筑波実験植物園研報 10：15-25，1991.
Ann. Tsukuba Bot. Gard.

Anatomical Study on Inflorescence Formation of *Cornus kousa* Buerg. ex Hance

By

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八田洋章*：ヤマボウシの花序形成に関する解剖学的研究

In the bud of the inflorescence, florets of *C. kousa* are surrounded by two pairs of scale leaves, outer and inner, further inwardly being surrounded by two pairs of involucral bracts. The total number of florets per inflorescence is due to the size of inflorescence, and 35 florets are formed on an average (Hatta 1979, 1983a).

The author has already reported on the process of development of the capitulum and its floret arrangement in *C. kousa*, using a scanning electron microscope (Hatta 1983a) and he also has reported the vascular course of scale leaves, which is almost the same as that of normal leaves; a pair of scale leaves receive six leaf traces from the central cylinder (Hatta 1983b). Six leaf traces emerge from the central cylinder, forming six leaf gaps. Three of them enter into either one of the pair of scale leaves.

In the present study, the internal morphology of involucral bract and floret on this species will be reported with particular attention to the arrangement of vascular bundles.

Materials and Methods

Materials used in this study were collected from about 50-year old trees of natural population located in Hakone, Kanagawa Prefecture in the summer and fall of 1979. The materials were supplemented with collections in the spring and summer of 1981 from 15-year old trees planted in the Tsukuba Botanical Garden.

The flower buds were fixed in formalin-acetic acid-alcohol(FAA). Sections were made by the standard techniques and were stained with safranin and fast green.

Result

1. Vascular course to involucral bract

The vascular bundle to the involucral bract emerges from vascular cylinder at the base of inflorescence and firstly ascend then descend (Fig. 1).

After the central cylinder supplies vascular bundles to the outer and inner scale leaves respectively, four groups of the vascular bundles reveal an arrangement of a squar (Fig. 2-1).

Six bundles run out from a diagonal corner (Fig. 2-2, arrow); median two of them form median bundles of an outer involucral bract and each two bundles on both sides form the lateral

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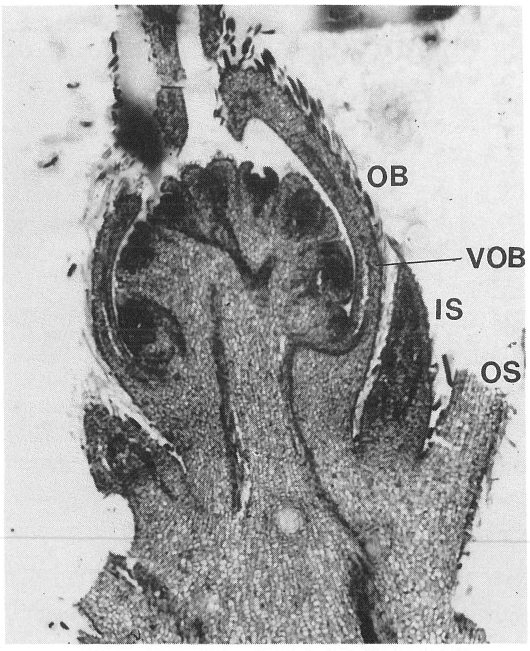

Fig. 1. A longitudinal section of the bud of an inflorescence showing the leaf trace of outer bract. IS: Inner scale, OS: Outer scale, OB: Outer bract, VOB: Vascular bundle of outer bract.

bundles respectively. These two bundles converge into one bundle later. This situation is the same as the other pair in the bracts.

At the base of the involucral bract, each of the six vascular bundles radially bifurcates (Fig. 2-3, arrow); six bundles emerge towards the involucral bracts, while the other six bundles remain in the main axis (Fig. 2-4, arrow).

They branch further in the involucral bract. At the central axis the six vascular bundles, on the other hand, become three groups, and finally unite into a central cylinder (Fig. 2-5).

2. Vascular course to the respective florets

Inflorescence consists of three parts of florets; upper, middle and lower parts, the upper part including terminal floret (Fig. 3). The vascular bundle runs into the lower, middle and upper parts, each being separated from the other.

• Vascular bundles running into lower and middle part

Each involucral bract of two pairs subtends three florets (Fig. 4) so that 12 florets in total constitute the lower and middle parts.

Fast, four vascular bundles constituting the central cylinder of the main inflorescence axis branch out from both ends of each, and one of branches from a bundle makes a couple of bundles together with that from an adjacent bundle. This couple enters a floret, which is centrally located in three florets subtended by a bract (Fig. 4-1). Thus, each couple enters a centrally located floret, respectively.

