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OBSERVATIONS ON THE CLIMBING ORGANS OF OLAX.

By

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MELCHIOR TREUB published a treatise in 1883 entitled "Sur une nouvelle categorie de plantes grimpantes". In it he described the climbing organs of representatives of the genera *Uncaria, Ancistrocladus, Artabotrys, Luvunga, Olax, Hugonia* and *Strychnos*, explaining them as short shoots transformed into sensitive hooks. When such a hook has embraced an object, it becomes irritated and then begins to grow in thickness, causing the hook to tightly grasp the covered object. The sensitive hooks therefore made extremely sophisticated climbing arrangements.

During a short stay in the jungle adjacent to the botanical garden ("Waterfall garden") in Penang, I noticed a peculiar liana, which formed a formal network due to "adhesions" of their separate stems, laid out over the nearby shrubs and trees. It showed that the cohesion was due to the above-mentioned climbing hooks, as ascertained by TREUB. When I made my observations, TREUB's work was not known to me, which is why I thought I had made a completely new obervation. The peculiarity of the present climbing arrangements has not been considered in the textbooks and manuals. I therefore consider it appropriate to once again pay attention to them, the more so as I am able to extend our knowledge beyond TREUB's findings.

The liana from which material was collected is either identical to *Olax scandens* or at least very close to this species. Since no flowers were present, the determination could not be carried out with absolute certainty.

The long-shoots are provided with two straight opposed, at least in younger stages, very sharp protruding ribs, which coincide with the two orthostichies. The leaves are scattered and in 1/2-position. Immediately above the point of attachment of the leaf there is a distinct torus on both sides of the shoot, which extends from there to a rib running along the shoot, which is not as pronounced as the main ribs coinciding with the orthostichies. The two "lateral ribs" lie in the middle of the main ribs. In the leaf axils buds form, which do not develop further at the lower parts of the long-shoot. If a long-shoot is damaged, new long-shoots can arise from such axillary buds, the first stem members are then very short. The "long-shoots" can sometimes have a sympodial construction. Axillary buds further up on the long-shoots grow out to side shoots. As a result of the growth conditions, these axillary and side buds developing therefrom move a comparatively long distance above the axial angle on the long-shoot. There is therefore a weak concaulescence here. Then in the axil a new bud shows up, an accessory bud (Figure 1 *a*), which lies between the petiole and the primary bud or its derivative, and between the two above-mentioned bulges. The axil therefore produces here serial buds. What function the adventive bud in *Olax* fulfulls, I do not know. In many other plants with serial buds, where the primary axillary bud or its derivative has moved up – for example, in many representatives of Rubiaceae, the adventive bud has the ability to regenerate damaged long-shoots. I assume that this is also the case with *Olax*.

The side shoot has limited growth under normal conditions. It has the following construction. First, you recognize a stem segment. Its leaf carries both a primary and an accessory bud in its axil. The primary bud develops into a raised short-shoot transformed into a hook. That this is really a short-shoot has been perfectly demonstrated by TREUB (1883), which by microscopic examination has demonstrated the presence of several rudimentary leaves at the tip of the young hooks (see TREUB 1883, Plate XII, Fig. 10). This segment is usually followed by a similar but shorter one. Here, too, therefore, a hook and an accessory bud form. This segment is followed by 2 to 5 pieces that gradually become shorter stem segments, in which the axils of the leaves usually carry at least only resting buds and no hooks. This feature sometimes marks the second stem segment. Rarely, however, can the third and even less often the fourth segment form hooks. The side shoots therefore carry usually 1, 2 or very rarely 3 or 4 hooks. If the tip of the lateral shoot is damaged, the dormant buds of the hookless axils begin to grow and form secondary lateral shoots, which as a rule carry only one hook (Fig. 1 a). The "side shoots" can thus sometimes have a sympodial structure or be branched. A good illustration of a part of a long shoot with hook-bearing side shoots is found in MASSART (1896, Plate XV, Fig. 12). If the side shoot is damaged further down, it will be regenerated by the accessory bud sitting under the hook. If the hooks are damaged at a younger stage, which seems very common – biting animals? –, thus, situated more towards the end of the longer segments of the side shoots and the leaf belonging to it is provided with a hook and an accessary bud axil.

