THE FLORAL ANATOMY OF ANCISTROCLADUS

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ABSTRACT

The floral anatomy of Ancistrocladus heyneanus, the only representative in India of the genus, is studied. The nipple-like projection above the ovary is shown to be the upper part of the ovary itself and not the basal connivant part of the styles as commonly mentioned in Floras and adopted by Keng in his paper on A. tectorius. A number of earlier observations and conclusions are shown to be due to faulty interpretations of the structure.

INTRODUCTION

ANCISTROCLADACEAE is a monogeneric family of uncertain affinities. Bentham and Hooker (1862–93) place Ancistrocladus in Dipterocarpaceae under the order Guttifera!es, while Engler and Prantl (1889–97) keep Dipterocarpaceae and Ancistrocladaceae along with a number of other families in their order Parietales. The genus has about 20 species. The flower has 5 sepals, 5 petals, 10 stamens in most of the species, and a syncarpous, unilocular tricarpellary ovary, usually described as inferior, and having a single laterally basal ovule. There are 3 free styles. The present paper deals with the floral anatomy of Ancistrocladus heyneanus Wall., the only species available in India. Duly stained serial transverse and longitudinal sections, and also cleared flower-buds were studied.

FLORAL ANATOMY

The vascular cylinder of the pedicel is a continuous one from which small traces which branch further in their upward transit are borne at a level much beneath the insertion of the calyx or its main traces (Figs. 1–3). There is no definite relation between the place of origin of these traces and the position of the calyx or other floral parts. These run upwards in the outer region of the floral axis for varying distances and many of them...
disappear even beneath the level of the sepals. A few of them, however, persist and run for some length in the marginal parts of the sepals. Hence they can be called as accessory marginal traces of the calyx.

**Figs. 1-7.** Fig. 1. T.S. through pedicel showing a few accessory traces of the calyx. Fig. 2. Slightly higher level. Fig. 3. Sepal median traces (K) are borne by the vascular cylinder. Fig. 4. Slightly higher level. Fig. 5. Origin of (1) the conjoint sepal marginal-petal (C)—stamen (A) strands, some of which are partly divided into their constituent traces. The sepal marginal traces are not labelled in the diagram; (2) antesepalous stamen traces and (3) three dorsal traces (G) of the carpels. In the centre is the vascular cylinder. Fig. 6. Higher level, showing the contraction of the vascular cylinder into a single strand (OV) for the ovule. Fig. 7. Ovular trace entering the ovule (labelling as in the previous figures).

Five sepal median traces are borne a little above the origin of the above-mentioned accessory traces and prominent leaf gaps are associated with them. These gaps close a little higher (Figs. 3 and 4). The bases of 3 of the sepals are much larger than of the rest but this difference is not reflected in the size of the vascular bundles. The vascular cylinder contracts slightly, and while doing so bears certain outward traces (Figs. 4 and 5). Five of these divide into outer sepal marginal traces, inner petal traces and innermost stamen traces for the antepetalous stamens. The
radial disposition of these traces, however, gets often disturbed even near the point of division of the strand into these three bundles. The sepal marginal traces branch further even before entering the sepals and they supply margins of adjacent sepals. Alternating with the above-mentioned 5 strands, and opposite the sepal median traces are given out 5 other stamen traces for the anteseptalous stamens. Above the origin of these the

vascular cylinder bears 3 carpellary dorsal bundles (Fig. 5) and then contracts into a single strand (Fig. 6) which runs upwards, bends slightly laterally and enters the funicle of the ovule which is laterally basal in position (Figs. 7 and 11). The ovular trace runs within the integument for a considerable distance, passing over the crest of the ovule and descending slightly on the opposite side (Fig. 11). Two out of the 3 carpellary dorsal bundles
are opposite two of the large sepals, while the third one alternates with two other sepals. The dorsal strands are equidistant from one another. In the upper half of the ovary, at the level of the top of the loculus, these divide in the radial plane a number of times, giving rise to a ring of equal sized bundles in the ovary wall (Figs. 8 and 9). The dorsal bundles are indistinguishable from the laterals at this level. At the roof of the ovarian loculus a solid strand of transmitting tissue is formed in the median line and this extends upwards upto the base of the 3 styles (Figs. 9 and 11). This tissue is either solid throughout its length or may enclose a narrow longitudinal canal for some distance. In a reduced state the transmitting tissue continues into the 3 styles. Thus above the level of insertion of the androecium, the gynoecium extends as a dome-shaped or nipple-shaped solid structure with a ring of bundles (the dorsal and the lateral bundles of the carpels) and a central strand of transmitting tissue. The 3 styles arise from a small depression at its top (Fig. 11). Just beneath the level

