メギ科の比較形態学的研究 VII：ナンテンの花の形態

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Studies in the Morphology and Systematics of Berberidaceae VII. Floral Anatomy of *Nandina domestica* THUNB.

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：メギ科の比較形態学的研究 VII ナンテンの花の形態

Introduction

In the course of morphological studies on the flowers of Berberidaceae, *Nandina* is discussed in this article. The genus *Nandina* comprises only one species; *Nandina domestica* THUNB., although many forma are known. This genus is usually placed in the monotypic subfamily Nandinoideae (HEINTZE, 1927; THORNE, 1974; TAKHTAJAN, 1980; KOSENKO, 1980) or in a separate family Nandinaceae (NAKAI, 1936; KUMAZAWA, 1938b; TAMURA, 1974). The distinctness of this genus has been shown in perianth morphology (HIEPKO, 1965), ovular morphology (KUMAZAWA, 1938a), seed coat anatomy (CORNER, 1976), wood anatomy (SHEN, 1954) and karyology (LANGLET, 1928; MIYAJI, 1930; KUROKI, 1967).

Knowledge of the floral anatomy of *Nandina* is quite poor, however. Information on the vasculature of the receptacle has not been given. The vasculature in the pistil of *Nandina* was studied by SAUNDERS (1928), CHAPMAN (1936), ECKARDT (1937) and KAUTE (1963), to determine the number of carpels involved in the pistil. However, they made no critical or careful comparison of the vasculature in the pistil of *Nandina* with that of other genera of Berberidaceae. The purpose of this study is to describe the floral vasculature of *Nandina* and to compare the results with those of the other genera of Berberidaceae.

Materials and Methods

The materials were fixed in FAA, cleared in NaClO, dehydrated in an n-butyl-alcohol series and embedded in paraffin. Sections were cut at 15 μm, and stained with safranin or hematoxyline-fast green. Several samples were cleared in NaOH, and stained with fuchsin. Voucher specimens from Sibushe-cho, Kyoto city are kept in KYO (*TERABAYASHI 752*).

Observations

The flowers are borne on a large, terminal panicle. The floral elements are trimerous and are arranged in whorls (Fig. 1-H). The sepals are in 7-11 whorls; triangular and very small in the outer whorls, and ovate and larger in the inner whorls, and are all scale-like (Fig. 1-B, C, D). In each sepal, the mesophyll is composed of parenchyma on the dorsal side and sclerenchyma on the ventral side, and the epidermis of the abaxial surface is cuticularized. The six ovate petals are in two whorls and have no glands. In the petals, the sclerenchyma of the mesophyll is poorly developed. The six stamens opposite the petals have anthers which open by longitudinal slits. The single terminal pistil includes an ovoid ovary, short style and peltate stigma. The ovary contains 2 (-3) bitegmic, anatropous ovules on the parietal placenta. At anthesis, the nucellus of the ovule is absorbed and the embryo sac is enveloped by the inner integument.

The pedicel consists of several layers: an epidermis; a cortex several cells thick; a ring of sclerenchyma; a circle of 5-7 vascular bundles and a pith in the center of the pedicel (Fig. 2-A). Beginning in the receptacle, the stelar bundles divide and increase in number. The floral receptacle is about 0.9-1.1 mm in diameter and 1.1-1.3 mm long. The lower to middle portion of the receptacle is also clearly layered and consists of: the cortex whose outer part is composed of specialized, well stained cells; a stele surrounded by the sclerenchyma; and the pith of large cells in the center (Fig. 2-B, C).

At the lowermost level of the receptacle, the stele begins to give off the traces to the sepals. At

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this level, the number of stelar bundles is 8-10. The outermost sepals often receive traces of a single nature: one of the stelar bundles divides into three, the median of which becomes the sepal trace. The traces to most sepals are of a double nature; two traces branch from two adjacent stelar bundles and fuse into a single trace. The trace divides into three, giving rise to one midvein and two laterals. The lateral veins divide once or twice dichotomously at the base of the sepal. No anastomose is observed in the sepal venation (Fig. 1-B, C, D). During separation of the sepal traces, the stelar bundles divide successively and more than 30 bundles are observed at the middle to upper level of the receptacle (Fig. 2-C, D, E). The division and fusion of stelar bundles are not regular. In the middle of the upper receptacular level, the sclerenchyma surrounding the stelar bundles disappears.