However, the most interesting feature of this *Olax*-species are the hooks themselves. Under the hook you can see the same structures that could be perceived under the attachment points of the side shoot. Apart from the accessory buds therefore are also two bulges available. At a more recent stage, the hook is fairly uniformly thick. During development, its base thickened considerably, giving the hook the shape that TREUB wanted to characterize as "en forme de corne de rhinoceros". The tip of the hook is bent, giving it a spiral shape. The spiral rarely extends much more than one turn.

During its development, the hook performs another twisting motion. At the same time as it increases in thickness, the whole hook rotates about an axis which coincides with that of the side shoot. As a result of this rotation process, the hook is "laterally" attached to the stem and sometimes even at its origin just opposite side. When these rotational movements take place, the leaf from whose axil the hook was formed has already fallen off. The leaf scar is always preserved. The two tori and the accessory bud can mostly also be seen. As a result of the fact that the base of the hook has grown strongly, the tip of the hook-carrying shoot, the leaf scar, the accessory bud, and the torus then look like appendage-like formations of the hook. As a result of the rotation, these structures gradually change their position. Initially, the leaf scar and the accessory bud were located on the ventral side of the stem portion, on which the hook sat, and symmetrically on both sides of them ran the two tori. During the final stage of rotation, there is usually one torus on the dorsal side of the hook, the accessory bud and the leaf scar lie laterally, and the other torus on the ventral side (Fig. 1 b-d). Judging from this, the rotation rule has usually 1/4 turn

The twisting phenomenon described above finds its final closure when the hook accidentally includes a support. Then it is stimulated to renewed growth in thickness. It swells and clasps the object. As a result, a very effective attachment is achieved. If the object is a branch of a foreign plant, a side shoot of *Olax* or another hook, this kind of clinging takes place. However, the runner with the hooks gradually shows a tendency to die, just as there has been no contact with a foreign object. The eventually achieved support is therefore only of temporary duration. If the hook coincidentally came in contact with a long shoot of the same plant species, the course is however different. The hook is then irritated to grow to a greater thickness than in the cases mentioned above, but beyond that also the touched parts of the long shoot are stimulated again to extremely thick growth (Figure 1 *fg,* 2 a, *cd*) . At the long-shoot immediately above the hook forms an annular torus around the trunk as a result of this process. A similar torus soon forms under the hook, but is not nearly as vigorous as that one. The constantly increasing in thickness hook is compressed in this way by also increasing in circumference torus-like structures from above and below. The result is a tight union of the hook with the tori. The long shoots are usually set vertically. The hook is by its encirclement more or less in a completely horizontal position. It is therefore included on the top and bottom of the torus. Adhesion takes place on these sides (see Fig. 1j and 1i). It occurs first between the hook and the upper torus, but the inside (ventral side) of the hook and the long-shoot do not grow together (Fig. 1i-j). As a result of the described processes, the separate stems of the liana are held together by strong knots. Such "knots" considered from different points of view are shown in Fig. 1f-h. The individual wood masses merge homogeneously (see Fig. 1 i-j). Unfortunately, the material was not of such a nature that it would have been possible for me to carry out a closer anatomical examination of the “knots”.

After the above-mentioned adhesion has taken place, the part of the lateral shoot, which now forms the link between two long shoots, begins to grow secondarily in thickness. The part of the side shoot located above the “knot” seems to develop in different ways in different cases. It often stays completely unchanged. In many cases, this part of the side shoot shows the tendency to atrophy and soon to fall off. In other, but rarer cases, the result is just the opposite. The rest of the side shoot gets an increased vitality and turns into a perfectly normal long-shoot. What in these cases is the deciding factor in the development of the tip of the side shoot, I can not judge. Presumably, it is associated with the establishment of the intimate connection between the vascular channels, as well as with the age and degree of vitality of the lateral shoots and the clasped long-shoots at the moment of their connection.

