We have also observed that disturbance of plants by repotting once the rhizome has formed, leads to premature senescence. It would obviously be undesirable for plants to become dormant on transfer to the field. We are therefore experimenting to determine the stages at which plants can be safely transplanted.

There appear to be several possible methods for handling large numbers of plants for field transfer:

1. The plants could be grown for one complete growth cycle in either trays or beds in the greenhouse. About 60 plants can be grown in a standard propagating tray. The small rhizomes can then be lifted, graded and replanted in the field in the spring.
2. The plants could be established in cell-packs in the greenhouse, so that after hardening outside, they could be transplanted with minimal disturbance to the root system.
3. The plants could be established in seedling trays and, after hardening outside, an attempt could be made to transplant into the field. This could be done approximately 4-6 weeks after transfer from culture before any visible rhizome development.
4. The plants could be transferred directly into the field in the spring. If they were planted in beds covered with a low polythene tunnel with a layer of heavy shade cloth, the plants might establish satisfactorily.

Flowering of the rhizomes. A treatment of the rhizomes with GA_3 at 40 ppm will stimulate vegetative growth of very small rhizomes and flowering in larger rhizomes. We have been able to flower rhizomes, 2 cm diameter, in pots in the greenhouse. The whole rhizomes were dipped into a solution of GA_3, drained and planted. Flowers developed two months later on the treated but not on the untreated rhizomes.

CULTIVATION AND PROPAGATION OF INSECTIVOROUS PLANTS

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Insectivorous plants are, of course, divided into many different genera which are distributed throughout the world.

I will endeavour to show you the differences within the different genera, as well as the propagation and cultural details of these particular plants.

SARRACENIA (Pitcher Plant)

Description. The leaf is moulded into a long, upright, funnel-shaped tube which is surmounted at its rear by a lid-like but immobile structure which is usually termed the hood. There is a variety of colour present on the funnel. In *S. leucophylla* the upper pitcher and hood are pure white nettled with dark red. In *S. minor* and *S. psittacina* their pitchers have white translucent windows or false exists which are very prominent.

Along with the attractive funnel the *Sarracenia* possess an attractive nodding solitary flower, from which large globular terminal buds on tall upright stems are produced. These are about 7.5cm in diameter and consist of five petal-like sepals under which hang the five rather longer true petals which hang over the pistil. The whole structure resembles an inverted umbrella. The colour of the petals can range from pale pink to crimson, while the sepals are often of a deeper shade.

The Trap. The interior of the pitcher is divided down its length into several distinct zones with rather different functions.

The surface of the lid is scattered with nectar glands which prime function is to attract the insects to the funnel. Interspersed between these glands there are short, sharp, downward-pointing hairs. About one or two inches down the funnel there is a glossy waxy surface which presents no foothold to insects. Scattered on this are microscopic glands which produce secreting juices containing digestive enzymes.

In the lower zone of the tube, the sides are lined with long, sharp, downward-pointing hairs and the attraction of strongly scented nectar brings the insects lower down and with the hairs and that of the narrowing funnel there is usually no escape.

Insects trapped in this way are flies, ants, bees, wasps, etc.

Culture. Container size can vary with size and type of plant. They should always be potted in spring or early summer when in full growth.

The mix can vary. We have found just pure spaghnum moss with weekly liquid feedings has produced large healthy plants, although mixes of three parts spaghnum moss, three parts peat, and one part of sand; *OR* six parts spaghnum moss, two parts perlite, and one part of sand, have been used with good results.

Sarracenia do best in fairly strong light, but need to be lightly shaded against direct sun. They should be grown in a cool greenhouse where temperatures should range from 10° to

15°C. Plants can be grown outdoors where similar temperatures are experienced

The plants should not be allowed to form thick clumps. To prevent this they should be divided every two or three years. Sarracenias usually die down after the growing season in summer and have a resting period of several months over winter. The pitchers in most species die from the top downwards and, when the whole leaf is dead, it should be carefully removed from the base

Hygiene plays an important part in successfully growing any insectivorous plant, removing any dead or dying material periodically, keeping the pots free from slime, and generally allowing free air movement around the plant to prevent mildew, etc., from developing

Propagation. Usually carried out in spring, either by division or by the sowing of seed.

