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SOME WAYS PLANTS CLIMB

CLIMBING plants often show adaptations that facilitate their climbing. These involve easily observed modifications of different plant parts, accompanied by internal modifications, particularly in the details of stem anatomy. In this note we shall consider only the external modifications.

For convenience in discussing them, climbing plants can be grouped in five general classes: 1) twiners, in which the main stem twines about a supporting agent; 2) branch climbers, having the side branches variously modified; 3) inflorescence climbers, with part or all of the inflorescence converted into climbing organs; 4) leaf climbers, with all or portions of the leaf modified; and 5) root climbers, in which special roots for climbing have been developed. These five classes will be discussed and illustrated by listing some examples suitable for growing in the greenhouse or out-of-doors. The lists include the scientific name of each plant, the name of the family to which it belongs, and a common name when available.

Twiners

Plants move. One simple plant movement is performed by the actively growing stem tip, which describes a circle or ellipse in the air. This phenomenon (technically called circumnutation), is a relatively basic act of plant growth, but is generally overlooked as it cannot easily be observed.

The magnitude of this movement may be measured in parts of a millimeter (about 1/25 of an inch) to as much as a meter (almost 40 inches). The circular movement of the stem tip is caused by differential elongation of plant cells, which in turn is controlled by differential distribution of plant hormones. For example, if the cells on one side of a stem elongate more than those on the opposite side, the stem bends in the direction of the side with less elongation. This type of movement is similar to that which causes plants to bend toward light in a darkened room. The time required for the stem tip to complete a revolution varies from a half hour to a day or more, so that observation at regular intervals will

allow one to see the progress of this phenomenon. A simple way to do this is to place a paper collar loosely around an actively growing shoot (a morning-glory is a good subject). Place a light directly above the pot containing the plant, so that the stem apex throws a shadow on the paper collar. Mark the position of the shadow on the paper collar with a pencil and make a note of the time. As the shoot apex moves, the shadow moves, and a time sequence can be established.

The twining habit, I believe, results from an exaggeration of the basic movement of circumnutation. It is relatively easy to understand how a plant with considerable apical movement twines — it merely has to have its free movement interrupted by an object smaller in diameter than the radius of its growing circle. Approximately half of all twiners have developed the supplementary mechanism of a sensitive stem (that is, there is a positive reaction to a contact stimulus) which increases differential cellular elongation and enhances the twining process. Other adaptations that facilitate twining are all geared to the reduction of weight of the stem tip. These include thin stems, strong apical dominance with little or no development of side branches, and delayed expansion of the leaf blade. Shoots that combine all of these features and circumnutate at a rapid rate are often called "searcher shoots," and their function is self-evident.

Much has been made of the direction in which plants twine, i.e. left *vs* right-handed or clockwise *vs* counter-clockwise. There is some common belief that the direction of twining is dependent on whether a particular plant is grown in the southern or northern hemisphere. Actually, few plants can be relied upon to maintain a definite twining direction, and most reverse direction from time to time. One notable exception is found in some species of *Dioscorea* (the true yams) in which the direction of twining is consistent enough to be helpful in the classification of members of the group.

In the following plant lists, herbaceous and woody twiners are listed separately. Care must be exercised in the placement of woody twiners in an outdoor situation, as the more robust ones such as *Celastrus* can cause severe damage or death to trees. Obviously, these powerful twiners should be grown on strong trellises or poles.

Herbaceous Twiners:

Scientific name	Family	Common name
Anredera cordifolia	Basellaceae	Madeira-vine
*Argyreia speciosa**	Convolvulaceae	
Bomarea spp.*	Amaryllidaceae	
*Dioscorea villosa**	Dioscoreaceae	
Hoya spp.*	Asclepiadaceae	Waxplant
Humulus japonicus	Moraceae	Japanese Hop

Herbaceous Twiners (cont.)