Exceptions to the above conditions are rare, but they do occur. Thus, in very rare cases, when a hook has included a side shoot, here also an adhesion take place. Such a case is shown in Fig. 1 *e.*

The links can sometimes create very strange pictures. This is especially the case when several hooks have been included in each other and have also enclosed other stem parts. Such an entangled knot is shown in Fig. 2 *b.*

By forming the knots described above, which cause separate stems to unite with “bifurcations”, the *Olax* liana acquires the reticular appearance that I have previously described as its most conspicuous feature. The description shows that the ability of the liana to maintain itself is mainly due to this connection of the separate stems, i.e. through the network structure. If the hooks had included foreign objects, this was only a temporary method of keeping the plant upright. Once the attachment of one's own trunks has been achieved, the plant will stay upright even when the temporary bases disappear. TREUB (1883) also wrote: “Les crochets servent eu premier lieu, a lier entre elles les branches de plante meme” [The hooks are used in the first place, to bind together the branches of the same plant] (fig. 13 pl. XII) ". GAMBLE after SLEUMER (1935) proved that *Olax scandens* is a tree-killer.

The intertwining of individual strains belonging to the same individual or to different individuals of *Olax scandens*, which may possibly be considered as a form of parasitism and autoparasitism when the individual vascular channels are securely intertwined, has nothing to do with *Olax*'s earlier proven parasitism and autoparasitism – BARBER has according to SLEUMER (1935) demonstrated that the *Olax* roots are active in other plant roots as well as in their own haustoria.

The climbing arrangements described here for *Olax* are perhaps devices that also occur elsewhere in the plant kingdom. According to TREUBS illustrations, perhaps the same "idea" is realized by representatives of *Uncara* (TREUB 1883, Plate VII, Figs. 8-9) and *Artabotrys* (TREUB 1883, Plate XI, Figs. 6-12). Whether the events taking place here are identical with those described by me for *Olax* does not emerge from TREUBS work since he does not say whether the support, although this is stimulated to a very strong growth in thickness, is a foreign instinct or of the same kind belonging long-shoot, runner, etc. He does not expect here any more than *Olax* does, whether there is a real bondage or only a close grip. It is not excluded that the conditions in *Uncaria* and *Artabotrys* completely coincide with those in *Olax*. The same peculiar method of support of the lianas would then be realized in quite different families.

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Fig. 1. *Olax* cfr. *scandens*. - a. Part of a long-shoot with lateral shoot. b-d. "Hook" after embracing foreign objects, seen from different sides. The foreign objects are taken away. (Ne = accessory bud, BI = leaf scar, W = torus). – c and d are older than b. e. An adhesion between a "hook" and a side shoot has taken place. (-h.) A normal "growth knot" (the long-shoot is indicated by dashed lines), seen from different sides, ij. Cross-section through an "growth knot" (i is much older than j) The "hook" is transverse, the long-shoot is longitudinal. A = longitudinal cross-section of wood, the lines indicate the course of the wood elements, B = cross-sectioned wood, the dotted lines indicate the course of the pith rays, C = peripheral parts of the "hook" cut through, D = longitudinally intersected peripheral parts of the long-shoot, E = a particularly vigorous zone with stone cells.

