Studies in the floral anatomy and morphology of Rubiaceae*
V. Naucleeae s.l.

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The tribe Naucleeae s.l. are characteristic of head-like inflorescence, funnel-shaped corolla, unbranched and long exserted style, two-carpellate ovary, syncarpous or free fruits, and the absence of raphid. Twenty-four genera are known from the tropics, as recently revised by Ridsdale (1978b). Here, five species of three genera are observed as in Table 5.

Table 5. The species examined and the voucher specimens.

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<th>Species</th>
<th>Voucher Specimens</th>
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Adina—In A. pilulifera, the flower is 5- or rarely 4-merous. Calyx-lobe is protuberant at base. There is a small appendage between the calyx-lobes. A thin ellipsoidal placenta is attached to the top of septum and bears two ovules at the both ends to septicidal face and one or two between them. Therefore, each of two loculi is occupied by three or four pendulous ovules (Fig. 21-B). A cup-shaped disc splits shallowly to deeply into two. There are druses in the upper half of ovary and disc and tannin cells in placenta and the outer portion of the periphery of ovary.

In a receptacle there are observed five calyx–stamen bundles, five corolla ones, and two dorsal ones, which run up in the periphery of an ovary. A calyx–stamen bundle

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Fig. 21. Diagrams showing vascularization of flower in *Adina pilulifera*. A. Longitudinal section of flower. B. Cross section at middle level of ovary. Broken lines of A show bundles running up in middle portion of septum.

Fig. 22. Diagram showing vascularization of flower in *Anthocophalus chinensis*. Upper third of right half shows loculicidal face as well as lower two third, though a cartilaginous loculus is added to that of left half.

divides tangentially into two at the uppermost level of ovary (Fig. 21-A). The outer one runs up straightly into a calyx-lobe where a bundle is surrounded by sclerenchymatous cells as in the bundle in bracteole. The inner one bends inward and supplies into a stamen. The corolla bundle also bends inward at the same level as the calyx and stamen bundles become free. At this level the dorsal bundle enters inward and goes down slightly along the upper limit of loculus and then runs up into a style.

At the level of the bottom of loculus, two bundles are branched from a calyx-stamen bundle and/or a corolla one near septum. Each of the bundles runs up into the middle portion of septum (Fig. 21). In the upper half of an ovary this bundle forks into two. At the uppermost level this bundle divides further into some short branches.

The bundles occurring in the center of a receptacle run up into the center of ovary and divide into two. Each of two enters into a placenta where a bundle forks into three or four ovular ones. After the departure of these bundles to placentae, two small traces appear to remain in the septum as in the case of Coptosapelta reported in the previous paper of this series. These traces end at a slightly upper level than that.

*Anthocophalus*—The observation on *A. chinensis* is made at the stage of unripe fruit. Two carpels form a two-loculate ovary, though at the upper third of loculus there are
four loculi formed by the development of a false septum (Fig. 23-B, C). These four loculi are surrounded with thick cartilaginous structure consisting of sclerenchymatous cells and contain one to seven seeds, respectively (Fig. 23-C, E). The placenta is attached to the upper third at the septum where a placenta divides into three branches, two entering into upper loculi and one into lower loculus. Disc is not recognized morphologically (Fig. 22). Calyx-lobe swells at its lower two-thirds, whose cross section is deltoid in outline. Any crystal and tannin cells are not observed in ovary.

In the fused part of receptacle, six to eight bundles begin to be separated radially from a round one (Fig. 23-A). At a slightly upper level than this, these bundles give off branches centripetally which fuse together to form a bundle running up in the center of ovary. The bundles supplying perianth, stamens and disc become ten in number below the middle level of ovary. Nearly at the uppermost level, these bundles branch disc bundle and corolla or stamen one, respectively (Fig. 23). The separation of both the bundles occurs nearly at the same level, though often disc bundles are given off at a little lower level than the separation of corolla or stamen ones. When disc and corolla or stamen bundles are branched at the same level, a branch forks up and down into a upper corolla or stamen bundle and a lower disc one. These bundles move inwardly in horizontal plane, bending slightly upwards in the former and downwards in the latter which usually forks. Among outer ten bundles, each of alternative five forks into two lateral calyx bundles, and the others are main calyx bundles. These calyx bundles are surrounded by sclerenchymatous cells as in the case of \textit{Adina pilulifera}.