Ipomoea spp.	Convolvulaceae	Morning-glory
*Lapageria rosea**	Liliaceae	
Menispermum canadense	Menispermaceae	Moonseed
Polygonum aubertii	Polygonaceae	Silver Fleece Vine
*Senecio confusus**	Compositae	Mexical Flame Vine
Thunbergia spp.	Acanthaceae	Clockvine

Woody Twiners:

Scientific name	Family	Common name
Actinidia spp.	Dilleniaceae	Chinese Gooseberry
Akebia spp.	Lardizabalaceae	
*Araujia sericifera**	Asclepiadaceae	Cruelvine
Aristolochia durior	Aristolochiaceae	Dutchman's Pipe
*Beaumontia grandiflora**	Apocynaceae	Herald's Trumpet
Celastrus species (Plate XVIII)	Celastraceae	Bittersweet
*Kadsura japonica**	Schisandraceae	Scarlet Kadsura
Lonicera japonica‡	Caprifoliaceae	Japanese Honeysuckle
*Petraea volubilis**	Verbenaceae	Sandpaper-vine
Pueraria lobata	Leguminosae	Kudzu-vine
Schisandra chinensis	Schisandraceae	Chinese Magnolia-vine
*Stephanotis floribunda**	Asclepiadaceae	
Wisteria floribunda	Leguminosae	

* Suitable only for greenhouse use in our northern climate. Some of these tropical species may be grown as annuals out-of-doors.

‡ Although Japanese honeysuckle generally grows within bounds in more northern areas it has become a dangerous weed in the south and care must be taken to see that it does not get out of hand.

Branch Climbers

The use of branches as climbing devices seems to be a more sophisticated method than simple twining. A complete range of modification can be found from

branches borne at right angles to the main stem, to those that have become hook-like structures, to those developing tendrils. In some plants these modifications occur spontaneously, but in others stimulation by contact is required. Oddly, this category of climber is most often associated with plant groups possessing opposite leaves.

Tendrils are slender, wire-like climbing organs which are highly sensitive to contact stimuli. The following remarks apply in general regardless of the origin of the tendrils (which can be modified stems, leaves, or inflorescences), as they all behave in essentially the same way. Tendrils circumnutate just as stem tips do, and they seem to be under a similar hormonal control. Most frequently the young tendril extends beyond the circumnutating stem tip and revolves independently of it. This double movement does not present difficulties to the plants, but when circumnutation of the tendril continues after that of the main axis has ceased, a new regime must be established; either the tendril curtails its circumscription by one half and straightens to pass the stem, or the main stem is engaged by it. On engagement the stem usually is released by the tendril and circumnutation is resumed (the mechanism for this action is not understood). Tendrils are extremely sensitive and are able to detect very small degrees of resistance to their free movement. The sensitivity of the tendril to touch may be general or restricted to very precise areas, depending on the species. The time span in which a tendril is active varies with the species and may be as long as a month. If not stimulated within its active period it often withers.

In the family Cucurbitaceae (gourds, cucumbers, squashes, etc.) tendrils are more highly specialized than in most other groups. In addition to the twining action already described, they have developed a secondary modification to increase their holding efficiency. After a tendril has twined about its support and is securely fastened it begins a double coiling action from a central point on the tendril. The structure formed resembles a spring and seems to function in the same manner.

Branch Climbers (variously reflexed branches):

Scientific name	Family	Common name
Combretum spp.*	Combretaceae	Bottlebrush
*Hippocratea volubilis**	Hippocrateaceae	
Lycium halimifolium	Solanaceae	Matrimony-vine
*Periploca gracea**	Asclepiadaceae	Silkvine
Plumbago spp.*	Plumbaginaceae	Leadplant

Branch Climbers (tendrils of branch origin):

Bryonopsis laciniosa	Cucurbitaceae	Marblevine

PLATE XVIII

(Top) *Celastrus orbiculatus*, a commonly grown woody twiner valued for its colorful fruits in autumn. (Bottom) *Congea tomentosa* (Verbenaceae), a typical non-sensitive branch climber. Its special modifications are stems with long internodes and well developed opposite branches borne at right angles to the main stem.

Branch Climbers (tendrils of branch origin): (cont.)

Cucurbita pepo var. *ovifera*	Cucurbitaceae	Gourds
Luffa cylindrica	Cucurbitaceae	Vegetable Sponge
Momordica spp.	Cucurbitaceae	Balsamapple
Sicyos angulata	Cucurbitaceae	Bur-cucumber

Inflorescence Climbers

Employing all or part of an inflorescence as a climbing mechanism is efficient only in terms of climbing, since flower production must necessarily be curtailed. In many species belonging to this class of climbers, flower production is completely suppressed, making it difficult sometimes to separate this class from the preceding one. In these instances precise determination requires detailed anatomical and developmental studies. Functionally the inflorescence climbers employ techniques similar to those described for the branch climbers. The modification of the inflorescence is most commonly in the form of either a tendril or a reflexed hook.

