripe berries, which are particularly attractive to children. Skin contact may result in dermatitis and itching, however, there are no reports suggesting that this can be serious.

Vetch

Lathyrus odoratus L.

Sweet Pea

Ingestion: Since the seeds resemble edible peas they have been commonly eaten by children (Frohne & Pfänder, 1984). Although all parts of the plant are toxic, particularly the seeds (Cooper & Johnson, 1984), the clinical effects, however, of eating small quantities (just a few seeds) are negligible and the majority of cases reported every year in the UK are asymptomatic. Poisindex (1992) indicates that clinical effects arise only after chronic ingestion (c. 4-8 weeks); symptoms include paralysis, weak heart beat, shallow breathing, muscular tremors and convulsions and in severe cases are potentially fatal (Turner & Szczawinski, 1991). The toxins affect the nervous system and may produce enlarged joints, degeneration of cartilage plates and haemorrhages (Fuller & McClintock, 1986). Such chronic ingestion, however, is not a problem in the UK (see *Other species*).

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** Amino acids called lathyrogens and their derivatives, notably aminopropionitrile, are present. Seedlings also contain isoxazolin-5-one derivatives. Cooking the seeds does not reduce their toxicity (Turner & Szczawinski, 1991). It is not known to what extent the toxicity of the cultivated forms varies.

Other species: The many other species of ***Lathyrus*** may also produce clinical effects after chronic ingestion similar to those of ***L. odoratus*** (Turner & Szczawinski, 1991). One exception is ***L. pratensis*** L., the only common British member of the genus, in which no poisonous substances have been found (Cooper & Johnson, 1984). The seeds of ***L. sativus*** L., the edible chick pea (pre-soaked to remove the toxins) are used both for animal feed and human consumption. Human poisoning by ***L. sativus***, however, is only likely where the species is being eaten continuously over a long period in times of food shortage. Such cases, resulting in a condition called lathyrism, is due to chronic ingestion of the plant and these are reported only from famine-stricken parts of the world (e.g. Bangladesh, China, Ethiopia and India) (Kaul, 1986).

Conclusion: All species of ***Lathyrus***, especially the widely grown ***L. odoratus***, but excluding ***L. pratensis***, contain toxins but fortunately, poisoning from this genus is unlikely to be a problem in the UK since chronic ingestion of the plant material over many weeks is necessary for any clinical effects to appear. Occasional ingestion of even sizeable quantities does not, therefore, constitute a poisoning hazard. No problems have been found arising from contact with the plant.

Privet

Ligustrum vulgare L.

Wild Privet

Ingestion: All aerial parts of the plant are poisonous, especially the berries (Cooper & Johnson, 1988). However, the regular trimming of ***Ligustrum*** hedges usually prevents fruit from developing, reducing the risk of poisoning, although hedge clippings remain a risk to children and livestock. The clinical effects of poisoning are nausea, vomiting and profuse diarrhoea, with colic-like abdominal pain due to intense gastro-intestinal inflammation. Although poisoning is rare in humans it can be fatal in children (Lang, 1987).

Some controversy hangs over the toxicity of the species since a number of cases over the years appear to demonstrate widely variable symptoms. For example, a case in Russia (Kozlov & Gulyaeva, 1983) describes how four children aged between 4 and 6 years ate an unknown quantity of Privet berries from bushes close to their village. 3 hours later all experienced vomiting and generalised weakness; two of the children (aged 4 and 5) became seriously ill. All were given stomach wash-outs but, despite this and within 1 hour of the treatment, the 4 and 5 year olds died, following a period of convulsions and irregular heart beat. The other two recovered. Another case, reported from Germany, describes how a two-year-old boy died within three hours of eating privet berries from a hedge surrounding a playground (the validity of this case however is not supported by the NPIS).

The outcome of these cases contrast significantly with all those encountered by the NPIS which involved only mild symptoms (Lang, 1987), and contrast with recent case data described by Frohne and Pfänder (1984) which indicate that of 65 cases, 55 were asymptomatic and 10 experienced vomiting and diarrhoea (one of these involved a 2-year old who ate two berries).

Skin contact: Bruising the leaves, for example, when pruning (Mitchell & Rook, 1979), or crushing the berries can cause irritant contact dermatitis in humans (Lang, 1987) yet this is unlikely to be serious (Lovell, (1992).

> **Toxins:** While Lang (1987) states that the toxin present is the glycoside ligustrin, other authorities remain uncertain of its presence (Fuller & McClintock, 1986).
>
> **Mechanisms:** The toxin ligustrin has an irritant action on the stomach, intestines and kidneys (Lang, 1987).

Other species: ***Ligustrum ovalifolium*** Hassk. (Garden Privet), ***L. japonicum*** **Thunb.** and ***L. lucidum*** Ait. *f.* have similar poisonous properties to *L.* ***vulgare*** L., although no reports of toxic exposure to *L.* ***lucidum*** have been found (Poisindex, 1992).

Conclusion: ***Ligustrum vulgare*, *L. japonicum*, *L. lucidum*, *L. ovalifolium*** and probably all other species in the genus are poisonous and are potentially fatal on ingestion. However, there is some confusion amongst toxicologists about the validity of the cases that resulted in fatalities. Contact dermatitis is not a significant problem.

Lobelia, Cardinal Flower, Indian Tobacco

Ingestion: All parts, and probably all species in the genus ***Lobelia***, contain toxic substances. However, human poisoning by ingestion of this plant is unlikely since it is unpalatable (Barnes, 1993) and cases are therefore rare. Most incidents of human poisoning resulting from ingestion of this plant have occurred as a result of overdosing on home-made medicinal preparations made from ***L. inflata*** L., ***L. cardinalis*** L., or ***L. fulgens*** **Willd.** (Hardin & Arena, 1974). Clinical effects include nausea, progressive vomiting, weakness, tremors and rapid and irregular heartbeat. In severe cases, convulsions, coma and possibly death from respiratory failure may occur (Turner & Szczawinski, 1979). ***L. tupa*** L. is reported to contain psychoactive properties and is considered a narcotic (Mabberley, 1987).

Skin contact: The sap of the leaves, stems and fruits are said to be irritant and capable of causing dermatitis (Tampion, 1977); however, cases are few. In particular, ***L. excelsa*** **Leschen.**, ***L. inflata*** and ***L. nicotinaefolia*** Heyne contain a white milky juice which can produce irritant dermatitis (Mitchell & Rook, 1979). With respect to ***L. erinus***, the widely grown bedding species, no cases of adverse reaction after handling are known, suggesting that the contact toxin may be absent; the toxicological literature neither denies nor confirms this.

Eye contact: ***L. urens*** L. is reported to cause inflammation if applied to the eyes (Lovell, 1993) and ***L. philippinensis*** **Skotsb.** contains a white milky juice said to be capable of causing blindness (Mitchell & Rook, 1979).

> **Toxins:** ***Lobelia*** species contain an alkaloid or mixture of alkaloids including lobeline and lobelamine (Lovell, 1993; Hardin & Arena, 1974). The presence of these in ***L. erinus*** is not known.
>
> **Mechanisms:** The pharmacologically active alkaloids affect the central nervous system and have emetic and depressant actions (Blackwell, 1990).

Conclusion: All parts of all species of ***Lobelia*** contain toxic substances, however, human poisoning by ingestion is rare due to the unpalatability of the plant. Although the potential for serious poisoning exists, cases are largely confined to the past misuse of the plant for medicinal purposes. Some species, such as ***L. tupa***, are psychoactive. The sap of the leaves, stems and fruits of ***Lobelia*** species (excluding ***L. erinus***) are irritant and capable of causing dermatitis, while the sap of ***L. urens*** and ***L. philippinensis*** has been known to cause damage to the eyes.

LUPINUS L. Leguminosae

(including Russell Lupin)

Lupinus polyphyllus Lindl.

Ingestion: All parts are toxic, especially the seeds which, borne in pea-like pods, are the part of the plant most likely to be eaten by children. Human poisoning is relatively rare despite the frequency of ingestion in the UK (Frohne & Pfänder, 1984). Two or more pods, or their seeds, can cause illness. Clinical effects include nausea and vomiting, abdominal pain, headache and dizziness (Cooper & Johnson, 1988).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** The quinolizidine alkaloids: lupinine, sparteine and anagyrine are present, together with peperidine and other types of alkaloids. These are not destroyed by drying (Frohne & Pfänder, 1984; Poisindex, 1992).

Other species: Several species are recorded as toxic, including ***L. perennis*** L. (Poisindex, 1992). The toxicity is variable but, in view of the difficulty of precise identification it is safest to consider all to be poisonous.

> **Toxins:** As above. Some species known as "Sweet Lupins" and including ***L. luteus*** L., have a low alkaloid content (Frohne & Pfänder, 1984).

Conclusion: All species of ***Lupinus*** are toxic, with the exception of the so-called "Sweet Lupins" which include ***L. luteus***. The pods and seeds constitute a hazard. Ingestion by children is frequent but poisoning is rare because large quantities of seeds would have to be eaten. There is no evidence that skin contact is harmful.

LYCOPERSICON ESCULENTUM Miller — Solanaceae

(synonyms: *L. lycopersicum*, *Solanum lycopersicum*)

Tomato

Ingestion: Although a toxin does exist in the cultivated tomato, it occurs in such a low concentration in the ripe fruit that it does not present a toxic hazard by ingestion. The ripe fruits are edible (Cooper & Johnson, 1984); the unripe fruits are not. The toxin is present in larger concentration in the haulm (stem), leaves and other plant parts; children have become ill after drinking a 'tea' made from the stem and leaves (Fuller & McClintock, 1986). Ingestion of these parts or the unripe fruit may result in the following clinical effects: vomiting, diarrhoea, irritation in the neck, headache, exhaustion and abdominal pains (Frohne & Pfänder). Cases of poisoning are very scarce and tend not to be serious.

Skin contact: Mild skin irritation from tomato leaves is common in gardeners, but allergic dermatitis seems to be rare (Lovell, 1993). Food handlers may develop allergies due to regular contact with the skin of the fruit, or they may experience immediate hypersensitivity (Lovell, 1993).

> **Toxins:** Steroidal alkaloid glycosides (solanines) are present in all plant parts but disappear as the fruit ripens (Frohne & Pfänder, 1984). Tomatine, similar to solanine, is also present with its aglycone, tomatidine (Watt & Breyer-Brandwijk, 1962).
>
> **Mechanisms:** The toxins are poorly absorbed across the gut (Frohne & Pfänder, 1984).

Conclusion: Although the ripe fruits of Tomato (***Lycopersicon esculentum***) are cultivated as a crop, toxins are present in the remainder of the plant and even in the unripe fruit. Ingestion of plant parts other than the ripe fruit may cause mild gastro-intestinal disturbances but these are unlikely to be serious unless very large amounts are ingested. Skin irritation is common in gardeners. Workers handling the skin of the fruit may also develop allergies.

Mirabilis jalapa L.

Marvel of Peru, Four o'clock Plant, False Jalap

Ingestion: The seeds and tuberous roots are known to contain a toxin which can give rise to digestive system disturbances (Cooper & Johnson, 1988) with acute stomach pain, vomiting and diarrhoea (Hardin & Arena, 1974). The seeds are likely to be particularly attractive to children. No case data, however, have been found. The root has been used as a purgative (Watt & Breyer-Brandwijk, 1962).

Skin contact: The root and seeds are reported to be irritant to the skin and mucosa (Mitchell & Rook, 1979) but no case data have been found.

> **Toxins:** The root and seeds contain the alkaloid trigonelline which is said to be non-toxic; it is thought that a resin may be responsible for the reported clinical effects. Calcium oxalate raphides are present in the fruit (Watt & Breyer-Brandwijk, 1962).

Other species: ***Mirabilis*** is a genus comprising some 200 species; ***M. jalapa*** is the only species in general cultivation.

Conclusion: The roots and seeds of ***Mirabilis jalapa*** appear to be toxic and have the ability to cause digestive system disturbances. They are also said to be irritant to the skin. In neither instance, however, are case data available.

NARCISSUS L. Amaryllidaceae

Daffodil, Jonquil

Ingestion: All parts of all plants within the genus ***Narcissus*** contain toxins. The bulbs have often been mistakenly eaten for onions since they are often stored, like onions, under similar domestic conditions. Indeed, bulbs, leaves or stems, have all been mistaken for vegetables, and after eating have lead to nausea, severe vomiting, abdominal pain and diarrhoea. The toxins are not destroyed on cooking. The onset of symptoms is usually short (e.g. 2 hours) but they are not usually prolonged and there are no reports of severe illness or death (Spoerke and Smolinske, 1990). Inconsistent case reports indicate that ingestion of less than one bulb in adults or children may produce marked symptoms, while up to 3 bulbs in adults has caused nothing more serious than gastro-intestinal effects (NPIS figures).

Skin contact: Contact with the bulb or sap from cut stems may cause irritant dermatitis. Irritant effects from handling the bulbs in bulk is an occupational problem (Gude *et al.*, 1988).

