

spaghnum. Keep moist until rooting takes place and pot as normal.

PROPAGATION AND CULTURE OF BROMELIADS

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The bromeliad family (*Bromeliaceae*) is exclusive to the New World — the Americas. Comprising 60 genera and about 1400 species they can be found growing wild in the southern United States, Central America, South America, and various outlying islands. Distribution is through 80° of latitude. Plants are subject to a variety of climatic conditions. Occurring north and south of the equator means plants receive rainfall at different times of the year. This results in widely different life patterns.

Bromeliad habitats range from purely tropical areas to mountain altitudes of 4000m, from sea shore to densely forested areas, and from inland areas to the southern ocean islands.

Climate variation throughout the distribution area has forced the bromeliads to adapt in many ways. Bromeliads have been very versatile in the adaptations.

The world's most well known bromeliad is the pineapple (*Ananas*), which is grown intensively in Hawaii, Australia, and the Phillipines, and exported over the world.

Growth Forms. Bromeliads are either epiphytic or terrestrial. The epiphytic plants are found in a variety of climatic areas, not just the jungle. An example is *Tillandsia usneoides*, or Spanish moss, which grows luxuriently on trees in the southern U.S.A., giving an almost ghostly appearance.

Terrestrial plants occur in most climatic zones growing in scrub, desert or jungle, marshes, rocks, or beaches.

Sizes of species vary - some *Tillandsias* are under 50mm in height and *Aechmea conifera* has leaves 3.5m long. Both are epiphytic. Other species have been recorded being 10m high, 2.5m in diameter or with 3m branching inflorescences.

The leaves are always arranged spirally and each genus tends to exhibit a particular type of leaf shape. Leaf shape influences the shape of the plant. Some are bulbose (bulb shaped), some others may be grass-like, moss-like or comprised of spreading rosettes. Leaf colour varies and leaves may be green, mottled, banded or reticulated.

Some bromeliads, mainly epiphytic ones, are the only plants that must have water in their growing centres to sur-

vive. Since there are no permanent water pools in the jungle, nature has provided these plants with a leaf arrangement to serve as reservoirs. Large volumes of water can be held. Even in a small potted plant a litre of water could easily be held. In nature a wide variety of fauna has specialised to live with the bromeliads — insects of many types, frogs and snakes.

Inflorescences and Flowers. Bromeliad rosettes end their growth with the formation of a terminal flower spike. Each rosette only produces one branched or unbranched inflorescence. (There are some exceptions.) The time it takes for an inflorescence to develop may be a few weeks to several months or over 12 months. Not only do these plants flower but also the last few rosette leaves or scape bracts on many species change colour. The bract colours present a great variety.

The flowers are typical monocotyledonous, with all whorls being of three parts. Blooms may last from a few hours to several days. The size of the inflorescence determines the flowering period as the individual flowers open over a period of time as each becomes mature.

Roots. In general the roots of bromeliads do not play the same role as do roots of other plants. Epiphytic species have very hard roots which attach themselves to their foundation by excreting a rubber-like substance.

The large terrestrial bromeliads, such as *Puya*, have strong root systems to anchor themselves and absorb nutrients.

Nutrient Uptake. Terrestrial plants with strong root systems absorb nutrients in the same way as other plants.

Epiphytic plants have developed trichomes which appear all over the leaves. Some species have many more than others which is directly related to their habitat. The trichome consists of two parts, a shield and water absorption cells. It is through the trichomes that water and nutrients are absorbed.

Culture. With over 1400 species of bromeliads of varied size scattered over such a wide climatic range, cultivation is difficult to describe, but by grouping species with similar climatic requirements, or only specializing in one group, many bromeliads can easily be grown.

A common mistake in New Zealand is to assume that all bromeliads must be grown in a glasshouse or similar structure. This is nonsense. New Zealand has a climate which varies almost as much as the climatic range of the bromeliad. In New Zealand there are many climatic areas, each with its good and bad points.

One important feature of New Zealand is its microclimates — an example is the north side of houses under the eaves

where, especially in the South Island, it is dry and hot with no frost all year round. Other microclimates under trees, in borders, on slopes, or near water can all be found. What does this mean for bromeliads? It means you can grow them outside if you choose the right area for the right plant.

A garden in Wellington features epiphytic and terrestrial bromeliads in an area of native bush all growing very well. My own garden in Christchurch features at least six species, one of which is almost in flower now (late spring). Puyas are featured in several borders in the Christchurch Botanic Gardens and they flower regularly. Do not underestimate our New Zealand climate. Some experimentation gives interesting results.

Generally, however, most collections are grown in pots or wired onto logs in glasshouses. A glasshouse provides protection from the elements and allows the plants to be grown to perfection — no tattered leaves, insect damage, or the like. A minimum temperature of 18 to 22°C during the growing season with ample humidity provides good conditions. Bromeliads do best with plenty of light but too much direct sunlight can damage the leaves.

Plant knowledge is very important in the cultivation of bromeliads. A person needs to know —

1. The plant's correct name — very important in this large family.
2. Its natural habitat and climatic conditions.
3. Whether it is epiphytic or terrestrial.
4. Whether or not it has a vigorous root system.
5. Any cultural requirements from the literature.

The answers to these questions will determine its treatment and eventual placement. Most can be pot-grown, even the epiphytic ones, but they must be potted firmly. There is a tendency today to grow bromeliads and other plants in more natural conditions. Many growers provide epiphytic plants with logs, fern trunks or similar to grow on.

