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Morphological implications of three bracts enclosing the flower of *Sarcandra glabra*

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3枚の苞葉に包まれたセンリョウの花の形態学的意義

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Although *Sarcandra glabra* (Thunb.) Nakai (Chloranthaceae) usually has no bracteole on the inflorescence, a flower of *S. glabra* subtended by one bract and two bracteoles was accidentally discovered and its floral vascular system was examined. Four vascular bundles run into the bract and flower from the stele of the inflorescence axis. After three bract bundles separate from the bract-flower bundles to enter the bract, a pair of bracteole bundles are subdivided from the flower bundles: the bract bundles and the bracteole ones are independently divided. Thus the bracteole is not interpreted as an accessory but as an independent organ; each bracteole subtends a male flower and a female flower.

センリョウは通常1枚の苞葉に抱かれた花を持つ。花の維管束走向を観察中に偶然，1枚の苞葉だけでなく，さらにその内側左右に小型の2枚の苞葉，すなわち小苞葉に抱かれた花が見つかったので，その花序軸から花への維管束走向を明かにした。苞葉と小苞葉の維管束は互いに独立し，小苞葉維管束は，苞葉維管束が分岐したあとに，花への維管束の分枝として出ていた。その結果，2枚の小苞葉は，苞葉や花序軸に由来する裂片ではなく，それらとは独立した器官であるとみなされる。すなわち2枚の小苞葉は，両性花の雌しべと雄しべが単性花の雌花と雄花の癒合によるとみなしたときの，雌花と雄花を抱く小苞葉と考えられる。センリョウの1個の両性花が1枚の苞葉と2枚の小苞葉を持つことは，この花が1個の雌花と1個の雄花からなる花序に由来する可能性を示唆している。

The flower of *Sarcandra glabra* is one of the simplest flowers among the angiosperms, which consists of one pistil adnate one stamen on the abaxial side without perianth. The bract is triangular and entire, but sometimes two- or three-lobed (Omori, 2003).

A flower subtended by one bract and two bracteoles was found by chance in the anatomical studying process. The inflorescences subtended by both the bract and the bracteoles were morphologically studied on *Ascarina* (Moore, 1977) of the same family and on *Myrica* of Myricaceae (Abbe, 1972); much reduced inflorescence of *Ascarina* resembles a bisexual flower and even one-stamen subtended by a bract of *Myrica* has been derived from many-stamen inflorescence.

It is necessary for exactly understanding the flower structure to observe and analyze the vascu-

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lar system from inflorescence axis to flower. In this study, the vascular system of the bract and flower was observed in detail and an morphological meaning of the flower with one bract and two bracteoles was examined.

Materials and methods

Living materials of *Sarcandra glabra* were cultivated at the Botanical Gardens of the University of Tokyo. The inflorescences were fixed by FAA (Formalin-Acetic acid-Alcohol) solution. After the materials were dehydrated by n-butanol-ethanol series and embedded in Palaplast to cut by rotary microtome at the thickness of 10 μm, they were counterstained by Hematoxylin, Safranin, Fast-green for preparation.

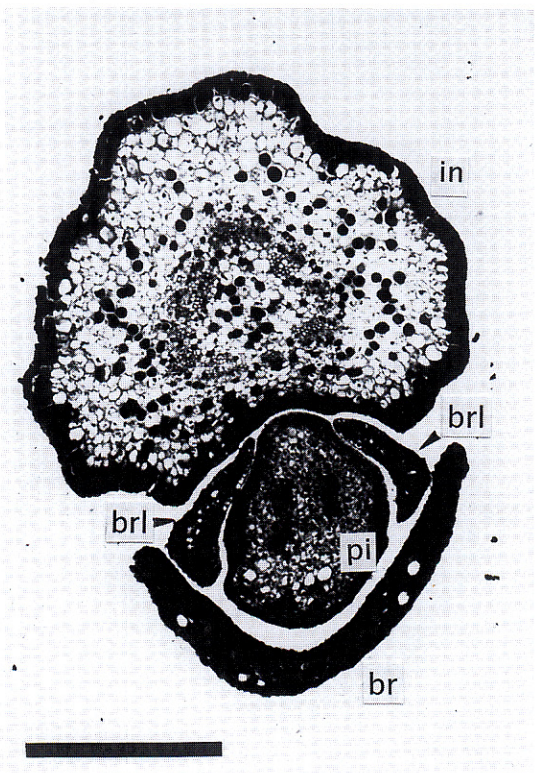

Fig. 1. Transverse section of the flower subtended by one bract and two bracteoles of *Sarcandra glabra*. *br:* bract, *brl:* bracteole, *in:* inflorescence axis, *pi:* pistil. Scale bar = 0.5 mm.