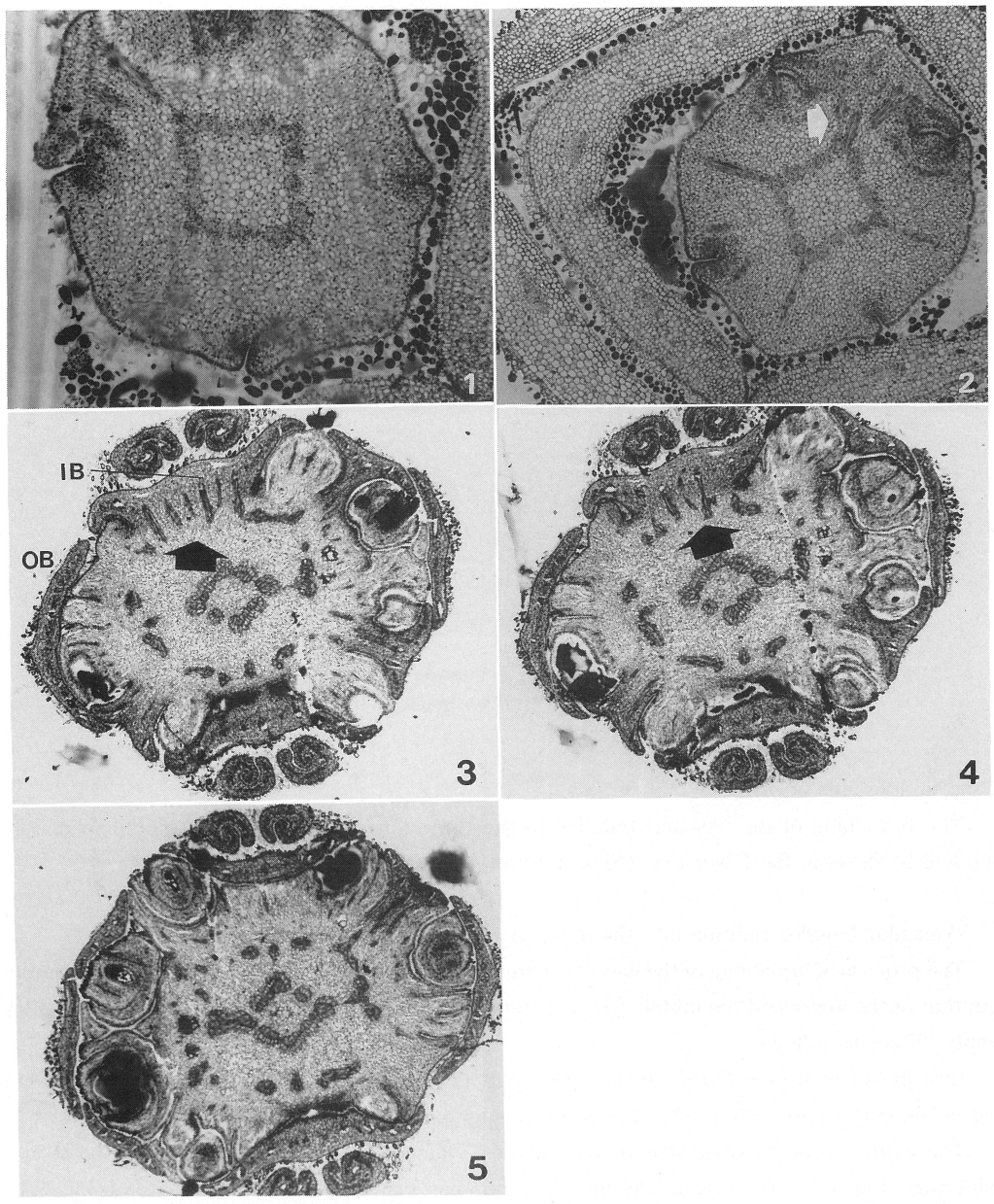

Fig. 2. Transverse sections of the bud of an inflorescence showing the leaf trace of involucral bract, arranged from the lowermost (1) to the uppermost (5). IB: Inner bract, OB: Outer bract, Arrows: See in the text.

Subsequently, a couple of fine branches is branched out from both ends of respective vascular bundles consisting of the central cylinder. A couple of fine bundles enters one lateral floret of the three florets subtended by one of the outer bract and the other couple from the other end enters the lateral floret subtended by the one of the inner bracts (Fig. 4-2).