Eye contact: Swelling of the eyelids or conjunctivitis may also occur (Spoerke and Smolinske, 1990).

Toxins: ***Narcissus pseudonarcissus*** L. contains at least 15 alkaloids, particularly lycorine. In all ***Narcissus*** species the two alkaloids considered responsible for sensitization are homolycorin and masonine (Gude *et al.*, 1988). Chelidonic acid and calcium oxalate crystals are both thought to be partly responsible for the irritant effects (Spoerke and Smolinske, 1990). Other toxins include the Amaryllidaceae alkaloids such as lycorine, galanthamine and haemanthemine. Of these, lycorine is usually present in the highest concentration (Jaspersen-Schibb, 1970).

Mechanisms: The alkaloids act as emetics (Spoerke and Smolinske, 1990). Chelidonic acid and calcium oxalate both act as irritants.

Conclusion: Any species of ***Narcissus*** may produce gastro-intestinal irritation on ingestion, which can be severe, especially in children. Most plant parts have been mistakenly eaten for vegetables and the bulbs for onions. Skin contact, particularly with the stems, may cause irritant and, more rarely, allergic reactions. Frequent exposure to the plant, such as in an occupational setting, increases the risk of clinical effects.

NERINE Herbert Amaryllidaceae

Guernsey Lily, Nerine

Nerine masonorum **Bolus**

Ingestion: It is likely that the bulb, at least, of ***N. masonorum*** contains a toxin, since toxic alkaloids have been found in the bulbs of many other members of the genus (Watt & Breyer-Brandwijk, 1962). Apart from the brief comment of Cooper & Johnson (1988) of effects "similar to daffodil poisoning", there is no record of poisoning following ingestion having occurred in Europe.

Skin contact: Although this plant contains a toxin found to be weakly sensitising in guinea-pigs (Lovell, 1993) there is no evidence of any contact hazard to humans. Fuller and McClintock (1986), however, include the genus in a list of plants considered to cause contact dermatitis.

> **Toxins:** According to Wiseman (in prep.) quoting Gude *et al.* (1988) the alkaloid masonine is present.

Other species: ***N. bowdenii*** **Watson** is the species most widely available. Its toxicity is likely to be similar to the above. The alkaloids tazettine and nerinine are recorded from ***N. sarniensis*** **(L.) Herbert** (Watt & Breyer-Brandwijk, 1962).

Conclusion: All plant parts of ***Nerine*** species probably contain one or more toxins, but there are no case data referring to human poisoning, either by ingestion or contact.

NERIUM OLEANDER L. Apocynaceae

Oleander

Ingestion: The whole plant is extremely poisonous, especially the seeds (Frohne & Pfänder, 1984). Children find the flowers attractive and have been poisoned by sucking out the nectar. One leaf is reported to be potentially lethal to humans (Turner & Szczawinski, 1991). The toxicity of the plant is unaffected by drying or boiling (Cooper & Johnson, 1988).

The first clinical effects of poisoning occur within a few hours: numbness of the tongue, abdominal pain, nausea, vomiting and diarrhoea (sometimes with blood) and a rapid pulse. Dilation of the pupils and visual disturbances may be observed. More serious cases are identified by the presence a slow, weak, irregular pulse and a fall in blood pressure, possibly resulting in death (Cooper & Johnson, 1988).

The immediate burning sensation in the mouth and the bitter taste act as a deterrent against consumption and the spontaneous vomiting which often occurs prevents the absorption of large amounts of poison. A fatal case occurred when the leaves were used to make a herbal tea in mistake for those of ***Eucalyptus*** (Cooper & Johnson, 1988). The use of Oleander sticks for barbecuing meat abroad has also lead to poisoning since the wood smoke is toxic (Mitchell & Rook, 1979).

Data from a German poison centre show that there have been many enquiries following ingestion of flowers or leaves although seldom are serious symptoms reported. This experience corresponds with an Australian study undertaken over a six year period during which time only one serious case developed (this was in a child already with a severe congenital heart defect) (Frohne & Pfänder, 1984).

Skin contact: The crushed leaves and stems are irritant, but there are few cases of dermatitis reported compared to the frequency of exposures. The allergenic properties of the plant have not been adequately studied (Mitchell & Rook, 1979).

Eye contact: There is no evidence that eye contact is harmful but it is likely that the skin irritants present may give rise to symptoms.

> **Toxins:** Cardiac glycosides of the cardenolide type, especially oleandroside and nerioside, are present (Frohne & Pfänder, 1984; Turner & Szczawinski, 1991).

Conclusion: All parts of ***Nerium oleander*** are highly toxic and potentially lethal. The plant's unpleasant taste, however, together with a burning sensation in the mouth, soon after ingestion, together with spontaneous vomiting, reduces the likelihood of significant quantities being eaten. Contact reactions from the plant are likely to be minor; few cases have been documented.

NICOTIANA TABACUM L. Solanaceae

Tobacco

Ingestion: Although ***Nicotiana tabacum*** is not grown in this country as a commercial crop for smoking, the ornamental varieties of this and closely related ***Nicotiana*** species (*see Other species*) are widely cultivated and contain the toxin nicotine in all their plant parts; this is certainly true of ***N. tabacum*** (Frohne & Pfänder, 1984). Cases of poisoning, however, resulting from direct ingestion, either accidental or intentional, of garden tobacco plants are very rare; cases are much more likely to arise as a result of children eating tobacco from cigarette packets or ashtrays; the lethal dose for an adult is c.40-60 mg (Frohne & Pfänder, 1984). Clinical effects arising after ingestion of fresh plant material are likely to include nausea, vomiting, diarrhoea, dizziness or headache, and trembling. In cases of serious poisoning the following effects may also be experienced: rapid but weak pulse, cold sweating, convulsions and, in severe cases, coma. Death usually results from cardiac arrest and respiratory paralysis (Frohne & Pfänder, 1984).

Skin contact: Clinical effects due to contact with ***N. tabacum*** are reported only to be a problem in those who handle the leaves in an occupational setting, e.g. harvesters and factory workers. In these situations, irritant reactions and, more rarely, allergic contact dermatitis have been recorded (Lovell, 1993).

> **Toxins:** A number of alkaloids are present, but it is the highly toxic alkaloid nicotine that is responsible for the clinical effects reported; nicotine is present in all plant parts. The leaves contain the highest concentrations, up to 9% (Frohne & Pfänder, 1984). The allergen present is not nicotine and has yet to be identified; it occurs in the fresh and cured leaves (Lovell, 1993).
>
> **Mechanisms:** Nicotine can be absorbed through the skin, lungs and mucous membranes, and acts very rapidly (Frohne & Pfänder).

Other species: Ornamental tobacco plants, grown for their attractive and sweetly fragrant flowers, are cultivars of ***N. alata***, ***N. langsdorfii*** and other speices (Lovell, 1993).

Conclusion: It is likely that ***Nicotiana tabacum*** and its other ornamental relatives have the potential to cause serious poisoning if any parts are eaten. However, case data are scarce. While the possibility of irritation or allergic contact dermatitis exists this is only likely in occupational settings.

(including Chincherinchee)

Ornithogalum umbellatum L.

Star-of-Bethlehem

Ingestion: All parts of the plant are poisonous; the toxins occur in greatest concentration in the bulbs (Poisindex, 1992). Children have been poisoned by eating the bulbs and flowers. The clinical effects of poisoning consist of digestive system disturbances with nausea (Cooper & Johnson, 1984).

Skin contact: The sap can cause intense irritation and dermatitis (Spoerke & Smolinske, 1990).

> **Toxins:** ***Digitalis***-like alkaloids (convallatoxin, convallaside, strophanthidin and sarmentogenin) similar to those in ***Convallaria*** are present. The content of cardiac glycosides is much lower than in ***Convallaria***. It is not known whether enough can be absorbed to produce cardiac toxicity (Poisindex, 1992; Spoerke & Smolinske, 1990).

Other species: Poisoning may be severe in ***O. thyrsoides*** **Jacq.** (Chincherinchee) and ***O. saundersiae*** **Bak.**, with vomiting, abdominal pain, diarrhoea and slow heart rate (Lampe & McCann, 1985; Watt & Breyer-Brandwijk, 1962). ***O. longibracteatum*** **Jacq.** (***O. caudatum*** **Ait.**), which is common in cultivation, is said to cause severe dermatitis (Mitchell & Rook, 1979). ***O. thyrsoides*** and ***O. saundersiae*** are said to be less irritant to the skin, although both are considered to be rather toxic by ingestion.

> **Toxins:** As above. Calcium oxalate raphides are present in the sap of some species, notably ***O. longibracteatum*** (***O. caudatum***).

Conclusion: All species appear to be toxic by ingestion and poisoning may result from the ingestion of the bulbs or flowers of ***O. umbellatum***, ***O. thyrsoides*** and ***O. saundersiae***. Several species, including ***O. longibracteatum*** (***O. caudatum***), ***O. thyrsoides*** and ***O. saundersiae*** may cause dermatitis from contact with the sap. Severe eye irritation may also be expected from contact with the sap, although no reports of this have been found. In both respects, there appears to be considerable variation in the degree of toxicity between species.

PAPAVER L. Papaveraceae

Poppy

Papaver somniferum L.

Opium Poppy

Ingestion: ***P. somniferum*** is grown in the UK as an ornamental plant rather than for the production of poppy seed for the baking industry or for the extraction of the dried latex (opium). The latex is the most toxic part of the plant (Fuller & McClintock, 1986) but since high opium-yielding cultivars are not grown in this country the likelihood of poisoning from UK-grown material is very remote. The seeds contain only minute quantities and are considered harmless; in central Europe cultivars are grown widely for their high seed production which are then used for decorating bread (Cooper & Johnson, 1988).

Poisoning from non-UK grown plants may arise through misuse, such as over-dosing on the prepared drug (opium), faulty medical treatment, attempted suicide with the pure alkaloids or opium, or accidentally through ignorance. A fatal case of accidental human poisoning in Germany occurred when tea was prepared by boiling the fruit-heads and then drunk (Frohne & Pfänder, 1984). Addiction to opium or its derivatives morphine, heroin or codeine is not uncommon and illegal trafficking promotes their availability (Turner & Szczawinski, 1991).

Chronic poisoning results in sweating, blistering, eczema, headaches, fever, twitching and excitement, together with vertigo which possibly results from lowered cardiac and respiratory rates. The clinical effects of acute opium poisoning are sleepiness, leading to stupor and coma and subsequent respiratory and cardiac arrest (Fuller & McClintock, 1986). Morphine produces a feeling of well-being, followed by depression; hence its addictive nature. A lethal dose of morphine in adults may be as little as 0.2 g (Frohne & Pfänder, 1984).

Skin contact: Outside the UK, eczema has been reported in those people chronically exposed to opium when used therapeutically (Fuller & McClintock, 1986). An occupational hazard also exists for those regularly handling morphine in factory situations (Mitchell & Rook, 1979).

Eye contact: Ethylmorphine can cause dermatitis of the eyelids (Mitchell & Rook, 1979).

> **Toxins:** The dried latex (opium) contains some 25 alkaloids, including the potentially toxic morphine. Codeine and heroin are toxic and widely recognised as addictive derivatives of opium (Fuller & McClintock, 1986).
>
> **Mechanisms:** Lengthy accounts are available about the mechanisms by which the toxins take effect, however, since poisoning by these in the UK is so unlikely they are not considered relevant for inclusion in this report (Morton, 1977; Chadri, 1966).

Other species: There are more than 100 species and subspecies in the genus ***Papaver***, but Frohne and Pfänder (Frohne & Pfänder, 1984) state that, as a rule, the amount of alkaloid present in the latex of ***Papaver*** species, other than ***P. somniferum***, is small. Poisoning is therefore unlikely.

Conclusion: Although ***Papaver somniferum*** has the potential for producing serious poisoning when eaten (with the exception of the seeds which are harmless) the likelihood of poisoning arising from eating UK-grown plants seems very remote since no case data are available. This is because the UK does not grow high opium-yielding cultivars; neither is the British climate favourable to such production, unless highly selected cultivars are grown. Addiction and death normally arise from illegally trafficked material imported from abroad where cultivars of ***P. somniferum*** are grown for their high opium yields rather than for ornamental or seed production purposes. All species of ***Papaver*** are potentially toxic but no case data have been found. Handling the plant does not appear to be a concern in the UK.

PARTHENOCISSUS QUINQUEFOLIA (L.) Planchon Vitaceae

Virginia Creeper, Wild Grape

Ingestion: The berries and, reputedly, the leaves of ***Parthenocissus quinquefolia*** contain toxins. Ingestion can result in serious clinical effects which include, after 24 hours, gastro-intestinal problems, dilated pupils, headache, sweating, drowiness, cramps, kidney damage and collapse (Westbrooks & Preacher, 1986); cases of poisoning, however, are rare (Cooper & Johnson, 1988). One rather old and poorly documented case (Warren, 1912; Tampion, 1974) suggests that a child died in the USA after eating a large quantity of the berries, and two more children died after swallowing the juice from the chewed leaves of the plant.