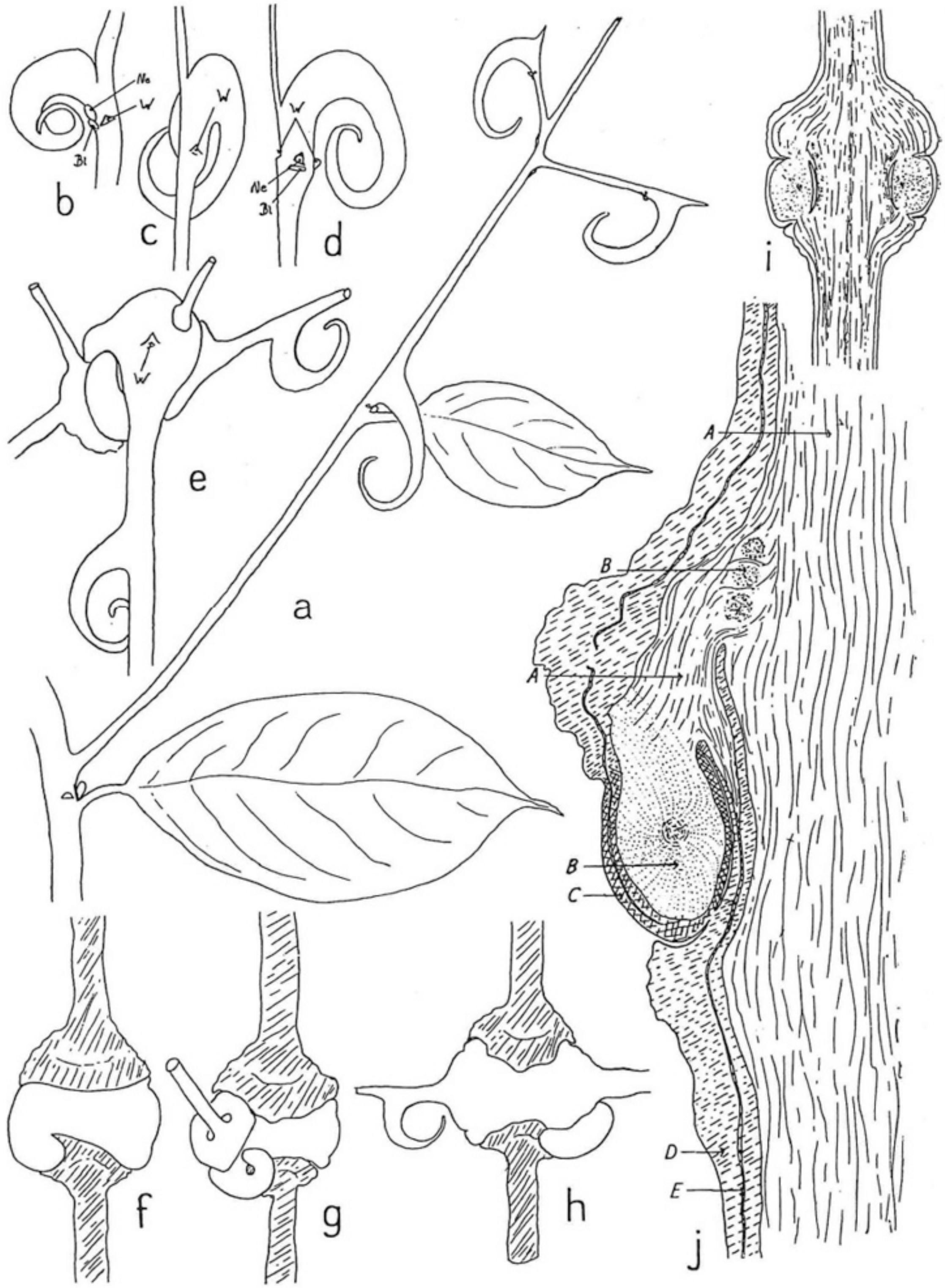

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Fig. 2. *Olax* cfr. *scandens*. "Bifurcations." Photos by T. HEMBERlG. c and d show the same "knot" from different sides; it is also visible a bit above the middle in a. The lower knot in b. is complicated and is formed by three "hooks" and a shoot.