The traces to the six petals are also of a double nature in origin from the stele (Fig. 2-E). A trace divides into three, becoming the midvein and two laterals. The lateral veins divide dichotomously once or twice in the basal region of the petal. Anastomoses were not observed in the venation. In their vascular anatomy, including venation, the petals are not different from the sepals.

At the level where the stamen traces are given off, the number of stelar bundles decreases to 20 due to the separation of traces and a fusion of the stelar bundles. At the same time, each bundle decreases in xylem mass, and the cell size of the pith becomes equal to that of the cortex. The traces to the stamens are usually of a double nature in origin from the stele, as in the petal traces (Fig. 2-F). Sometimes, only one bundle leads to a stamen trace, or three neighborring stelar bundles fuse into a single stamen trace. The stamen trace is singular throughout its course. After separation of the stamen traces, there remains more than six bundles intercalated by six trace gaps. These bundles all enter the terminal pistil.

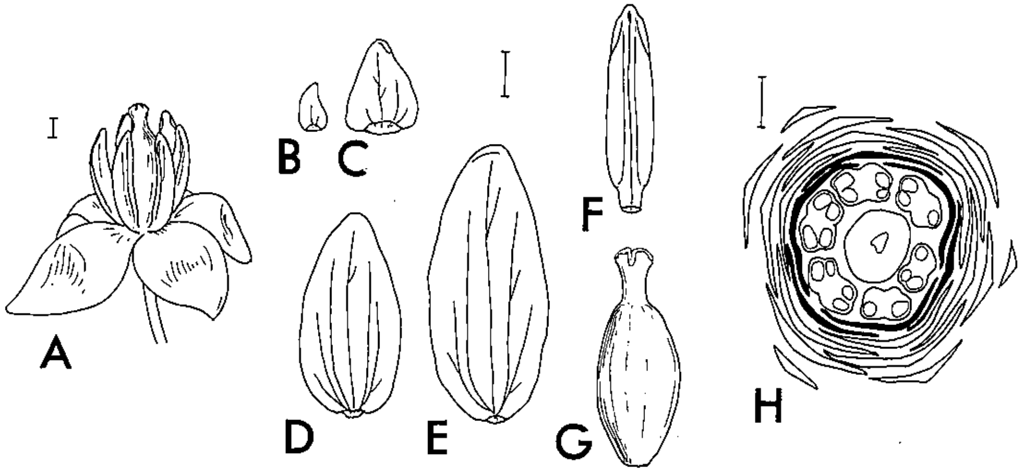

Fig. 1. *Nandina domestica*. A: Flower. B, C: Outer sepals. D: Middle sepal. E: Petal. F: Stamen. G: Pistil. H: Transverse section of a floral bud. Petals are blacked out. Scales all indicate 1 mm length.

In the base of the pistil, the vascular bundles are arranged in a small circle which give off weak branches that become the veins of the ovary wall. One of the bundles becomes the dorsal bundle and is a little more complicated than the lateral veins. The small circle of vascular bundles moves towards the ventral side of the ovary and 3-4 main bundles are observed in the placental region (Fig. 3-A). The one or two bundles along the loculous side are exhausted as the veins of the ovary wall, or fuse with the two ventral bundles in the placental region, or are rarely exhausted in becoming the ovular traces. The number of ventral bundle is usually two, rarely only one. At the middle of the placenta the ventral bundles give off two ovular traces (Fig. 3-B). Just after the separation of the ovular traces, the ventral bundles give off bundles which move towards the dorsal side of the ovary. The ventral bundles and their branches alone pass through the style and

