B.—Climbing Plants.

CHAPTER XI.

On Climbing Plants.

THE sweet-pea, the bryony, the clematis, the vine, the ivy, the hop, the passion-flower, the sarsaparilla, the deadly nightshade, the virginian creeper are but a few of the plants, whose graceful forms will rise in imagination before every observer of Nature at the bidding of the title of the first of the botanical works of Charles Darwin. Two questions rise most naturally to the lips of each observer. What advantage do these plants derive from climbing, and how do they climb? Of the advantages derived by plants from this habit other writers have spoken. To be able to reach the light and to expose green surfaces to its action and to that of the air is of distinct value to the plant. But to the inquiry as to how this desirable end has been attained no answer in any sense fully satisfactory had been given until in 1865 the journal of the Linnæan Society was honored by containing an essay subsequently enlarged into the book known as "Darwin's Climbing Plants."

Herein, as everywhere in his writings, the naturalist is found to be very keenly alive to the beautiful adaptations encountered in Nature. But with him there is no talk of design or of the wisdom of the impalpable. Throughout the 206 pages of this book the word god never once occurs. When he sees a beautiful adaptation of some organ to some end he asks what is the advantage in the life-struggle to the possessor of that organ of the end attained, and through what slow steps of gradual change has the organ passed to its complete adaptation. They are to be found, these intermediate steps to-day. Witness in the common grape-vine the series of gradations between the ordinary flower-stalks and that extreme modification of a flower-stalk known as the tendril of the vine. Witness in the common garden berberry the series of gradations between the ordinary leaves and the extreme modification of a leaf known as a spine. And the acute mind of a Darwin recognises in the plants to-day many more of these intermediate steps, and sees ever the growing evidence that there has been no leap, no hiatus, but an unbroken series connecting the primal plants with those that throng our fields, woods, and gardens at this hour.

Climbing plants present four divisions. (1) Those climbing by the aid of rootlets, as the ivy. (2) By aid of hooks, as some few roses, one species of *Rubus (R. australis)* and the yellow bedstraw. (3) Twining plants, as the convolvulus or the hop. (4) Plants with sensitive organs that coming into contact with any structure, clasp it, as the clematis or the vine.

(1) Rootlet Climbers. Only a few pages are devoted to these plants. The ivy has nothing of the power possessed by other plants that will be described anon of moving either towards or from the light. Its rootlets allowed to press against glass adhere very slightly thereto and secrete a small amount of yellowish matter. A particular kind of fig, upon close investigation by Darwin, gave evidence that led to the belief that its rootlets first secrete a viscid fluid, absorb the watery part thereof (the fluid will not dry on exposure to the air even for many days) and leave behind a cement. These rootlets, when allowed to press against glass, left upon removal atoms of yellowish matter like that formed by the ivy rootlets.

(2) Hook-Climbers also call for but passing notice. They show no spontaneous revolving movement, if they are simply hook-climbers. Very frequently, however, hooks are developed upon the twining and tendril bearing plants. To these last, as of far greater interest, I now pass.

(3) Twining Plants. When the stem of a hop-plant comes out of the ground its first two or three internodes (the portions of the stem intervening between the points of insertion of successive leaves) grow up erect. Then even though none other plant and no beneficently-placed hop-pole be near, the young internode that is now formed at the top of the growing stem bends slowly and gracefully to one side and travels steadily round to every point of the compass, describing a complete circle, as the

minute hand of a watch moves over the face. Two hours eight minutes is the average length of time that each swing round occupies, and as each internode of the stem grows older and younger ones are formed upon its summit it ceases to revolve. Thirty-seven of revolutions such as these were performed by one carefully-observed internode of a hop-plant ere it suddenly became motionless. This number of revolutions performed by only one internode of the plant, considered in conjunction with the number of internodes successively developed, will give some idea of the admirable chance the plant will have of striking in its revolutions against some support and then revolving round that support. For as soon as the revolving stem, wandering round and round, strikes some support, it will necessarily cease to grow at the point of contact but as the free projecting part beyond continues to revolve the point of contact will become a line and the hop will twine round the hop-pole.

The twining plants in our temperate climate are only able to grow round stems of moderate thickness. They cannot compass huge stems. The power to do so would be injurious to them, for, as they are only annual plants, in one year they could not if they twined round trees of great circumference struggle up into the light. On the other hand, the twiners of tropical forests are able to work round trunks of trees and for them this is well. Amidst the dense luxurious growth of the tropical forest, were they destitute of this power, plants of many years' duration could never hope to grow up into the light at all. Thus is the great truth of Natural Selection once more to the fore with an explanation.

It has been mentioned above that many twiners have hooks developed at the end of the shoots. These serve to seize the support and also enable the shoot to obtain a much closer hold upon that support and thus prevent the ever-present possibility of the shoot being blown away from its support by the wind from becoming actual.

