Mitsuko SUGIYAMA: A vascular system of "node to leaf" in *Michelia champaca* L.

杉山明子: キンコウボクの葉の維管束系

The comparative study of vascular traces in the vegetative shoot of the Magnoliaceae has been carried out in an attempt for further understanding in the study of angiosperm phylogeny. Providing such intention, the author reported previously on the vasculature of *Magnolia virginiana*, and this is the second study of her series (Sugiyama 1972).

Materials and methods *Michelia champaca*, distributed in southern China, is cultivated at the Botanical Garden, Faculty of Science, the University of Tokyo. It has an arborescent habit. The materials were treated in the same way as described previously (Sugiyama 1972). The terminology of vascular construction applied here are mainly based on the sense of Ezelarab and Dormer (1963).

Observation and discussion Eight bundles depart from the axial stele leaving eight gaps at the node of the young shoot (Fig. 19-B). All the bundles enter the petiole base as foliar traces. No stipular traces occur directly from the axial stele, however, the branches of the farthest lateral traces from the median trace M, that is traces L4, enter the stipule (Fig. 19-B). At the petiolar base, eight foliar traces, a median trace M, a predetermined ventral trace L1 and three pairs of lateral traces L2, L3 and L4, are discriminated respectively (Figs. 1-6). Apparently, one trace L1 seems to be lacking here as will be discussed later (Fig. 19-B).

Median trace M bifurcates above the node where foliar traces are leaving from the axial stele to give rise to trace m which soon branches off two traces m′ at the upper level (Fig. 5). One of trace m′ enters the ventral position while the other further diverges to produce two traces m″ at the medullary position (Figs. 6-9). At the laminar base, remained trace m, a direct derivative from median trace, divides again to give rise to medullary

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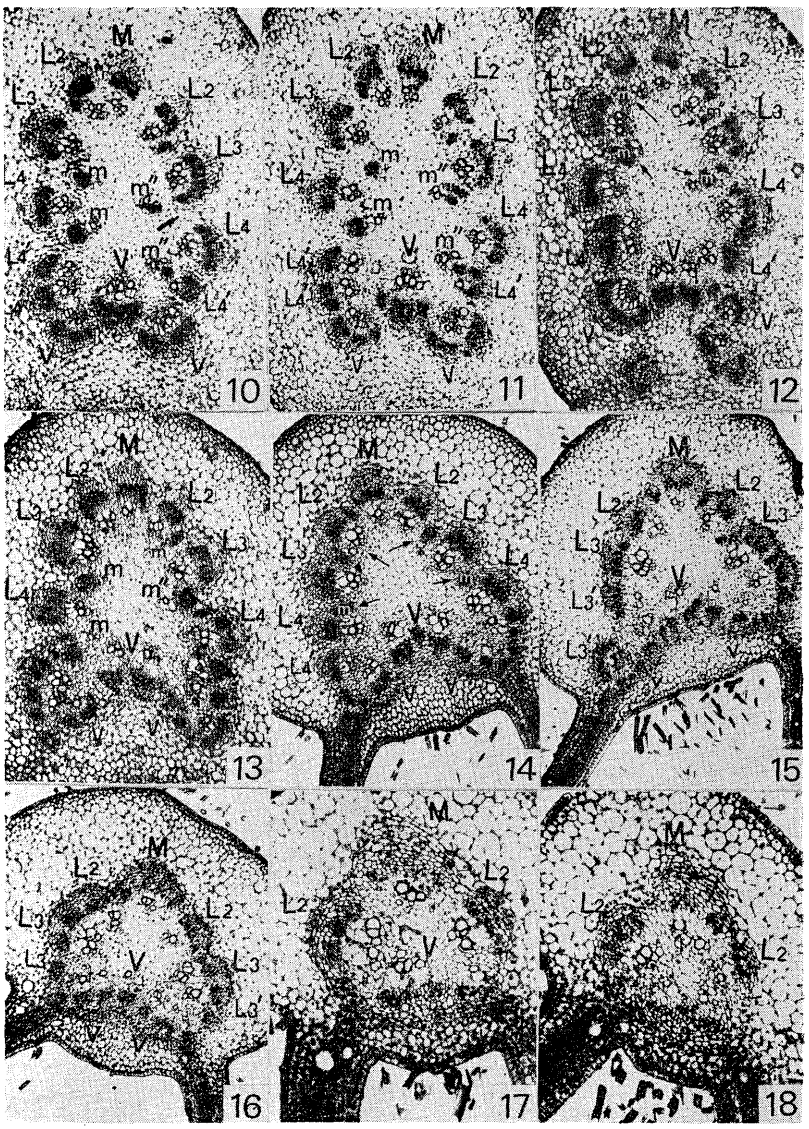
traces, thus four medullary traces, two traces m and two traces m″, have occured at the petiole base (Fig. 10). Above the laminar base, the four medullary traces of the leaf are located laterally in the foliar vascular ring and act as lateral traces. They eventually anastomose with lateral traces L2 or L3, respectively and become indistinguishable (Figs. 11–15).