1 *Division* — Split the rhizome with a sharp knife when the plant is starting to make young growth. Each division should have several roots attached and the lengths should be between half and one inch long. These sections should be potted into a sarracenia mix with the top of the rhizome just being exposed. The pot should then be placed in a water tray away from direct sunlight, and shoots usually appear two weeks to a month after potting.

2. *Seed* — Seed always has to be fresh for good germination, and should be sown directly onto spaghnum moss, or equal parts of spaghnum moss and peat can be used. Seed should not be covered, the pan being placed in a water tray with, if possible, humidity and bottom heat being applied. Germination can take anything up to six to eight weeks and, as soon as seedlings can be handled, they should be pricked out into very small pots or tubes

DROSERA (Sundew)

Description. In this particular plant the upper surface of the leafblade is thickly covered with tentacles, which is pinkish in colour and is crowned by drops of clear colourless liquid which tends to glisten in the sun, hence the common name of sundew

In this genus there are over 90 recognised species scattered over the world, many being found in Australia They are usually growing in the wild in poor, acid soils, usually in bogs.

The species differ in size and habit between one another,

some being ⅛″ long, some 2′ (60cm) long The roots of this plant can be tuberous, fleshy or fibrous depending on the species involved

The tentacles which catch the prey are held outwards so they are exposed to the smallest insect. These tentacles consist of gland tipped stalks which are egg-shaped in appearance. They have dual functions. Firstly they secrete the sticky liquid which catches the prey. Secondly they produce the enzymes like peroxidase acid, phosphatase, esterase and protease, which have been found amongst others in the liquid, and which help to dissolve the skeleton of their victims.

It is not known what attracts small insects to the leaf. It has been suggested that it could be the bright drops of sticky liquid which may suggest nectar or that there is a scent which is procuded to attract them.

General Cultivation. This can differ greatly depending upon what species is encountered, but most require a large amount of light, but should be shaded from direct sunlight to prevent scorching of foliage

Like sarracenias, we have grown droseras very successfully in straight spaghnum moss with weekly liquid feeding in the summer months and in between periods keeping the moss moist

Propagation. This can be achieved by sowing seed, by leaf cuttings, or by root cuttings, although the two latter methods sometimes can destroy the plant.

Sowing seed is one of the best ways to increase numbers of plants. sowing directly onto spaghnum moss without covering the fine seed. They should then be placed into a humid atmosphere being maintained at around 21°C. and kept moist at all times. We use a propagating pit which has an air-tight lid on it with heating cables placed in sand at the bottom, onto which the pan is placed.

Germination can take up to eight weeks, when the seedlings large enough to handle are pricked out into pots with about 10 plants per container.

Leaf cuttings. One should select healthy leaves of reasonable size and cut them off with a sharp knife with a small part of petiole attached Lay the leaves, tenacle side uppermost, *flat* on the spaghnum surface. Then sieve a layer of fine spaghnum moss over top of the leaf, pressing the moss down into contact with this, allowing small areas of the leaf to be exposed. After about one month. buds should start forming at the base of the tentacles and, when large enough to be handled, potted up.

Root cuttings. The method used is same as for leaf cut-

tings, removing pieces of healthy root and placing them onto moist spaghnum moss, over which a layer of fine moss is sieved. Subsequent handling is the same as for leaf cuttings.

DIONAEA MUSCIPULA (Venus Fly Trap)

The foliage of this plant is in a rosette produced from a shoot unbranching rhizome which is clothed with the succulent bases of the petioles of previous leaves. The leafblade is in the form of the twin-lobed trap borne on a petiole which is often flat and usually wedge shaped, widening towards its end. Flowering takes place in early summer.