Skin contact: Contact with the plant has frequently been reported to give rise to smarting of the skin as well as dermatitis, however, many reports, mostly those from the USA, may relate to ***Rhus radicans*** **L.** (Poison Ivy) with which ***P. quinquefolia*** may have been confused (Mitchell & Rook, 1979).

Eye contact: Although no data are available, the effects of eye contact are likely to be similar to those associated with skin contact.

> **Toxins:** The presence of soluble oxalic acid in parts of the plant is believed to be responsible for the cases of poisonings reported (Frohne & Pfänder, 1984).

Conclusion: The berries and leaves of ***Parthenocissus quinquefolia*** contain toxins which have the potential to cause serious poisoning although large quantities would need to be ingested. Only old cases of poisoning, involving children, are reported in the literature. Contact with the foliage may give rise to smarting and dermatitis, although there exists some doubt about the identity of plants referred to in case material.

Chinese Lantern

Ingestion: Ingestion of the unripe berries may cause vomiting and diarrhoea; the ripe berries are edible (Turner & Szczawinski, 1991), although those grown in the UK for ornamental purposes should not be considered a food source (Frohne & Pfänder, 1984; Spoerke & Smolinske, 1990). Most authorities indicate that only the rhizomes and leaves are toxic (Stary, 1983).

Skin contact: All parts except the fruit contain substances which can be transported via secretory hairs (Frohne & Pfänder, 1984); these may be irritant.

> **Toxins**: The unripe berries contain solanine (Poisindex, 1992). All parts of the plant contain C28 steroids, e.g. physalin A. The rhizomes contain pyrrolidine and secotropane alkaloids (Frohne & Pfänder, 1984).

Conclusion: The ripe berries of ***Physalis alkekengi*** are not toxic but ingestion of other parts of the plant including the unripe berries has the potential to cause unpleasant gastro-intestinal distubances. Skin irritant effects are probably mild.

Poke-weed, Poke-root

Phytolacca americana L.

Ingestion: All parts of the plant are highly poisonous, notably the root and leaves, but particularly the bark (Fuller & McClintock, 1986). Ingestion of the leaves (sometimes recommended as a pot-herb) or berries can cause poisoning. The berries are said to be less toxic when ripe (Poisindex, 1992); up to ten ripe berries are considered harmless for an adult but they could cause serious poisoning in an infant.

Clinical effects involve an immediate burning and bitter taste in the mouth, followed half an hour to 5 hours later, by nausea, vomiting, abdominal cramps, diarrhoea and headache, leading to severe hydration and shock (Fuller & McClintock, 1986). Recovery is usually within 24 hours. According to one report, following consumption of a tea made from the leaves (Poisindex, 1992), additional symptoms included sweating, urinary incontinence, confusion, weakness and brief loss of consciousness. Ingestion of a small portion of the root has produced similar effects (Cooper & Johnson, 1984). Most or all cases are reported from the USA and poisoning by Poke-weed does not feature in European statistics (Frohne & Pfänder, 1984).

Skin contact: The leaves are acrid and the juice from them may cause smarting and inflammation, especially to damaged skin (Mitchell & Rook, 1979).

Eye contact: The sap may cause serious inflammation of the eye-lids (Mitchell & Rook, 1979).

> **Toxins:** All parts of the plant contain a triterpene saponin (phytolaccigenin), glycoproteins, asparagine, phytolaccine, a resin (phytolaccatoxin) and up to 10% oxalic acid (Poisindex, 1992). Unidentified mitogens, that can be absorbed through abrasions in the skin, are also present. These substances increase white blood cell activity and may damage red blood cells (Fuller & McClintock, 1986).

Other species: It is likely that all species of ***Phytolacca*** are similarly toxic. Most data refer to ***P. americana*** L., an uncommon species in the UK. ***P. latbenia*** **(Buch.-Ham.) H.Walter** and ***P. acinosa*** **Roxb.** are rather frequent in cultivation and are often misidentified as ***P. americana*** (re. the illustration in Frohne & Pfänder, 1984). The leaves of ***P. esculenta*** **Van Houtte** are said to be edible (Bailey, 1976).

Conclusion: The potential for serious poisoning is possible following ingestion of the leaves or the raw blackberry-like berries. The ripe berries are somewhat less toxic than the unripe ones. The acrid taste of the raw leaves is likely to discourage ingestion but may not prevent it. Contact with the sap may cause irritation, especially to damaged skin and to the eyes.

Pieris

Pieris japonica (Thunb.) D.Don

Japanese Pieris, Lily-of-the-Valley Bush

Ingestion: All parts of the plant contain a toxin which, on ingestion, may produce cardiovascular disturbances (Fuller & McClintock, 1986); however, no reports of human poisoning have been documented and the harsh texture of the evergreen foliage makes human ingestion unlikely. In contrast, severe animal poisoning has been recorded, with clinical effects similar to those of ***Rhododendron*** (Frohne & Pfänder, 1984). Vomiting, cramps and death from respiratory failure are recorded in livestock (Roth, Daunderer & Kormann, 1984).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Acetylandromedol is present in all parts (Frohne & Pfänder, 1984). The names andromedotoxin, asebotoxin and grayanotoxin I are all used for acetylandromedol (Frohne & Pfänder, 1984 and Yahagi,1982).

Other species: ***P. formosa*** **(Wall.) D. Don** and ***P. floribunda*** **(Pursh) Benth. & Hook.** are also commonly cultivated. It is probable that their toxicity is similar to that of ***P. japonica***.

Conclusion: Little information is available regarding the toxicity of the genus ***Pieris*** and human case reports are scarce. In livestock, poisoning can be serious. There is no evidence that skin contact is harmful.

Plumbago, Leadwort

Plumbago auriculata Lam.

(synonym: *P. capensis* Thunb.)

Cape Plumbago, Cape Leadwort

Ingestion: Toxins are present in, at least, the roots, leaves and stem of the plant. While it is likely that ingestion may result in severe gastro-enteritis, no cases have been reported (Spoerke & Smolinske, 1990). Animal tests have shown that the toxic element stimulates the central nervous system, large doses of which can result in convulsions followed by paralysis (Watt & Breyer-Brandwijk, 1962).

Skin contact: Contact with the leaves, stem and especially the root of the plant has lead to blistering of the skin in sensitive individuals (Mitchell & Rook, 1979). Old case data from Africa, where the plant originates, describe how the clinical effects arising from contact with the plant have been used in many varied ways, often for cosmetic purposes. One report describes how a woman rubbed the powdered bark of this species all over her body resulting in her death; the outcome was thought to be due to the irritant principle present (Watt & Breyer-Brandwijk, 1962). However, no case data arising from contact with this plant have been recorded in the UK and only occasionally in the USA (Spoerke & Smolinske, 1990). According to Hardin and Arena (1974) all parts of the plant have the potential to cause dermatitis.

> **Toxins:** A quinone, plumbagin, mainly concentrated in the roots is believed to be the irritant toxin involved. Another toxin, oil of plumbago, is also present (Watt & Breyer-Brandwijk, 1962)
>
> **Mechanisms:** The toxins are central nervous system stimulants and gastro-intestinal irritants.

Other species: All species of ***Plumbago*** are believed to contain irritant toxins, especially the roots. In the past, very serious clinical effects have been reported (Watt & Breyer-Brandwijk, 1962; Spoerke & Smolinske, 1990); cases in the UK, however, are rare.

Conclusion: All parts of all species of ***Plumbago*** are likely to contain irritant toxins, especially the roots. Although the potential for serious poisoning by ingestion or contact exists, case data from the UK and the USA are very sparse. Most cases refer to incidents in Africa, where, in the past, contact with parts of the plant have been made intentionally for a variety of medicinal and cosmetic reasons.

POLYGONATUM Mill. Convallariaceae

Solomon's Seal

Polygonatum multiflorum (L.) All.

Ingestion: All parts of the plant appear to be poisonous (Lang, 1987). The toxicity of the attractive black fruits may be due to the high content of saponins in the seeds. The fruits are reported to have an unpleasant sweetish taste and have caused poisoning in children (Cooper & Johnson, 1988). Although no case details are available, Lang (1987) indicates that the following clinical effects are possible: nausea, vomiting and diarrhoea, with blurring of vision, excitement and, if very large quantities are consumed, problems with cardiac conduction.

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** Saponins are present (Frohne & Pfänder, 1984); other active chemicals identified are asparagin and diosgenin (Lang, 1987).
>
> **Mechanisms:** Gastric irritation and cardiotoxicity (Lang, 1987).

Other species: It is reasonable to assume that all species of ***Polygonatum*** have a similar toxicity. The above information about toxins also applies to the fruit of ***P. odoratum* (Mill.) Druce** (Cooper & Johnson, 1988), but this plant's main toxin, in addition to the above, is convallamarin which has a digitalis-like action on the heart (Lang, 1987).

Conclusion: All parts of all species of ***Polygonatum*** are believed to be poisonous and the fruits, at least, may have the potential to produce serious clinical effects on ingestion. The unpleasant taste of the poisonous fruits, however, may reduce the likelihood of poisoning. Few case data are available. There is no evidence that contact is harmful.

PRIMULA L. Primulaceae

(*excluding* ***Primula obconica***; see separate entry)

Primrose, Primula

Ingestion: The toxicological literature is very sparse regarding poisoning following ingestion of ***Primula*** species. The only reference found is that by Cooper and Johnson (1988) which states that digestive system disturbances can occur. No case data are available.

Skin contact: Irritant and contact dermatitis reactions have been reported from those handling species of ***Primula***, especially in an occupational setting. However, Lovell (1993) quoting Hausen (1978), states that "Although many hardy species contain primin, it is unlikely that the degree of exposure is adequate to cause sensitisation.". ***P. farinosa*** L. may give a reaction, but this has not been confirmed. Growers of ***P. auricula*** L. (Auricula, Bear's Ears) who may experience an irritant reaction, develop a tolerance to the allergens after regular exposure. However, some growers of ***P. auricula*** may suffer recurrent symptoms after a break from handling of only a few days (Lovell, 1993).

For those species less frequently grown, reports of contact reactions are rare; examples include ***P. malacoides* Franchet** and ***P. sinensis* Sabine ex Lindley** (Lovell, 1993).

> **Toxins:** The major allergen in ***P. obconica*** is a quinone called primin; it is also found in other hardy species of ***Primula*** (Hausen, 1978, cited by Lovell, 1993). In one test, 12 species of ***Primula*** out of 82 other members of the Primulaceae family were found to contain primin (Hausen, 1978, cited by Mitchell & Rook, 1979). In all the remaining species screened, other quinoid compounds were detected; for example, the contact sensitiser primetin has been found in ***P. mistassinica*** (Hausen *et al.*, 1983, cited by Lovell, 1993). Primetin is found in the greatest concentration in the small glandular hairs which cover the leaves and stems (Lovell, 1993).

Conclusion: The toxicity by ingestion of species of ***Primula*** (excluding ***P. obconica***) remains poorly documented; the scarcity of data suggests that poisoning, if it were to arise, is unlikely to be serious. Contact with the plants (excluding ***P. obconica***) in occupational settings is likely to give rise, in some individuals and only with some species, to irritant and allergic reactions. Outside an occupational setting, the likelihood of contact reactions developing is low but sensitivity varies between individual people.

PRIMULA OBCONICA Hance Primulaceae

Poison Primula, German Primula

Ingestion: There has been no record of toxic ingestion from this plant according to Poisindex (1992), yet Cooper and Johnson (1988) state that ingestion may lead to mild digestive-system disturbances. In addition, a sensitised individual chewing a leaf may experience intense swelling of the oral and pharyngeal membranes, possibly followed by digestive-system disturbances (Spoerke & Smolinske, 1990).

Skin contact: ***Primula obconica*** is a very popular and long-established house-plant grown for its attractive flowers but it is well-known as an irritant plant since it can cause severe contact dermatitis (Cooper & Johnson, 1988). In particular, the removal by hand of dead flower-heads may result in contact between the skin and the plant's resinous secretion, containing the allergen(s) (Frohne & Pfänder, 1984). This secretion can easily be carried on the fingers to other parts of the body thereby enlarging the area of exposure. All parts of the plant are allergenic, but the allergen(s) is found principally in and on the surface of microscopic glandular hairs whose highest concentration is found on the calyx and bracts surrounding the flower head (Lovell, 1993). Lovell reports that the allergen(s) are absent from the coarser long hairs that impart roughness to the leaves.

There is a significant occupational hazard, especially amongst florists who may handle the plant on a regular basis. An extensive literature exists about primula dermatitis since its effects are so widespread. Spoerke and Smolinske (1990) report that in the USA "there has been increased reluctance among florists to stock ***P. obconica*** because of the [resulting] dermatitis, but this species is still commonly sold as seed." Innumerable case reports have been documented such as those in De Corres *et al.* (1987) and Nakamura (1983); at one time, cases were so numerous that continued sales of the plant looked unlikely (Rook and Wilson, 1965). Rook (1961) reported that the species was the commonest cause of plant dermatitis in Britain and, according to Lovell (1993), this is still true today.