After the branching of the vascular bundle into the respective floret in the lower part finishes, the bundles resume the ring consisting of four groups (Fig. 4-3). Then the branching to the florets

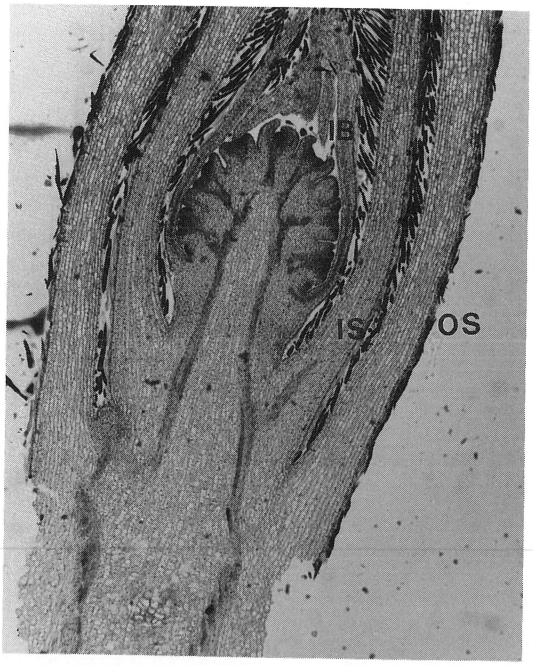

Fig. 3. A longitudinal section of the bud of an inflorescence showing the vascular supply from the central cylinder to florets. IB: Inner bract, IS: Inner scale, OS: Outer scale.

of the middle part begins.

The branching of the vascular bundles to the three florets of middle part is approximately identical to those in the lower part (Figs. 4-4 and 4-5).

•Vascular bundles running into the upper part

The process of branching of the vascular bundle to the florets of upper part differs considerably with that of the lower and the middle part depending on the number of florets in this part, vascular supply differs as follows;

In a flower with nine florets in the upper part (Fig. 5), the central vascular bundle forms a ring in the transverse section after the vascular supply to the middle part (Fig. 5-1).

The central cylinder divides into two bundles, which then unites into two rings; large and small rings (Fig. 5-2). Each ring divides into three bundles, making the six bundles in total (Fig. 5-3).

Three bundles consisting of the small ring then enters the florets while the three bundles derived from the large ring bifurcate; so that nine bundles in total appear (Figs. 5-4 and 5-5).

In a flower with 12 florets in the upper part (Fig. 6), the vascular bundles branch out from the central vascular rings forming three rings (Figs. 6-1 and 6-2).

Each ring divides into three branches again, forming nine bundles (Figs. 6-3 and 6-4).

Some bundles branch off moreover, giving rise to 12 bundles in total (Figs. 6-5 and 6-6; arrows).

3. Vascular supply in a floret (Fig. 7)

At the base of a floret, the vascular bundles supplied from the central cylinder of an inflorescence