Trace L1 occupying the position closest to median trace M at the nodal level becomes adaxially inversed orientation and laterally gives rise to trace L1′ at the lower level of the petiole (Fig. 8). These ventrally located traces L1 and L1′ anastomose with derived trace m′ of median trace M, and form ventral trace V. It gives rise to traces v on both flanks by lateral division (Fig. 9), as a result, the ventral traces are composed of a single trace V and two traces v. The ventral traces v send veins and veinlets to laminar laterals at the successive levels in fusing lateral trace derivatives (Figs. 10–17). Therefore, the leaf laminar venation is mainly supplied by anastomosed traces of derivatives from both lateral traces and ventral traces. Above the level shown in figure 17 toward the tip of the leaf where lateral traces L2 produce laminar venation, the ventral trace V takes no part in it, gradually decreases in size and eventually fades away (Figs. 17–18).

Three pairs of the lateral traces, traces L2, L3 and L4, are recognized at the petiole base (Figs. 6–7). Above this level, a pair of lateral traces L4 sends basal laminar lateral venation anastomosing with derivatives from the ventral traces v (Figs. 11–13). Thus the basal part of the leaf lamina is covered with derivatives of the pair of lateral trace L4 as well as the branches of ventral trace v. When they diminish at the foliar stelar ring, lateral traces L3 start sending laminar venation likewise (Fig. 15). The ventral traces v also take the part in the laminar lateral venation here. As lateral traces L3 are reduced completely at the foliar stelar ring, lateral traces L2 start giving rise to laminar venation. At this level, ventral trace v have disappeared and ventral trace V alone remains adaxially without branching off any lateral veins (Fig. 17). Towards the tip of the lamina, lateral traces L2 tend to unite to form a single bundle but each sympodium is still distinguishable (Fig. 19-A·12, -C·12).

To compare "node to leaf" vasculature of *Michelia champaca* of the present investigation and that of *Magnolia virginiana*, eight leaf traces

Figs. 1-18. Serial cross view of "node to leaf" vascularization in *Michelia champaca* L. Figs. 1-7: Above the node of vegetative shoot. ×30. Figs. 8-9: At petiolar level. ×32.



Figs. 10-13: Lower level of leaf lamina. ×40. Figs. 14-16: Middle of leaf lamina. ×40. Figs. 17-18: Upper end of leaf lamina. ×100. Symbols: M: median trace, L1: predetermined ventral trace, L2, L3, L4: lateral foliar traces, m, m′, m″: foliar traces derived from median trace, V, v: ventral traces. Detailed explanations are in the text.

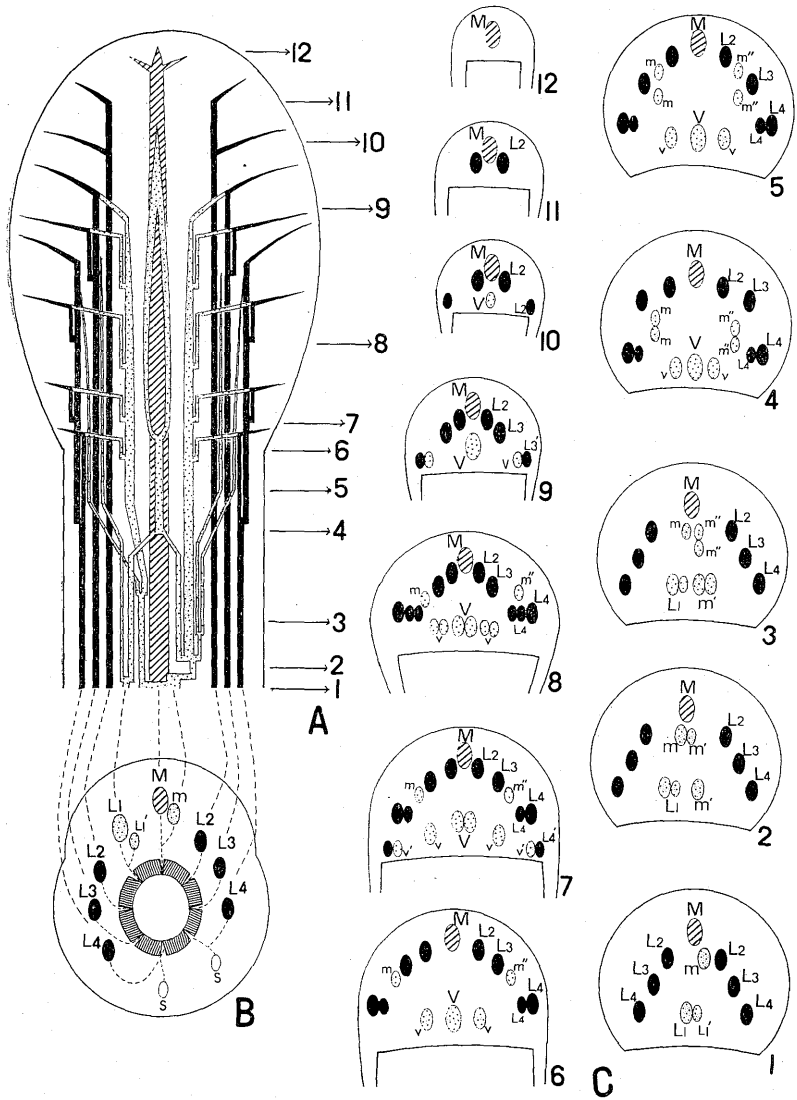


Fig. 19. Shematic interpretations of "node to leaf" vascularization in *Michelia champaca* L. A: Vascularization of petiole to leaf lamina, 1 to 6 are the petiolar levels whereas 6 to 12 indicate laminar levels. B: Cross sectional view at the node. C: Series of cross sectional view at the equivalent positions correspond to A.