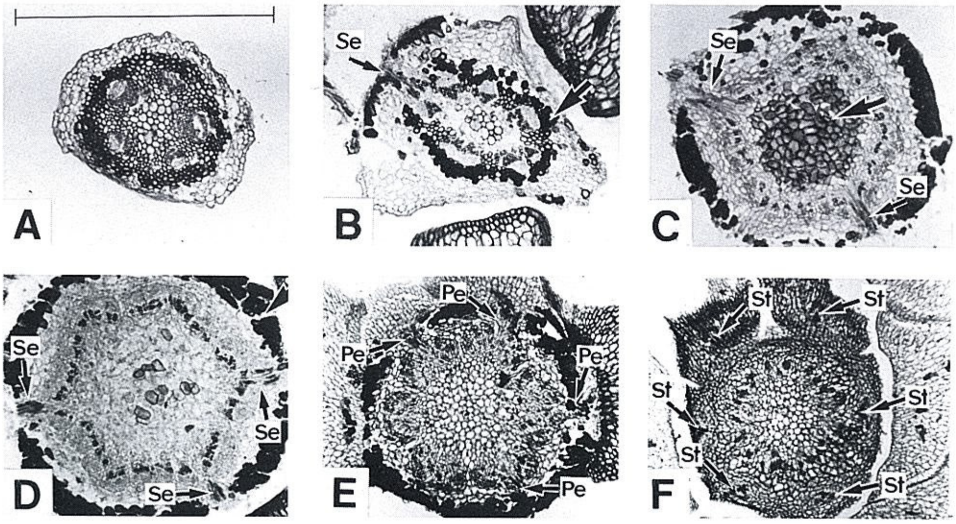

Fig. 2. Transverse sections of the receptacular region. A : Pedicel. Five bundles are arranged in a single circle. B : Lowermost level of the receptacle. The trace to outermost sepal is given off (Se). A large arrow indicates sclerenchyma surrounding vascular bundles. C : Middle level of the receptacle. The traces to middle sepals are given off(Se). A large arrow indicates pith cells with thick wall covered by many pits. D : Upper level of the receptacle. The traces to inner sepals are given off(Se). A large arrow indicates specialized peripheral cells of cortex. E : Uppermost level of the receptacle. The traces to petals are given off(Pe). F : Uppermost level of the receptacle. The traces to stamens are given off(St). A scale indicates 1 mm length.

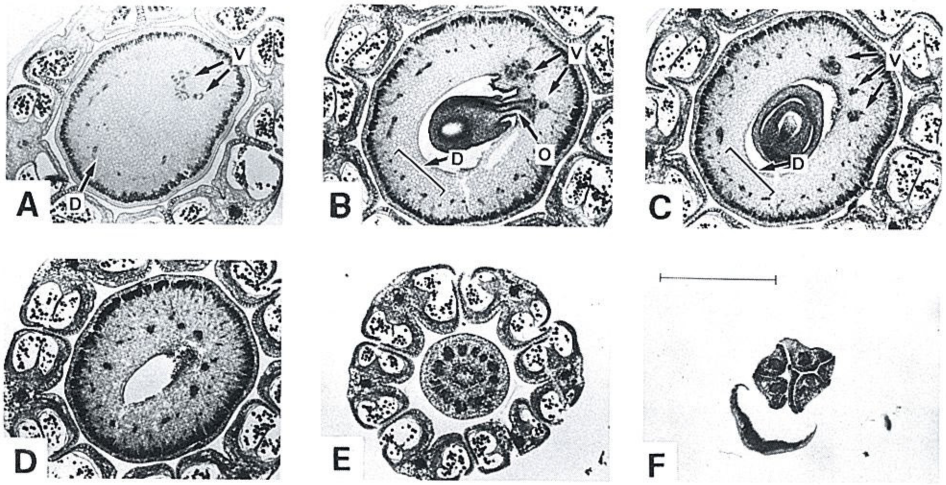

Fig. 3. Transverse sections of the pistil. A : Base of the pistil. At ventral side, two ventral bundles(V) and additional bundles are observed. At dorsal side, a dorsal bundle(D) is observed. B : Middle level of the ovary. An ovular trace(O) is given off from ventral bundle. The dorsal bundle is branched dichotomously. C : Upper level of the ovary. D : Uppermost level of the ovary. The bundles surrounding the locule are all derived from ventral bundles. E : Style level. Stylar canal is observed in the center. F : Stigma level. Stigma is lobed into several parts. A scale indicates 1 mm length.

supply the stigma, repeatedly branching dichotomously. The dorsal bundle and the lateral veins also repeatedly branch dichotomously and cover the ovary wall. These veins all become blind in the ovary wall, and anastomoses are seldom observed.