The primary symptom is dermatitis most often occurring on the face and hands, however, like all allergic reactions, the severity varies between people. Clinical effects range from itching and burning sensations in the fingers which may become swollen and slightly inflamed to, in severe cases, intense inflammation, swelling and painful eruptions. Secondary symptoms may develop in acute cases and these include anorexia, nervous irritation and insomnia (Spoerke & Smolinske, 1990). In sensitised individuals, some reports indicate that symptoms may develop after entering a room containing the plant but without any direct contact with the plant (Lovell, 1993).

Chronic cases, due to multiple exposures over short intervals, may cause thickening and folding of the facial skin which becomes yellow-red in colour and covered with thin but tight scales, especially around the eyes (Spoerke & Smolinske, 1990).

Eye contact: Few case data are available although eye irritation such as conjunctivitis and iritis have been reported (Spoerke & Smolinske, 1990).

Toxins: Much of the literature refers to the presence of primin, a benzoquinone derivative, as the sole contact allergen responsible for dermatitis reactions. Lovell (1993), however, suggests that one or more other allergens may also be present.

Plants of ***P. obconica*** vary in their allergenicity according to season and local conditions. In summer, for example, ***P. obconica*** is at its most allergenic, while in winter its allergenicity is almost non-existent. Overwatering can quickly reduce allergenicity whereas a healthy plant growing on a sunny window-sill with high nitrogen levels is more likely to be acutely allergenic (Lovell, 1993).

Other cultivars/varieties: Many cultivars and varieties of ***P. obconica*** are available and some are known to be more allergenic than others (Lovell, 1993), however, little recent and detailed information is available. One UK retail outlet sells a cultivar called 'Freedom Mix' which, it is claimed, is primin-free (Jones, 1994); no further details are available.

Conclusion: All parts of ***Primula obconica*** (except the cultivar 'Freedom Mix') contain at least one allergen widely documented as giving rise to mild or often severe dermatitis. The serious occupational problems associated with handling this plant are well known and some florists have discontinued its sale for this reason. Although not all individuals are sensitive to the allergen(s), all parts of the plant should be regarded as potentially dermatitis-causing. Variation between the allergenicity of different cultivars of ***P. obconica*** (other than 'Freedom Mix' which is primin-free) seems likely but clear evidence of this is not yet available. The allergenicity of the plant is seasonal and also varies with local growing conditions.

PRUNUS LAUROCERASUS L. — Rosaceae

(synonym: *Laurocerasus officinale* Roemer)

Cherry Laurel, Laurel

Ingestion: All parts of the plant, particularly the seed and leaves, contain toxins. Since the ripe fruits are very attractive to children, they are commonly ingested (NPIS). Although the flesh of the fruit is relatively harmless, serious poisoning can result if the seeds are chewed and swallowed (Cooper & Johnson, 1988). Fruits have been eaten in mistake for those of the Edible Cherry (***Prunus avium*** L.). Poisoning has also resulted from the use of the leaves to flavour food (Cooper & Johnson, 1984) in mistake for those of Sweet Bay (***Laurus nobilis*** L.).

Following ingestion of the leaves or chewing of the seeds, symptoms may include vomiting, headache, shivering, fits and respiratory paralysis (Stary, 1983). However, there have been no recent reports of serious toxicity. The fatal dose is not known.

Skin and eye contact: There is little evidence that skin contact is harmful; although a recent unpublished account (Atkins, 1993) describes how contact with the sap of the leaves can cause severe irritation to the skin and eyes.

> **Toxins:** Cyanogenic glycosides (prunasin and amygdalin) are present in all parts of the plant. The pulp of the fruit contains a low concentration of cyanogenic glycosides but the seeds have a high concentration of amygdalin. Prunasin has been estimated to occur at a concentration of 1-1.5% in the leaves (Frohne & Pfänder, 1984).
>
> **Mechanisms:** Cyanogenic glycosides yield hydrocyanic acid when hydrolysed by the appropriate enzymes in crushed plant material or, in some circumstances, in the digestive system. Hydrocyanic acid inactivates cellular respiration causing oxygen starvation and death (Cooper & Johnson, 1984).

Conclusion: All parts of ***Prunus laurocerasus***, particularly the seeds and leaves, contain toxins. Since the fruits of the plant are attractive to children and easily confused with those of the edible cherry (***Prunus avium***) they are commonly ingested. The seed contains a high concentration of toxins and, although unlikely, if it is chewed and ingested with the fruit, there is a possibility of poisoning, which may be severe. The leaves have been mistaken for those of the Sweet Bay (***Laurus nobilis***) and, if used in cooking, there is a risk of poisoning. Problems associated with skin or eye contact are poorly documented but the potential for irritation appears to exist.

Pasque Flower

Pulsatilla vulgaris Miller

(synonym: *Anemone pulsatilla* L.)

Ingestion: All parts of the plant are toxic but poisoning by ingestion is rare and is limited almost entirely to animals. Clinical effects to be expected are gastro-intestinal irritation with colic and diarrhoea (Frohne & Pfänder, 1984).

Skin contact: The sap is irritant to the skin, which may become inflamed and blistered. However, most recorded incidents have arisen as a result of the use of the crushed leaves as a poultice and not from normal handling (Mitchell & Rook, 1979).

> **Toxins:** The glycoside ranunculin is present throughout the plant. It is readily hydrolysed to the skin-irritant protoanemonin. The latter becomes inactive on drying as it is then converted to anemonin (Cooper & Johnson, 1984).

Other species: ***P. patens* (L.) Miller** and ***P. pratensis* (L.) Miller** have similar properties to ***P. vulgaris***. The use of ***P. patens*** as a poultice has resulted in bullous dermatitis and hyperpigmentation. The vapour from the crushed leaves can cause irritation of the conjunctiva and the nasal mucosa (Mitchell & Rook, 1979).

Conclusion: All parts of all species of ***Pulsatilla*** are poisonous but human poisoning by ingestion is most uncommon and the clinical effects are likely to be mild. Skin irritation from the normal handling of cultivated species is rarely reported.

Buttercup

Ranunculus acris L.

Meadow Buttercup

Ingestion: All parts of the plant are toxic but poisoning by ingestion is rare and is limited almost entirely to animals. Clinical effects to be expected are gastro-intestinal irritation with colic and diarrhoea. In severe cases of animal poisoning, nephritis and paralysis have been reported (Frohne & Pfänder, 1984).

Skin contact: The sap is irritant to the skin, which may become inflamed and blistered (Mitchell & Rook, 1979).

> **Toxins:** The glycoside ranunculin is present throughout the plant. It is readily hydrolysed to the skin-irritant protoanemonin. The latter becomes inactive on drying as it is then converted to anemonin (Cooper & Johnson, 1988; Frohne & Pfänder, 1984).

Other species: All accounts seen refer to various weed species, including ***R. repens*** and ***R. sceleratus*** L. (Frohne & Pfänder, 1984). Hand weeding of ***R. repens*** L. may cause inflammation of the hands (Mitchell & Rook, 1979). The species most commonly cultivated is ***R. asiaticus*** L., to which no adverse effects have been attributed.

Conclusion: All parts of all species of ***Ranunculus*** are believed to be poisonous on ingestion but cases are unlikely to be serious. Contact with the sap of the plant has been known to give rise to skin irritation.

RHAMNUS L. Rhamnaceae

Buckthorn

Taxonomic note: This account includes the closely related ***Frangula alnus*** L. *(Alder Buckthorn) which is widely sold as* ***Rhamnus frangula****. The latter is an earlier name for the species and one that has now become a synonym of* ***F. alnus****.*

Ingestion: The berries, bark and twigs of all species of ***Rhamnus*** contain toxins. In the past, cases of serious poisoning have arisen when the bark of the plant (especially ***R. cathartica*** L.) was used medicinally as a laxative or abortifacient; adult and childhood cases of over-dosing have occurred and have resulted in fatalities. Today, poisoning due to ***Rhamnus*** tends to be of a less serious nature and normally involves young children who are tempted by the juicy berries or chew the twigs. Two children in Germany, aged 20 months and 3 years, died after eating some berries, but reports from toxicological centres in Germany over a long period indicate that poisonings have been relatively minor (Frohne & Pfänder, 1984).

Clinical effects are usually mild and limited to transient abdominal pain with vomiting and diarrhoea; only if a large quantity is eaten are symptoms likely to be more serious: violent gastro-intestinal effects with haemorrhage, accompanied by fluid depletion, kidney damage, muscular convulsions, difficult breathing and collapse (Cooper & Johnson, 1984).

The dried bark of ***R. purshiana*** has been used to prepare purgative drugs, such as the laxative Cascara Sagrada (Mabberley, 1993).

Skin contact: ***R. cathartica, R. californica*** and ***Frangula alnus*** are reported to cause a strong irritant reaction on the skin and mucous membranes. It is likely that all other species in the genus ***Rhamnus*** produce a similar reaction. In addition, ***R. purshiana*** yields emodin which can cause allergic dermatitis (Mitchell and Rook, 1979).

> **Toxins:** The toxins responsible are glycosides which, on hydrolysis, produce purgative anthraquinones (Cooper & Johnson, 1984).

Conclusion: The bark, twigs and berries of all species of ***Rhamnus*** contain toxins which, in sufficiently large quantities, have the potential to cause serious poisoning. Such cases, however, are rare and have usually arisen as a result of the plant (particularly ***R. catharticus***) being used in the past for medicinal purposes as a purgative. Children are most at risk because of the tempting juicy berries. On contact, the sap and probably the berries have a strong irritant effect on the skin.

RHEUM x HYBRIDUM Murray — Polygonaceae

Rhubarb

Taxonomic note: This is a hybrid between ***Rheum rhaponticum*** *L. and* ***R. palmatum*** *L.* (R. x ***cultorum*** **Thorsrud & Reis, nom. nud.**, R. x ***rhabarbarum auct., non*** L., R. x ***rhaponticum auct., non*** L.).

Ingestion: The cooked red leaf stalks of this plant, the commonly cultivated Rhubarb, are highly edible. All other parts, however, are poisonous and it is unwise to eat any part of the plant raw (Cooper & Johnson, 1988). Clinical effects of poisoning have been reported within an hour of eating the leaves. They include severe abdominal pains, nausea, vomiting, weakness, difficult breathing, burning of the mouth and throat, drowsiness, muscular twitching and, in severe cases, convulsions, coma and death. Should the patient recover, then liver and kidney damage still remains a possibilty (Turner & Szczawinski, 1991). Eating any other part of rhubarb raw can cause digestive system disturbances.

Many cases of poisoning have arisen from eating the raw and cooked leaves. In the First World War this practice was recommended in Britain when food was scarce, and some fatalities resulted (Cooper & Johnson, 1988).

Skin contact: Contact with the leaves has occasionally given rise to dermatitis (Mitchell & Rook, 1979).

Eye contact: There is no evidence that eye contact is harmful, however, it may cause unpleasant effects.

> **Toxins:** Oxalates of calcium or potassium, and oxalic acid are present in all parts of the plant, particularly the leaves (Turner & Szczawinski, 1991). Anthraquinone glycosides are suspected to be responsible for the highly poisonous nature of the leaves.
>
> **Mechanisms:** Oxalates combine with calcium in the blood, resulting in a reduction in the calcium content and the formation of calcium oxalate crystals in parts of the body (Cooper & Johnson, 1988). The irritant nature of oxalates and oxalic acid (Turner & Szczawinski, 1991) may be responsible for the dermatitic effect (Mitchell & Rook, 1979). On hydrolysis anthraquinone glycosides break down to form anthraquinone aglycones that are cathartics and act on the large intestine (Fuller & McClintock, 1986).

Conclusion: With the exception of the cooked leaf stalks, all parts of ***Rheum* x *hybridum***, particularly the leaves, are poisonous. Although recent poisonings are scarce, poisoning in the past frequently occurred due to the belief that the leaves were edible. It is probable that other species in the genus have a similar toxicity. Problems associated with handling this plant are considered to be negligible.

RHODODENDRON L. Ericaceae

(including Azalea)

Rhododendron

Rhododendron ponticum L.

Rhododendron

Ingestion: The whole plant is toxic, including the nectar. The likelihood of poisoning by ingestion of the foliage is very remote, however, cases have been recorded in children. Licking the nectar of the flowers has also given rise to poisoning in both adults and children. Clinical effects reported are tingling in the fingers and toes, numbness, loss of co-ordination and inability to stand, nausea, vomiting and low blood pressure. Recovery is normally complete recovery within a few hours (Cooper & Johnson, 1988). More serious poisoning may produce a slow heart rate and abnormal heart rhythms (Spoerke & Smolinske, 1990).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** The toxicity is attributed to diterpenes known as grayanotoxins which are present in all parts of the plant, including the nectar.

Other species: All species of ***Rhododendrons*** are considered to be toxic by ingestion. Some species of ***Azalea*** and ***Rhododendron*** have been known to give rise to rashes, especially those individuals who regularly propagate the plants for the nursery trade (Spoerke & Smolinske, 1990). Cases of contact dermatitis due to handling the foliage are uncommon (Mitchell & Rook, 1979).