Inflorescence Climbers

Scientific name	Family	Common name
*Bougainvillea spectabilis**	Nyctaginaceae	
Inflorescence parts converted to simple reflexed hooks which become woody with age.		
*Antigonon leptopus**	Polygonaceae	Coral Vine
Tip of inflorescence converted into tendrils.		
*Cardiospermum halicacabum**	Sapindaceae	Balloon-vine
Lower portion of inflorescence base converted to watch spring-like tendril.		
Cissus spp.*	Vitaceae	Ivy Treebine, Grape Ivy
Entire inflorescence converted to twining tendrils.		
Parthenocissus quinquefolia	Vitaceae	Virginia Creeper
Whole inflorescences converted to branched tendrils with sucker-discs at tips.		
Parthenocissus tricuspidata	Vitaceae	Boston Ivy
As preceding species.		
Passiflora spp.* (Plate XIX)	Passifloraceae	Passion Flowers
Entire inflorescence or a portion of it converted to tendril.		
Paullinia spp.*	Sapindaceae	
Lower portion of inflorescence converted to tendril.		
Securidaca spp.*	Polygalaceae	Easter-vine
All parts of inflorescence sensitive and tendril-like in action but no special tendrils.		

PLATE XIX

(Top) *Dalbergia* sp. (Leguminosae), a climber with lateral branches modified into tendril-like structures. (Bottom) A passion flower, *Passiflora coccinea*, climbing by simple, sensitive tendrils which are highly modified inflorescences.

Leaf Climbers

Some of the most highly evolved climbing mechanisms are found among the leaf climbers. This category may be subdivided on the basis of the part of the leaf modified: 1) the entire leaf, 2) the petiole and stipules, 3) the midrib, and 4) the apex. The modifications (Plate XX) are often so unique that in some instances comments within the plant lists are again necessary.

Entire Leaf Modified:

Scientific name	Family	Common name

Asparagus plumosus Liliaceae
Entire leaf converted to horny reflexed hook.

*Anisostichus capreolata** Bignoniaceae Crossvine
Compound leaves converted into compound twining tendrils.

*Doxanthus unguis-cati** Bignoniaceae
Has opposite compound leaves each composed of three leaflets. Leaflets of one leaf of each pair converted into three hooks (appearing like bird's feet). When tips of the hooks secure a hold they produce additional tissue and grow into the irregularities of the substrate surface.

Rubus cissoides Rosaceae
Leaf blade becomes very much reduced with three main veins developing many retrorse thorns.

*Ruscus androgynus** Liliaceae Climbing Butcher's Broom
Entire leaf converted into a reflexed hook.

Petiole and Stipule Modifications:

Clematis spp. Ranunculaceae
Leaves are divided into leaflets and the petiolule of each leaflet is sensitive and somewhat tendril-like.

*Quisqualis indica** Combretaceae Rangoon Creeper
As leaf matures, the petiole reflexes and becomes hook-like. The hook is persistent and becomes woody long after the leaf blade is shed.

*Rhodochiton volubile** Scrophulariaceae
Combination petiole twiner and stem twiner.

Smilax hispida Liliaceae Greenbrier
A pair of twining tendrils found near the junction of blade and petiole.

Tropaeolum majus Tropaeolaceae Nasturtium
Petiole sensitive and tendril-like.

PLATE XX

Diagram of various modifications of leaf parts to form climbing organs. ***a,*** *Calamus* sp. (Palmae) frond apex modified into retrorse hooks. ***b,*** *Gloriosa rothschildiana* (Liliaceae) leaf apex modified into tendril. ***c,*** *Asparagus plumosus* (Liliaceae) entire leaf converted into reflexed hook. ***d,*** *Nepenthes* sp. (Nepenthaceae) midrib acts as tendril during development. ***e,*** *Tropaeolum* sp. (Tropaeolaceae) petiole sensitive and twining. ***f,*** *Smilax* sp. (Liliaceae) stipules modified into tendrils. ***g,*** stylized drawing of unmodified leaf.

Midrib Modified:

Nepenthes spp.	Nepenthaceae	Climbing Pitcher-plant

As leaf develops a blade is formed. The tip continues growth and becomes a sensitive twining tendril. Further growth produces an elaborate and characteristic pitcher at the apex of the tendril.