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Figs. 11–13. Fig. 11. Diagrammatic L.S. of flower of *A. heyneanus*. The sepal marginal bundles which arise from the strand marked C + A are not shown (Acc—Accessory bundle). Fig. 12. Diagrammatic L.S. of flower-bud of *A. tectorius* redrawn from Keng’s paper, showing the recurrent bundles (Rec) and their course in the median portion of the gynoecium as depicted by him. In this figure, the vascular bundles are shown as dotted lines as done by Keng. Fig. 13, a, b, c and d. Successive transverse sections through a trace from base upwards. The appearance of the same trace in a longitudinal section passing through the line drawn across each is described in the text.
of the basal ends of the 3 styles, the lateral bundles of the carpels disappear leaving only the three dorsal bundles to run within the styles (Figs. 10 and 11). In the stigmatic region they bifurcate before disappearing. The actual separation of the sepals, petals and stamens occurs just above the level of the top of the ovarian loculus (Figs. 9 and 11). Although the sepals are completely freed only at this level, their margins become clearly demarcated even from the top of the pedicel. The level of separation of the calyx, corolla and androecium is more or less at half the distance from the base of the ovary to the base of the free styles (Fig. 11). Each of the sepals receives a median and some lateral bundles which continue to branch further. There is a short corolla-androecium tube (Fig. 9) which splits into its constituent parts. The 10 filaments, which are apparently in a single ring and detached also at the same level, are also laterally connate for a very short length. Each of the petal median traces also branches while entering the petal. The antepetalous stamens are shorter than the antesepalous ones.

**DISCUSSION**

Keng (1967) gave a brief description of the floral anatomy of *A. tectorius* (Lour.) Merr., a species which resembles *A. heyneanus* in general floral morphology, including the number of stamens. He mentioned that all his sections failed to reveal the structure of the ovule and that he believed that the differentiation of the tissues in the ovule must be at a very late stage. Thus the flower-buds observed by him must be very young ones in which the ovule appears just as knob. In mature buds the ovule is very well developed. As young buds do not show the full vasculature, he failed to observe a number of features of floral anatomy as well. Moreover, during the growth of the flower-bud, even the topographical relations between the traces are liable to change. The close similarity between *A. tectorius* and *A. heyneanus* in floral morphology makes one expect a similarity in vasculature as well, but due to observation of very young buds a number of his observations are wrong.

Firstly, Keng refers only to the 3 dorsal bundles of the carpels and to no other bundles of the ovary wall. *A. heyneanus* has in the upper half of the ovary wall a ring of bundles formed by the branching of the dorsal bundles. It is an accepted fact that only the main bundles of an organ would be seen in young buds. The branching can often be seen only at an older stage. It is very likely that old flower-buds of *A. tectorius* would show the prominent branching of the dorsal bundles as seen in *A. heyneanus*. 
Keng wrote that the "main traces", run in the hypanthium upwards for some distance, turn downwards to form what he called as "recurrent bundles", then abruptly bend upwards and meet at the base of the ovary locule where the placenta is located. He also wrote that "these traces further appear on the top of the ovary locule and finally meet the dorsal traces at the tip of the styles". He did not explain in the text how these appear at the top of the ovarian loculus, but his figure of a diagrammatic longitudinal section through a flower (redrawn for reference as Fig. 12 of this paper) shows that these travel upwards close to the loculus up to its top, bend inwards towards the centre, and then run upwards in the median line upto the bases of the styles. This is a most unlikely course for those bundles. His transectional figures of the flowers do not show these strands at all—because they are not there at all. He did not observe any vascular supply to the ovule. What is normally expected is that any bundle which goes close to the place of insertion of the ovule would either end blindly or enter the funicle. There is no reason why they should suddenly turn sideways after coming up to the ovule, run in the ovary wall upwards close to the loculus, then turn towards the centre to run up to the styles. It is the vascular cylinder of the floral axis which contracts into a single strand and supplies the ovule, running even within the integument. What he described as appearing at the top of the ovary loculus and running to the base of the styles is actually the strand of transmitting tissue and not vascular tissue at all. He observed very young buds with the ovule also not properly developed, and as such it is sometimes not possible to make out whether a strand of tissue appearing like a procambial strand develops into a vascular bundle or transmitting tissue or some other type. Keng apparently relied upon single longitudinal sections of the buds. He found what he thought as separate vascular bundles (actually a vascular cylinder with central parenchyma, cut longitudinally) running up to the base of the ovule. Being young buds the vascular bundle is not seen in the young ovule, but he saw the strand of transmitting tissue at the top of the loculus, assumed it as vascular bundles, and imagined that the vascular tissue which he saw at the base of the loculus must be going up along its sides and joining the tissue at the top of the loculus. Keng did not mention the number of recurrent bundles but because he said that these are downward extensions of the "main bundles" which according to him are 5 in number, these also must be 5 which run upwards to the base of the ovary and then appearing at the top of the ovary to run to the bases of the styles. This number 5 is irreconcilable with the fact that there are only 3 dorsal bundles which are equidistant from one another, and these five recurrent bundles are also equidistant from one another. Although Keng did not refer to ventral
bundles of the carpels anywhere, these 5 cannot be interpreted even as the ventral bundles, one less, because they are equidistant from one another. The course of the recurrent bundles reminds one distantly of the condition seen in some Santalaceae. No reference is made to the orientation of the xylem in these bundles, which should be reverse if they are really recurrent. *A. heyneanus* does not show any recurrent bundles, and Keng's interpretation in *A. tectorius* is based on a wrong observation. Leaf traces and perianth traces in most families are channelled at their base, appearing in transverse section as arcs with incurved margins, and becoming flat or cylindrical a little higher up. For purposes of explanation, four transectional diagrams of such a trace are shown in Fig. 13, a, b, c, and d, at successively higher levels. Longitudinal sections through them along the lines drawn would show two bundles in a, the same closer to each other in b, the two fused into a single strand in c and d. If one observes only one longitudinal section of this trace it would give the appearance of two traces fusing together, or if one imagines further, as a bundle going up and then running downwards as a recurrent bundle. Keng's observations are wrong because he apparently did not observe complete series of longitudinal and transverse sections for a correct correlation of the structure as seen in them. His transverse sectional figures do not show the recurved bundles. He cited a photomicrograph in his paper for the recurrent bundle, but even this photomicrograph does not illustrate what he wanted to prove but only the appearance in longitudinal section of a bundle with incurved margins at its base.