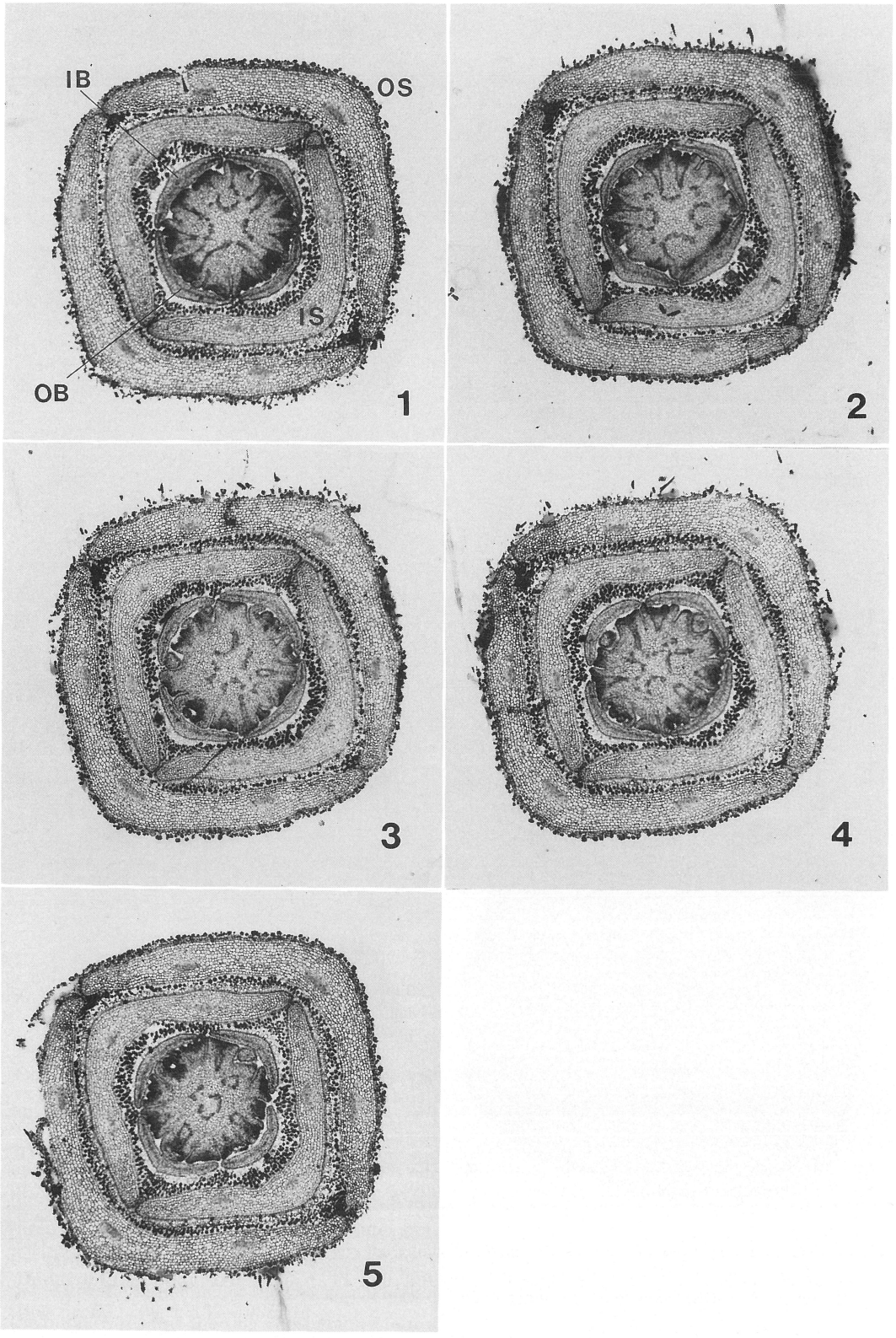

Fig. 4. Transverse sections showing the vascular supply from central cylinder to each floret group, arranged from the lowermost (1) to the uppermost (5). IS: Inner scale, OS: Outer scale, IB: Inner bract, OB: Outer bract.