Apex Modified (tendrils):

Adlumia fungosa	Papaveraceae	Climbing Fumitory
*Cobaea scandens** (Plate XXI)	Polemoniaceae	Cup and Saucer-vine
Flagellaria spp.*	Flagellariaceae	
Gloriosa rothschildiana	Liliaceae	Gloriosa Lily
Lathyrus odoratus	Leguminosae	Sweet Pea
*Mutisia latifolia**	Compositae	
*Stylidium scandens**	Stylidiaceae	

Apex Modified (hooks):

Calamus ornatus	Palmae
Desmoncus major	Palmae

Root Climbers

At least 30 percent of all the flowering plant families that have climbing members include some root-climbers among them. Since roots used in climbing have their origin in stems rather than in other roots, they are called "adventitious" roots. They may be restricted to the nodes (points of leaf attachment), or may arise anywhere along the climbing shoot. Usually adventitious roots arise only on the side of the shoot towards the surface being climbed, where the humidity may be slightly higher and the light less intense. Specialized climbing roots are short in length and life duration. They have an increased sensitivity to contact stimuli and an accompanying loss of positive geotropism. Very often the shoot that gives rise to adventitious roots is restricted to the function of climbing and the side branches from it perform the photosynthetic and reproductive functions. In this case the climbing shoot often bears leaves of smaller size and sometimes different shape from those of the lateral branches. The incorrect terms "juvenile shoots" and "adult shoots" are often applied in these instances to differentiate the two types of shoots. Climbing shoots of some length climb either in a very open spiral or the shoots are noticeably zig-zag to make full use of mechanical advantage inherent in such a system.

PLATE XXI

Cobaea scandens (Polemoniaceae). A leaf climber with compound leaves, the terminal leaflets of which are converted into sensitive tendrils.

Root Climbers:

Scientific name	Family	Common name
Campsis radicans	Bignoniaceae	Trumpet-creeper
Epiphyllum spp.*	Cactaceae	Orchid Cactus
Euonymus spp.	Celastraceae	
*Ficus pumila**	Moraceae	Creeping Fig
Hedera helix	Araliaceae	English Ivy
Hydrangea anomala	Saxifragaceae	Climbing Hydrangea
Monstera spp.*	Araceae	
Philodendron spp.* (Plate XXII)	Araceae	
*Piper nigrum**	Piperaceae	Black Pepper
*Rhaphidophora aurea**	Araceae	
Rhus radicans	Anacardiaceae	Poison Ivy
Schizophragma hydrangeoides	Saxifragaceae	
*Vanilla planifolia** (Plate XXII)	Orchidaceae	Vanilla

A sixth class of climbers may be needed to include a number of plants that climb but in which an obvious adaptative mechanism is not present. These plants sometimes are called "weavers." A good example is the climbing roses where the only adaptation seems to be the production of long canes with thorns. As non-climbing roses also possess thorns there is a legitimate question of whether or not the thorns are evolved specifically as a climbing adaptation. The term weavers implies that these plants climb by forming a large mass of inter-twined branches. Such plants usually are planted in conjunction with a trellis or other support.

Finally, there are a few plants that are often mistaken for climbers. Some species of *Clusia* and *Ficus* fall into this category. Seed germination often takes place in a tree crotch or axil of a leaf (palms are particularly favored habitats) sometimes high above ground level. As the seedling develops (Plate XXIII), specialized roots hold it to the substrate while others grow toward and eventually reach to the ground and provide the water and minerals necessary to insure continued growth. As the seedling develops in size the substrate tree may be destroyed and as its decomposition takes place the former climber (which by this time may be quite large) becomes free-standing.

PLATE XXII

(Left) *Vanilla planifolia* (Orchidaceae) climbing the stem of a tree fern by adventitious roots, produced singly at each node. (Right) A root climber, *Philodendron* sp. (Araceae), with horizontal holding roots which secure the plant to the tree and vertical nourishing roots which descend to the ground.

Climbers are especially rewarding for the gardener, for their potential interest is not limited solely to the flowering period. In addition, they can be employed to brighten difficult-to-handle locations such as walls, fences, and tree trunks. Some of them are a bit particular about exposure, soil, etc., and consultation with one of the excellent available reference books will prove helpful. Many plant and seed catalogs also offer useful cultural directions. The plants listed above are only a sampling of the climbers available; others will no doubt come to mind displaying additional climbing mechanisms or variations on those previously mentioned. One or more of these climbers deserves a favored spot in your garden or greenhouse.

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PLATE XXIII

Clusia rosea (Guttiferae). Not a climbing plant but one which has germinated on the palm plant and has formed horizontal holding roots and vertical nourishing roots which have reached the ground. The vertical roots eventually become stem-like.