The Trap. This is made up of two lobes upon which are attached to a continuation of a spine. The upper surface of each lobe is dished, along which are some 15 to 20 prong-like teeth, upon when closed interlock

Inside the trap there are several trigger hairs which are the mechanism that springs the trap Most of the upper surface is scattered with microscopic glands and, in particular, there is a narrow band of glands which secrete nectar, so attracting the insects to the trap. Other glands that are present are used for the digestion of the prey.

Insects usually have to brush against the trigger hairs twice to activate the trap, and this has been seen perhaps as a safety mechanism against accidental closure, e.g. wind, etc. After the insect has activated the trap, the prey is held in place by the interlocking jaws until a second phase starts, that of narrowing and flattening of the two lobes against the insect's body. Then digestive juices are released form the upper surface glands digesting the insect's body except the wings, etc.

General Cultivation. We have found the best way of growing the Venus flytrap is to place several plants in a large 30cm bucket with just straight spaghnum moss in the container with weekly liquid feedings. Other mixes that have been used are one part peat moss and one part sand, or just peat moss alone.

Keep the mix moist at all times and grow the plants in a well-lighted position although away from direct sunlight; during winter reduce water to avoid rotting.

Propagation. This is mainly done by sowing seed straight onto spaghnum moss with a light covering of fine spaghnum moss over the top. A mixture of peat and spaghnum has also been used by us with success. Keep in a moist, humid, position with temperatures, if possible, maintained around 20°C. Seedlings should be pricked out as soon as possible into small pots, after which they should be potted up together when large enough.

Leaf cuttings also can be used as another means of propagating this plant although, by far, seed is the best and most convenient way.

NEPENTHES (Pitcher plant)

These plants are basically climbing in nature and grow in damp humid places, as in tropical jungles, etc., but in some other places they grow along the ground and over low shrubs, etc They are able to climb through the use of tendrils which can be seen growing from the tips of the long flat leaves, as these attach themselves to supporting vegetation.

The Trap. Usually produced in summer, it starts with a swelling at the end of the tendril of a recently formed leaf. This grows fairly rapidly, the tendril hanging down due to its increased weight As the flat bud approaches maturity it is suddenly inflated with air, the pitcher starts to obtain striking markings. After a few days the lid opens and in the bottom can be seen fluid which has been secreted after inflation.

The pitcher attracts its prey by producing nectar-secreting glands which liberally cover its inner surface. Just inside the pitcher are downward-pointing hairs, from which there is, about ⅓ down the pitcher, a glaucous waxy area offering very little footing to the insect. The remainder of the pitcher consists of a smooth, glassy, glandular surface fitted with microscopic glands which secrete digestive fluid found in the bottom of the pitcher and also absorbs the foods resulting from the digestive process.

General Cultivation. Temperatures ranging from 15 to 21°C seem to be best although many plants thrive above and below these settings. The plants require a high level of humidity, from 70 to 90% should be maintained at all times.

A mix which we have found good is one part leafmould, plus one part chopped spaghnum moss, although there are many similar ingredients that could be used. We also base feed and foliar feed weekly; the plants generally should be kept moist at all times.

Propagation is by seed or by cuttings.

Seed can be handled as previously suggested for the Sarracenias.

Cuttings are best taken in spring or summer, the length being from 6 to 8″ long (15-20cm). These can be dipped into a fungicide to help prevent rotting. Cuttings should be placed into a propagating pit with bottom heat of 21°C provided, and should be treated with hormone powder. High humidity during the rooting period should be maintained by frequent syr-

inging After several weeks a well-rooted plant develops which can be potted.