Observations

A flower of *Sarcandra glabra* subtended by three bracts, or one bract and two bracteoles (*br* and *brl* in Fig. 1) was found by chance, when vascular system was anatomically observed on pre-matured inflorescences for the purpose of examining the developmental features of the flower. The vascular bundles run through the inflorescence axis and flower as follows.

Among vascular bundles arranged in circle in transverse section of the inflorescence axis (*in* in Fig. 2-A), four bundles separate from the stele to be bract-flower bundles (shading and darkened areas in Fig. 2-A). They repeatedly join and separate to become two bract bundles (*b* and *b'* in Fig. 2-B) and three flower bundles (*1, 2, 3* in Fig. 2-B) in the transitional part from inflorescence to flower. The bract bundle *b* bifurcates to be two bundles (*b1, b2* in Figs. 2-D) and they enter the bract (*br* in Figs. 2-H). Each of the flower bundle *1, 2* provides one branch (*1bo, 2bo* in Figs. 2-F to 2-H), which enters the bracteoles (*brl* in Fig. 2-I) on the adaxial and lateral sides of the bract. The flower bundle *3* enters the stamen (*st* in Fig. 2-J) adnate to the dorsal side of ovary (*3s* in Fig. 2-J). The remaining flower bundle *1* bifurcates to run through the ovary wall to the upper part of pistil (*1* in Fig. 2-J). The bundle *2* is divided into two bundles, and one of them enters the ovule and the other runs through the pistil (*2, ov* in Fig. 2-J).

Discussion

As mentioned in the observations, the bract bundle and the bracteole bundles of the flower of *Sarcandra glabra* are independently separated from the flower trace each other. The vasculature means that these small bracteoles are not mere auxiliary or accessory organs such as a lobe of the bract or the inflorescence axis but are regarded as a real bracteole subtending a flower. As a result of the observations, it turned out that the flower of *S. glabra* rarely has two bracteoles with a bract although ordinal flowers are subtended by one bract.