> **Toxins:** The toxin content varies in different species and cultivars; few have been evaluated in detail (Mitchell & Rook, 1979).

Conclusion: All parts of ***Rhododendron*** species are moderately toxic on ingestion, however, few human cases have been reported. The foliage is unpalatable and is unlikely to be eaten. Contact dermatitis is a possible occupational hazard for workers in the nursery trade.

RHUS L. Anacardiaceae

Sumac

Rhus typhina L.

Stag's Horn Sumac

Ingestion: The raw fruits and leaves can cause mild digestive-system disturbances, however, the fruits are edible when placed in water for a short time and are used to prepare a drink known as "Indian lemonade" (Frohne & Pfänder, 1984). Few case data are available.

Skin contact: The leaves are said to contain an irritating sap, however, patch tests do not confirm this except where there may be previous sensitisation by other ***Rhus*** species. Only one case of dermatitis is reported (Mitchell & Rook, 1979). It is possible that the species is not biochemically homogeneous implying that some varieties, or cultivars cause dermatitis while others do not (Mitchell & Rook, 1979). Frohne and Pfänder (1984) state that the highly irritant compounds present in ***Rhus vernix*** L. are absent from the latex of ***Rhus typhina***.

> **Toxins:** The plant contains a high content of tannin and plant acids (Frohne & Pfänder, 1984).

Other species: ***Rhus glabra*** **L.**, closely related to ***Rhus typhina*** (Bean, 1970-80), has a similarly low toxicity with only one report of dermatitis (Mitchell & Rook, 1979). However, several species of ***Rhus***, including the following, contain highly irritant phenolic compounds:

Rhus radicans L. [Poison Ivy] (*Toxicodendron radicans* (L.) Kuntze);

Rhus toxicodendron L., [Poison Oak] (*Rhus toxicarium* Salisb., *R. quercifolia* (Michx.) Steudel, *Toxicodendron quercifolium* (Michx.) Greene, *T. toxicarium* (Salisb.) Gillis);

Rhus verniciflua **Stokes** [Japanese Lacquer-Tree] (*R. vernicifera* DC., *Toxicodendron vernicifluum* (Stokes) F.A. Barkley);

Rhus vernix L. [Poison Sumac] (*R. venenata* DC., *Toxicodendron vernix* Kuntze).

The above taxonomic classification follows Brummitt (1992) and Gillis (1971).

Ingestion: Eating fruits of these species causes gastro-intestinal irritation and has been known to be fatal (Westbrooks & Preacher, 1986).

> **Toxins:** All parts of these plants contain the toxic and highly allergenic phenolic resin urushiol (Benezra *et al.*, 1985).

Skin contact: These species produce allergic contact dermatitis with itching, redness and blisters; swelling, headache and fever, may occur and prolonged contact may lead to hospitalisation (Westbrooks & Preacher, 1986). So potent are the contact toxins that symptoms are likely to arise from contact with the pollen, smoke from burning plants and even clothing or tools that have been in contact with the plant (Turner & Szczawinski, 1991). Allergic reactions to these species requires urgent dermatological referral (Lovell, 1992).

Conclusion: ***Rhus typhina*** and ***Rhus glabra*** are considered to have a low toxicity on ingestion or contact. However, the other species of ***Rhus***, detailed in this review, have the potential for serious poisoning both on ingestion and contact. Rarely are these species available commercially available in the UK; their trade should be discouraged.

RICINUS COMMUNIS L. — Euphorbiaceae

Castor-oil Plant

Ingestion: All parts of the plant are toxic; the seeds, in particular, are highly dangerous to adults and children alike. The seeds ("castor oil beans") are attractive in appearance and apparently have a nut-like flavour. Cases of ingestion by both adults and children are not infrequent and are likely to have serious or fatal results. A single seed may prove fatal but conversely there has been full recovery after eating several seeds. The release of the toxin depends on how thoroughly the seeds are chewed; also their toxin content may vary (Cooper & Johnson, 1988). A single seed may contain 0.25 mg ricin; in its pure form, the lethal dose for an adult. The clinical effects of poisoning appear after a latent period of 2 -24 hours or more and include vomiting, abdominal pain, diarrhoea with blood (sometimes lasting several days and causing severe dehydration), circulatory collapse and sometimes death (Frohne & Pfänder, 1984). Although the plant does not usually set seed in this country, seed is widely sold in garden centres.

Skin contact: Dermatitis may occur following contact with the foliage, the seeds (particularly when threaded into necklaces) or the oil (when used in cosmetics). The residue left after extraction of the oil ("pomace") is reported to be a contact allergen; the active substance has not been identified. One allergic reaction resulted simply from biting into a bean (Mitchell & Rook, 1979); a similar reaction was recently reported to NPIS (1993).

Eye contact: The dust from the residue left after oil extraction is reported to cause conjunctivitis (Mitchell & Rook, 1979).

> **Toxins:** The highly toxic protein (lectin) ricin and low-molecular weight glycoproteins with allergenic activity are present in all parts, but in highest concentration in the seeds (Frohne & Pfänder, 1984). The allergen may be ricinoleic acid (Lovell, 1993a).

Conclusion: All parts of ***Ricinus communis*** are highly toxic and there is the potential for serious poisoning and fatality on ingestion. The majority of poisoning cases have arisen following ingestion of the attractive seeds. Although the plant does not normally set seed in this country, seeds are widely sold in garden retail outlets. Both the seeds and the foliage may cause dermatitis after repeated handling; seeds are also reported to have caused allergic reactions.

ROBINIA L. — Leguminosae

Acacia

Robinia pseudoacacia L.

False Acacia

Ingestion: All parts except the flowers are toxic, with highest concentrations of the toxins occurring in the bark and seeds (Poisindex, 1992). Children are likely to be attracted to the seeds of this tree which, when ripe, are scattered freely from the pods. The clinical effects of ingestion are lassitude, dilated pupils, nausea, vomiting and diarrhoea with a risk of dehydration from fluid loss (Lampe & McCann, 1985). In severe cases there may be reduced heart action and stupor but no fatalities in humans have been recorded (Turner & Szczawinski, 1991).

Skin contact: There is no firm evidence that skin contact is harmful other than by mechanical injury from the thorns (Mitchell & Rook, 1979).

> **Toxins:** The toxic action results from the lectin, robinin (robin), which has haemagglutinating and mitogenic properties; also present are the toxalbumins phasin and robitin. The toxicity of robinin by oral administration is said to be lower than that of either ricin or phasin (Frohne & Pfänder, 1984; Poisindex, 1992).

Other species: Other species are occasionally cultivated but all reported cases of poisoning refer to ***R. pseudoacacia***.

Conclusion: All parts of ***Robinia pseudoacacia***, with the exception of the flowers, are toxic; the bark and seeds contain the highest concentration of the toxins. Although cases of poisoning may be potentially serious, very few cases have been documented. Poisoning by other species of ***Robinia*** have not been recorded and their toxicity is not known. There is no evidence that skin contact is harmful.

RUSCUS ACULEATUS L. — Ruscaceae

Butcher's Broom

Ingestion: Although the large and bright red berries of this species are likely to be attractive to children, ingestion of the berries may result in mild digestive-system disturbances (Cooper & Johnson, 1988). No quantitative information nor case data of poisonings have been identified. The young shoots have been prepared and eaten like asparagus (Yeo, 1968).

Skin contact: There is no evidence that skin contact is harmful.

Toxins: Clinical effects may result from the presence of a substance called ruscogenin, a saponin (Watt & Breyer-Brandwijk, 1962).

Other species: ***R. hypoglossum*** L. is also cultivated (Philip, 1992-93) but no toxicity data are available.

Conclusion: Toxicological information about ***Ruscus aculeatus*** is extremely scarce since no case data are available. No contact problems are known.

Rue

Ruta graveolens L.

Rue, Common Rue, Garden Rue

Ingestion: *R. graveolens* contains rue oil which is toxic and, when taken internally, causes severe stomach pain, vomiting, exhaustion, confusion and convulsion; large doses have been known to be fatal. Case data concerning ingestion of any part of ***Ruta*** are very scarce.

Skin contact: There is a high probability that contact with any part of the plant coupled with and exposure to bright sunlight will lead to photo-dermatitis (Westbrooks & Preacher, 1986). Such contact causes the skin to become photo-sensitive and serious clinical reactions are not uncommon. Within 1-2 days, clinical effects to be expected are painful red weal-like streaks on the body, followed by blisters and eventually dark brown, hyper-pigmentation of the skin. The latter may last for several months or even years (Lovell, 1993). Some reactions in recent years, especially in children, are so severe as to require hospital admission. Allergic reactions are very rare (Lovell, 1993).

Eye contact: There are no available data but in view of the potential severity of skin reactions, eye contact is likely to be harmful too.

> **Toxins:** In addition to psoralens, α-pinene, limonene and eucalyptol are present (Lovell, 1993).
>
> **Mechanisms:** The skin reaction is a photo-toxic one rendering the skin hyper-sensitive to UVA light. The furocoumarins form adducts with DNA in the skin, thereby giving rise to a photo-toxic reaction in the presence of UVA light (Lovell, 1993).

Other species: ***Ruta chalepensis*** L. and ***R. corsica*** DC. contain the same toxins as ***R. graveolens*** (Lovell, 1993) so would be likely to result in similar reactions after skin contact in sunny conditions.

Conclusion: When handled in bright sunlight, all parts of all species of ***Ruta*** have the potential to cause severe skin contact problems with long-lasting, sometimes permanent, effects. The toxicity of the oil found in the plant suggests there is the potential for serious poisoning on ingestion; it is likely, however, that serious clinical effects would only result after a large ingestion.

Elder

Sambucus nigra L.

Elder, Elderberry

Ingestion: Although the berries are well-known as being harmless when cooked or processed, the raw fruits and other raw plant parts are considered poisonous. The roots and stem have been known to cause poisoning (Cooper & Johnson, 1984) and the raw berries, even in small quantities, have lead to serious vomiting in children (Frohne & Pfänder, 1984). Clinical effects usually involve mild gastro-intestinal irritation with nausea, vomiting and diarrhoea. In animals, more serious poisoning has been documented (Lang, 1987).

Skin contact: The leaves and bark are reported to be irritant (Mitchell & Rook, 1979) but there are no case data relating to normal handling of the plant.

> **Toxins:** Various toxic substances are present, including terpene volatile oils, the glycosides rutin, sambunigrin and quercitrin, together with iridoids, anthocyanins and tannins. In addition, the fruits and seeds contain cyanogenic glycosides. The toxic activity of the berries is diminished or destroyed by heat (Frohne & Pfänder, 1984; Lang, 1987).

Other species: Most toxicological data refer to ***S. nigra*** L., but similar clinical effects are reported from ***S. racemosa*** L., ***S. canadensis*** L. and ***S. ebulus*** L. (Frohne & Pfänder, 1984) whose toxic principles, therefore, are likely to be similar.

Conclusion: All parts of all species of ***Sambucus*** are somewhat poisonous. Human poisoning in adults has occurred after the consumption of raw berries of ***S. nigra***. In children, the ingestion of even a small number of berries may cause unpleasant digestive system disturbances. The leaves and bark are reported to be irritant to the skin, but no case data have been reported from normal handling.

SCHEFFLERA Forster & Forster *f.* — Araliaceae

Umbrella Tree, Star Leaf

Ingestion: Species of ***Schefflera*** are considered to have a low oral toxicity (Poisindex, 1992); no cases of human poisoning have been reported. Ingestion may, at worse, result in mild vomiting or diarrhoea, numbness, tingling of the mouth and loss of co-ordination (NPIS figures; Spoerke & Smolinske, 1990).

Skin contact: Handling ***Schefflera*** species may give rise to allergic contact dermatitis (Lovell, 1993). Such a reaction has been attributed to the following species after gardening exposures: ***S. kwangsiensis* Merrill ex Li**, ***S. arboricola* (Hayata) Merr.**, ***S. actinophylla* (Endl.) Harms**, ***S. venulosa* Harms.** and ***S. actinophylla-S. macrostachia* Harms.** hybrids. A 35-year-old nursery worker, with no previous history of skin ailments, developed eczema on her hand and forearm after working with ***Schefflera*** for 2 weeks (Spoerke & Smolinske, 1990).

> **Toxins:** The irritant nature of the leaves may be attributable, at least in part, to the presence of oxalate which has been measured in ***S. actinophylla*** at a concentration of 0.9-1.5% (Frohne & Pfänder, 1984); such oxalates are not considered responsible for the allergic reactions reported. The contact allergen in ***S. arboricola*** has been identified as falcarinol, a polyacetylene compound (Spoerke & Smolinske, 1990). It is likely that other species contain this or related allergens.

Conclusion: Species of ***Schefflera*** are considered to have a low oral toxicity; no cases of human poisoning have been reported. Handling the plant, however, even in a gardening situation, may give rise to allergic contact dermatitis reactions.