The *Floras*, for example of Hooker (1872) and Cooke (1903), refer to the 3 styles as articulated to a rounded or shortly cylindric epigynous disk. Keng did not use the word "disk" but followed the same interpretation as in the *Floras*, which, the floral anatomy of *A. heyneanus* shows to be wrong. A comparison of Keng's longitudinal section of the flower of *A. tectorius* (reproduced as Fig. 12 of this paper) with the longitudinal section of *A. heyneanus* (Fig. 11) would make the point clear. The general morphology of the flower and the topography of the floral parts in both is identical. Keng wrote that "the 3 styles are articulated at the middle portions, the upper halves totally free, the lower halves partly connivent and partly joined to form a cone-shaped structure. Only the cone-shaped structure is persistent and becomes very prominent in the fruit, while the upper halves are deciduous". Figures 11 and 12 show that this dome-shaped part is actually the upper part of the ovary, above the level of the loculus. This is as thick (except at the extreme tip) as the actual ovarian region in
the basal loculus-bearing part. In this dome-shaped portion the dorsal bundles of the carpels bear a number of laterals in *A. heyneanus*, which were not observed by Keng, apparently because the buds sectioned by him are very young. These lateral bundles of the dorsals disappear near the base of the separate styles, leaving only the dorsal bundles to continue into them. This region is the upper sterile zone of the ovary and not the conjoined styles. The three styles arise in a very clear depression at the top of this dome-shaped portion. What Keng and the *Floras* mention as the middle of the length of the style is actually the base of the styles. What is called by them as the lower connivant part of the styles which is persistent and well developed in the fruit is the upper region of the ovary itself which develops along with the lower portion. Both external morphology and anatomy confirm it. Van Steenis (1954) also clearly stated as follows: “Ovary for the greater part inferior, consisting of 3 carpels, 1-celled, protruding into a nipple-shaped elongation, bearing 3 articulated styles..... Hutchinson apparently assumes the style to be represented by the nipple-shaped extension of the ovary above the calyx on tip of which 3 free stigmas are articulated, but,. .... I assume the styles to be articulated with the ovary.... The nipple enlarges in fruit and forms a distinct part of it.”

The floral anatomy of *A. heyneanus* fully supports the contention of Van Steenis for the genus. Keng cites *Flora Malesiana* of Van Steenis, but he did not even refer to the above interpretation given in that work. Following the conventional descriptions he called the ovary as completely inferior, on the assumption that the dome-shaped part is the style. The ovary is definitely semi-inferior, the floral parts being inserted somewhere midway along the length of the ovary.

Keng gave a correction to the statement in *Floras* that the sepals are quincuncial and not imbricate. The sepals are no doubt quincuncial, but this type of aestivation is only one type of imbrication. These two terms are not mutually exclusive. One is a sub-type of the other.

**REFERENCES**