depart from the axial stelar ring in both genera, however, the behavior of each trace is not identical. At the node, *Michelia champaca* has no independent stipular trace arising directly from the axial stele but the stipular supply is wholly dependent on the lateral branches of traces L4, the farthest lateral traces from the median trace M (Fig. 19-B). In *Magnolia virginiana* the independent stipular trace occurs at the node and the stipule receives traces both from the stipular trace and from divergences of the farthest lateral traces to median trace M. At the nodal level, one of the determined ventrals, the trace L1 of the nearest lateral traces to the median trace M, is also absent here (Fig. 19-B), while a pair of traces L1 has occurred at the equivalent level of the node in *Magnolia virginiana*. The trace L1 is thus predestinated to become a ventral trace in both genera, however, only a single trace L1 is inverted in *Michelia champaca* to take the part of the ventral trace at the petiolar level (Fig. 19-C·1).

Concerning laminar lateral venation in *Michelia champaca*, traces derived from lateral L3 and L4 each send lateral veins in company with lateral divergences of ventral traces v (Fig. 19-A, -C·7). The ventral trace V stays unbranched above the level where ventral traces v have left the foliar stelar ring, and remains in the foliar stele of the upper leaf lamina (Fig. 19-C·8, -C·9). The lateral traces L2 giving rise to laminar laterals do not accompany any ventral derivatives above this level (Fig. 19-C·12). On the other hand, ventral trace V stays unbranched and sends no lateral veins at any levels of the leaf lamina in *Magnolia virginiana*.

Medullary traces have originally derived from median trace M in the petiolar strand and their occurrence is characteristic of this plant (Fig. 19-C·1 to 4), although these medullary traces join and anastomose with lateral traces L2 and L3 above the level of the laminar base (Fig. 19-A).

The phylogenetical significance of above observation is still unknown and further detailed information should necessarily be accumulated on allied genera.

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キンコウボク (*Michelia champaca* L.) の茎から葉に至る維管束の走行を追跡した。茎節において，8葉跡，8葉隙を生じ，これらは1本の中央脈 M，3対の側脈 L_2, L_3, L_4 と葉柄基部で腹脈になる L_1 が1本とからなる。独立した托葉維管束はみられず，側脈 L_4 からの分枝のみが托葉へ入る。腹脈予定の維管束 L_1 は中央脈 M に隣接した片側に1本が存在するのみである。従って葉柄の維管束環では，中央脈 M の左右対称位置に L_2, L_3, L_4 がそれぞれならび，向軸側には L_1 とその分枝 L_1' が位置する。

中央脈 M はまず分枝 m を生じ，これは更に2本の m′ を分枝する。この結果，中央脈 M から由来する維管束は m と2本の m′ ということになる。このうちの1本の m′ は腹脈へ移行し，葉身基部において L_1, L_1' とゆ合し，腹脈 V とその両側に2本の v を生じる。他の m′ は更に分枝し，2本の m″ を生じる。また m も同様に分枝して2本となる。この4本の維管束は葉における維管束環の内側にあり，髄走維管束として存在するが，葉身の中部でこれらは側脈 L_2, L_3 とゆ合してしまう。

葉身を走る葉脈の大部分は側脈 L_2, L_3, L_4 に由来するが，同時にここでは腹脈 v から由来する分枝とゆ合しながら順に，葉身の下部へは L_4 と v からの分枝がゆ合した葉脈，葉身の中部へは L_3 と v の分枝がゆ合した葉脈を送りだしている。これらが消失すると L_2 が分枝をはじめ，葉脈を送りだすが，この位置で腹脈 v は消失する。残された腹脈 V は分枝せずそのまま葉身上方で消失する。従って L_2 の分枝と腹脈 V に由来する分枝のゆ合はみられない。向軸側で腹脈 V が消失したのち，その上方で側脈 L_2 は中央脈 M とゆ合し，L_2 の分枝が葉脈をだし消失すると M のみが葉身先端部で残される。かくて中央脈 M は葉身先端部の限られた部分にのみ葉脈をだす。

前報の *Magnolia virginiana* との比較において，独立した托葉維管束 S がないこと，腹脈予定維管束 L_1 の片方が欠けていること，中央脈 M に由来する髄走維管束 m, m″ が葉柄から葉身基部にみられること，腹脈の一部 v が葉脈への分枝をだすことなどがこの種において特徴的である。これらの維管束走行の系統学的意味については更に多くの資料について検討する必要があろう。