The separation of dorsal bundle occurs at the lower half of ovary including the level of receptacle (Fig. 22, 23-D). As false septum develops, dorsal bundle enters into and runs up into false septum (Fig. 23-B, C). This bundle reaches the center of ovary at the middle level of four-loculate part. On the other hand, a bundle entering into the center of the base of ovary forks into two at the level where the stalk of placenta is attached to septum (Fig. 22, 23-D). Two bundles enter into placentae, in which each bundle divides into three, one going down and two entering into two upper branches of placenta.

\textit{Uncaria}—The corolla-lobes are imbricate at its entire length in bud at least in three species observed, differing from the \textit{Ridsdall}’s observation (1978). An annular disc swells distinctly when blooming (Fig. 24-C). An ovary has two loculi. An elongate placenta bears many ascending ovules (Fig. 24-D, E). The acute parts near a micropyyle and its opposite side of a rectangular ovule seem to grow up into tail-like wings (Fig. 24-D, E, 25). The number of ovules in a loculus is much more in \textit{U. macrophylla} than in \textit{U. laevigata} and \textit{U. rhynchophylla} (Fig. 24-D, E, 25). The placenta is attached to septum by broad connection from the middle to the apical part of septum in \textit{U. macrophylla} (Fig. 23-D), to an upper third of septum in \textit{U. laevigata} (Fig. 24-E), and to an upper quarter part of septum in \textit{U. rhynchophylla} (Fig. 25). The druses occur in the periphery of ovary and placenta of \textit{U. rhynchophylla}, but not in \textit{U. macrophylla} and \textit{U. laevigata}. There are tannin cells in placenta and the outer portion of the periphery of ovary in \textit{U. laevigata}.
Fig. 23. Flowers of *Anthacephalus chinensis*. A. Cross section of fused part of receptacles (×50). B. At upper third of ovary (×50). C. In the lowest level of four-loculate part of ovary (×50). D. Longitudinal section of ovary (×30). E. That of loculus surrounded with sclerenchymatous tissue (×50).

(Fig. 24-B, E), but not in *U. macrophylla* and *U. rhynchophylla* (Fig. 24-D).

A receptacular stele divides into ten bundles running up into the periphery of ovary. Among them the dorsal (—disc) bundles are branched from the bundles at the dorsal portion of loculus at the upper half of ovary (Fig. 25). At the upper level than this, each of the five bundles among ten divides into a main calyx bundle and a stamen (—disc) one. Each of the other five divides into a small lateral calyx bundle and a corolla one at the level above the upper limit of loculi, except in *U. rhynchophylla* which lacks lateral
Fig. 24. Flowers of Uncaria laevigata (A, B, E) and U. macrophylla (C, D). A. Cross section in lower half of ovary (×50). B. At level where placenta is attached to septum (×50). C. Longitudinal section of disc (×50). D. That of ovary showing placenta attached to upper half of septum (×50). E. Showing placenta attached to upper third of septum (×50).

calyx bundle. In this species, calyx bundle sometimes gives off a short branch extending horizontally. The separation of disc bundles occurs mostly at the level above the apical portion of loculus and sometimes in an upper fifth of ovary. The disc bundles are separated from corolla bundles and stamen ones, 5–9 in U. laevigata, 4–7 in U. rhynochophylla, and 3–5 in U. macrophylla. The bundle supplying a style gives off a disc bundle in some cases of U. macrophylla and U. laevigata. The disc bundles branch and run up along the outer portion of a disc where disc and hypanthium are fused together but the former differs from the latter in the shape and size of cells (Fig. 24-C, D, 25).
The bundles remaining in the center of receptacle fuse to become two placenta bundles. These two run up in the center of septa in parallel with loculicidal face in *U. macrophylla* and *U. laevigata*, and with septicidal one in *U. rhynchophylla*. In *U. macrophylla*, a placenta bundle gives off repeatedly the branches entering into a placenta along broad connection (Fig. 24-D). In *U. laevigata*, each of placenta bundles enters into different placentae, and in *U. rhynchophylla* each of two bundles divides into two, each entering into different placentae.