Scilla, Squill

Ingestion: All parts of the plant, especially the bulb, are thought to contain toxins which could give rise to severe poisoning (Watt & Breyer-Brandwijk, 1962). The toxins present irritate the gastro-intestinal tract and clinical effects include pain in the mouth, nausea, vomiting, diarrhoea, abdominal pain and cramps. In severe cases, cardiac symptoms may occur such as a slowed heart-beat result, together with blood circulation problems and possibly an abnormal rise in the blood calcium level. Poisoning is rare in humans and no case data are available (Spoerke & Smolinske, 1992).

The violent vomiting reaction following ingestion is likely to explain the lack of human case data; rats, however, who cannot vomit suffer high mortality after ingestion of Squill and hence its use as an effective commercial rat poison called Red Squill (Blackwell, 1990).

Skin contact: Species of ***Scilla*** have been known to irritate the skin but the extent of the reaction is not well documented; furthermore, case data appear to be rather dated (Spoerke & Smolinske, 1992; Mitchell & Rook, 1979).

> **Toxins:** Cardiotoxic glycosides similar to those in ***Digitalis*** L. are thought to be the toxic agent in these plants. These glycosides are known as scillarens (Cooper & Johnson, 1988), bufa- or scilla-dienolides (Spoerke & Smolinkse, 1992).

Conclusions: Ingestion of ***Scilla*** plants are likely to have the potential to cause serious poisoning, however, no human case data are available. The sap has been known to cause skin irritation and dermatitis but recent case data to support this are lacking.

SKIMMIA Thunb. Rutaceae

Skimmia

Ingestion: ***Skimmia*** species have red berries attractive to children, however, empirical data suggest that ***Skimmia*** are not toxic on ingestion and there are no reports of poisoning (Poisindex). Ingestion of even large amounts of the plant may cause only mild vomiting and diarrhoea (NPIS).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Alkaloids at a concentration of 0.5%, chiefly skimmianine, have been isolated from the dried leaves of ***Skimmia*** species (Chopra *et al.*, 1949; Stary, 1983). ***Skimmia laureola* (DC.) Decne.** contains photo-toxic substances, including 5-methoxypsoralen, (Lovell, 1993) but no case data are available. Skimmianine from ***Skimmia japonica* Thunb.** has been found to be toxic to frogs and rabbits (Chadha, 1966-85).

Conclusion: Although the berries of ***Skimmia*** species are attractive to children, all parts of the plant appear to be of low toxicity by ingestion. Skin contact does not seem to be harmful; ***S. laureola*** contains furocoumarins but no case data indicate these have caused problems.

SOLANUM DULCAMARA L. Solanaceae

Woody Nightshade, Bittersweet

Ingestion: All parts of ***Solanum dulcamara*** contain toxins but cases of poisoning to date only concern the ingestion of the berries. The latter, which change in colour from green to yellow to red on ripening, are very attractive to children and frequently ingested. Although the berries are less toxic when ripe (Frohne & Pfänder, 1984), their ingestion may cause vomiting, diarrhoea and a sore throat. In severe cases, symptoms include headache, dizziness, drowsiness, temperature and possibly breathing difficulties (Lang, 1987). One fatality has been reported (Alexander *et al.*, 1948), involving a 9 year old girl who frequently ingested berries from local hedgerows.

Skin contact: There is no evidence that contact is harmful.

> **Toxins:** The main toxic constituents are the alkaloids solanine, solaneine and solaceine, the saponins dulcamaric acid and dulcamaretic acid. These are concentrated in the unripe berries and leaves but are present in all parts of the plant (Turner & Szczawinski, 1991), including the ripe berries.

Conclusion: All parts of ***Solanum dulcamara*** are poisonous, particularly the unripe berries and leaves. Ingestion of the berries, which are very attractive to children, may give rise to serious poisoning and are potentially fatal. There is no evidence that skin contact is harmful.

SOLANUM PSEUDOCAPSICUM L. — Solanaceae

Christmas Cherry, Winter Cherry, Jerusalem Cherry

Ingestion: All parts have a low toxicity, including the ripe berries (Spoerke & Smolinske, 1990). The large number of calls to poison centres indicate that children find the fruits attractive to eat (NPIS figures). Eating a few berries can result in nausea, abdominal pain and drowsiness (Cooper & Johnson, 1988). In 1935, experimental intravenous administration to patients demonstrated the slowing of the heart beat and slight hypotension (Watt *et al.*, 1932).

Skin contact: There is no evidence that skin contact is harmful.

Toxin: The species contains the alkaloid solanocapsine.

Mechanisms: Solanocapsine acts directly on cardiac muscle, slowing it down (Frohne & Pfänder, 1984). As an irritant it has caused vomiting in cats and may also be responsible for mild digestive symptoms in humans (Watt *et al.*, 1932).

Other species: ***Solanum capsicastrum* Link ex Schauer.** also contains solanocapsine and is considered to have a similar toxicity to ***S. pseudocapsicum*** (Cooper & Johnson, 1988). There is often confusion in the identification of the two species. The most noticeable differences are that ***S. pseudocapsicum*** is a hairless plant bearing globose orange-red fruit and ***S. capsicastrum*** is a densely hairy plant and produces ovoid yellow fruit (Jaeger, 1985).

Conclusion: All parts of ***Solanum capsicastrum*** and ***S. pseudocapsicum*** have a low toxicity. The berries are attractive to children, however, their ingestion results only in minor digestive problems. There is no evidence that skin contact is harmful.

Sorbus

Sorbis aucuparia L.

Rowan, Mountain Ash

Ingestion: The berries, commonly ingested by children, are slightly toxic when raw (Roth *et al.*, 1984). Eating a large number may cause mild gastro-intestinal troubles, with vomiting and diarrhoea (Frohne & Pfänder, 1984). One reference suggests that the berries can cause symptoms of excitement, convulsions and respiratory distress in children. Since the toxin is largely destroyed by drying or boiling, hence the fruits can be used in preserves with no ill effects (Lang, 1987).

Skin contact: There is no evidence that skin contact is harmful.

> **Toxins:** Parasorbic acid is present in the berries and amygdalin is found in the seeds in very small (harmless) amounts (Frohne & Pfänder, 1984).

Other species: ***Sorbus torminalis* (L.) Crantz, *S. aria* (L.) Crantz, *S. domestica*** L., ***S. koehneana* Schneid.** and ***S. prattii* Koehne** are probably harmless; at most they may give rise to slight gastro-intestinal symptoms (Frohne & Pfänder, 1984).

Conclusion: The ingestion of large numbers of raw berries of ***Sorbus*** species may cause mild gastro-intestinal effects; the potential for serious poisoning would, therefore, appear to be very low. There is no evidence that skin contact is harmful.

SYMPHORICARPOS L.

Caprifoliaceae

Symphoricarpos

Symphoricarpos albus (L.) Blake

(synonym: *S. racemosus* Michx.).

Snowberry

Taxonomic note: the variety that appears to have become naturalised in Europe is ***S. albus*** **var.** ***laevigatus*** **(Fernald) Blake**, *a synonym of* ***S. rivularis*** **Suksd.** *(Tutin et al., 1964-80; Philip, 1992-93).*

Ingestion: This plant produces conspicuous white berries which are popular with children as missiles in pea-shooters since they explode with a pop on impact (Frohne & Pfänder, 1984). The plant is widely cultivated and has also become naturalised throughout much of the country (Lang, 1987). The berries have a long-standing reputation for being toxic (Turner & Szczawinski, 1991) but the literature on this is often contradictory. The NPIS iadvise that ingestion of small numbers of berries does not constitute a poisoning risk.

Frohne and Pfänder (1984) report that experience from the Berlin and Zurich Toxicological Centres indicate that the ingestion of 3-4 berries does not cause symptoms, but larger volumes may result in vomiting, dizziness and abdominal pains. However, a case described by Turner and Szczawinski (1991) indicate that clinical effects in a child in Britain occurred after ingestion of only 3 berries. Many authorities doubt the validity of older case data and believe that the bad reputation that this plant has received is due to a single much quoted and rather dramatic report dating back to 1885 when 4 children in Norfolk became semi-comatose after eating a large quantity of the berries. Cooper and Johnson (1988) indicate there have been very few recent incidents in the UK, all with only minor symptoms.

Additional symptoms from old case reports include dehydration, delirium, semi-coma and, in one case, death (Lang, 1987; Turner & Szczawinski, 1991).

Skin contact: The plant is reported to have irritant properties, particularly the fruit sap, which may cause dermatitis (Lang, 1987; Mitchell & Rook, 1979). No case data, however, have been found to confirm this and information is extremely sparse.

> **Toxins:** The berries contain a reputedly poisonous substance called viburnin. Several alkaloids are also present, e.g. chelidonine, a narcotic characteristic of the poppy family (Fuller & McClintock, 1986), but the toxicity of these alkaloids has not been determined. Also reported to be present are saponins, tannins, terpenes, triglycerides and coumarins (Cooper & Johnson, 1984). It is thought that some of these may be responsible for the irritant actions on the stomach and possibly the skin (Lang, 1987).

The literature does not discriminate between the toxicity of *S. albus* and its widely naturalised variety *S. albus* var. *laevigatus*.

Mechanisms: Irritation mostly to the intestinal mucosa (Westbrooks & Preacher, 1986).

Other species: ***S. orbiculatus*** (Coral Berry or Indian Currant) is also cultivated in the UK; it has purplish fruits but no cases of poisoning have been reported. Frohne and Pfänder (1984) consider them to be "as harmless as those of *S. albus*".

Conclusion: The toxicological literature about ***Symphoricarpos albus*** is not clear-cut; the largest body of evidence suggests that the berries of the plant are, at least, mildly toxic and may give rise to sickness and diarrhoea. Only very old case data suggest that symptoms may be more serious, yet the recent literature casts doubt on their validity. Mild dermatitis may result from sap of the berries although this is not clearly supported in the literature. No information has been found indicating the toxicity of other parts of the plant, nor other species in the genus.

Taxus, European Yew

Taxus baccata L.

Yew, European Yew

Ingestion: All parts of the plant, including dried clippings (Cooper & Johnson, 1988) are toxic, with the exception of the fleshy red arils (fruit-flesh) (Lang, 1987). Children find these orange-red arils attractive but poisoning will only occur if the seed is eaten and chewed; the fleshy aril alone is non-toxic. A wide range of symptoms are likely if poisoning has occurred: vomiting, diarrhoea, dilated pupils, dizziness, lethargy, decreased heart rate and other altered heart function, a decrease in blood pressure, difficult breathing, fits and coma (Lang, 1987). Death is usually due to respiratory or heart failure.

Serious poisoning in recent years arising from accidental ingestion of ***Taxus baccata*** is rare. However, documented cases in the medical literature describe incidents of severe poisoning, including death from intentional ingestion. These include adults eating the leaves, or decoctions of leaves and bark (Czerwek & Fischer, 1960; Feldman *et al.*, 1986; Frohne & Pribilla, 1965; Schulte, 1975; Yersin *et al.*, 1987). Old medical texts from the last century record various cases of childhood fatalities (Hurt, 1836; Thompson, 1868).

Skin contact: Contact with the wood of ***T. baccata*** may rarely cause skin irritation (Woods & Calnan, 1976).

> **Toxins:** The alkaloids taxine A and B occur in all parts except the fleshy aril. An irritant volatile oil is present throughout the plant. Ephedrine, taxiphyllin, a cardiac glycoside and 5-8 other unidentified compounds are also present (Lang, 1987). Taxine B is cardioactive and is mainly responsible for the cardiotoxicity (Bauereis & Steinert, 1959). Irritant substances are responsible for gastro-intestinal irritation. The taxine alkaloids are non-irritant and rapidly absorbed.

Other species: It is likely that all other species of ***Taxus*** have a similar toxicity. A 5 year old girl suffered severe heart rhythm abnormalities and almost died after ingestion of leaves and berries from ***T. brevifolia*** Nutt (Cummins *et al.* 1990). A man died after a presumed intentional ingestion of leaves of an unspecified ***Taxus*** (Sinn & Porterfield, 1991).

> **Toxins:** Taxines and irritants are likely to be present in all ***Taxus*** species.

Conclusion: All parts of all species of ***Taxus***, excluding the fleshy arils, are highly toxic on ingestion. The attractive arils ('berries') are the parts most likely to be eaten by children. Serious poisoning, possibly death, may occur if the seed is chewed and swallowed. Ingestion of other toxic plant parts or their infusions have also given rise to serious poisoning. Skin irritation is seldom a problem, although there may be a higher risk in occupational settings.

Thuja

Thuja occidentalis L.

White Cedar

Ingestion: The scale-like leaves contain an essential oil which can cause serious poisoning following ingestion. The toxicity of other plant parts is not known. The clinical effects of poisoning arising from leaf ingestion include local irritation, long-lasting clonic-tonic muscle spasms, convulsions and degenerative changes in the liver, renal damage, and bleeding from the mucosa of the stomach (Frohne & Pfänder, 1984). No case data are available.