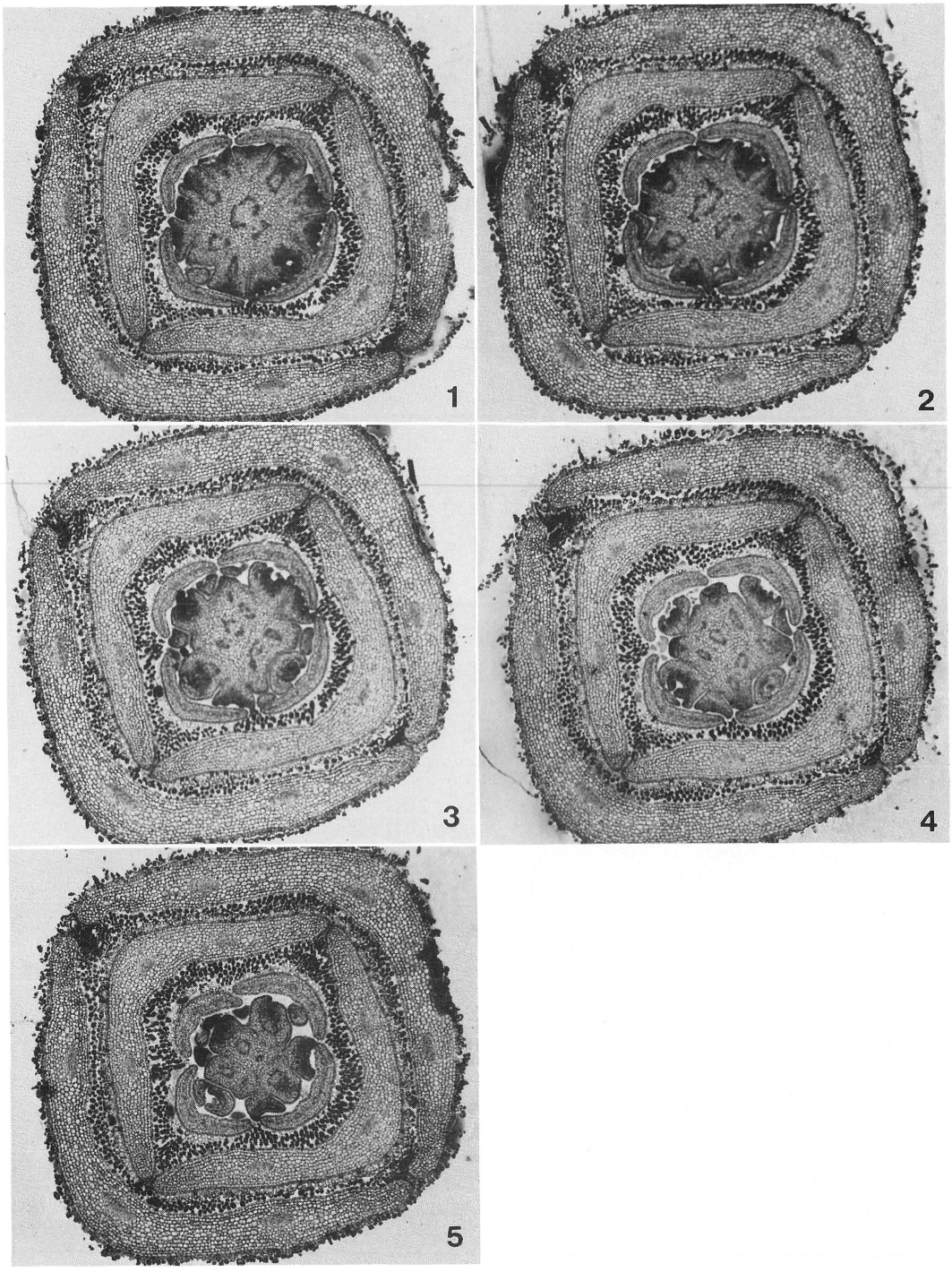

Fig. 5. Transverse sections of the central cylinder of young inflorescence in the bud showing the vascular supply to upper nine florets at the upper part, arranged from the lowermost (1) to the uppermost (5). IB: Inner bract, OB: Outer bract, IS: Inner scale, OS: Outer scale.