Taxonomical comments—The system of the tribe Naucleeae s.l. was recently revised by Riøsdal (1975, 78, 78b), who took much importance to the difference in placentation. According to his system, *Uncaria* was transferred to the other tribe, tribe Cinchoneae, chiefly based on the difference in the structure of placenta, ascending ovule, and the modes of dehiscence of fruit. As described above, the placentation differs considerably from each other among the three genera observed. If the placentation was a feature to reflect the phylogenetic course of our genera, these three genera may safely be separated even into three different tribes. As noted in the foregoing articles of this series, the structure of placenta is mostly uniform within the same tribe, but distinctly different among the genera in the tribe Naucleeae. In *Uncaria*, a placenta becomes longer and shows a tendency to be separated at the lower part of septum. This tendency resembles that of *Adina*, but differing in the shape of placenta. *Anthoccephalus* differs from the other genera of the tribe in the presence of false septum and cartilaginous structure. The conclusive remark will be given after the floral anatomy will be made for the other tribes, and I have an impression at the moment that Riøsdal is correct in referring *Uncaria* to the other tribe than Naucleeae. It is not recommended to evaluate the feature in placentation too much, and the combination of the other morphological features including ovule structure will elucidate the systematic difference among the genera treated here.

The structure of seeds of *Uncaria* is different from that of *Adina* and *Anthoccephalus* in the presence of distinct wings. In this feature *Uncaria* is similar to *Wendlandia* as described in part of this series (Fukuoka, 1980). The occurrence of the wing seems to be correlated with the shape of ovule, though no actual evidence can be given here. As to the structure of the ovule, *Adina* and *Anthoccephalus* are different from *Uncaria* in not an
ascending ovule and generally roundish outline, and similar to each other in the swollen base of calyx-lobes, the calyx bundle surrounded by sclerenchymatous cells, and in the presence of dorsal bundles showing a tendency to become free at the base of ovary.

Reference


摘要 Hooker (Genera Plantarum, 1873) は花序が頭状で、花冠は筒状漏斗形、子房は2室、花柱は長くつき出て分裂し、集合果になるなどの特徴をもったものをまとめてカギカズラ亜科とした。その後この亜科はよくまとまった自然群とみなされ、Airy Shaw (A dictionary of flowering plants and ferns 8版, 1973) は植物体の形や栄養器の形態がシクエンシ科 Combretaceae (特に Combretum) に似ているとして独立した科 Naucleaceae とした。アカネ科とシクエンシ科との類縁はすでに指摘されていることであるが、生殖器管からカギカズラ亜科アカネ科に属することに疑問はないし、形状や栄養器管からも何ら矛盾はない。

Ridsdal は各子房室に頂生する1個の胚珠をつけ種子に種衣が発達する Cephalanthus を独立した亜科とした。また胎座型、胚珠の形態、果実の裂開のしき方、花冠裂片の閉じ方などからカギカズラ属と Mitragyna をキナノキ亜科へ移した。Anthocephalus は偽隔歯があり、子房室の上部1/3は4室、それ以下は2室で、各4室は厚膜組織で囲まれていることなどから亜科として分けた。またタニワタリノキ属などは胎座が小型化し、子房室上部で隔歯につくことなどからタニワタリノキ亜科とされた。

胎座型からはここで観察した3属は単として分類しても良いほどの違いがある。しかし扱った観がきわめて限られているため Ridsdal の分類系について充分な評価をすることはできないが、この観察の結果からは妥当な見解といえる。

最後に Ridsdal の新しい分類系を紹介しておく。この中でタニワタリノキとヘッカニガキは別属とされている。

Cephalantheae
Cephalanthus
Cinchoneae キナノキ亜科
Mitragyninae カギカズラ亜科
Mitragyna, Uncaria カギカズラ属。
Naucleae タニワタリノキ亜科
Adina タニワタリノキ亜科
Adina タニワタリノキ属、Sinoadina ヘッカニガキ属、他14属。
Naucleinae
Nauclea, Sarcocephalus、他2属。
Anthocephalinae
Anthocephalus.