Among genera of the same family, *Ascarina*

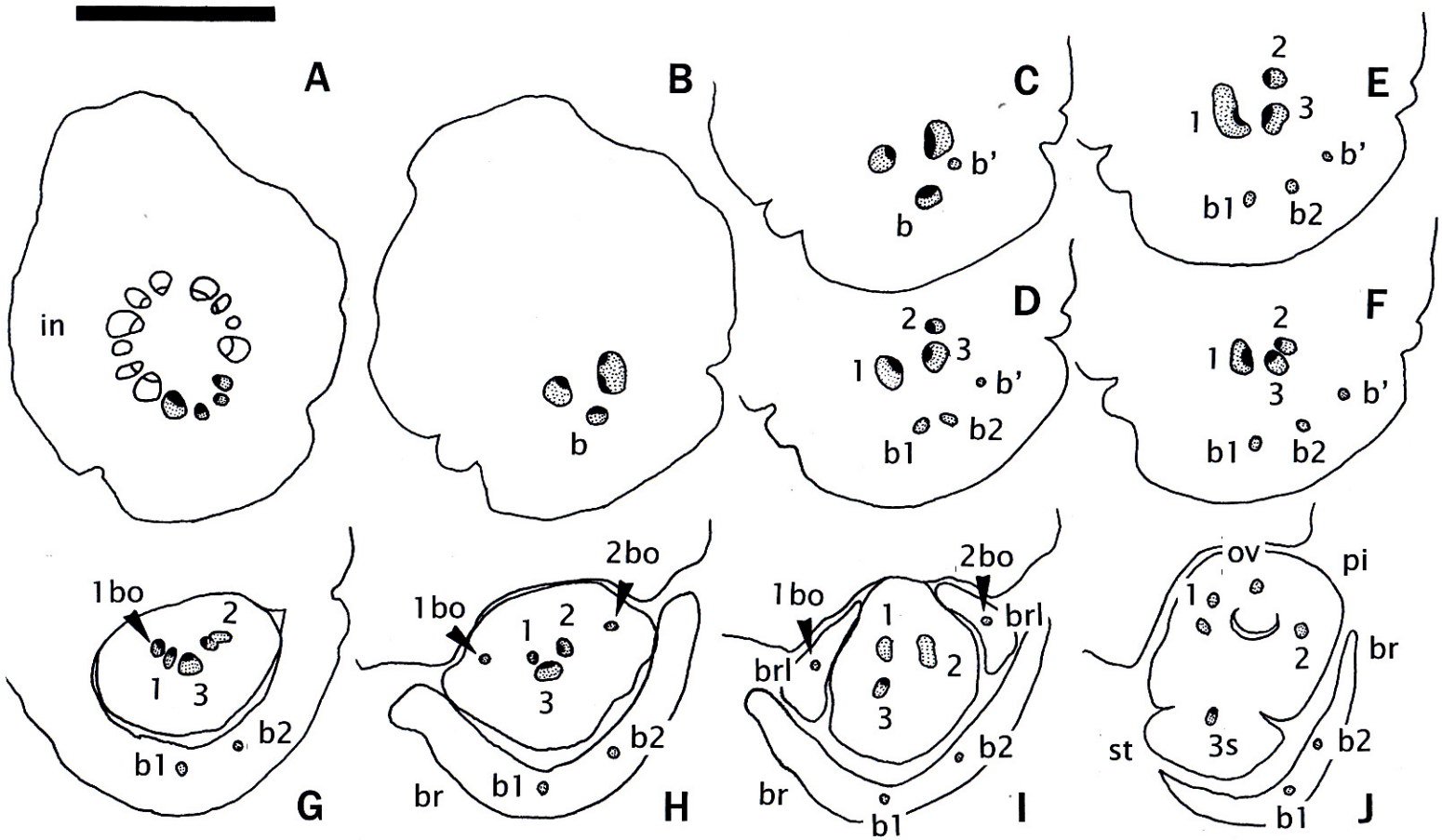

Fig. 2. Serial transverse sections of the flower subtended by one bract and two bracteoles of *Sarcandra glabra*. A. Four vascular bundles (shading and darkened areas) run into the transitional part of the inflorescence axis to the bract and flower. B, C. One of them becomes a bract bundle (*b*) at the basal part of flower, and another one supplies a bract bundle (*b'*). D, E. The vascular bundle *b* bifurcates at the basal part of bract (*b1, b2*), and the remaining vascular bundles are flower bundles (*1, 2, 3*). F. The flower bundles *1, 2* and *3* are arranged in circle at the basal part of flower. G, H. The bract bundles *b1, b2* enter the bract (*br*). Each of the flower bundles *1, 2* supplies a bracteole bundle (*1bo, 2bo*). H, I. The bracteole bundle *1bo* and *2bo* enter the bracteoles. J. The flower bundle *3* enters the stamen (*3s*). The bundle *1* bifurcates to run through the pistil, and the bundle *2* divides into a pistil bundle and an ovular bundle (*ov*). *1, 2, 3*: flower bundles, *b, b'*: bract bundle, *bo*: bracteole bundle, *br*: bract, *brl*: bracteole, *in*: inflorescence axis, *ov*: ovular bundle, *pi*: pistil, *s*: stamen bundle. *st*: stamen. Scale bar = 0.5 mm.

(Moore, 1977) has bracteoles even in such small inflorescence as consisting of one female and one male flowers; so a small inflorescence of *A. lucida* resembles to a flower but was proved to be an inflorescence consisting of a female and a male flower by the existence of the bracteoles and by the loss of the petiole (Moore, 1977). In *Hedyosmum*, male inflorescence consisting of innumerable one-stamen flowers was interpreted to be an equivalent of the male flower of *Ascarina* (Leroy, 1983). The flower of *Sarcandra glabra* is inferred to be derived from a female and a male flowers by the independent vascular system between pistil and stamen attached to the dorsal side of the pistil, and it is suggested that there is resemblance between the flower of *S. glabra* and the small inflorescence of *A. lucida* (Omori, 2003).

By an elaborate analysis of continuous variations the male inflorescences of *Myrica esculenta* (Myricaceae) consisting of eight stamens with three bracteoles to one stamen with one bracteole, it was proved that one-stamen flower was derived from the inflorescence (Abbe, 1972).

That the bracteole bundles are regularly provided at the upper node of the bract is not suggested to be a deformity but one of the essential natures of this flower even if it is a rare flower. Although this rare sample should not be overestimated, it is a reasonable interpretation that such a simple flower consisting of one pistil and one stamen of *S. glabra* was derived from such the inflorescence as *A. lucida* (Moore, 1977) or *M. esculenta* (Abbe, 1972).

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