Discussion

Vasculature in the receptacle

The receptacular morphology of *Nandina* is unique in its length and well differentiated histology. These were not observed in other genera of the Berberidaceae.

The number of whorls in the petals and stamens and in the pistils are generally constant in the Berberidaceae, but that of the sepals is rather variable in each genus. The number of sepal whorls varies even in a single inflorescence in some species. This study gives no clear answer to the question of whether the large number of whorls of sepals in *Nandina* is the primitive condition or is a secondarily derived condition through multiplication.

As for the vascular supply to the perianth lobes and stamens, the small elements of the outer whorls are usually traversed by traces of a single nature, while the elements of the inner whorls are traversed by the traces of a double nature. This tendency in the trace pattern is observed in other genera of the Berberidaceae as well (TERABAYASHI, 1977, 1978, 1979, 1981, 1983a). *Nandina* differs from *Ranzania, Podophyllum, Dysosma* and *Diphylleia* in having no cortical vascular system in the floral receptacle (TERABAYASHI, 1977, 1983b).

As described above, there is no distinct difference between the sepals and petals in the manner of the vascular supply from the receptacular stele or in venation. In external morphology too, the inner sepals and petals are similar to each other. HIEPKO (1965) observed that only *Nandina* shows no retardation in the development of the petal among the genera of Berberidaceae. In other genera of the Berberidaceae, the sepals and petals are easily distinguised in their outline, venation, texture and also in the manner of development (HIEPKO, 1965; TERABAYASHI, 1977, 1978, 1979, 1981, 1983a, 1983b). There is a possibility that the petals of *Nandina* may have evolved in a way different from that of other genera of the Berberidaceae. However, various studies are necessary before we arrive at a conclusion to this question.

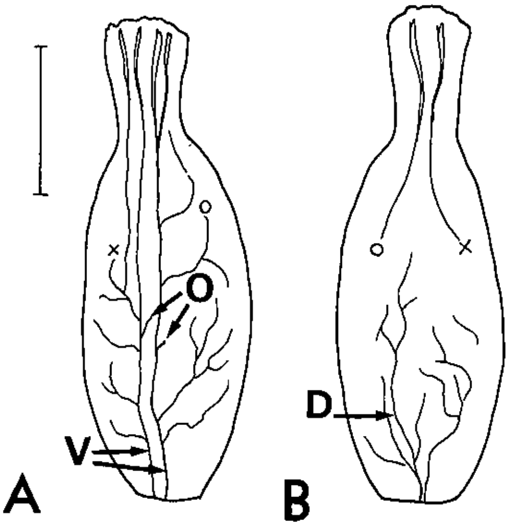

Fig. 4. Illustrations of cleared pistil. A: Ventral view. B: Dorsal view. The marks, circle (O) and cross (×) indicate the continuity of bundles. D; dorsal bundle, V; ventral bundle, O; ovular bundle. A scale indicates 1 mm length.

Vasculature in the pistil

The pistils of *Nandina* are cylindrical and without a ventral suture, as in the other genera of the Berberidaceae. The vascular anatomy is also basically the same as in the other genera. Each pistil is usually traversed by two ventral bundles, a dorsal bundle and some lateral bundles in the ovary wall. The ovular traces are given off from the ventral bundles and from bundles other than the ventral bundles at nearly the same level in the middle portion of the parietal placenta. The vascular supply of ovules in *Nandina* is not fundamentally different from that in such genera as *Ranzania, Epimedium, Vancouveria, Plagiorhegma, Jeffersonia, Diphylleia, Dysosma* and *Podophyllum*, whose placentas are parietal but bear many more ovules (TERABAYASHI, 1977, 1979, 1981, 1983b). The vascular pattern in which only the ventral bundles pass through the style and supply the stigma, and that the dorsal bundle ends in the upper level of the ovary is also constantly observed in such genera as *Epimedium, Vancouveria, Plagiorhegma, Jeffersonia* and *Achlys* (TERABAYASHI, 1979, 1981). In *Caulophyllum,* *Leontice, Gymnospermium, Bongardia*, some species of *Berberis* and some examples of *Ranzania*, no distinct dorsal bundle is observed (TERABAYASHI, 1977, 1978, 1983a). I consider that the retreat or reduction of the dorsal bundle indicates one direction of evolutionary trend in the pistillate vasculature of the Berberidaceae.