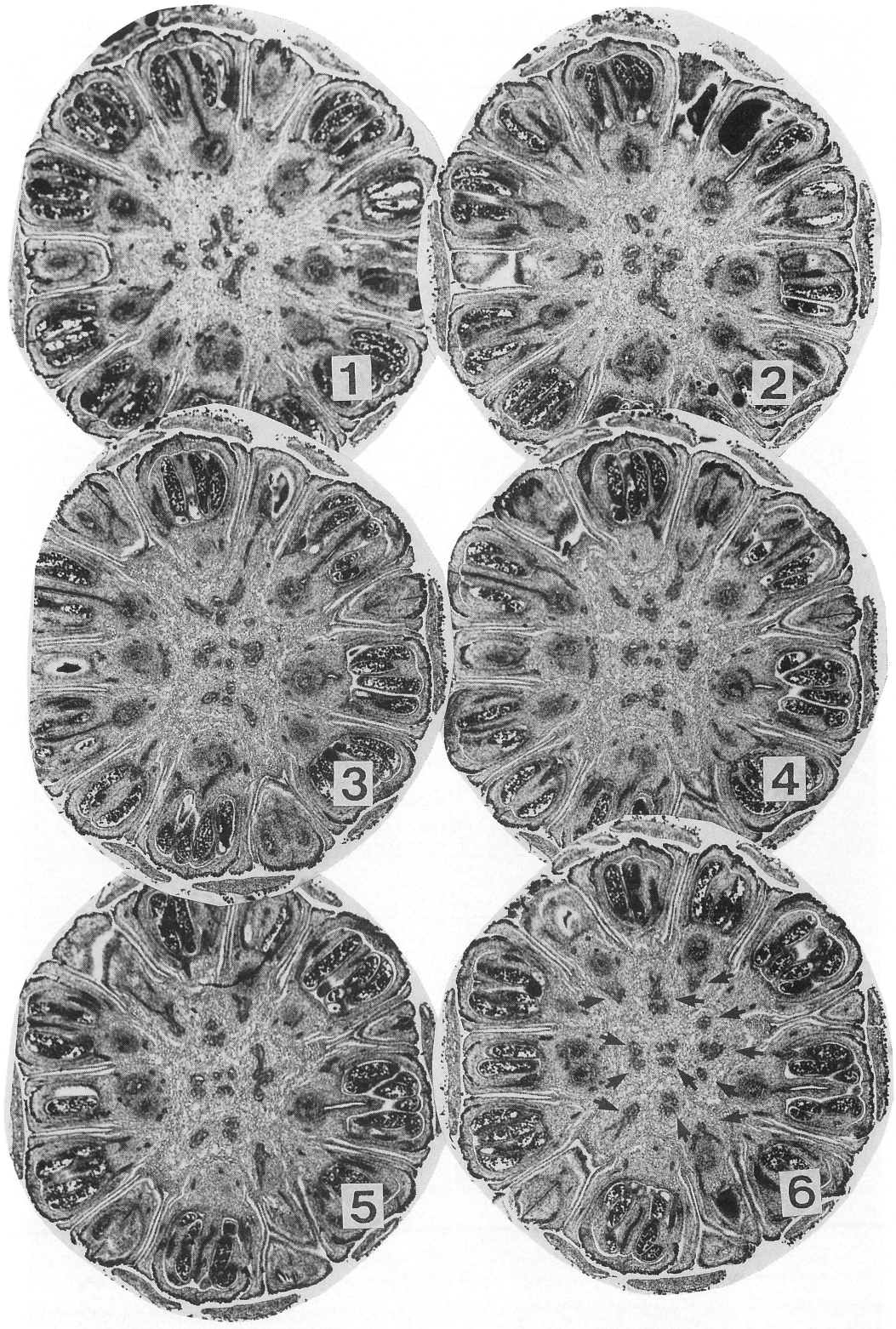

Fig. 6. Another example of transverse sections of the central cylinder of young inflorescence in the fully developed bud showing the vascular system to upper twelve florets at the upper part, arranged from the lowermost (1) to the uppermost (6). Arrows: Vascular bundles to twelve florets.