Finally comes the inquiry into the reason of this remarkable revolution of plants. The reply to this inquiry is due to other thinkers than our greatest. None has, however, made greater or more legitimate use of the principle about to be enunciated than the author of "Climbing Plants."

Not only is light not necessary to growth—it is injurious. Plants grow better in the dark, as some people seem to think children do, judging from their method of punishment. They *feed* better in the light. The side of a stem therefore remote from the light will grow more rapidly than the side of the stem turned towards the light. Thus plants grow lightwards. Thus the vagrant vines go "seeking the sunshine." These strange revolutions of the twining stems are due to greater growth upon the side of the stem that is away from the centre of the circle described by the twining plant, and when that plant catches a support the arrest of growth upon the side of the stem next the support and the continuance of the growth upon the side of the stem away from the support will cause the twiner to grow round and round the body upon which it rests.

(4) Plants with sensitive organs. Of the true climbing plants as distinct from mere twiners or from those that climb by means of hooks or by means of rootlets; of those plants that climb by the help of organs that undergo movement when they are touched two divisions exist. These are (*a*) leaf-climbers, (*b*) tendril bearers. These will be considered in the present chapter. (*a*) Leaf-climbers. (i.) The earliest condition of those sensitive plants, whose sensitiveness leads to the remarkable movements known as "climbing," is encountered in a plant closely allied to our English Snapdragon. In this plant the peduncles or stalks of the flowers revolve in a feeble fashion, and are slightly sensitive to a touch. As yet, however, these flower stalks are not turned into true tendrils, and we have here only the very earliest stage of a true climbing plant. (ii.) The next condition is met with in the Gloriosa, a member of the lily order. In this plant the leaf actually becomes a sensitive organ, having for function the help of the plant in its upward growth, lightwards. But it is only just the tip of the leaf that is modified. (iii.) The petioles or leaf-stalks next take on the functions of revolution, of sensitiveness, of clasping and climbing. Of this no better illustration can be than the familiar Clematis. The upper, younger internodes of most species of Clematis go wandering, after the manner of the twining plants, round and round in slow circles. Thus the leaves run good chance of coming into contact with stems or twigs, or even the trellis-work that the hand of man has erected at the southward-looking porch of the country home. Such objects as are thus encountered are seized slowly but

surely by the petioles or leaf-stalks of those leaves that are borne into collision with these objects of support. For the petioles of the Clematis are sensitive, and the moment they come into contact with any object they begin to grow less vigorously upon the side thus touched, whilst upon the side that is free they continue to grow as strongly as before. Hence the leaf-stalk winds slowly round the supporting body holding it in ever closer and more extensive embrace. Internodes at the upper part of the stem slowly swinging round in circles : contact of the petioles of the leaves with other bodies : the sensitive petioles growing in less degree upon the side of contact than upon the side that is free ; slow winding of the petiole round and round the supporting body and your Clematis is a climbing plant. These three stages, then, have been observed. (i.) The plant allied to the snapdragon, with its feeble revolutions and its feeble sensitiveness ; (ii.) the Gloriosa with its sensitive, clinging leaf-tip; (iii.) the Clematis with its sensitive petioles. Even between these gradations are yet others. In evolution it is veritably " wheels within wheels." Thus in the different species of Clematis a remarkable set of gradations present themselves between the very limited sensitiveness of *Clematis montana* and the far more general sensitiveness of *Clematis viticella.* It is very interesting to watch in the various plants the responsive power to touch spreading over larger and larger areas with constantly increasing advantage to the plant. And again in the Tropæolum of our gardens, more commonly known as the Indian cress or as the nasturtium or " sturtian " of the gardener, many stages are seen between certain threads with just a suspicion of flattening at the free end and perfect leaves. Of this plant Darwin writes .—

" Until the plant grows to a height of two or three feet, requiring about a month from the time when the first shoot appears above ground, no true leaves are produced, but, in their place, filaments colored like the stem. The extremities of these filaments are pointed, a little flattened, and furrowed on the upper surface. They never become developed into leaves. As the plant grows in height new filaments are produced with slightly enlarged tips; then others, bearing on each side of the enlarged medial tip a rudimentary segment of a leaf ; soon other segments appear, and at last a perfect leaf is formed, with seven deep segments. So that on the same plant we may see every step, from tendril-like clasping filaments to perfect leaves with clasping petioles. After the plant has grown to a considerable height, and is secured to its support by the petioles of the true leaves, the clasping filaments on the lower part of the stem wither and drop off; so that they perform only a temporary service."

(*b*) Tendril climbers. A tendril is a structure that is sensitive to touch and is used for climbing. These thread-like organs with their ready response to any contact and their notable power of twining round and clinging to objects, are the loftiest stage encountered in the study of climbing plants. We have seen rootlet climbers and hook climbers; we have seen plants climbing by aid of *part* of their leaves, as the tip or the stalk. Now we come to plants that climb by means of special structures that are modifications of complete organs, not of parts of organs, and are known as tendrils. Let us consider (i.) the organs transformed into tendrils (ii.) two or three special plants that are tendril bearers (iii.) the adhesive structures seen at the free ends of certain tendrils (iv.) the spiral contraction of these organs after they have caught their supports (v.) the causes of their revolution.