From a stand point of floral vascular anatomy, the genus *Nandina* should not be excluded from the Berberidaceae.

Acknowledgement

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Summary

The floral vasculature of *Nandina domestica* is investigated. The flowers are composed of many sepals in many whorls, 6 petals in two whorls, 6 stamens and a single terminal pistil. The traces to the outermost sepals are of a single nature, while to the middle and inner sepals, petals and stamens are of a double nature. Each pistil is usually traversed by two ventral bundles, a dorsal bundle and some lateral bundles. The ovular traces are given off from the lateral bundles at the placental region or from the ventral bundles. The style and stigma are supplyed only by the bundles derived from the ventral bundles. The monotypic genus *Nandina* is considered to constitute a separate family by some authors. However, the anatomical evidence suggests that this genus should be included in the Berberidaceae.

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摘　要

一連のメギ科の花の比較解剖学的研究において，本報ではナンテンを扱った。白色の花は大型の円錐花序につく。花は3数性，各要素は輪生配列する。7－10輪のがく片，2輪の花弁，2輪の雄蕊，および1本の雌蕊によって花は構成される。小花柄内には5－7本の維管束が一輪をなして配列する。花床のレベルで，維管束はがく片の跡の分出をはじめる。外側の小型のがく片へは1管束性の跡を分出し，中～内側のがく片，花弁，雄蕊へは2管束性の跡を分出する。ナンテンでは，メギ科の他の属と異ってがく片と花弁の外形上のハッキリした差はないが，跡についてもがく片と花弁の間に差はない。雌蕊には（1－）2本の腹管束，1本の背管束がある。胚珠の跡は腹管束ないしは腹管束以外に胎座領域に入る維管束から分出される。腹管束由来の維管束のみ柱頭領域に達する。こうした雌蕊の形態はメギ科の他の属のそれと基本的には同じ構造を示すものであると言える。ナンテン属はいくつかの特異な形質をもっているゆえに，単型のナンテン科にするべきだという考えがあるが，花の比較解剖の見地からはメギ科に入れておくべきものであるということが示唆される。

(Received Feb. 5, 1983)

○　**ジュズシャジクモ沖縄県で発見**（須賀瑛文）Hidefumi SUGA：*Chara fibrosa* var. *minuta* Found in Okinawa Prefecture.

ジュズシャジクモは千葉県印幡沼のみを産地（今堀：日本淡水藻図鑑 p. 777—1977年—）とされていた小形の輪藻類である。

今回，沖縄県立南風原高等学校の高良拓夫氏が採集され，筆者に送られてきた標本の中にジュズシャジクモらしいものがあったので今堀宏三博士に確認していただいた。その結果「印幡沼のものより大形であるが，その他の特徴は一致するので *Chara fibrosa* var. *minuta* である。」とのご返事があった。

千葉県とはずい分かけ離れた沖縄県で第2～第4の産地が見つかったことは興味あることである。生育環境等については，いずれ高良氏がその詳細を発表されることと思う。

新産地は次の3か所である。

○　沖縄県中頭郡（ナカカミグン）北中城村（キタナカグスソン）万ギ堂（1978.10.1採集）
○　沖縄県中頭郡中城村（ナカグスソン）北上原（池）（1978.10.1採集）
○　沖縄県中頭郡北谷村（チャタンソン）桑江（池）（1978.11.3採集）

○　宮脇　昭編　**日本植生誌，中国**，至文堂（〒162 東京都新宿区西早稲田2－11－13），昭和58年2月28日発行。B5版，540頁＋別冊（付表と植生図）。定価48,000円。

屋久島（1980），九州（1981），四国（1982）に引続き，全10巻を予定する大著述の中の第4巻である。内容は申すもでもなく，中国地方の植生を群落組成表，現存・潜在自然植生図，植生断面模式図とともに総合的にもとめたものである。（里見信生）