Species having smaller plants and smaller root systems need only a small pot 75mm to 125mm, but larger species require up to a 200mm pot. The stronger rooted species require larger pots. It is necessary to provide a firm but well-drained soil mixture. Potting of plants is generally done in late spring.

Mounting plants on logs or branches is simply carried out. Place some sphagnum moss where plant is to be mounted, position the plant and firmly wire it on. Wire is a little more invisible but a plastic product could easily be substituted.

The “branches” in the Christchurch Botanic Gardens for public display are actually a pipe and No. 8 wire structure, surrounded by 13mm chicken wire filled with sphagnum moss. It won't rot or fall down and allows for easy mounting and good root holding.

Nutrients are given to display material via a liquid feeding programme. Commercial preparations are used.

Bromeliads do not tolerate lime. Lime is excreted from the plants through the leaves and left as a deposit on the outside of the leaves.

Flowering of plants is normally left to nature, the plants producing flowers when conditions are right. Some, such as *Billbergia nutans*, are very free flowering. Flowers have been induced commercially using carbide solutions, ethylene gas, or naphthelene acetic acid.

In collections of plants, flowering is always the crowning success of growing these plants. In commerce, flowering could mean quicker sales. It depends on your operation. Seed is formed in either dry capsules or in attractive berries.

Propagation. There are obviously two methods of propagation. Sexual — or by seed, and asexual — from vegetative material.

Seed is often collected in the wild and sent or sold to the horticultural industry — be it a botanic garden or nursery. Seed from a known origin is more likely to be true to name and provide a good line of plants. Seed collected from a collection of plants — such as a botanic garden's collection or nursery stock — is more likely to be of hybrid origin, because many bromeliads are self sterile. This latter seed should be sown with caution.

Obtaining nursery stock from seed is time-consuming, taking from 3 to 5 years, and up to 30 years to obtain flowering size plants.

(a) *Atmospheric Tillandsias*

Seed is best sown on a brush seed bed. A bundle of conifer branchlets tied together to make a cylindrical mass about 40mm thick. Seed is sown on and through this and sprayed with water. The seed sits tightly on the twigs and soon this can be dipped in a can of water. As the young plants grow they can be transferred to “permanent” mounts. When growing spray with a complete fertiliser every month.

(b) *Other Bromeliads*

Fresh seed is the best and will give fast germina-

tion. Sow in pots or trays on a 50:50 mixture of peat and sand. Other specialist mixtures are used.

Do not cover the seeds as they germinate only in light conditions — remember many are epiphytic.

Pricking-out follows as soon as a few leaves have grown. Potting-on can be done when plants are of reasonable size. Depending upon how well each species responds to being potted, epiphytic bromeliads can be grown in pots. If they are not doing well, then transfer them to a mounting structure - logs, tree ferns, or even a display epiphyte tree.

In the Christchurch Botanic Gardens the epiphytic tree display features many plants. In fact the "tree" — that pipe and wire structure — is divided into sections, e.g. a moist tropical section, and a drier more temperate section.

The range of species, and collecting seed in various collections, has resulted in a large number of hybrids. Many have been named. Care is needed in obtaining and sowing seed. Resultant plants should be checked for hybridism. Rouging of plants should be undertaken to remove inferior quality plants.

Vegetative Propagation. Although mature plants bloom once and die they produce offsets or "pups" which can be used for propagation. Only with poor conditions should you actually kill a plant. There are, of course, a few exceptions.

Offsets are produced about flowering time and, as the mother plant is dying (after flowering), the offsets obtain nutrition from the mother plant. They grow very quickly.

Offsets appear or develop in several ways — some at the base of the inflorescence, in the axils of basal rosette leaves, from adventitious offsets, and offsets from the inflorescence (Ananas). In all cases offset propagation is a quick method of producing mature plants quickly. A well-cared-for plant could be mature enough to bloom in 12 months.

Offsets are removed with a sharp knife at the point of attachment. Timing of the removal is important. If offsets are removed too soon then they will take longer to reach maturity. But early removal may mean the plant will produce more offsets. The longer it is attached, the better quality of offshoot. Again, depending upon the species, the size of the offset depends on the treatment. Offsets with a good root system can be potted up and treated as young plants. Those with few or no roots can be placed in a propagating mist pit with bottom heat for three weeks. A medium of sphagnum moss is quite suc-

cessful. Some hardier species do not need mist. The "tanks" of funnel shaped bromeliads must be filled with water.

SUMMARY

The large number of bromeliad species (over 1400 from 60 genera) and their wide growing adaption to various climatic areas and growing situations makes it very difficult to give an authoritative account on the culture and propagation of these plants. To add to this list of species are the many hundreds of hybrids that have been raised. This is only an introduction to this wide and interesting group of plants. Bromeliads are easily cared for and should be grown more by the horticultural industry.

REFERENCES

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NEW DEVELOPMENTS IN SPRAY APPLICATION TECHNOLOGY

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ABSTRACT. The basic principles of controlled droplet application (CDA) spraying and electrostatic spraying are reviewed, with particular reference to how these techniques can increase the efficiency of spray application

The introduction of these techniques and their acceptance in New Zealand is discussed

1. INTRODUCTION

The sole reason for applying pesticides (including herbicides) is to protect crop yield potential. To do this, one must transmit an appropriate quantity of active ingredient to a population of specific targets such that the organism or weed endangering the yield may collect it and be killed.

Whilst present spray application techniques may, on the whole, be effective they are inefficient. New developments in spray application techniques are directed at improving this efficiency, whilst maintaining or improving effectiveness.

This paper reviews two of the most important of these new techniques; controlled droplet application (CDA) spraying and electrostatic spraying. There is, however, one other develop-