(i.) These tendrils are formed out of various organs. Thus the tendril of the passion-flower is a whole branch transformed: that of the vine is a flower-peduncle: that of the ordinary pea is a modification of certain of the leaflets: that of the sweet-pea of the whole of the blade of the leaf: that of the sarsaparilla plant or of the cucumber and its allies arises from the alteration of the little leaf-like bodies seen at the base of the petiole in some plants—*e.g.*, the rose, and known as stipules.

(ii.) If anyone will examine the tendril of the grape-vine he will find the following arrangement. From the main stem comes off a common peduncle that soon divides into two parts. Of these two parts one bears flowers, the other becomes the tendril. The common peduncle does not respond to a touch or a rub at all: the one of its two divisions carrying flowers is feebly sensitive: the true tendril is excessively sensitive. Sometimes the division that bears flowers carries only a few blossoms. In those cases it is very interesting to notice that this division is then far more sensitive, and has indeed taken on more of the character of a true tendril. The whole apparatus of common peduncle, flower-bearing division and true tendril, is capable of slow spontaneous movement, that affords to the tendril every chance of coming into contact with some object of support.

The bignonia, species of which can be seen at Kew, has tendrils that are modified leaves. It is a plant of especial interest on account of its remarkable habit of searching, as it were, for holes or crevices wherein to insert the extremities of its tendrils. The tendril will travel slowly over the surface of a woody stem until some hole is reached, when the end of the tendril straightway passes into the aperture. Sometimes the tendril is fastidious, and, not satisfied with the particular hole it has first encountered, will draw itself out again and insert itself into another more to its liking. Such a habit would naturally be of value to a plant growing upon trees with many noticeable irregularities of surface, and the bignonias affect especially trees that are covered with moss or lichens.

Of the Cucumber order one very remarkable climber is known by the somewhat lengthy appellation of *Echinocystis lobata*. As the tendril revolves at an angle of about 45° with a horizontal line, suddenly at one part of its course it stiffens and straightens itself so as to become for a little time nearly or quite vertical. If this strange temporary straightening did not occur, the free revolving end of the tendril would without doubt strike against the extremity of the plant, and the tendril would be arrested in its movement by the plant itself. This is prevented by the temporary straightening of the tendril, and as soon as by this device the end of the climbing organ has passed beyond the end of the stem of the plant that forms the obstacle in its way the tendril falls again into its old inclined position.

(iii.) The development of adhesive masses at the free ends of tendrils demands especial notice. The well-known Virginian creeper, so often seen covering the sides of houses to-day, a plant belonging to the same order as the vine, presents such structures. Soon after the tendrils of the Virginian creeper have laid themselves down, as it were, upon a wall the tips swell, become red and form little disks or cushions. These envelope "every minute and irregular projection, insinuate themselves into every crevice," and also appear to secrete a resinous and adhesive cement, reminding us of the ivy among the root climbers. Some of the bignonias and certain members of the cucumber order present the same peculiarity.

(iv.) When tendrils have clasped a support they undergo a general spiral contraction that necessarily shortens their length, and confers upon them a very distinct elasticity. The contraction begins from half-a-day to two or three days after the tendril has caught its support. This spiral contraction is of the utmost value to the plant. If the shoot is inclined, the shortening of the tendril draws it up and lifts the leaves yet more fully into the light. If the shoot is vertical, the shortening of the tendril is of use, for but for that shortening as the main stem grew, the shoot would be left slack, were it not for the spiral contraction which draws up the stem as its length increases. Again, the tendrils being thus rendered highly elastic, the strain due to the weight of the supported plant is distributed over many branches, not concentrated too greatly at one point. Further, a tendril that has seized upon a support, always becomes twisted in one direction in one region of its length, in the opposite direction in another region of its length, whilst between the two regions of opposed twisting intervenes a straight portion. But for this curious reversal of the twist of the tendril that organ would during the process of spiral contraction now under study become ruptured. Those who have noticed a draper winding up a piece of ribbon as he says, "And the next article, please?" or those who have ever flown kites, will understand the value of this reversal of the twist of the tendril.

(v.) Finally the causes of the revolution of tendrils. Probably these are of nature similar to the causes of the movements of the twining plants. There is increased growth along a special line of the tendril: a longitudinal line that travels slowly round the organ and bows successive parts to the opposite side. This growth is of course upon the side opposite to that which becomes concave. Charles Darwin is also of opinion that along with this increased growth upon the convex side there is contraction of the cells along the concave side. By both these means the sensitive tendril will be made to grow slowly round the object of support, fulfilling its functions as the most specialised organ met with among the climbing plants.