DARLINGTONIA CALIFORNICA (Cobra Lily)

Commonly called the cobra lily, this plant has an expanded hood and forked tongue, resembling a striking cobra. The pitchers may reach 30″ (75cm) in height, the tube widens gradually upwards, bending at the top where it is inflated to form the dome-like hood. The roof of the dome is heavily spotted with windows, and inside the pitcher is scattered with small nectar glands. Also found in the pitcher are stiff pointed hairs which are directed backwards towards the tube. The remainder of the tube is clothed with long, thin down-pointing hairs. No digestive enzymes appear to be secreted by *Darlingtonia*, but water is produced from the walls which is found at the bottom of a pitcher An insect is attracted into the dome by the nectar glands and starts feeding. When its time to leave, the insect flies to the most lighted portion of the dome which is the false windows on the roof and is thereby trapped and finally falls into the watery liquid at the bottom of the pitcher. Then with the aid of bacterial action the insect's body is slowly broken down into a nutritive solution which is finally absorbed into the plant.

General Cultivation. This plant is usually grown in pure spaghnum moss in about a 15cm pot size The plant should be protected from hot direct sun by the use of shade cloth, etc. and, in particular, the roots of the plant must be kept constantly cool, especially in the summer. The average temperature which seems best for these plants is from 12 to 15°C.

Propagation. The best method is by potting up offshoots from the rhizome, although it can also be propagated by seed. First the seed should be soaked in water until all have sunk to the bottom of the container. The seed should be sown on spaghnum moss with a fine covering over top of fine spaghnum moss Until germination has taken place the seed should be kept cool and away from direct heat, etc. Plants should be potted up as soon as they can be handled.

PINGUICULA (Butterwort)

There are 48 known species in this genus. All are fibrous-rooted perennials. In summer they develop flat rosettes of blunt oblong or elliptical leaves They are greasy to the touch, due to the droplets of sticky substance borne by the numerous stalked glands which cover the surface.

There are two kinds of glands on the leaf surface. The primary function of the stalked sticky gland is to catch and

detain prey, but also plays a secondary role in digestion. The other kind is similar to the stalked gland but is ¼ the size, and is seated in a slight depression. Both these glands produce enzymes which rapidly reduce and dissolve the soft parts of the insect The resulting nutritive fluid is absorbed into the plant's system.

General Cultivation. All Pinguiculas are retarded by root disturbance and should never be repotted while in summer growth. They require good light, but must be shaded from direct sun. The plants are best grown several to a pot to make a more compact unit. These, like all the other insectivorous plants, require frequent watering in the summer but with reduced water in the winter.

Propagation. This is done by seed sown in mid-winter in a pan with a mix of equal parts of peat and sand. The seed is placed on top and not covered. The pan should then be placed in a tray of water. After germination, the seedlings should be pricked out into their permanent pots, grouping several into a pot.

CEPHALOTUS

This plant possesses two types of leaves, the non-carnivorous foliage leaves and the pitcher leaves, which are borne in a rosette.

The Trap. This resembles a moccasin slipper in shape. It has a sideless heel having been curved over to form the lid. The belly is short and tubby, curving forwards towards the base. A curious feature of the internal structure of the trap is the thick wide collar below the rim which overhangs the well. This is covered with many nectar glands. The sides of the well are also glossily surfaced. In its upper part are numerous digestive glands.

General Cultivation. Again we have had good results growing these in straight spaghnum moss with weekly liquid feedings. Another mix which is used is two parts moss, one part leafmould, one part perlite, and one part sand. The pots can be placed in trays of water with regular watering throughout the summer. Plants should be shaded from the hot, direct summer sun.

Propagation. This is mainly achieved by division of the clumps. Root cuttings can also be taken from thick roots ½ to 1" (1.3 to 2.5cm) long, cut with a sharp knife. Use a mixture of two parts sand to one part peat moss. Lay cuttings flat, covering with 3mm of compost.

Leaf cuttings can also be taken, where the entire leaf is removed with the base (6mm) inserted into a bed of live

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 adaptions.

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 terrestial. 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.

Terrestial 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-