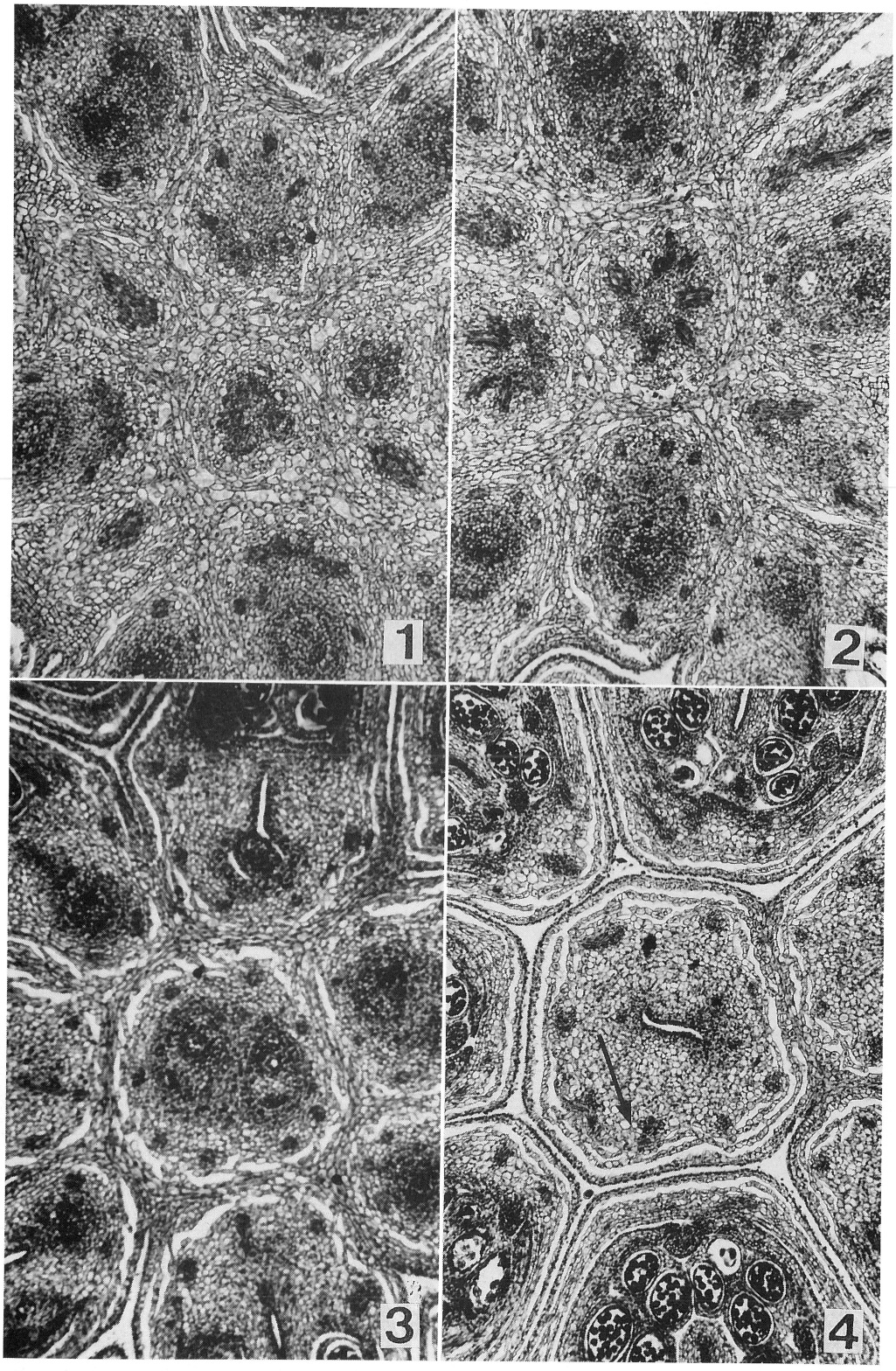

Fig. 7. Transverse sections showing the vascular supply in a floret, arranged from the lowermost (1) to the uppermost (8). C: Calyx, F: Filament, P: Petal, Arrows: See in the text.

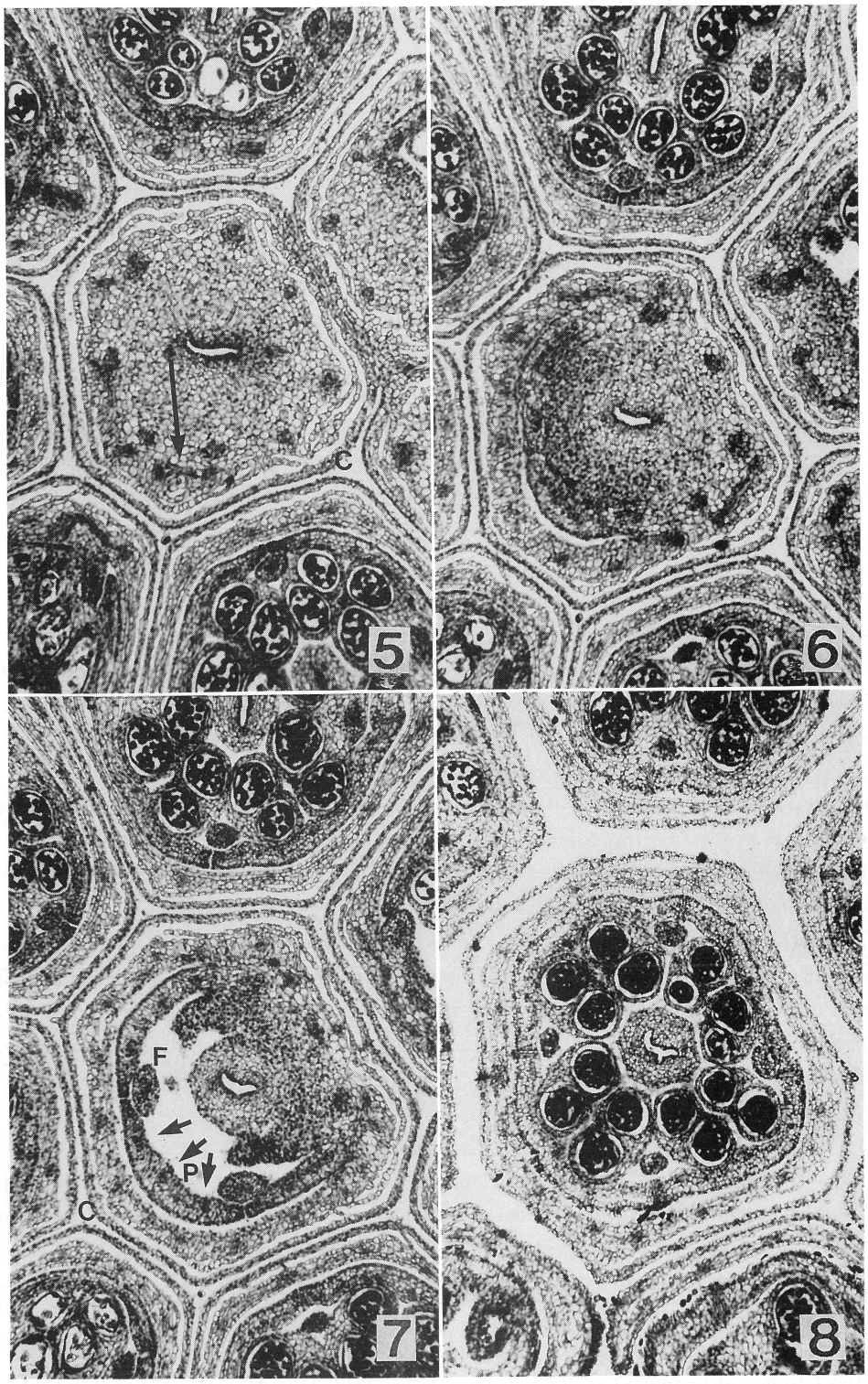

Fig. 7. (continued)