Skin contact: The essential oil in the leaves has a strong local irritant action (Frohne & Pfänder, 1984) leading to inflammation of the skin (Mitchell & Rook, 1979); leaves and branches have caused dermatitis in gardeners. Case reports from 1920 describe how several workers in an occupational setting developed a range of symptoms from dermatitis to respiratory problems (Mitchell & Rook, 1979)

Eye contact: There is no evidence that eye contact is harmful but the irritant properties of the volatile oil may have the potential to affect the eyes.

> **Toxins:** The monoterpene, thujone, in the volatile oil, is the main toxin present.

Other species: Although ***Thuja*** species are unlikely to be eaten, if consumed there is the likelihood of severe digestive system disturbance, followed by liver and kidney damage (Cooper & Johnson, 1988).

The branches and wood of ***Thuja plicata*** **D.Don** are allergenic (Turner & Szczawinski, 1991) and there are many cases of occupational dermatitis and allergic respiratory reactions. The leaves and branches of ***T. orientalis*** **L.** have been known to cause dermatitis. The wood of ***T. standishii*** **(Gord.) Carr.** (synonym ***T. japonica*** **Maxim**) can also cause occupational dermatitis and respiratory symptoms (Mitchell & Rook, 1979).

> **Toxins:** The sensitising agents in ***T. plicata*** are tropolones; the respiratory symptoms are due to plicatic acid. The sensitising agent in ***T. standishii*** is beta-thujaplicin (Mitchell & Rook, 1979).

Conclusion: Ingestion of the leaves of any species of ***Thuja*** has the potential to cause severe poisoning. The toxicity of other plant parts, however, is not known. Skin contact with the leaves or branches of all the above-named species may produce allergic dermatitis, usually in people already allergic to sticking plaster. The volatile oil contains a skin allergen but contact is unlikely unless the leaves are crushed or the wood sawn or burned. Occupational dermatitis can occur.

Tulip

Tulipa gesneriana L.

Taxonomic note: this is an extremely complex species taxonomically from which most of the garden cultivars have been derived. The following taxa were given species names in the past but cannot be separated satisfactorily from ***T. gesneriana****:*

> ***T. didieri*** **Jordan,** ***T. elegans*** **Baker,** ***T. fulgens*** **Baker,** ***T. galachia*** **Freyn.,** ***T. grengiolensis*** **Thommen,** ***T. marjolettii*** **Perrier & Songeon,** ***T. mauritiana*** **Jordan,** ***T. platystigma*** **Jordan,** ***T. retroflexa*** **Baker,** and ***T. viridiflora*** (Walters, 1984).

Ingestion: The bulbs, at least, are known to contain toxins. 5 bulbs have been reported to have produced slight gastro-intestinal symptoms (Frohne & Pfänder, 1984). Clinical effects of poisoning are nausea, vomiting and increased salivation (Spoerke & Smolinske, 1990). A number of cases refer to their use as food in mistake for onions. One such case in 1978 involved five people who ate a goulash containing Tulip bulbs. Within 10 minutes they developed breathing difficulties, sweating, vomiting, and intense salivation. One person developed cardiac palpitations but all recovered with symptomatic treatment. Whether the symptoms were due to the presence of tulipalins or other substances is not known (Frohne & Pfänder, 1984).

Skin contact: The whole plant contains allergens, the concentration of which is highest in the bulb. However, the concentration throughout the plant varies with the season (Lovell, 1993). Information concerning the toxicity of the flowers is contradictory: Frohne and Pfänder (Frohne & Pfänder, 1984) report that the flowers in particular contain the allergens, while Mitchell and Rook (1979) state that the concentration of allergens is lowest in the petals. These differences may be attributable to seasonal variation.

Where Tulips are grown as a crop, bulb handlers often develop contact sensitisation, a condition known as 'tulip fingers'. This is an allergic contact dermatitis brought on by contact with the bulbs or their sap. 'Tulip fingers' is especially common in the Netherlands. In 1935, for example, a study showed that up to 85% of bulb handlers in the country had developed dermatitis (Spoerke & Smolinske, 1990). Variation in harvesting techniques of the flowers affects the risk of contact sensitisation. In Sweden and Germany, for example, the bulb is split with a knife, yielding a longer stem and the risk of dermatitis is 60% in operatives (Lovell, 1993). In Denmark, the same condition accounts for some 4% of all plant-related dermatitis. Since 'tulip fingers' is seasonal and sometimes mild it is, however, probably under-reported. Despite this, severe cases have been reported such as the 2 cases described by Spoerke and Smolinske (1990) involving serious facial swelling and speech impediment.

The medical condition 'tulip fingers' is made up of different components comprising 3 main clinical syndromes: i) an irritant effect (often appearing within 24 hours) which develops due to contact with the abrasive bulb coat. This is accompanied by severe tingling and erythema of the finger tips ('tulip fire'), particularly around the finger nails; ii) granulation tissue develops under the nails, with loosening and transverse splitting of the nails and, in severe cases, abscesses develop beneath the nail; iii) an allergic reaction occurring in sensitised individuals where a scaly cracking eczema develops under the nail and spreads around it. Secondary spread to the arms, face and genitalia may occur particularly in flower handlers (Lovell, 1993).

The dust in Tulip sheds may also be responsible for rhinitis, asthma and antibody reactions such as urticaria (Lovell, 1993; Mitchell & Rook, 1979).

Eye contact: The dust in Tulip sheds may precipitate conjunctivitis (Mitchell & Rook, 1979).

Toxins: The contact allergens are the lactones known as tulipalins (or tuliposides) A and B. Tulipalin A is the most active (Frohne & Pfänder, 1984). A toxic lectin and a toxic glycoprotein are also present (Spoerke & Smolinske, 1990).

Mechanisms: Tulipalins are allergenic and lectins are known to be gastro-intestinal irritants. The glycoprotein has DNA-synthesis-inhibiting properties (Spoerke & Smolinske, 1990).

Cultivars: Florists have reported that 'Praeludium' and 'Rose Copeland' cause dermatitis more frequently than other cultivars; bulb handlers have also found the latter to be more irritant than others. Sensitised florists report that they can handle some cultivars more easily than others, although patch testing to nine cultivars all gave similar results (Mitchell & Rook, 1979).

Other species: *T. fosteriana* Irving, from which Foster 'Red Emperor' Tulips are derived (Lovell, 1993), was found to contain less allergen than 11 others tested (Mitchell & Rook, 1979).

Conclusion: Due to lack of species specific information it is safer to regard the toxicity all species of ***Tulipa*** as follows: the bulbs are poisonous on ingestion but do not have a high toxicity; cases of poisoning are rare. The main risk is from contact, mostly in occupational settings, where severe dermatitis and other serious allergic reactions may develop. The allergen in ***Tulipa*** is also present in ***Alstroemeria*** and ***Erythronium*** (Mitchell & Rook, 1979); cross sensitisation may therefore be a problem.

False Helleborine

Veratrum album L.

White False Helleborine

Ingestion: All parts, especially the roots, are toxic. Severe poisoning is rare because of the sharp burning taste that is likely to be experienced soon after ingestion. Clinical effects appear from half an hour to 4 hours post-ingestion and include nausea and vomiting, followed by low blood pressure, slow heart rate, numbness, weakness and abnormal heart rhythms (Poisindex, 1992); fatalities are rare (Frohne & Pfänder, 1984).

Skin contact: All species are reported to be irritant (Mitchell & Rook, 1979), but no case data are available. The likelihood of contact dermatitis is low.

> **Toxins:** The glyco-alkaloids protoveratrine, veratramine and jervine are present (Chiej, 1984).
>
> **Mechanisms:** The toxins paralyse the nervous system (Chiej, 1984).

Other species: It is likely that ***V. viride*** Ait. and ***V. nigrum*** L. have a similar toxicity to ***V. album***. According to Roth, *et al.* (1984) the fatal dose of ***V. viride*** may be as little as 1-2 g of the root.

> **Toxins:** ***V. viride*** is reported to contain the glycoalkaloids veratridene, veratrine, veratramine, veratrasine, veratrin and other alkaloids in all plant parts (Poisindex, 1992). Cyclopamine is cited as the most important alkaloid according to Fuller & McClintock (1986).

Conclusion: All species and all parts of ***Veratrum*** are highly toxic. The acrid burning taste makes serious accidental poisoning rather unlikely but all parts, especially the roots, have the potential to cause severe poisoning. All species are reported to contain skin irritants but no case data have been seen.

Periwinkle

Vinca minor L.

(see also ***Catharanthus roseus***)

Lesser Periwinkle

Ingestion: All parts of the plant contain a toxin, however, no cases of ingestion or poisoning arising from ingestion are recorded (Frohne & Pfänder, 1984).

Skin contact: There is no evidence that skin contact is harmful. One report of contact dermatitis under special circumstances (the extraction of alkaloids) almost certainly refers to ***Catharanthus***, *q.v.* (Mitchell & Rook, 1979).

> **Toxins:** All parts of the plant contain the indole alkaloid vincamine (Frohne & Pfänder, 1984).

Other species: ***V. major*** L. is also commonly cultivated but no incidents of poisoning have been recorded.

Conclusion: Toxic substances are present in all parts of ***Vinca*** species, but no cases of poisoning, either by ingestion or contact, are recorded.

VISCUM ALBUM L. — Viscaceae

Mistletoe

Ingestion: The stem and leaves of Mistletoe are highly toxic. Frohne and Pfänder (1984) state that the toxins are absent from the berries and case reports indicate a lack of symptoms after their ingestion. However, Cooper & Johnson (1988) indicate that the berries are poisonous but less so than the leaves and stems. They state that eating a few berries has either no effect or causes mild stomach-ache, whilst eating a large number of berries (quantity not given) may lead to stomach cramps and diarrhoea. One fatal poisoning has been recorded although no details are given.

It would appear that the toxicity of each plant is dependent upon the species of the host plant (Frohne & Pfänder, 1984); for example, Mistletoe growing on lime or poplar trees is considered more poisonous than that growing on apple trees (Cooper & Johnson, 1988).

Skin contact: There is no evidence that contact is harmful.

> **Toxin:** A mixture of toxic proteins (viscotoxins A and B) is present. Also present are toxic alkaloids and lectins including viscumin (Lampe & McCann, 1985).
>
> **Mechanisms:** Viscumin inhibits protein synthesis. The toxic mechanism for viscotoxins is not known (Lampe & McCann, 1985).

Conclusion: The stems and leaves of ***Viscum album*** are highly toxic but there are no reports of these being eaten by humans. The berries are the plant part most likely to be eaten but these are considered to have a low or possibly variable toxicity according to the identity of the host tree. There is no evidence that contact is harmful.

WISTERIA Nutt. Leguminosae

Wisteria

Ingestion: All parts, especially the bark and seeds, are poisonous. As few as two seeds are said to have the capacity to cause serious poisoning in children (Frohne & Pfänder, 1984) although a 2 year-old girl who ate two pods and a 7 month-old child who ate a "leaf" [leaflet?] showed no symptoms (Roth *et al.*, 1984). Pods, or a few seeds have caused gastro-enteritis and repeated vomiting. Other clinical effects include diarrhoea, paralysis, convulsion and respiratory failure; symptoms generally abate within 24 hours (Poisindex, 1992).

Skin contact: There is no evidence that skin contact is harmful (Mitchell & Rook, 1979).

> **Toxins:** A toxic glycoside, wistarin, lectins and a resin are present in all parts but it is unclear what is responsible for the reported clinical effects (Frohne & Pfänder, 1984).

Other species: The information above refers to ***W. sinensis* (Sims) Sweet** (Frohne & Pfänder, 1984), ***W. floribunda* (Willd.) DC.** and ***W. frutescens* (L.) Poir.** (Poisindex, 1992). It is probable that all other species are also toxic.

Conclusion: All parts of ***Wisteria sinensis***, ***W. floribunda*** and ***W. frutescens*** are highly toxic, particularly the pods and seeds (which are produced rather erratically in the UK). It is likely that all other species in the genus are similarly toxic. The potential for serious poisoning exists, particularly for children who eat only a few seeds. There is no evidence that skin contact is harmful.

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APPENDIX 1

APPENDIX 1

Report commissioned by the Horticultural Trade Association to investigate the possible occurrence of toxic tropane alkaloids in the volatiles produced by species of *Brugmansia* or *Datura* in cultivation. 19 October 1993.

Volatiles from Flowers and Leaves of *Brugmansia* x *candida*

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Introduction

Species of *Brugmansia* and the closely related genus *Datura* are becoming more popular as houseplants; one of the most widely cultivated is *Brugmansia* (=*Datura*) x *candida*. These genera are known to contain tropane alkaloids in the leaves and flowers that are poisonous to humans on ingestion (Cooper and Johnson 1988). The horticultural trade has expressed concern about whether tropane alkaloids may be produced as volatiles causing ill-health in people who remain in close proximity to a plant for long periods in an enclosed environment. The major tropane alkaloids in the genera, scopolamine and hyoscamine (tropine tropate), are solids at room temperature with melting points of 196°C and 108°C respectively. Thus it would seem unlikely that they would be constituents of the 'vapours' produced by the plant; however, possible breakdown products may be sufficiently volatile, for example tropine boils at 233°C.

To investigate the volatiles produced by *Brugmansia* x *candida*, the air from around leaves and flowers (the headspace) was analysed by the technique of thermal desorption - gas chromatography - mass spectroscopy (TD-GC-MS). In this technique, air is pumped through a tube packed with a porous polymer called Tenax that traps volatile organic compounds. Once enough volatiles have been trapped, they are released from the polymer by passing hot inert gas through the tube and transferred directly into a gas chromatograph which separates the volatile compounds from one another. Each individual volatile is then passed into a mass spectrometer to obtain its 'mass spectral fingerprint' that can be compared with libraries of 'fingerprints' from known compounds. The mass spectrum and the order in which the compound separates in the gas chromatograph (the relative retention time) provide information on the likely identity of the compound.

Technical Details of Experimental Methods

Flower volatiles of *Brugmansia* x *candida* (Kew Accession No. 1965-57503, growing in the Temperate House) were collected *in situ* by enclosing a flower in a glass dome and sampling the headspace through either 3mm or 0.8mm diameter freshly desorbed sampling tubes (CHISA Type A, Scientific Glass Engineering Ltd. (SGE)) packed with Tenax TA (60-80 mesh, Thames Chromatography). The sampling period was 18 h overnight.

Leaf volatiles were collected *ex situ* by placing a sprig of foliage (containing about five freshly expanded leaves) in water in a large desiccator and sucking air (filtered through Tenax) through the system into a 3mm sampling tube. The sampling period was 30 h during which time air from the laboratory was also sampled directly to identify background volatiles that had passed through the prefilter.

For TD-GC-MS analysis the sample tubes were inserted into a thermal desorption injector (SGE) fitted to a Perkin Elmer 8500 gas chromatograph (GC). The injector temperature was 320°C and the tubes were allowed to desorb for 5 min. Desorbed volatiles were concentrated at the beginning of a 25m x 0.22mm i.d. x 0.25µm BPX5 gas chromatography column (SGE) using a liquid CO_2 cryogenic cold trap (SGE); the GC oven temperature during trapping was 40°C. Chromatography of the volatiles was them achieved using an oven temperature programme of 40-180°C (5°C/min), 180-360°C (10°C/min), 360°C (10min) with a helium carrier gas pressure of 20 psi. The effluent from the column was split between a flame ionization detector (FID) and an ion trap detector (Finnigan-MAT); the latter provided 70eV electron impact mass spectra (MS) of the eluting compounds in the mass range 30-650 m.u. Compounds were identified by means of relative retention times and computerized searching of two mass spectral libraries: one produced by the National Institute of Standards and Technology with 62,235 entries (Ausloos *et al.* 1992) and a library of essential oils with 502 entries (Adams 1989). The approximate percentage composition of each component was obtained from the FID data.

Table 1: Composition of scents collected from each of three flowers of *Brugmansia* x *candida*.

Compound	*Flower 1* *27 July*	*Flower 2* *30 July*	*Flower 3* *5 August*
Benzenoids:			
benzaldehyde	2.9	5.9	3.9
benzyl acetate	-	0.1	0.7
benzyl benzoate	-	0.4	0.6
benzyl salicylate	-	0.7	0.7
methyl benzoate	1.4	1.4	1.4
methyl salicylate	-	3.8	-
phenylethyl alcohol	2.2	1.2	3.1
Monoterpenes:			
1,8-cineole	16.5	18.9	4.8
limonene	3.6	4.3	3.5
ocimene (*cis* and/or *trans*)	49.1	38.0	52.3
α-pinene	0.5	<0.1	0.1
β-pinene	1.4	3.4	2.4
trans-sabinene hydrate	1.0	0.5	1.3
α-terpineol	3.5	3.1	4.9
α-terpinolene	0.9	0.2	1.1
α-thujene	0.3	0.3	0.3
Sesqiterpenes:			
z-*trans*-α-bergamotene	<0.1	0.1	0.1
β-cedrene	0.5	0.2	-
β-elemene	-	-	0.1
α-farnesene	1.7	3.4	2.8
cis,trans-farnesol	<0.1	0.1	0.2
trans,cis-farnesol	<0.1	1.3	0.9
trans,trans-farnesol	<0.1	0.3	0.3
trans-nerolidol	4.5	6.2	5.4
Alkaloids:			
indole	-	0.2	1.1

To investigate the volatility of tropane alkaloids, an aqueous solution containing 10 mg each of scopolamine, hyoscamine and tropine was dried onto filter paper that was then covered with a beaker for 1 h before sampling the headspace for 30 min as above.

Results.

Headspace analysis of tropine, scopolamine and hyoscamine absorbed onto filter paper revealed that only tropine produced sufficient vapour pressure to be detected by TD-GC-MS; it was possible to analyse all three alkaloids by injecting them directly into the GC-MS.

The composition of flower and leaf volatiles produced by *Brugmansia* x *candida*, as determined by headspace TD-GC-MS, are given in tables 1 and 2. In both analyses it was possible to identify all the major components, which totalled about 90-94% of the flower volatiles and 83-86% of the leaf volatiles. The majority of volatiles were terpenoids, although a number of benzenoid alcohols and esters were detected, particularly in the flower scent. Only one alkaloid was detected, indole, which was present in the flower scent.

Table 2: Composition (%) of leaf volatiles produced by *Brugmansia* x *candida*.

Compound	*Collection 1 11 August*	*Collection 2 18 August*	*Collection 3 5 October* [a]
Benzenoids:			
ethyl benzoate	0.5	-	-
methyl salicylate	5.3	2.7	6.3
Monoterpenes:			
trans-ocimene	4.4	0.9	5.2
perillene [b]	20.6	13.9	25.3
α-pinene	1.5	1.3	2.9
Sesquiterpenes:			
z-*cis*-α-bergamotene	2.8	2.2	2.5
z-*trans*-α-bergamotene	9.9	9.3	8.8
β-bisabolene	-	-	2.5
β-caryophyllene	1.9	2.0	1.7
dendrolasin	11.3	8.8	13.0
β-elemene	1.9	-	2.4
cis-β-farnescene	4.9	4.4	4.8
α-guaiene	1.5	2.6	0.5
γ-gurjunene	7.5	10.9	2.3
trans-nerolidol	0.1	-	1.0
santalol acetate	2.2	8.4	-
α-santanlene	1.3	2.3	2.9
β-selinene	6.5	12.2	1.5
β-sesquiphellandrene	0.8	1.2	2.4

[a] Flowering period finished [b] Identification based on MS only

The monoterpenes ocimene and 1,8-cineole were the dominant components of the flower scent. In two of the three flowers sampled, ocimene comprised about 50% of the total mass of volatiles produced. It was not possible to determine whether the ocimene component was a mixture of *cis* and *trans* forms of this molecule, or just one of the forms, because of the mass spectral and retention time similarities between the two, and the disproportionate amount present compared to closely eluting compounds which could be used as relative retention time markers.

The range of volatile compounds produced by the leaves was different to the flowers (table 2). There was a greater structural diversity of sesquiterpines, but fewer benzenoid esters and monoterpenes could be detected (some of the minor low molecular weight constituents may have been masked by background volatiles). The major components of the leaf volatiles were identified as the monoterpene perillene – comprising up to 25% of the total mass of volatiles produced – and the sesquiterpene complement of perillene, dendrolasin. It should be noted that the identification of perillene made here is based only on mass spectral similarity with library data.

Discussion

All the volatiles identified in the headspace analysis of flowers of *Brugmansia* x *candida* have been reported previously in flower scents (Knudsen *et al.* 1993). The presence of the acyclic sesquiterpene alcohols farnesol and nerolidol in the scent, together with benzenoid alcohols (e.g. phenylethyl alcohol) and associated esters derived from them and from salicylic acid, is typical of the 'white floral' perfume type used in perfumery (Kaiser 1993). This combination of volatiles is common amongst white flowers which tend to release their scent during the late evening or night and are mostly pollinated by moths. Baker (1961) has observed the American hawk moth (*Phlegethontius sexta*) visiting flowers of *Datura meteloides*.

In the only reported analysis of *Datura* or *Brugmansia* scent in the literature, Kaiser (1991) found that 2,6-dimethyl-3(*E*),5(*Z*),7-octatrien-2-ol was the major constituent in *Datura arborea* in a survey of the presence of this unusual trienol in scents; no other details of the scent composition of *D. arborea* were given. This trienol was not evident in the present analysis, and more recently it has been claimed that it is an artefact, being formed slowly from *trans*-ocimene when activated charcoal is used to trap the scent and GC analysis is delayed. In this study Tenax TA was used to trap the scent and analysis was performed immediately after. Given the more frequent occurrence of *trans*-ocimene over the *cis* form in flower scents, and the erroneous report of the trienol in *Datura*, it seems likely that the ocimene component of the *Brugmansia* scent, which could not be confidently ascribed to one or both forms, is mainly composed of the *trans* form. The high percentage of ocimene in the *Brugmansia* flower scent is not unusual; e.g. *trans*-ocimene comprises 11% of the scent of *Nicotiana otophora*, another member of the Solanaceae (Loughrin *et al.* 1990), and is an important component of many orchid scents - in *Laelia anceps* it comprises 87% of the scent (Kaiser 1993).

Compared to the flowers, the leaves produced fewer benzenoid esters but a greater structural diversity of terpenoids, including perillene and dendrolasin which are less frequent constituents of essential oils. Perillene is known mainly from *Perilla* oil (Misra and Husain 1987, Nishizawa *et al.* 1990), whilst dendrolasin occurs in, amongst other things, sweet potato (Belardini and Lanzetta 1983). Seeds of *Perilla* species, from which the oil is extracted, are routinely cooked in curry meals in north east India. Both perillene and dendrolasin are furanoid terpenoids and terpenoids of this class are often noted for their odour; perillene is somewhat similar to rosefuran, an important odour constituent of rose oil. Both compounds also occur in the defence secretion of the ant *Lasius* (=*Dendrolasius*) *fuliginosus* (Bernadi *et al.* 1967).

The *Registry of Toxic Effects of Chemical Substances* gives hazard and toxicity information for many of the volatiles produced by either the flowers or leaves of *Brugmansia* x *candida* (Lenga 1988, Connolly and Hill 1991). However this is also true for the majority of flower scents and numerous compounds used in perfumery, many of which are known to have biological effects (Buchbauer 1993). For example, the alkaloid indole – present in *B.* x *candida* scent – is toxic but is a frequent constituent of flower scents; e.g. it is present in the scents of common garden plants like *Narcissus*, *Syringa* and *Philadelphus* (Knudsen *et al.* 1993). In assessing whether the volatile chemicals produced by *B.* x *candida* represent a risk to a person in close proximity to the plant, perhaps in a closed room for several hours, one must consider the level of exposure to the chemicals through inhalation. As Ford (1991) points out, for a person using a normal amount of a typical perfume, the level of exposure to each chemical in that perfume through inhalation is well below the acceptable average concentration for eight-hour inhalation of all but the most extremely toxic occupational chemicals.

Estimating the quantity of volatiles produced by a *Brugmansia* plant would be a difficult task involving quantitative trapping of compounds, a procedure with numerous inherent difficulties and errors. From the analyses undertaken here, the quantity of volatiles being emitted by the leaves did not appear to be particularly high – a 30 h sampling period was required to collect nanogram quantities of compounds from about five leaves. The quantity of volatiles produced by the flowers was considerably greater. Partial sampling of volatiles from one flower saturated a trap within a few hours, which correlated with the perceived strong scent of the flowers, although human perception of scent can give misleading indications about the amount of volatiles present. As with other strong scented flowers, some people may find the scent of *Brugmansia* 'overpowering' after a period of time, with the prolonged sensory stimulation of the terpenoids and benzenoid esters causing headaches and possibly nausea.

In conclusion, this study could not identify any chemicals in the volatiles produced by the leaves or flowers of *Brugmansia* x *candida* which would be of immediate cause for concern. However, it should be noted that the technique of TD-GC-MS does not guarantee error-free identification of compounds. To achieve this, it would be necessary to isolate each volatile and subject it to more powerful analytical techniques; a process requiring considerable input of man hours and resources. If there are further substantiated reports of people suffering ill effects from being in close proximity to species of *Brugmansia* or *Datura*, then it would be advisable to analyse the particular species or cultivar under suspicion. In addition to direct headspace analysis, an examination of the volatile constituents of the plant indirectly – namely by extracting or distilling off the volatiles – might allow more in depth study, possibly in collaboration with a flavour and fragrance company.

Finally it should be re-emphasised that all parts of *Brugmansia* and *Datura* are extremely toxic if ingested since they contain some of the toxic tropane alkaloids that are present in deadly nightshade, *Atropa belladonna* (Cooper and Johnson 1988). Eating any part of the plant may result in death and it is not recommended that the plant is grown where there may be young children without supervision.

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Important

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