(Figs. 7-1 and 7-2). There are eight vascular bundles (Fig. 7-3). The eight bundles radially bifurcate respectively, forming 16 branches in total (Fig. 7-4, arrow).

Furthermore, each of the outer eight bifurcates along the wall of the calyx tube (Fig. 7-5, arrow). The filaments and petals become visible (Figs. 7-6 and 7-7). The 16 vascular bundles branching off from the outer eight bundles enter the calyx (Fig. 7-6). The eight inner vascular bundles branch alternately into petals and filaments (Fig. 7-7). The bundle supplied into petals further split into three bundles (Fig. 7-7, arrows).

In the calyx tube, 16 vascular bundles could be identified, in the petals three, in the filament one, respectively (Figs. 7-7 and 7-8).

Discussion

In the *Cornus kousa* Buerg. ex Hance which has a decussate phyllotaxis, six leaf traces and leaf gaps are visible when the vascular bundles emerge from the central cylinder of the axis to foliage or scale leaves. As a rule, three of them enter into each petiole (Hatta 1983b).

Although the involucral bract, in general, is considered to be a foliar organ (Jackson 1928), present results on the involucral bract show a difference in vascularization to that of the foliar leaf (Fig. 2-1): clear gaps can not be observed in the case of the involucral bract.

The process of vascular bundle formation from the central cylinder of inflorescence towards florets takes place as follows; two of the four vascular bundle constituting the central cylinder of an inflorescence give rise the bundles to the central one of the three florets at the base of an involucral bract (Figs. 4-1 and 4-2). Fine vascular bundles emerging from the ends of the one vascular bundle are supplied to the other florets than the central.

Comparison of the bundles to florets with those to involucral bracts shows that (i) the two bundles emerging from a corner of the central cylinder in the involucral bract (Fig. 2-1) correspond with those to the central floret, and that (ii) the vascular bundles on the two sides of the involucral bract (Fig. 2-2, arrow) correspond to the couple of the fine vascular bundles found in the outer florets.

Observations by the scanning electron microscope show that the floret of both side are secondary in origin (Hatta 1983a) and that branchings from the vascular bundle to the two sides of involucral bract are secondary in origin. The dome-like primordium of the inflorescence divides into three parts, upper, middle and lower. From each part, four protrusion (totally 12) emerges towords the outer and inner couple of bracts. Three floret primordia formed from each protrusion at the lower and middle parts.

The involucral bract has been commonly treated as an intermediate organ between a leaf and a calyx, and morphologically a foliar organ (Lawrence 1951). In this species, however, the pattern of the vascular supply to the involucral bract resembles to that of the florets in the inflorescence.

The outer morphology, observed by Hatta (1983a) was confirmed anatomically in the present study. The vascular bundles are supplied differently between the central floret and the two lateral florets at the base of the involucral bract.

When the bundles are supplied to the central floret, the vascular bundles are thick, whereas when the bundles are supplied to the two laterals are thin. This substantiates anatomically the earlier assumption (Hatta 1983a) that the central floret is the primary branching from the main

axis, whereas the florets on the both side are secondary one.

Acknowledgements

I wish to express my cordial thanks to Prof. Noboru Hara of University of Tokyo and Dr. Syuichi Nosiro of the Forestry and Forest Products Research Institute for valuable suggestions and critical reading of this manuscript.

摘　　要

ヤマボウシの総苞片および小花群への維管束走行の観察を行い，すでに報告した普通葉，鱗片葉への維管束走行の結果，および走査型電顕（SEM）による花序形成の経過と比較検討した。

総苞片では維管束の中心柱から計６本の維管束が走行するが明瞭な葉隙が認められず，普通葉や鱗片葉の観察結果とかなり異なる。花序の中心柱から小花群への走行は，総苞片に抱かれる３小花のうち中央の小花へは中心柱を構成する４つの維管束群が関与し，両脇の小花にはそれらの１つだけに過ぎず，後者は前者の二次分枝と観察された。この結果はSEMの観察による推定を裏付けるものである。

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